Developing Attract-and-kill Strategies To Manage Spotted Wing Drosophila, *Drosophila Suzukii* Matsumara, In Raspberry.

Male

Female

Peter Jentsch

78th AnnualNew England, New York and Canadian
Fruit Pest Management Workshop
October 18-19, 2016
BBCC, Burlington, VT

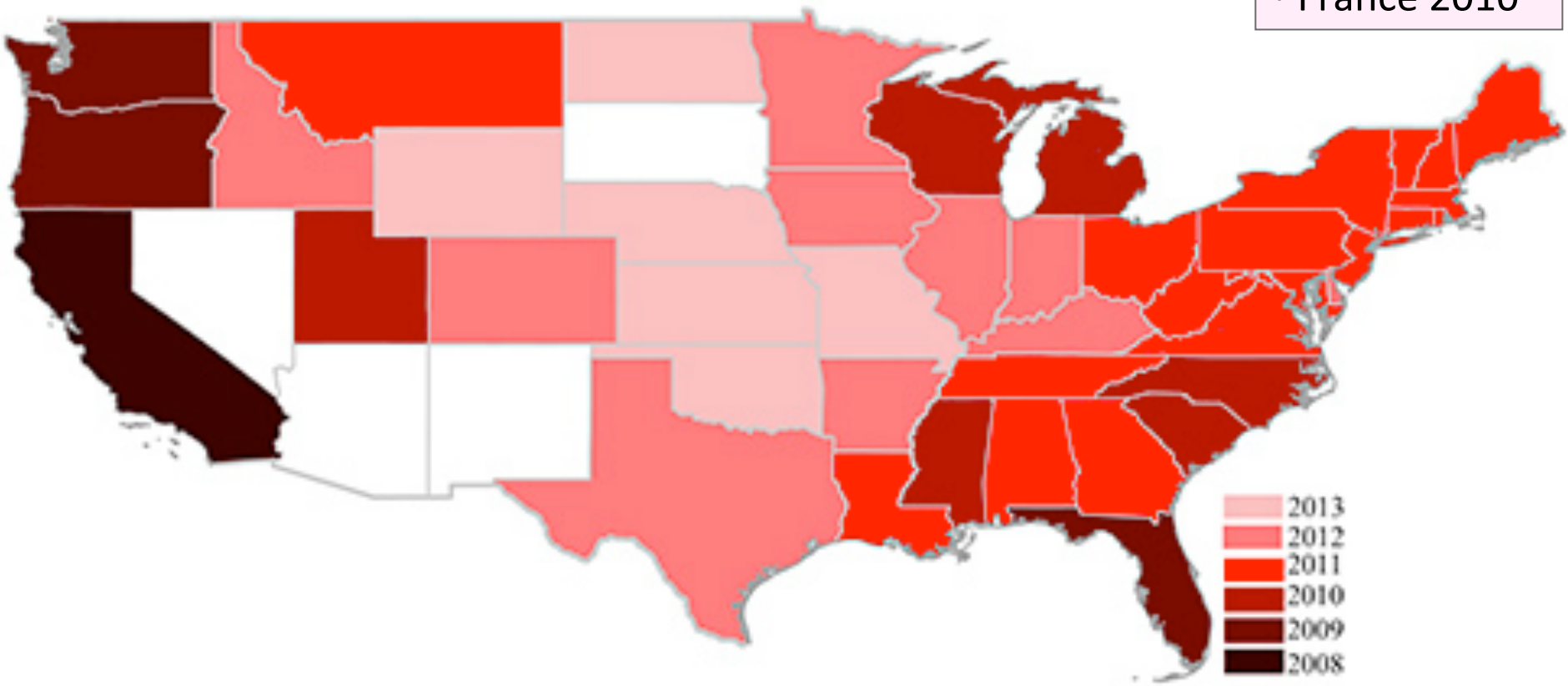
Questions and Objectives

- What components offer effective olfactory, visual and sensory perception for attraction?
- Can we construct an long lasting, economicilly viable Attract and Kill station to reduce SWD populations leading to reduced fruit injury?
- Can Attract and Kill (AtK) Technologies work well alone or do they require the combination of other management strategies to reduce pesticide loading in small fruit production systems?

SWD Spread from 2008 – 2013 in the US

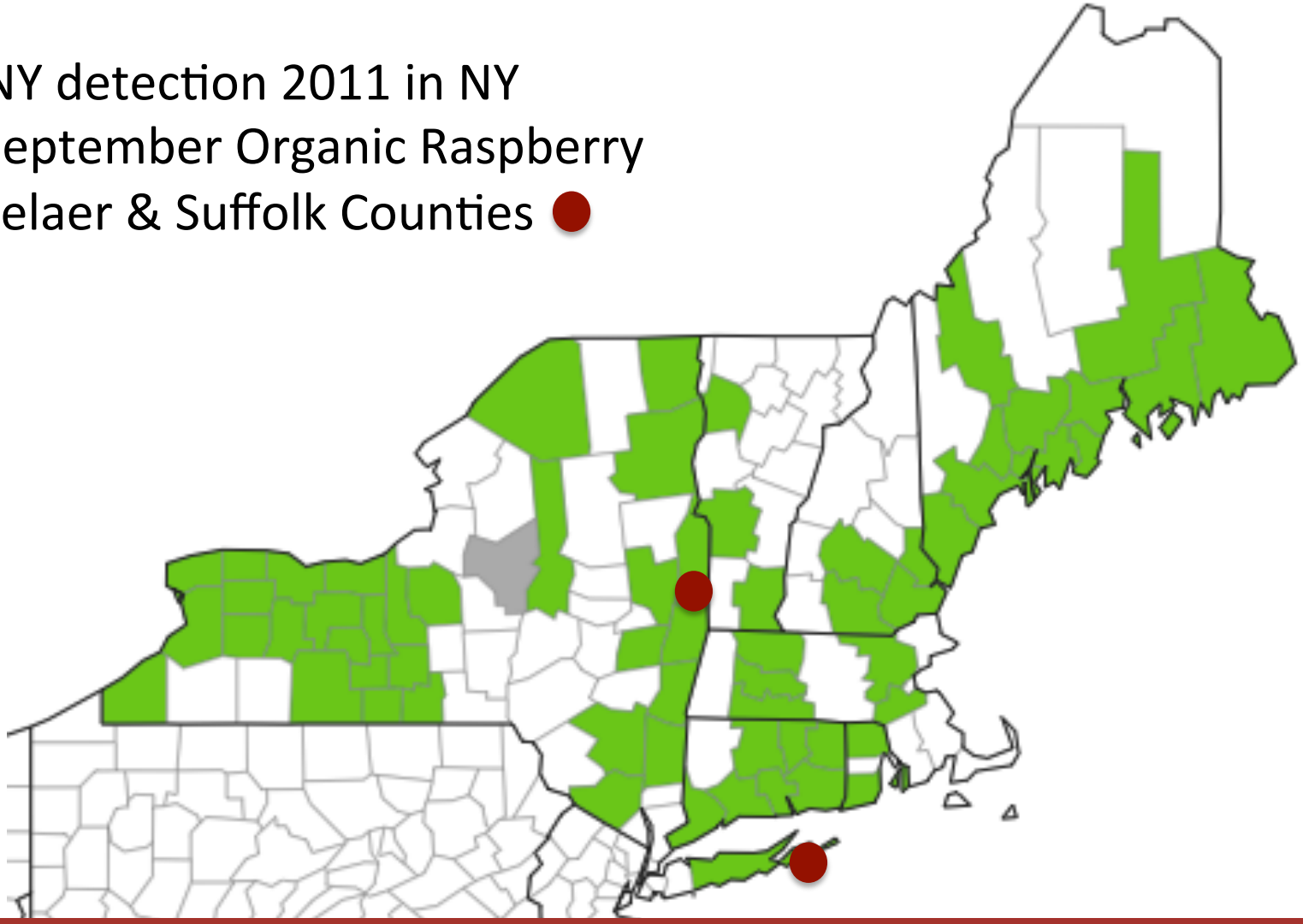
Hawaii 1980

- Italy 2009
- Russia 2009
- Spain 2009
- France 2010



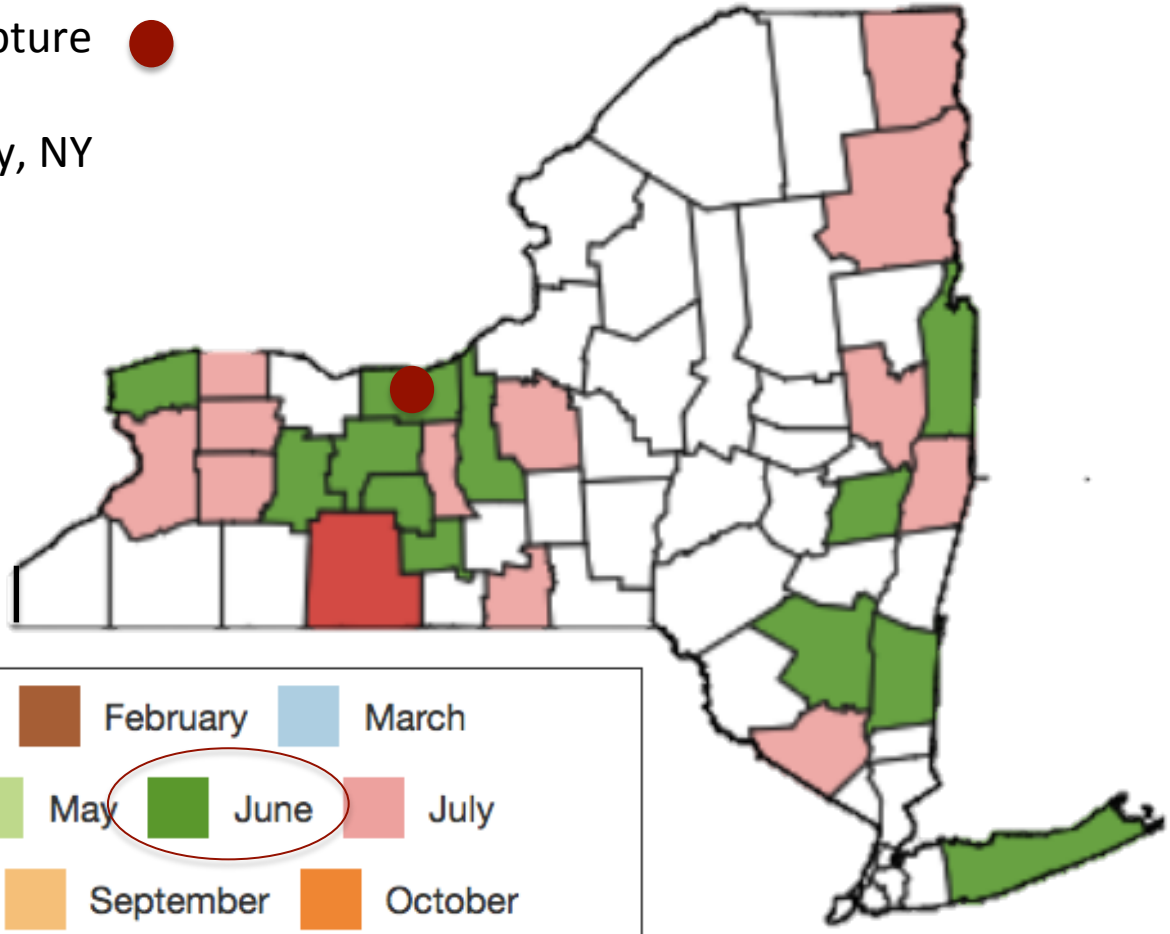
SWD in New England - 2016

First NY detection 2011 in NY
Mid-September Organic Raspberry
Rensselaer & Suffolk Counties



SWD in New York - 2016

First State Capture
June 21, 2016
Wayne County, NY

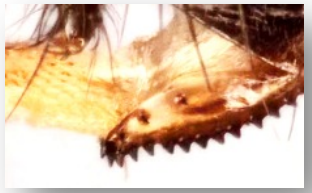


Legend

January	February	March
April	May	June
July	August	September
October	November	December
Not Found		

Monitored in 25 Counties in NYS

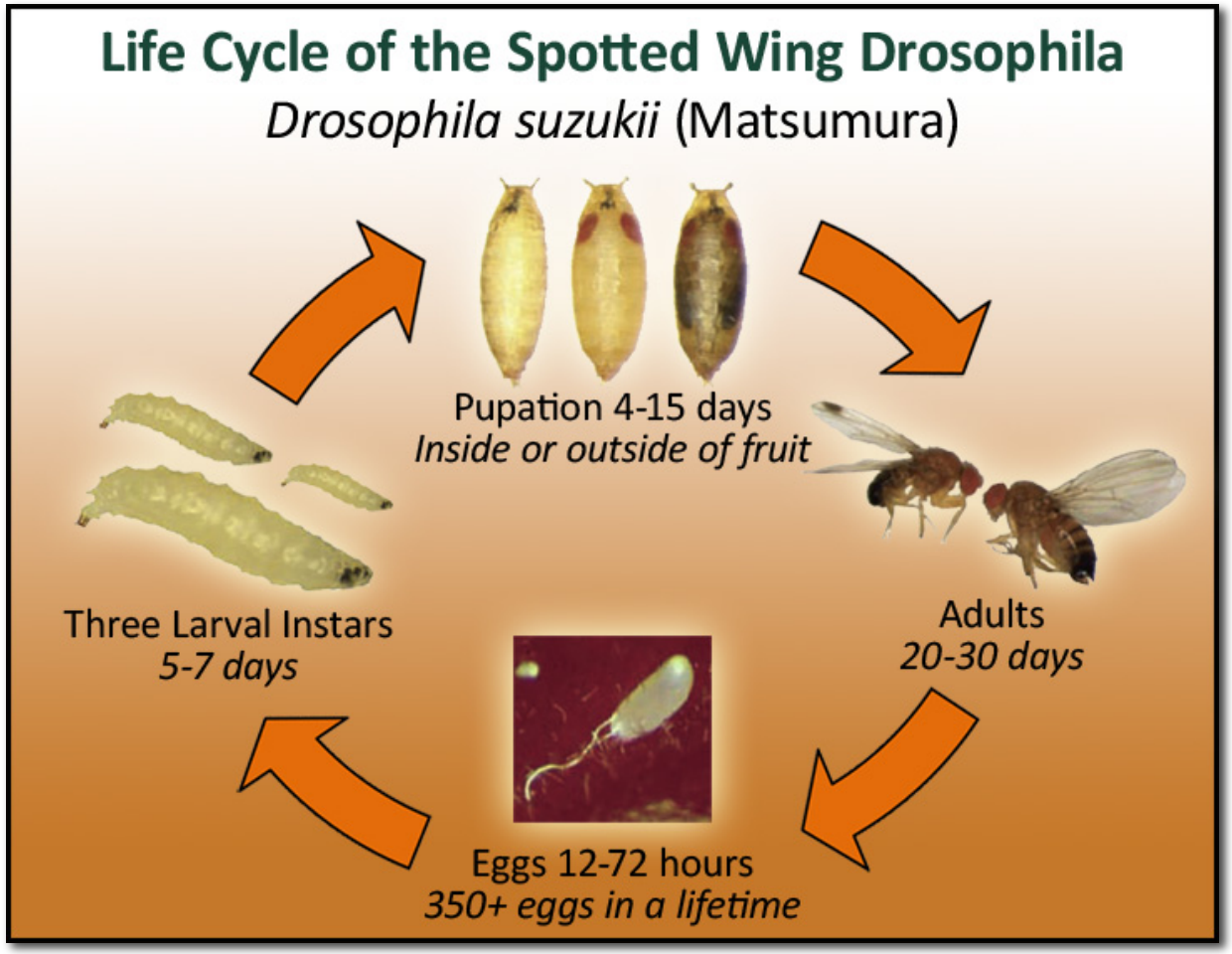
Success of SWD in Small Fruit



Occupies a relatively non-competitive niche

- Able to penetrate and oviposit into un-ripened fruit using a highly scleratinized & serrated ovipositor .

Reproductive Success of SWD in Small Fruit



- Optimal development is at 65-70°F, **~12 day** generation time.
- Adult flies live for 3-6 weeks, and females can lay over 300 eggs.
- Limited by high heat in summer and by winter cold. But, SWD populations are found in cold regions of Japan.
- 3-10 generations in NY

Fruit Affected by SWD

Highest risk

Strawberries

Raspberries

Cherries (Late var,)

Nectarines

Blueberries

Blackberries

Moderate risk

Peaches

Grapes

Pears

Apples

Tomato

Alternate hosts

Wild plants with berries, such as…

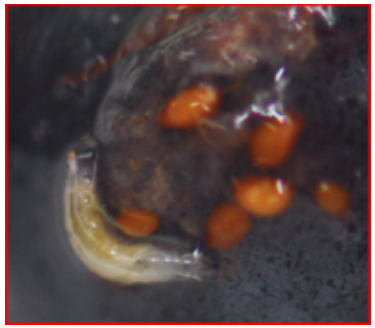
Tartarian Honeysuckle

Snowberry

Elderberry

Pokeweed

Dogwood

SWD Alternate Host: Population Development in the HV

- Honeysuckle is a primary host for SWD; *L. tartarica* fruit favored over raspberry in June-August.

Sampling and Monitoring Protocols

Monitoring

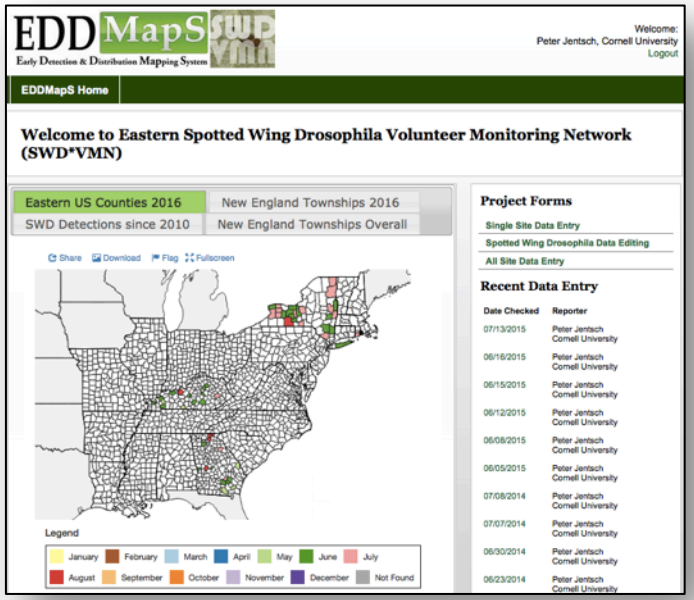
Weekly trap captures, 4 traps per site including Tartarian Honeysuckle *L. tartarica*

Extension Outreach: EDDMaps

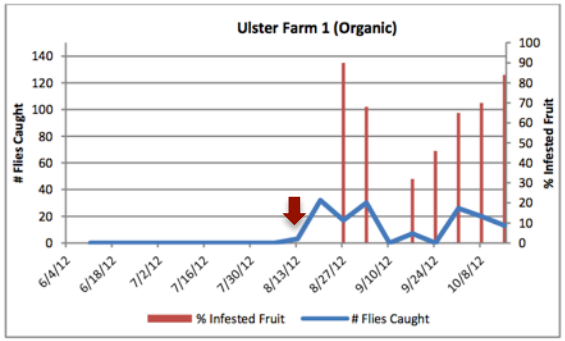
Sampling

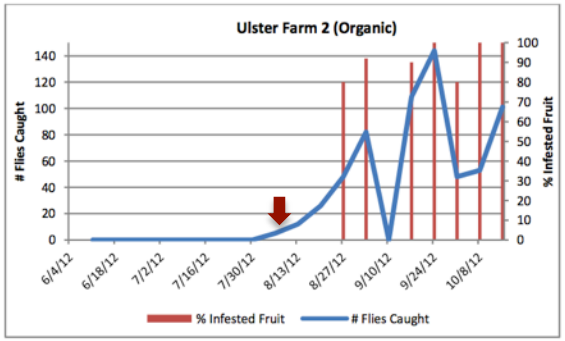
Weekly 25 fruit from each of 4 plant clusters (10')

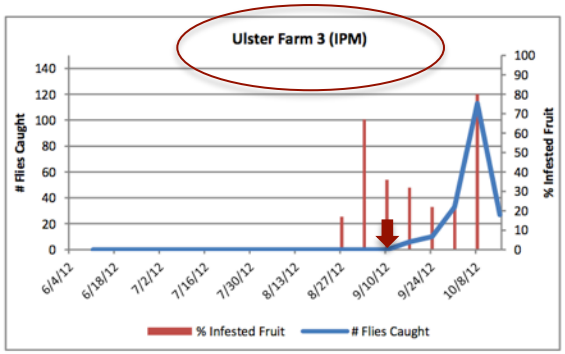
Weigh and assess fruit for SWD eggs (expressed as eggs/gram)

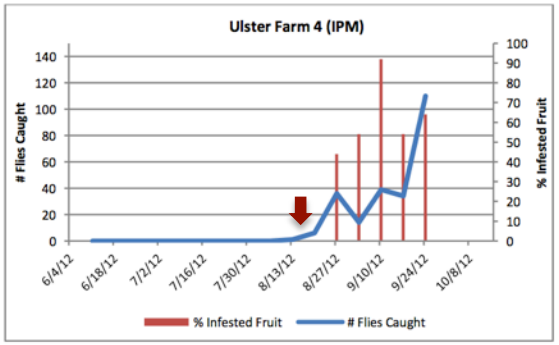


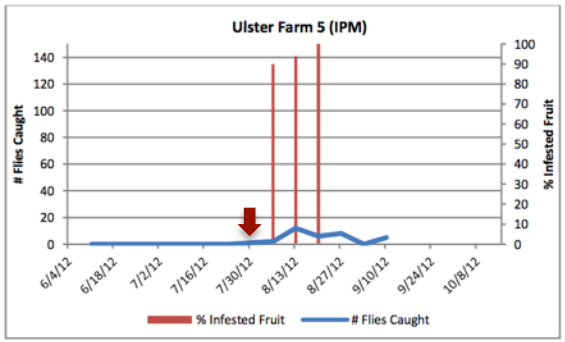
Monitoring SWD Using ACV on 6 Farms in the Hudson Valley Eastern, NY - 2012

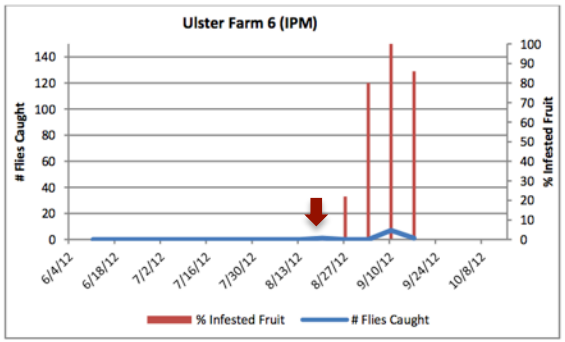








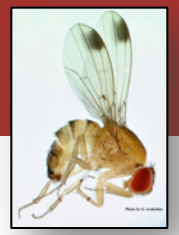




Fruit Monitoring & Injury

- SWD oviposition may precedes adult trap captures in production systems.
- Newer traps have increased sensitivity to adult presence
- Conventional and organic production systems contain raspberry fruit with SWD eggs & larva.

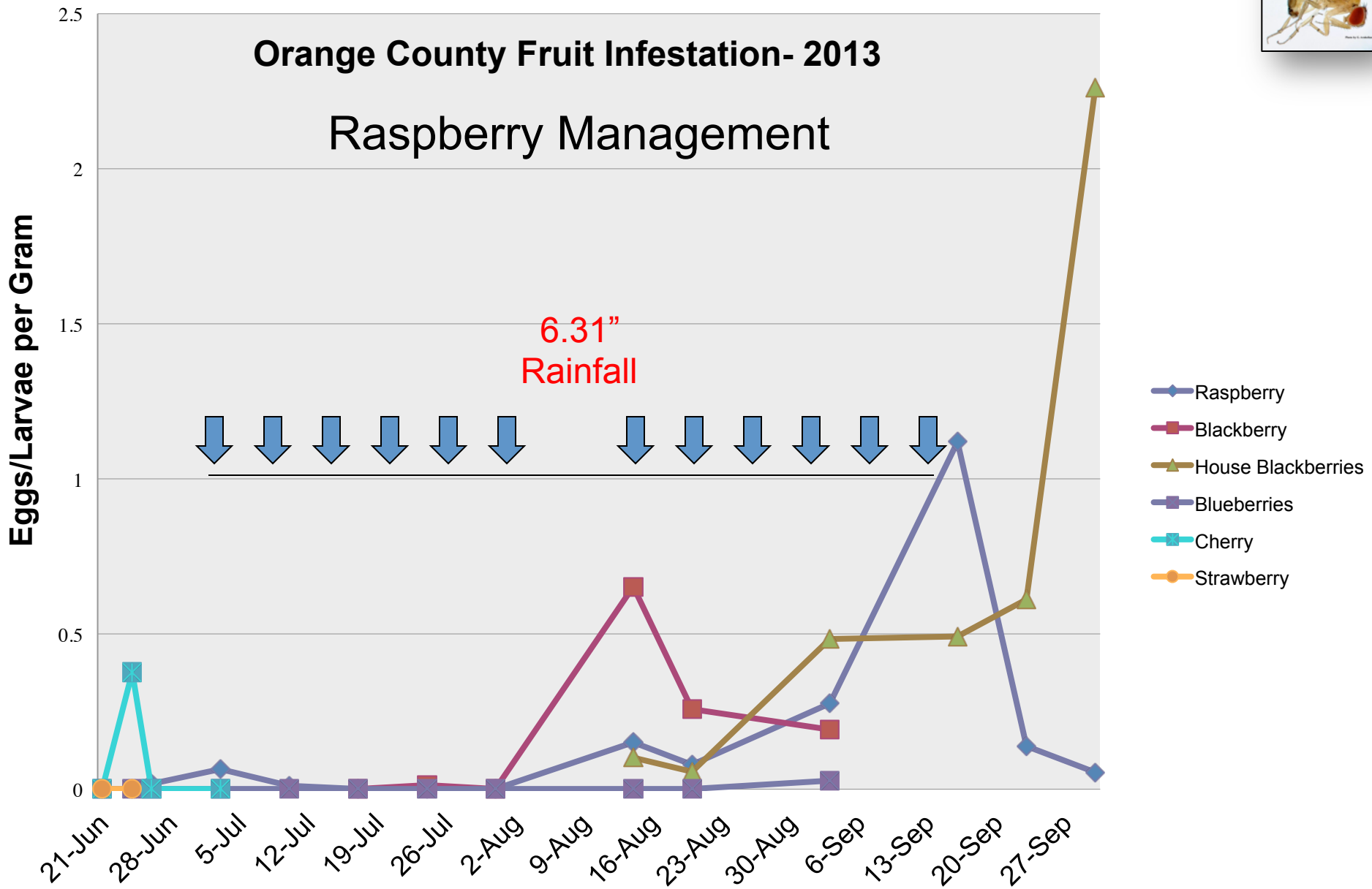
Managing Insecticide Resistance: Raspberry



SWD Control in Mixed Small Fruit; Orange Co. 2012

Date	Material	Rate	Commodity
27 June	Malathion 57	2 pts./A	Raspberry
1 July	Assail 30SG	5 oz./A	Raspberry
5 July	Malathion 57	2 pts./A	Raspberry
12 July	Delegate 25WDG	3 oz./A	Raspberry
14 July	Brigade	8 oz./A	Raspberry
19 July	Assail 30SG	5 oz./A	Raspberry
22 July	Danitol	16 oz./A	Raspberry
27 July	Mustang Max	4 oz./A	Raspberry
30 July	Assail 30SG	5 oz./A	Raspberry
	6.31” Rainfall; 6 day application interval		
5 August	Delegate 25WDG	3 oz./A	Raspberry
19 August	Brigade	8 oz./A	Raspberry

Managing Insecticide Resistance: Raspberry



AtK Based Literature Eastern US

Tracy Leskey (USDA-ARS)
Developing a Behaviorally Based Attract and Kill System for SWD

- **Color important**; black and red routinely outperformed other colors.
- **A spherical shape: size greater than 2.5 cm acceptable.**
- **Baits** enhance SWD capture
- **SWD infestation in raspberries reduced by 50% when sphere with sugar and bait in caged studies. Sprayed fruit + AtK in combination most effective in managing SWD compared to either alone under high pressure.**

Cesar Rodriguez-Saona, Rutgers State U. Of N.J., Richard Cowles Univ. Conn.
Bait comparisons of SWD in blueberry

- **Suzukii and Trece baits very effective at capturing SWD with Trece and apple cider vinegar capturing higher numbers of non-SWD flies.**

Cowles, R. S., C. Rodriguez-Saona, R. Holdcraft, G. M. Loeb, J. E. Elsensohn, and S. P. Hesler. 2015. **Sucrose improves insecticide activity** against *Drosophila suzukii* (Diptera: Drosophilidae). J. Econ. Entomol. 1 – 14. DOI: 10.1093/jee/tou100.

AtK Based Literature Western US

Alan L Knight, Esteban Basoalto, Wee Yee. **Adding Yeasts with Sugar** to Increase the Number of Effective Insecticide Classes to Manage Drosophila suzukii (Matsumura) (Diptera: Drosophilidae) in Cherry
Pest Management Science · October 2015

Alan L Knight, Esteban Basoalto, Wee Yee. Developing a new bait for spotted-wing drosophila in organic cherry production
Acta horticulturae 1001(1001):147-152 · July 2013

Increased attractiveness of bait using bread yeast, Saccharomyces cerevisiae

- **Exceeds the attractiveness of commercial products GF-120® and Nu-Lure®,**
- **Addition of the sugar-yeast bait to Entrust increased fly mortality 4-fold in early-season bioassays with green and yellow cherries, reducing eggs laid and larval infestations by 50%**

SWD Adult Preference Binary Choice Tests
Mean # AtK Component Attractiveness

25% Red Raspberry Concentrate
75% Apple Cider Vinegar
Brewers yeast: *Saccharomyces cerevisiae*

Methods: Development of Attract and Kill for Management of SWD in Small Fruit

AtK Construction

- 3” substrate woven polypropylene netting as a base
- Super Absorbent Polymer (SAP)
- Gelatin
- Red raspberry concentrate
- Apple cider vinegar
- Brewers yeast
- 1% A.I.
- AtK solution applied at 2 mL/disk

Methods: Development of Attract and Kill for Management of SWD in Small Fruit

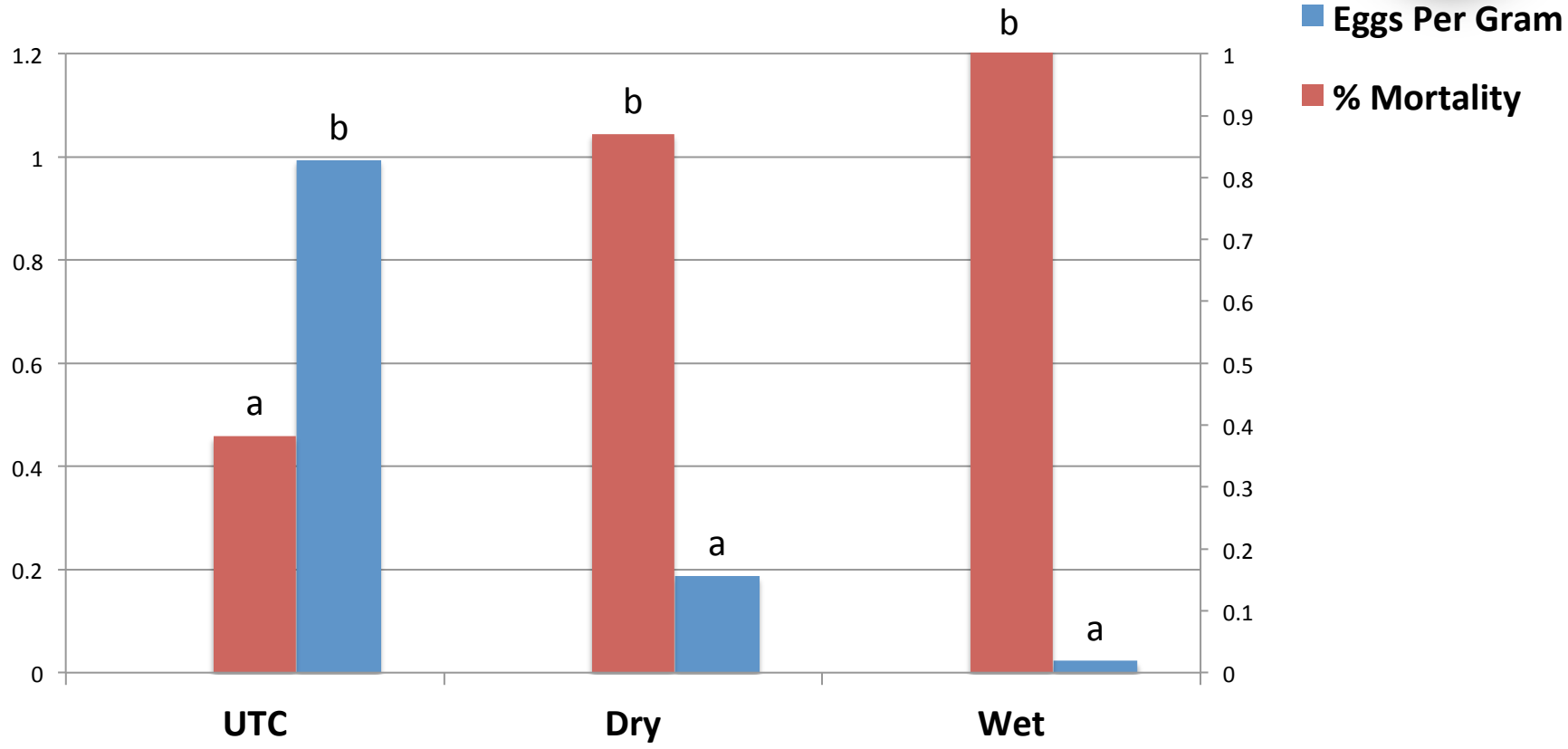
Insecticide Product	Active Ingredient (IRAC Group)
Malathion 5EC	malathion (IRAC 1B)
Imidan 70W	phosmet IRAC 1B)
Assail 30SG	acetamiprid (IRAC 4A)
Scorpion 35 SL	dinotefuran (IRAC 4A)
Brigade EC	bifenthrin (IRAC 3A)
Mutang Max	zeta-cypermethrin (IRAC 3A)
Pyganic EC 1.4	pyrethrin (IRAC 3A)
Triple Crown	bifenthrin, imidacloprid, zeta-cypermethrin (IRAC 3A, 4A)
Delegate WG	spinetoram (IRAC 5)
Entrust SC	spinosad (IRAC 5)
Exirel	cyazypyr (IRAC 28)
BotaniGard; Mycotrol	*Beauveria bassiana* strain GHA
BalEnce	*Beauveria bassiana* Diptera-specific strain (HF23
Boric Acid	99% Boric Acid
Hot Shot Maxattrax Roach Powder	99% Boric Acid formulated

Attract and Kill Station Efficacy

Lab Caged Studies (25 SWD 48h 75F 75%rH 14/10 LD)

Attract and Kill Station Recharge Efficacy

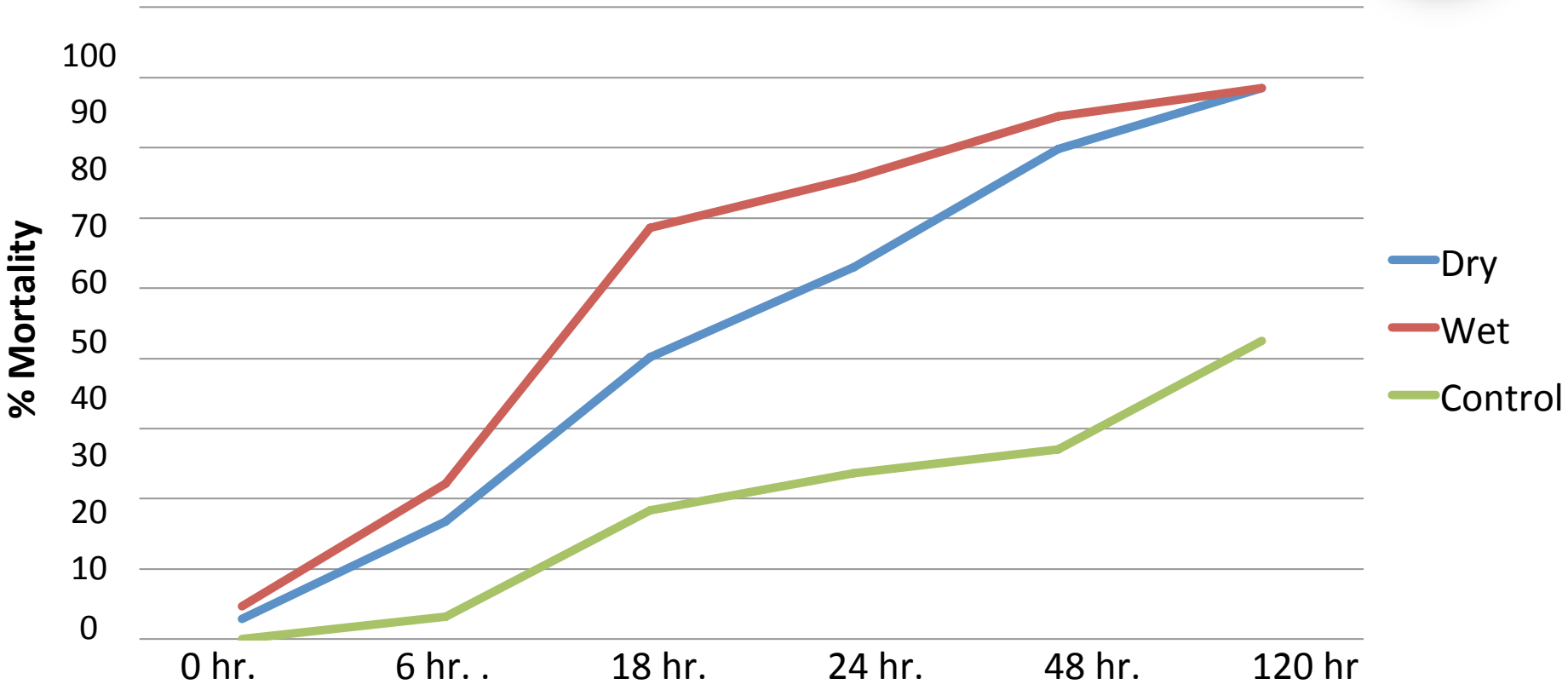
SWD Eggs Per Gram of Raspberry & Adult Mortality @ 72h
24h (Wet) vs 7d (Dry) treated disks



1% A.I. Entrust (spinosad-Dow)

Attract and Kill Station Recharge Efficacy

SWD Adult Mortality



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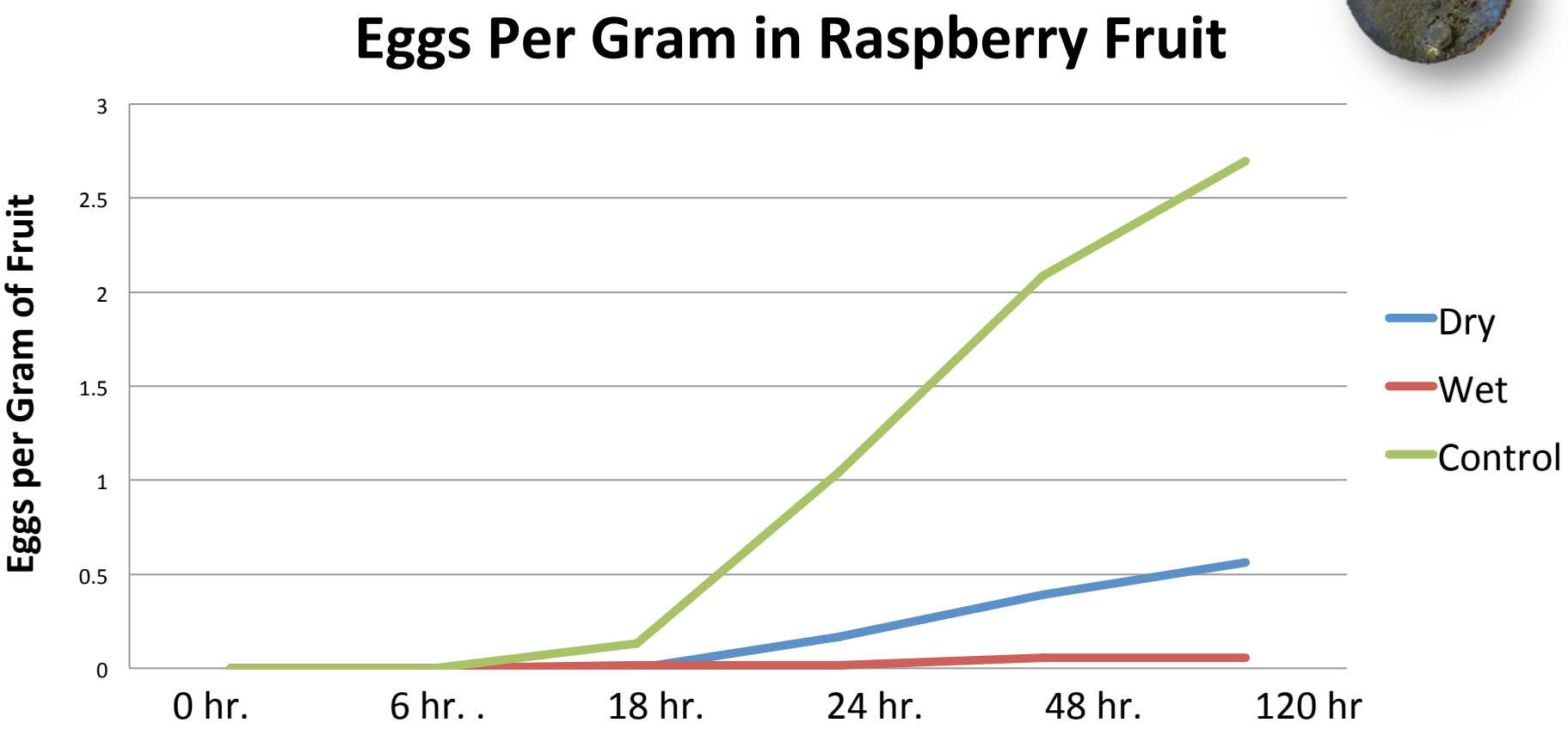

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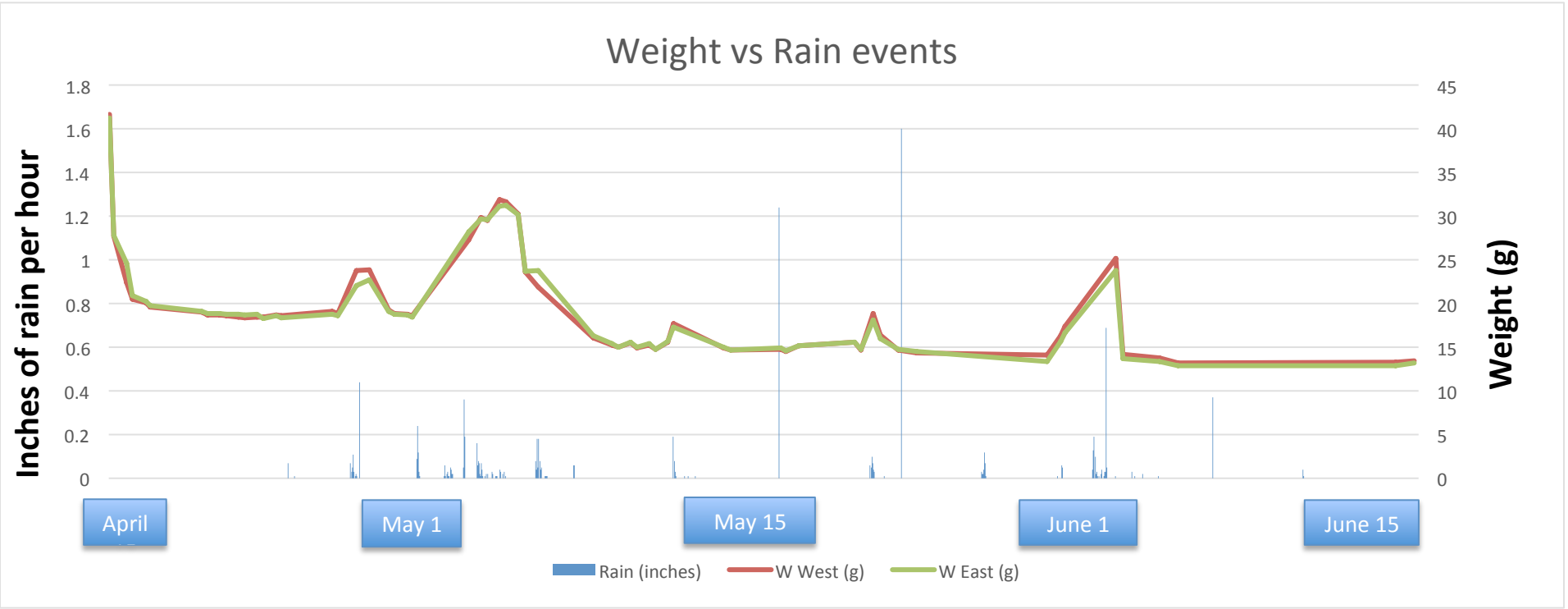
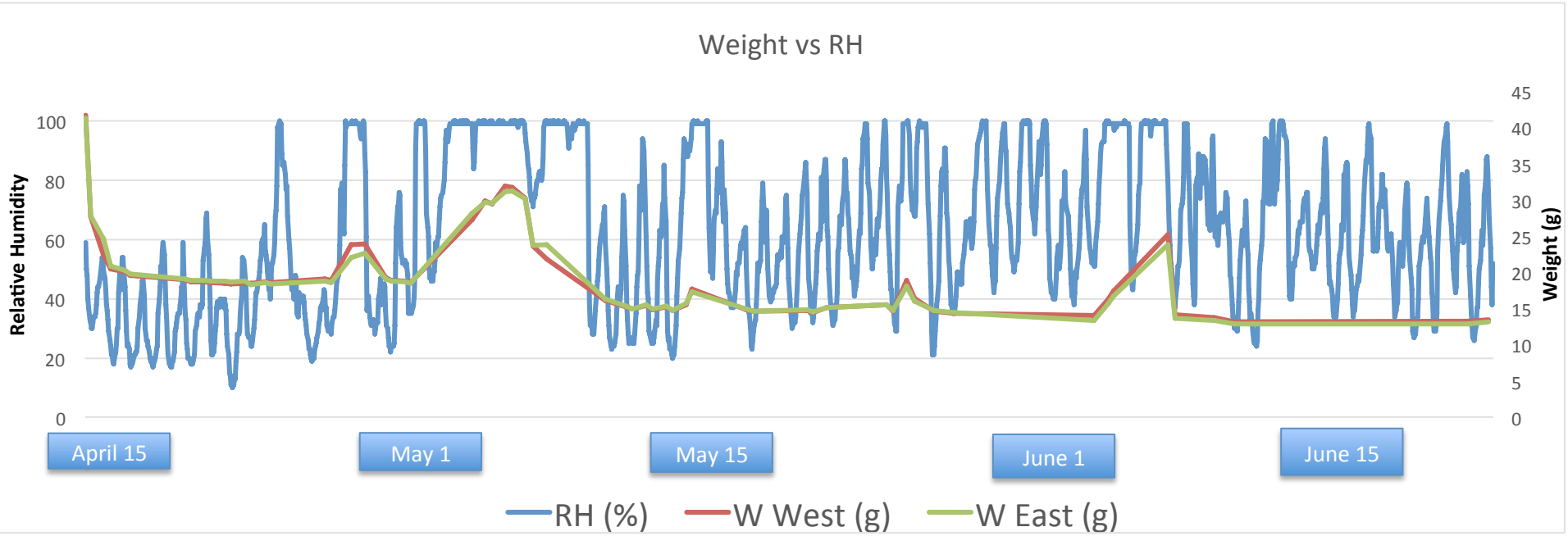
Insecticidal Options for AtK Stations



Observations

- Initial weight loss of ≥50% in 30 hours and overall seasonal weight loss of 70%.
- Extended rain events increase flucations in AtK disk weight.

Attract and Kill Station Recharge Efficacy

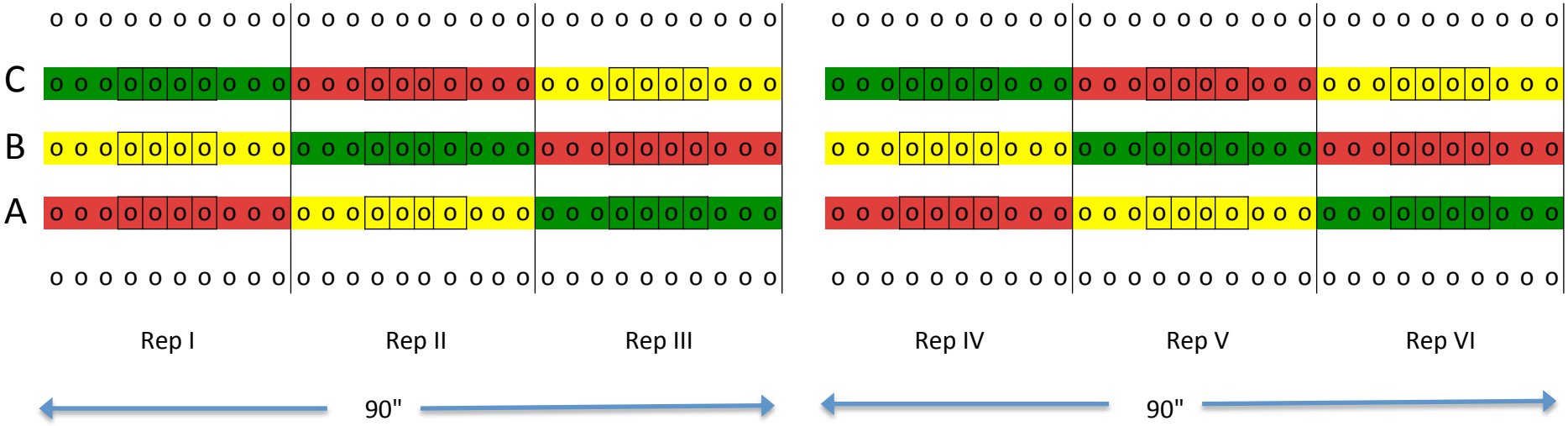


Observations

- Extended high relative humidity also increase weight.
- Inversely, low rH reduces weight.
- Morning dew is also absorbed by the disk.

Attraction of Drosophila to AtK from Morning Dew

Experimental Field Design*



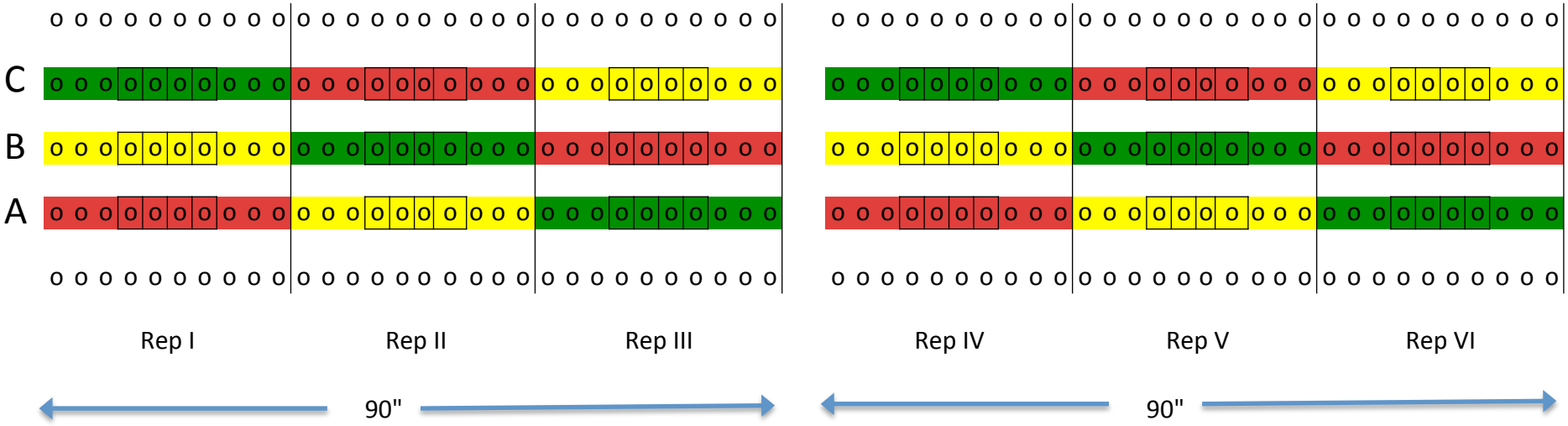
3 Raspberry Plantings on 3 Farm sites in two NY counties
1 Conventional & 2 Organic Production Systems

AtK placement timed for each row (A,B,C)

A. 1st SWD in NY (14th June)
B. 1st SWD on site (19th June)
C. 1st SWD oviposition of fruit (25th June)

* Row spacing- 11’; plant spacing 3’; 2 of 3 sites used wire trellis used to hang AtK stations

Experimental Field Design



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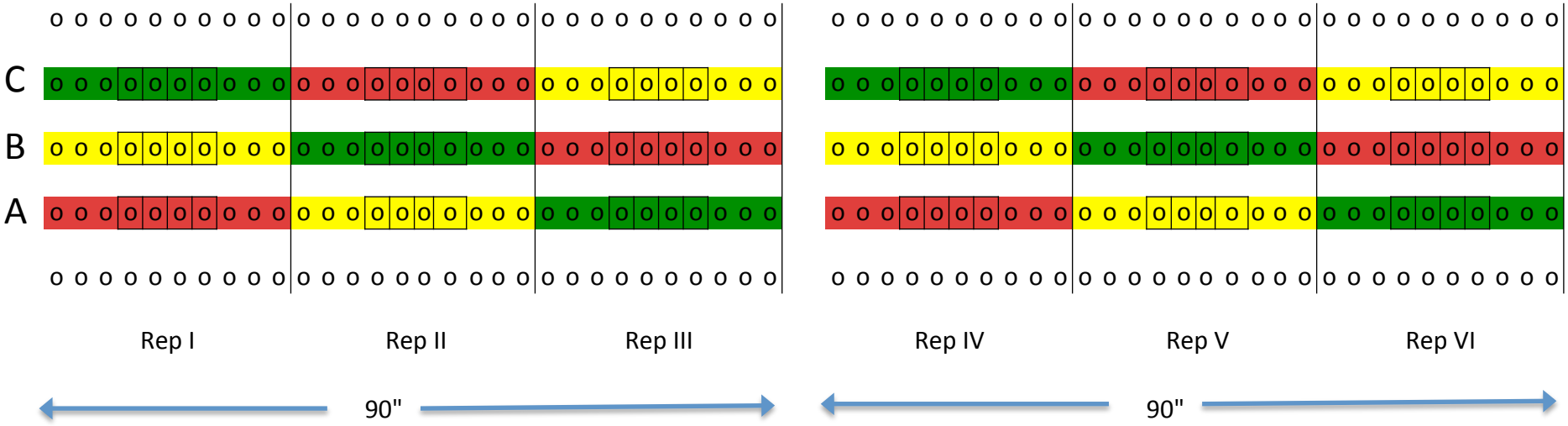
Split Block

(Reps I-III)
Red and Yellow Disk sprayed weekly

(Reps IV-VI)
Red and Yellow Disk sprayed 2x/week

Experimental Field Design



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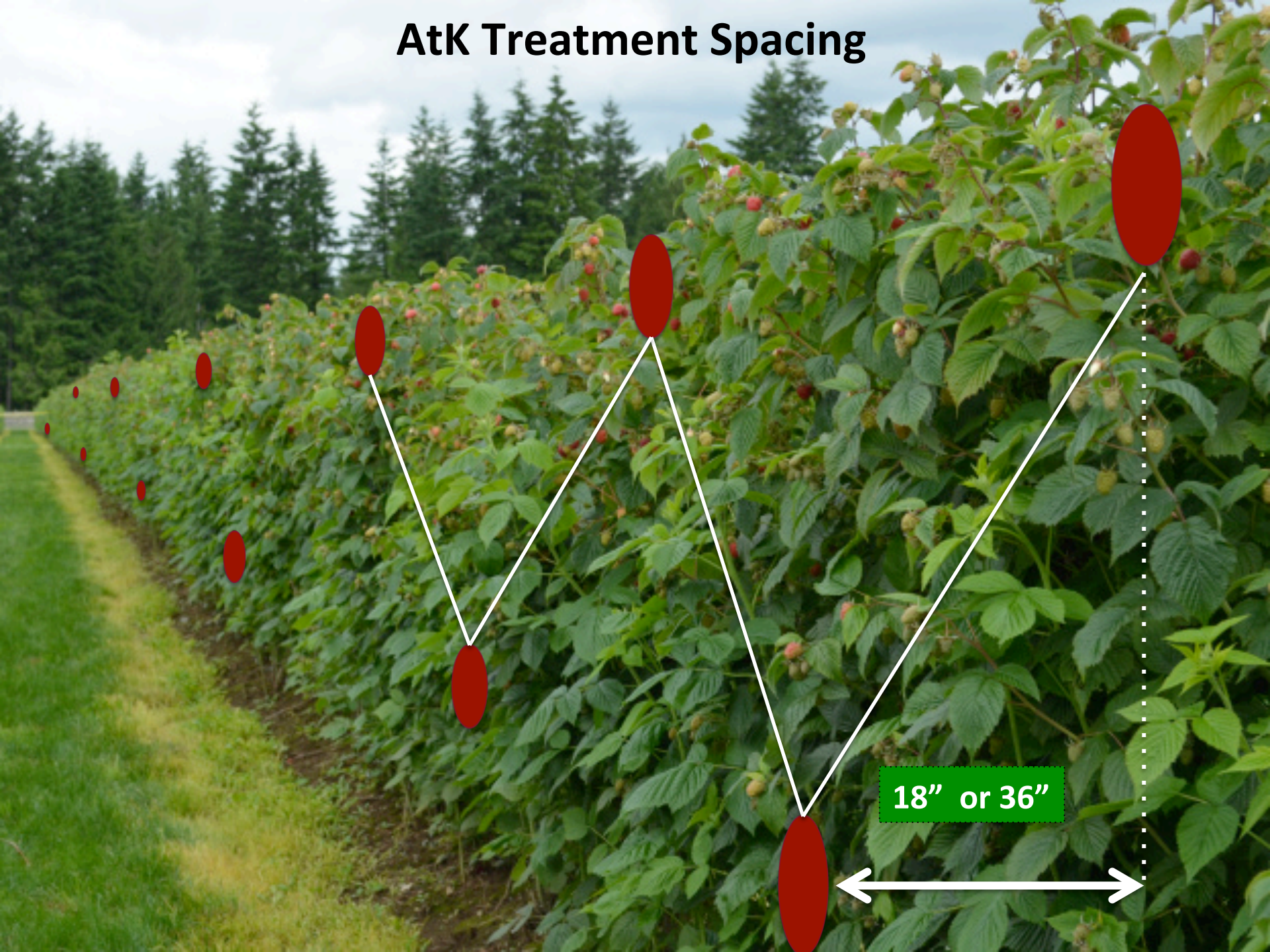
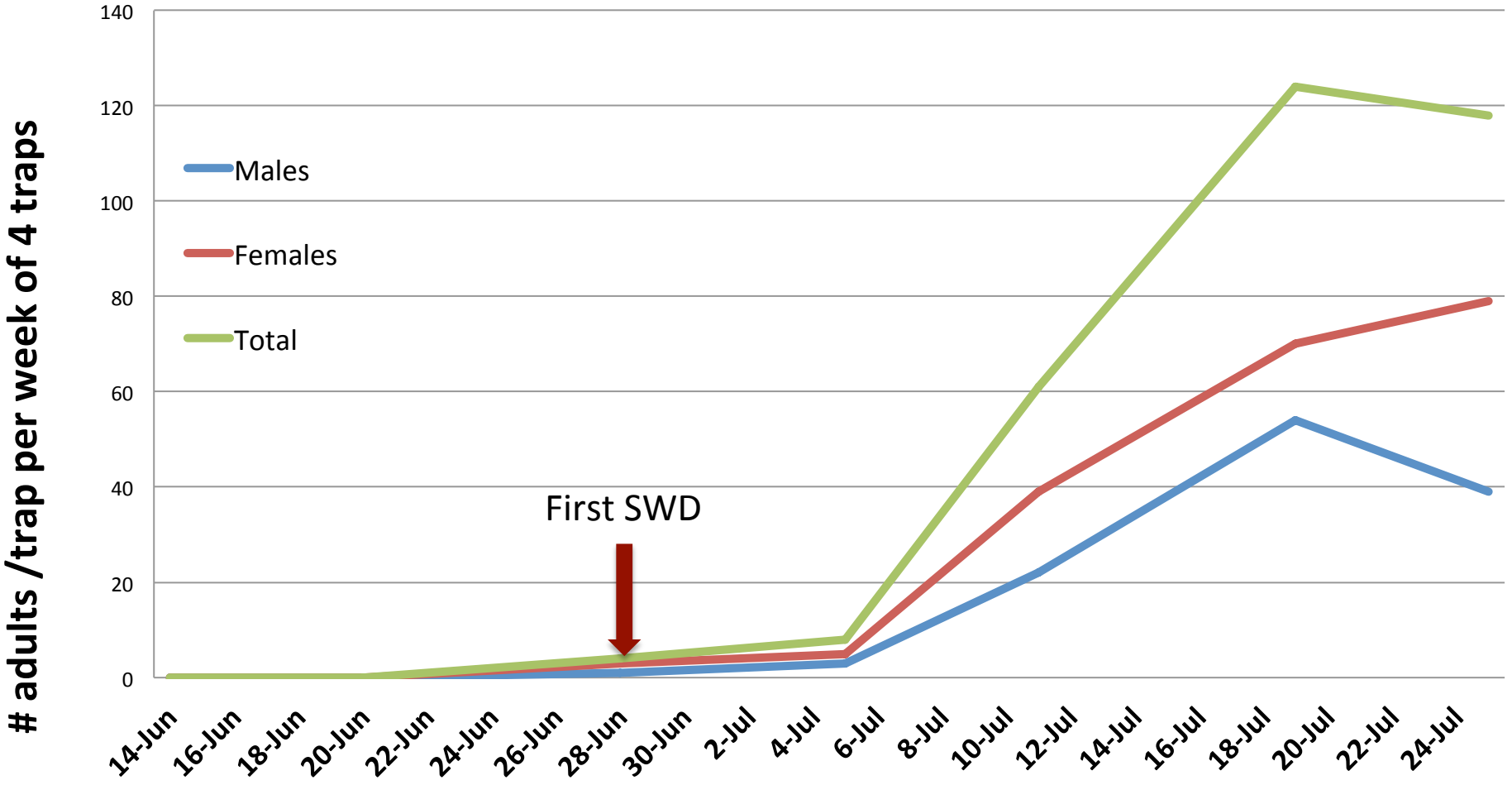
Treatments

Red	O	1% Borax treated disks spaced at 1.5' (120) Disks/ side = 240 disks/ row
Yellow	O	1% Borax treated disks spaced at 3' (60) Disks/ side = 120 disks/ row
Green	O	Untreated disks spaced at 3' (60) Disks/ side = 120 disks/ row

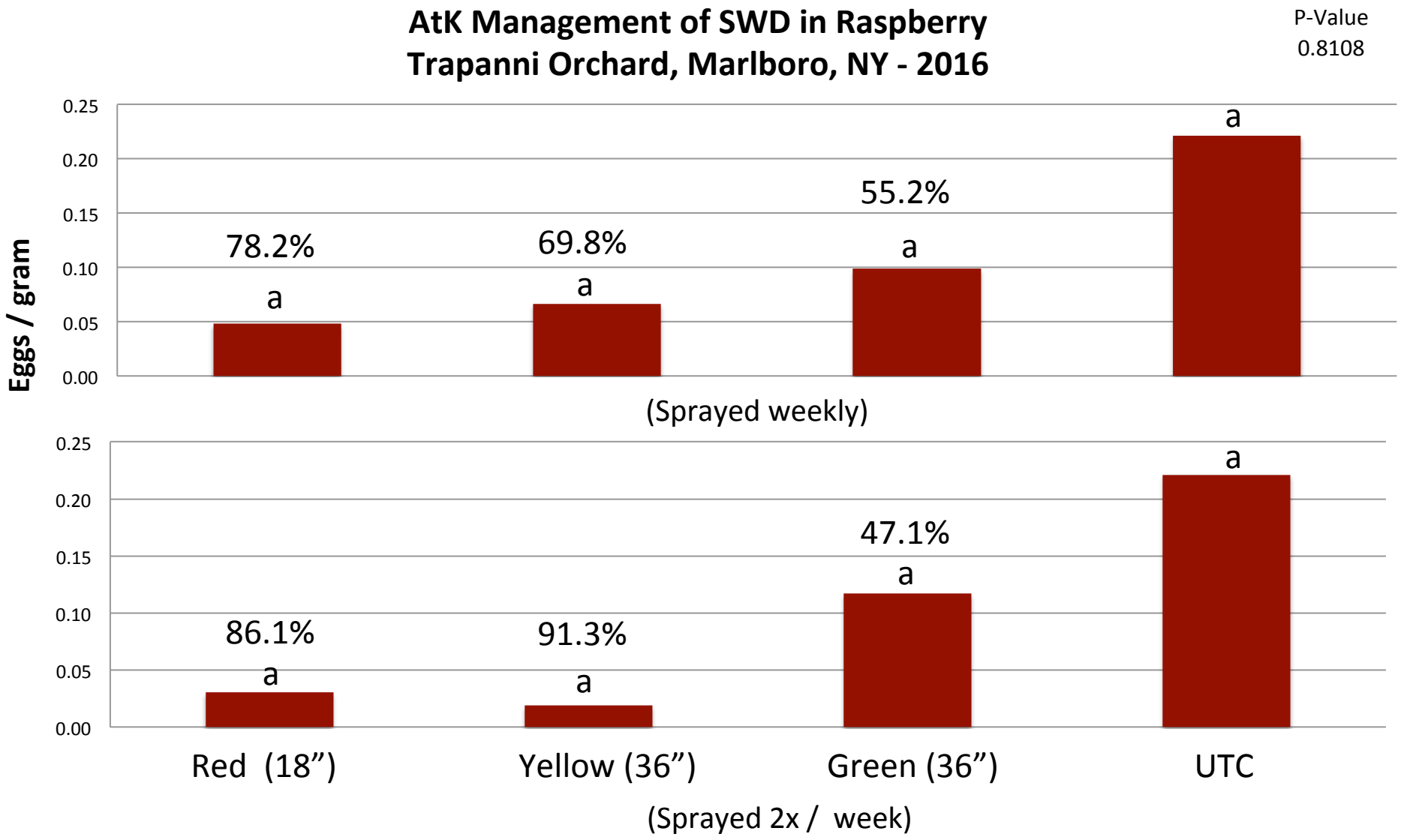
AtK Treatment Spacing



SWD in Conventional Red Raspberry Planting
Milton, NY - 2016



SWD Damage Means in Raspberry Fruit



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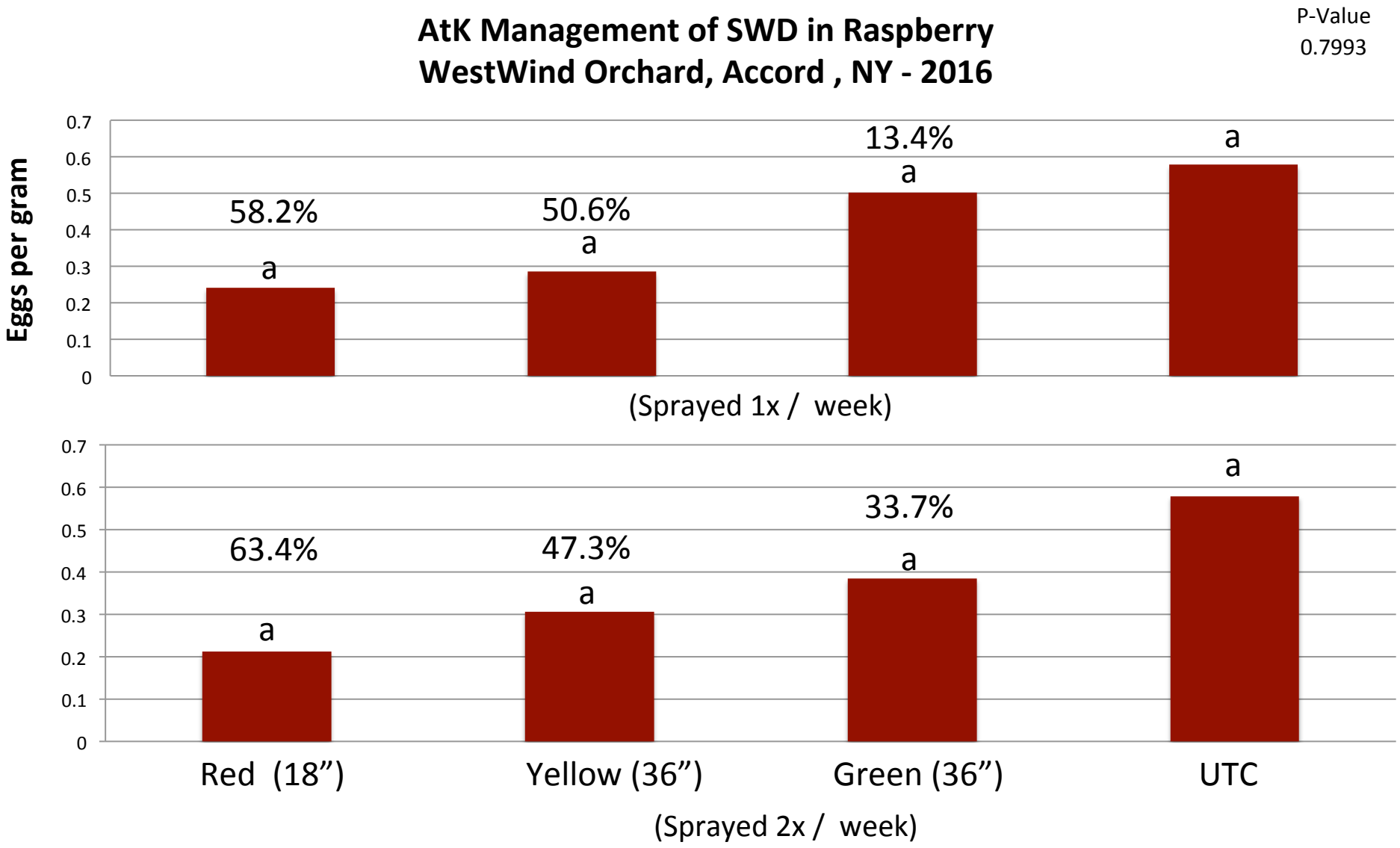

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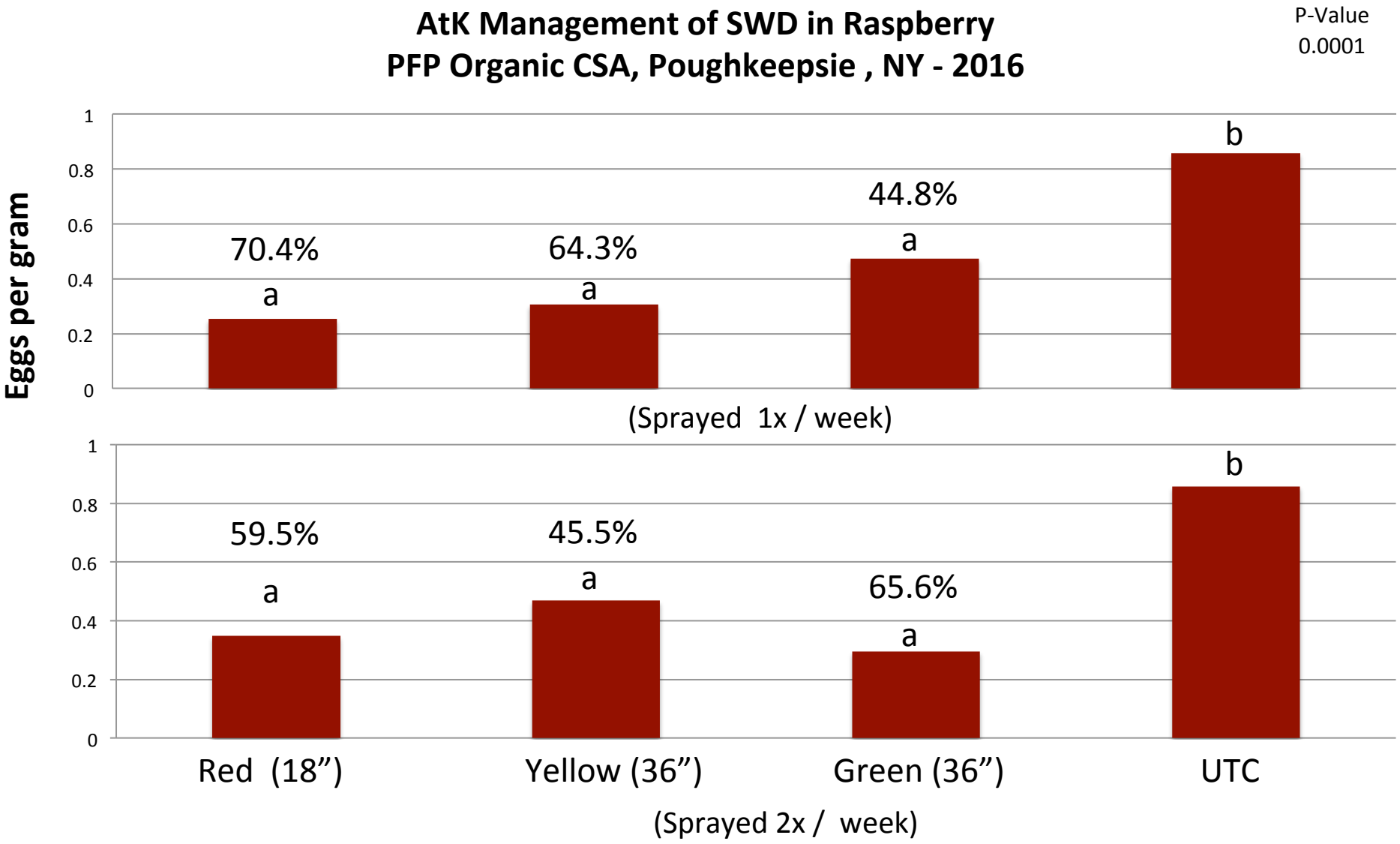
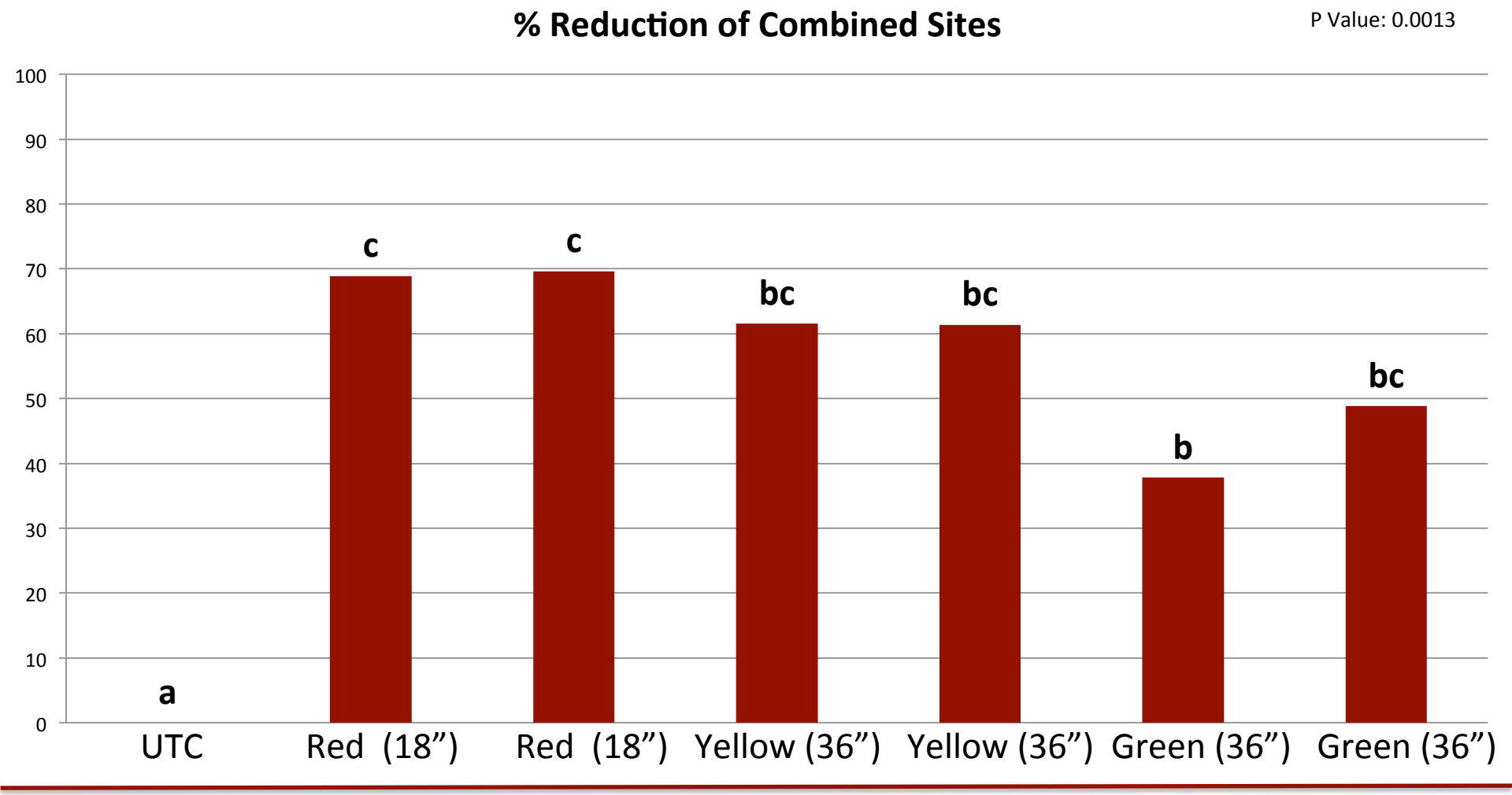
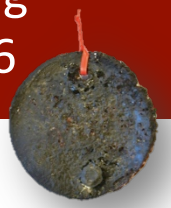


Combined Farm & AtK Application Timing



Sprays/wk.	1x/wk.	2x/wk.	1x/wk.	2x/wk.

Table 1. Evaluations Of Attract and Kill stations For Controlling Spotted Wing Drosophila in Raspberry [a]. Hudson Valley Research Lab. Highland N.Y. - 2016



Treatment / Spacing	Timing	% Reduction in Oviposition at each Site			
		WW	PFP	Trapani	All Sites
Boric Acid 18" (Red)	1x Weekly	58.2 a	70.4 a	78.2 a	68.9 c
Boric Acid 36" (Yellow)	1x Weekly	50.6 a	64.3 a	69.8 a	61.6 bc
Means		54.4	67.4	74.0	65.3
Boric Acid 18" (Red)	2x Weekly	63.4 a	59.5 a	86.1 a	69.7 c
Boric Acid 36" (Yellow)	2x Weekly	47.3 a	45.5 a	91.3 a	61.4 bc
Means		55.4	52.5	88.7	65.6
Untreated Disk 36" (Green)		13.4 a	44.8 a	55.2 a	37.8 b
Untreated Control		0.0 a	0.0 b	0.0 a	0.0 a
P value for transformed data		0.7993	0.0001	0.8108	0.0013

[a] Evaluation made on Raspberry June to September. Data were transformed using $\log_{10}(x+1)$ using Fishers Protected LSD ($P \leq 0.05$). Treatment means followed by the same letter are not significantly different. Arithmetic means reported.

Conclusion

- **Attract and kill strategies have been shown to provide reduced levels of infestation from spotted wing drosophila in conventional and organic raspberry production systems.**

- **Further study of placement density and reapplication intervals of AtK disks for optimumal control is needed prior to recommendations for use.**

- **Use of AtK + 1% Boric Acid in combination with cultural control, frequent harvest intervals, berry sanitation and harvest low temperature storage strategies may decrease the impact of SWD while reducing the resistance potential in SWD populations from frequent insecticide use.**

Partnership Thanks

- New York Farm Viability Grant - OAR 15 013
- Greg Loab, NYSAES, Geneva, NY
- Juliet Carrol, NYS IPM, Geneva, NY
- Tim Lampasona, Jonathon Binder, Mike Fraatz
  Hudson Valley Research Laboratory

Fabio Chizola, WestWind Farm, Accord, NY

Poughkeepsie Farm Project, Poughkeepsie, NY

Trapani Farm & Orchard, Marlboro, NY