



Spotted wing drosophila in southeastern berry crops

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Spotted wing drosophila

Topics

Biology and invasion history

Impacts

Hosts and susceptibility



Spotted wing drosophila

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Hosts and susceptibility

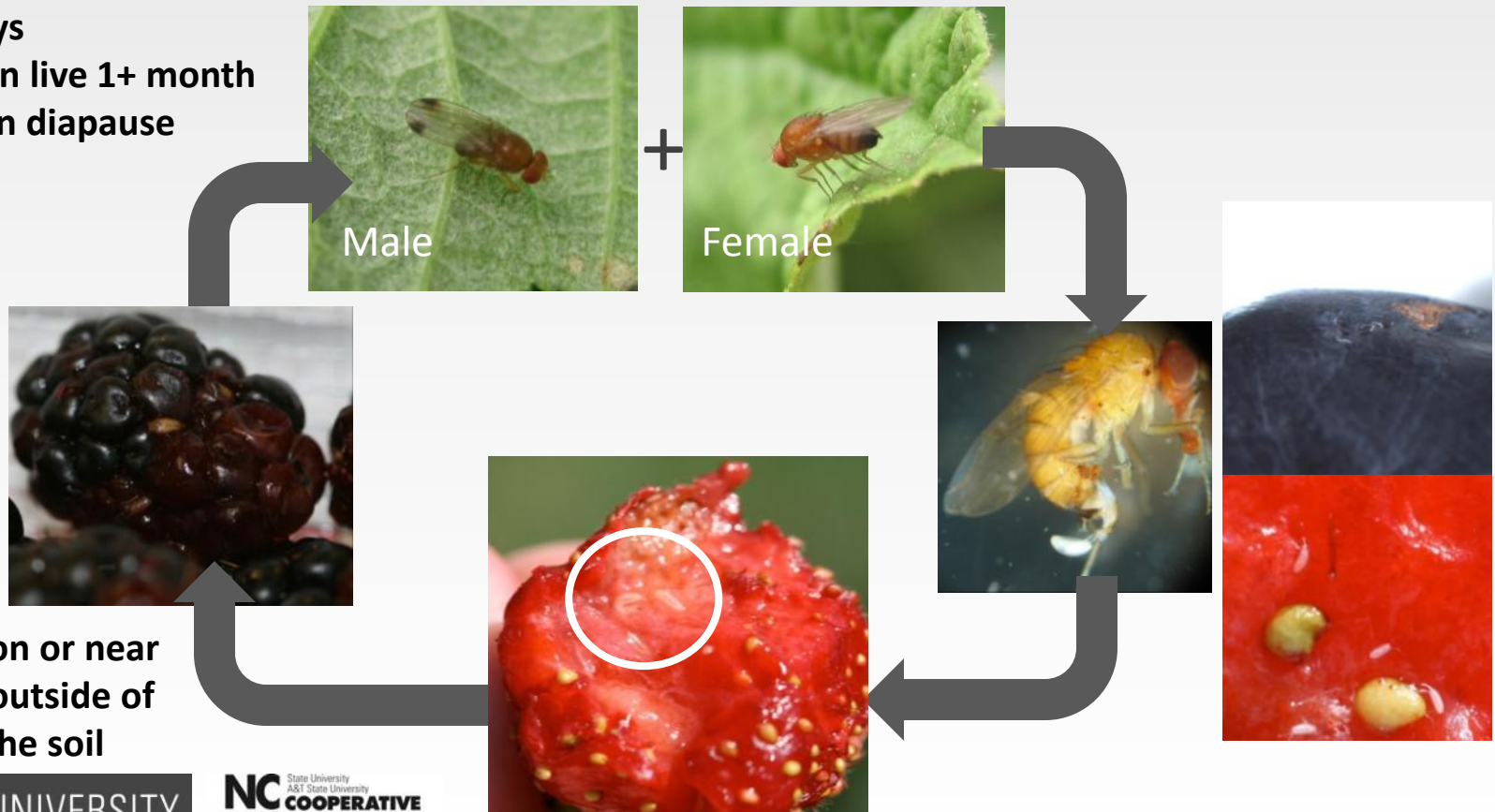
Spotted wing drosophila life cycle

Generation time (adult to adult):

10-15 days

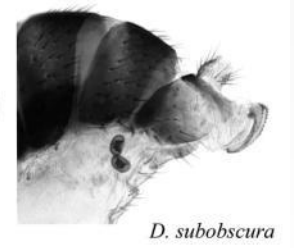
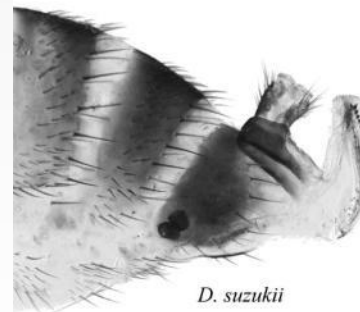
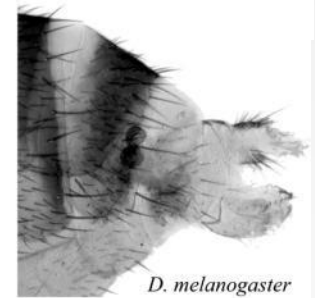
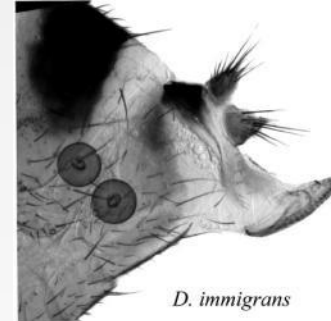
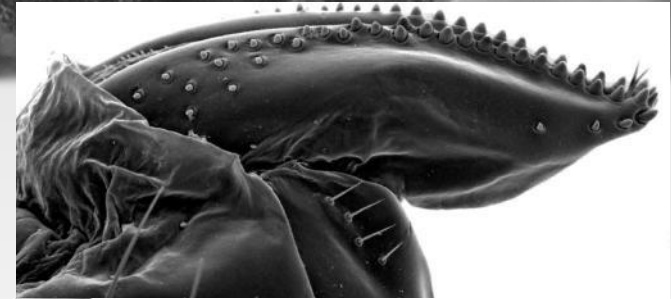
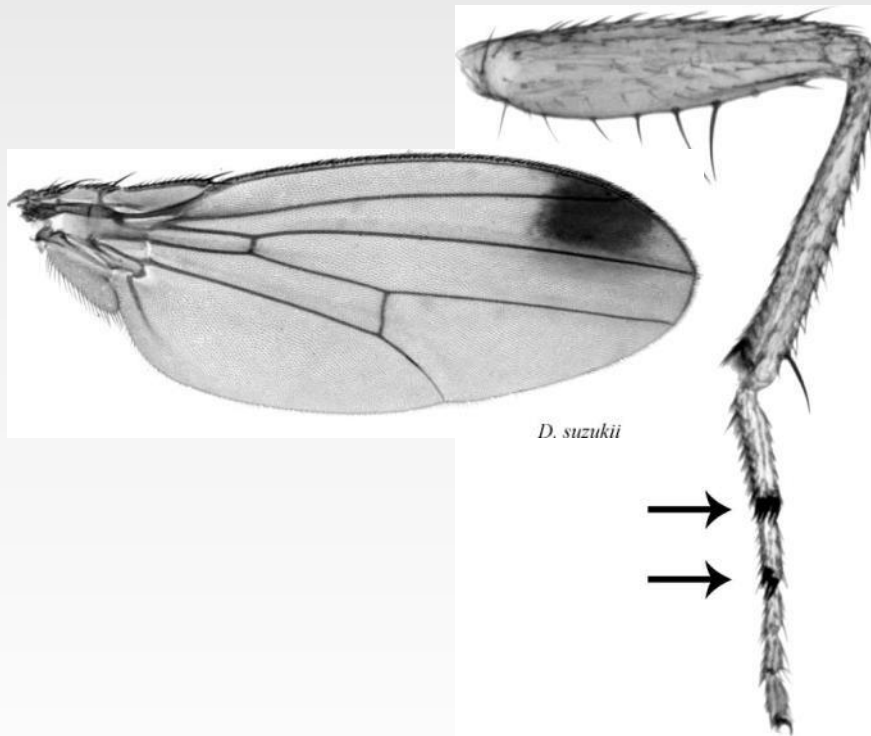
Adults can live 1+ month

No known diapause



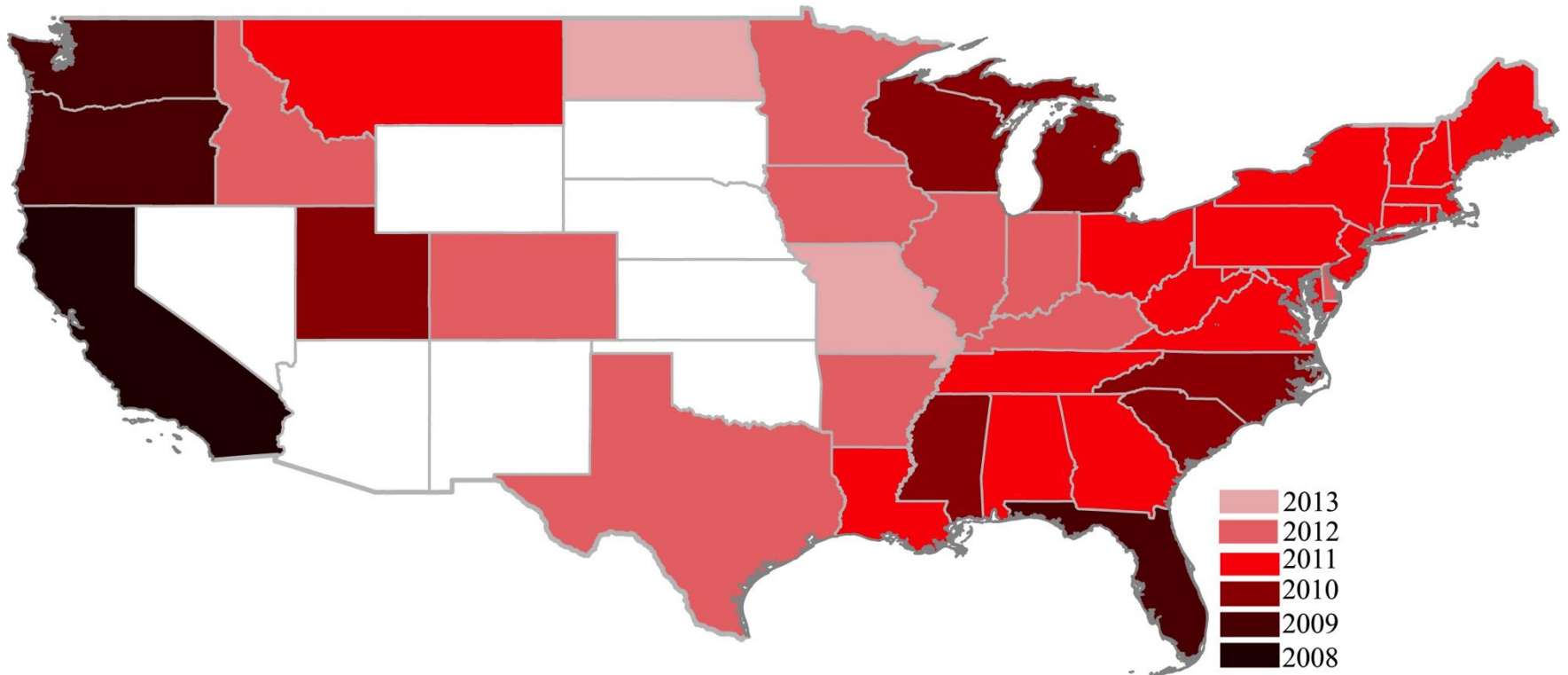
Pupate on or near fruit or outside of fruit in the soil

Spotted wing drosophila identification

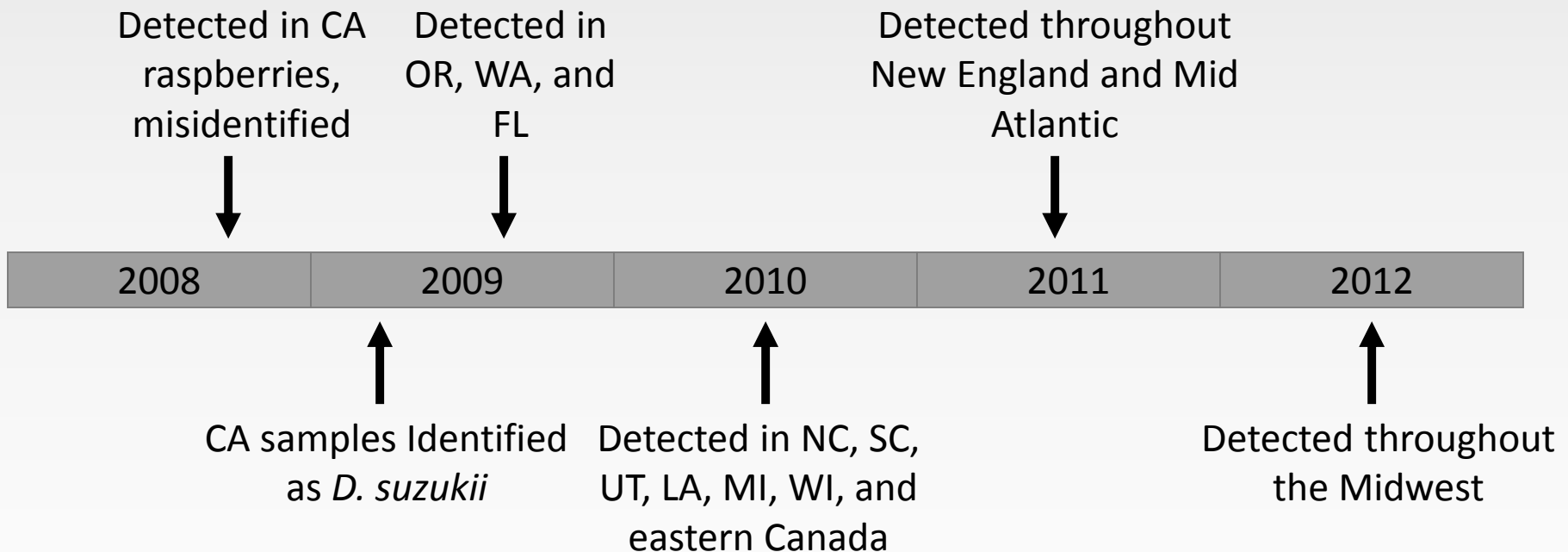


(Hauser 2011, Pest Management Science)

Spotted wing drosophila invasion history



Spotted wing drosophila invasion timeline



Records prior to CA identification: Damage to cherries in Japan in 1916 (Kanzawa 1939),
Detected in HI in 1980s

Regional monitoring activities

Spotted Wing Drosophila Volunteer Monitoring Network ([SWD*VMN](#))

Established in 2010

24 sites, 3 states, 9 positive

18 volunteers

Expanded in 2011

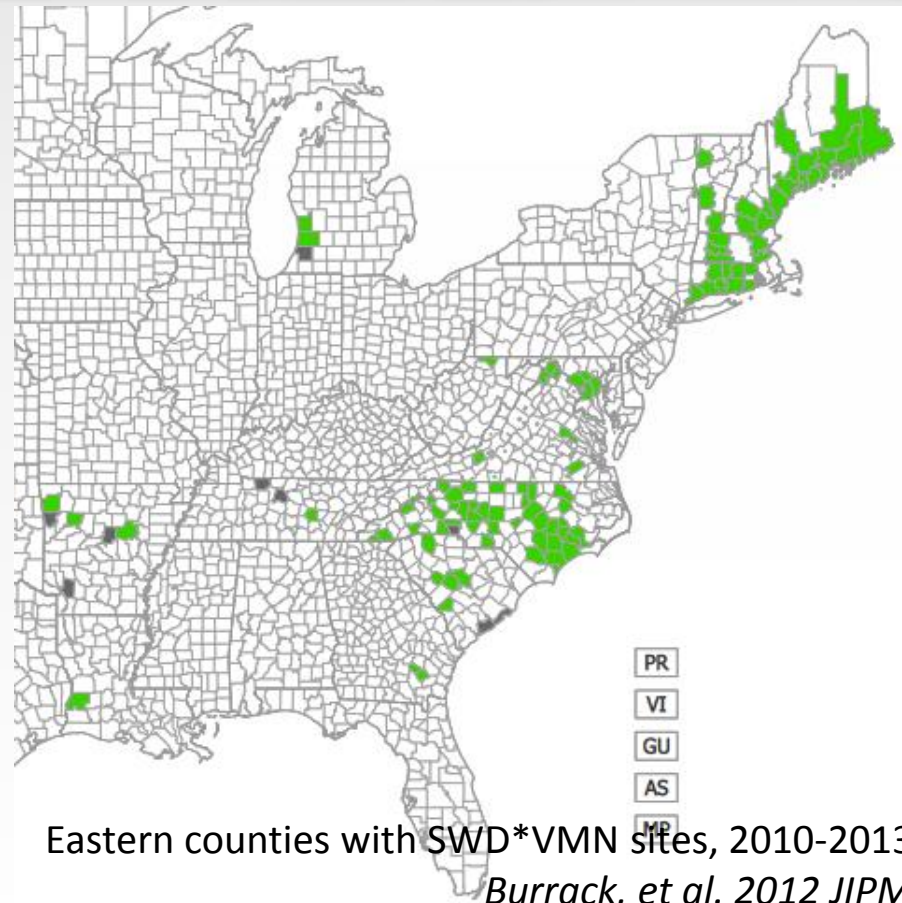
75 sites, 8 states, 63 positive

38 volunteers

...and 2012

286 sites, 12 states

(expanded to New England)



Eastern counties with SWD*VMN sites, 2010-2013
Burrack, et al. 2012 JIPM

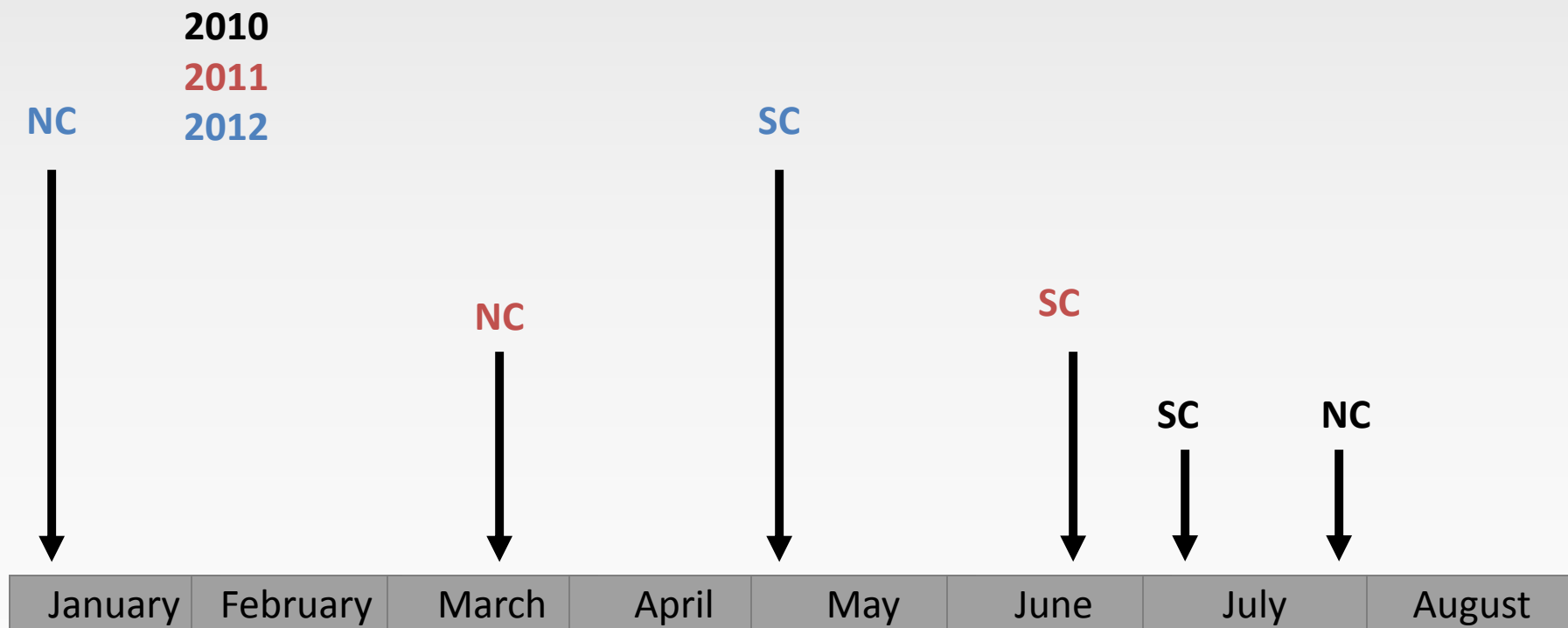
Seasonal biology

Date of first detection



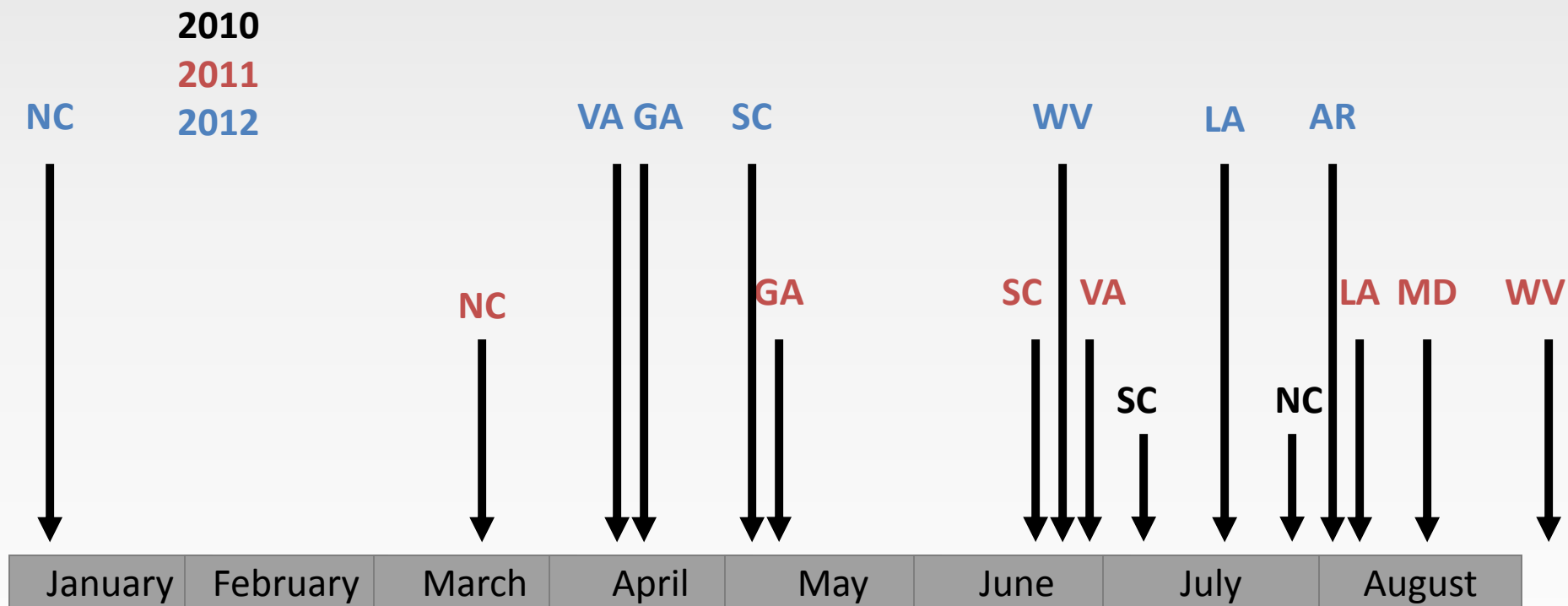
Seasonal biology

Date of first detection



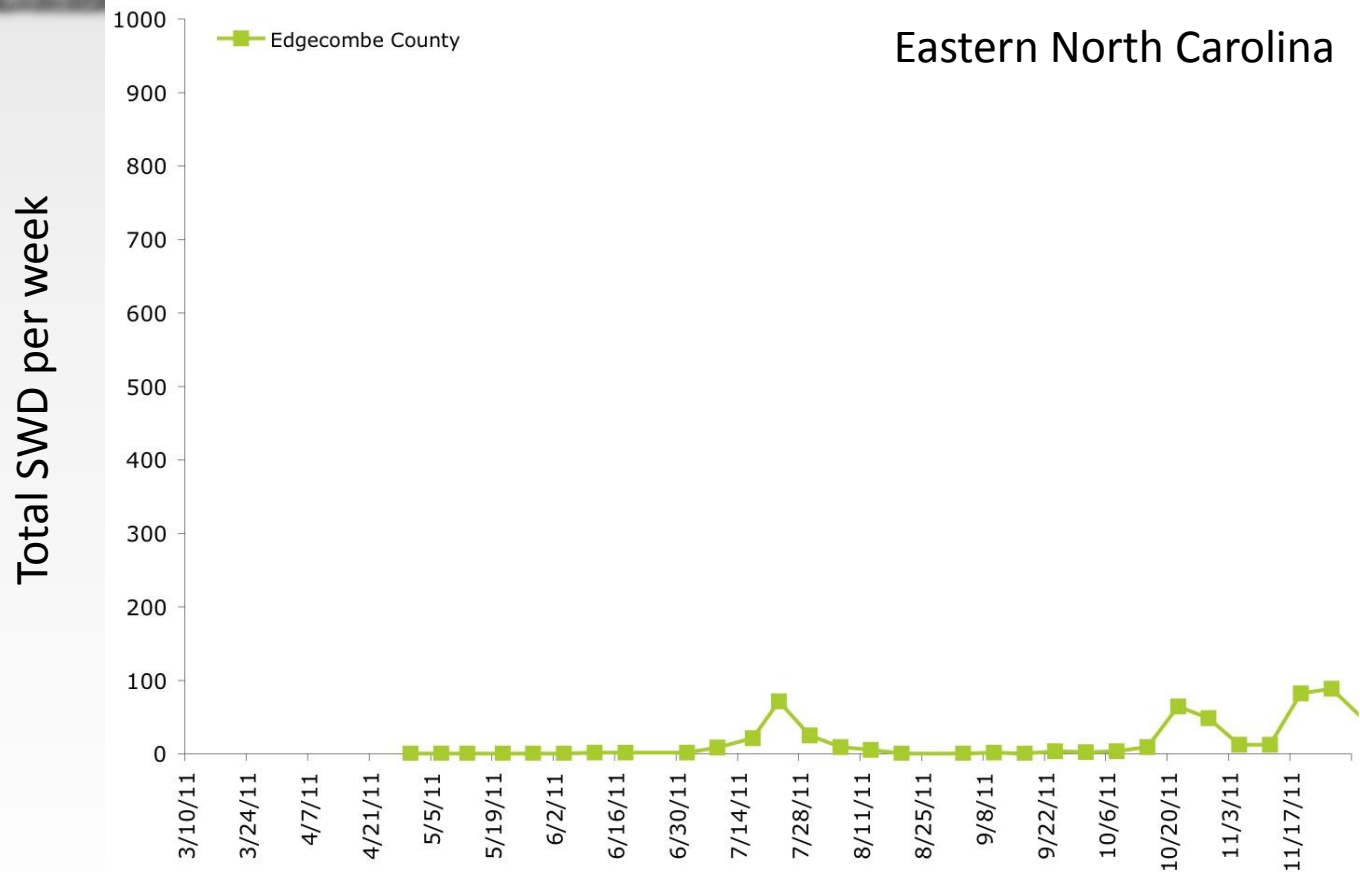
Seasonal biology

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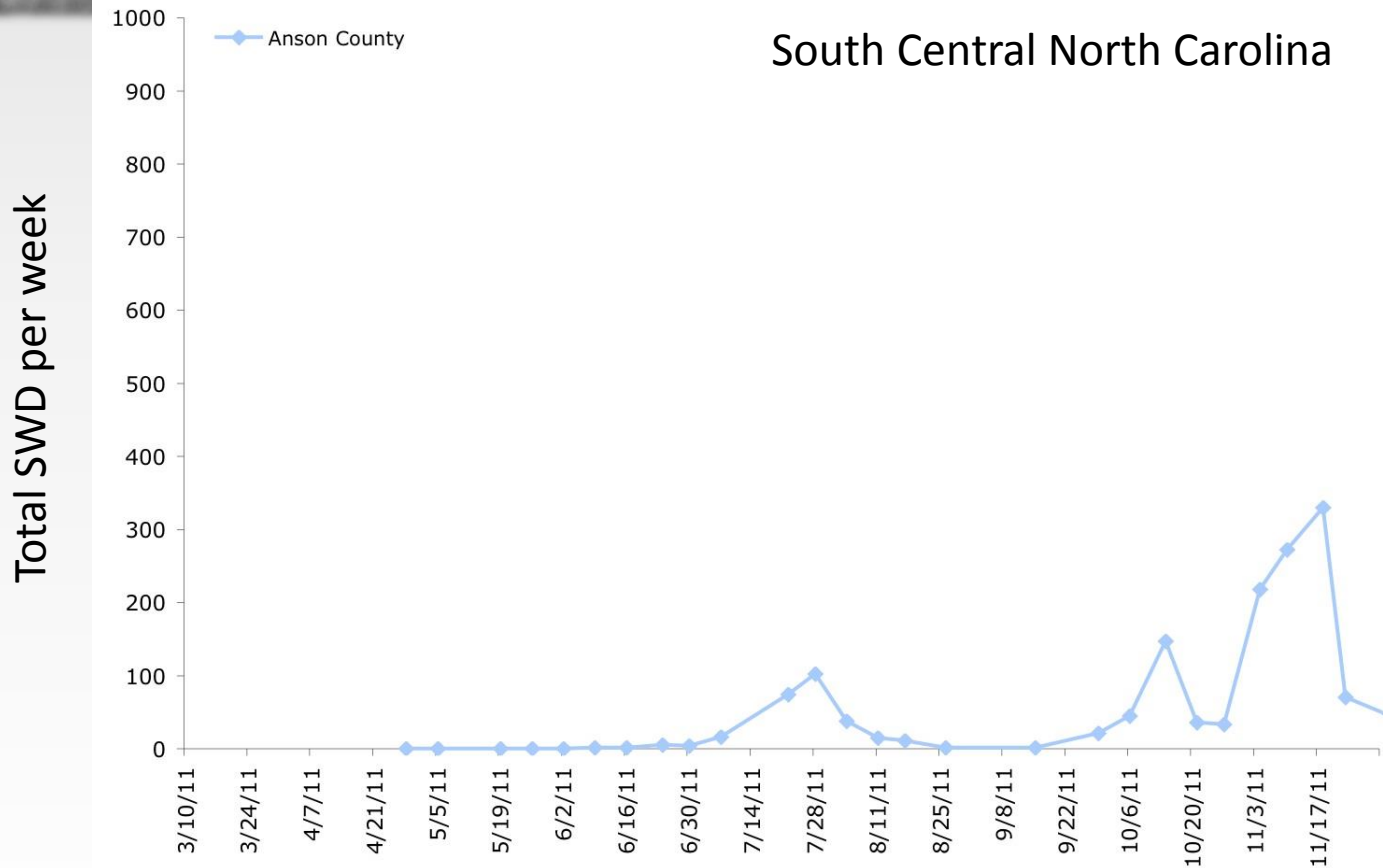
Seasonal biology

Populations during the growing season



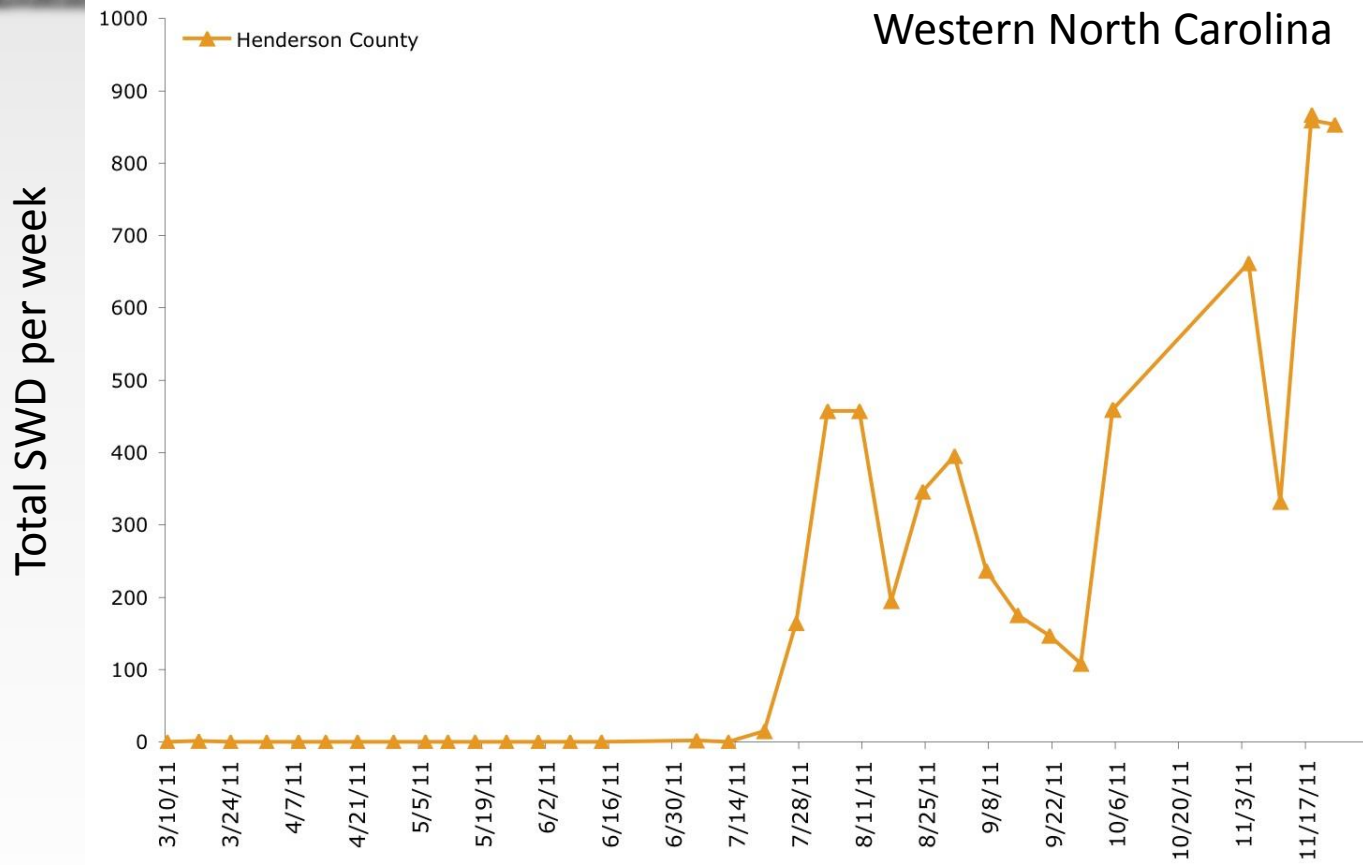
Seasonal biology

Populations during the growing season



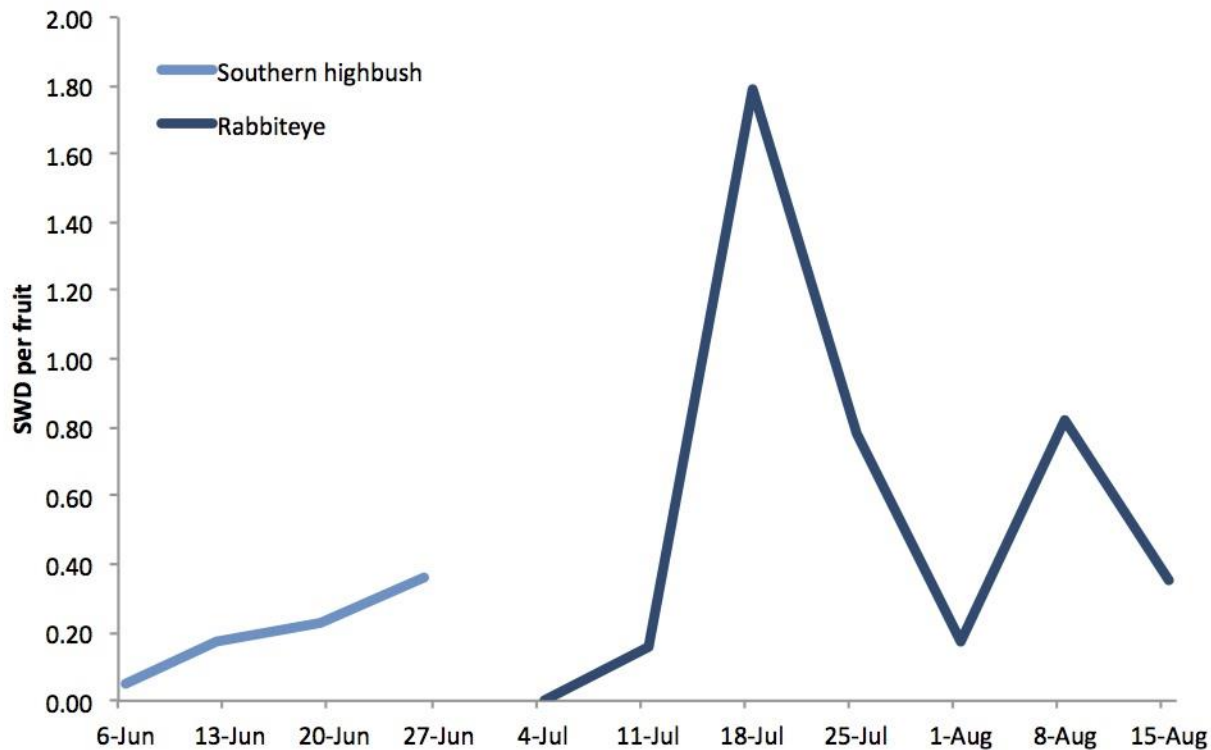
Seasonal biology

Populations during the growing season



Seasonal biology

Populations during the growing season



Observed infestation (field and laboratory) in 7 SHB and 4 RE varieties

No significant differences in infestation in the field

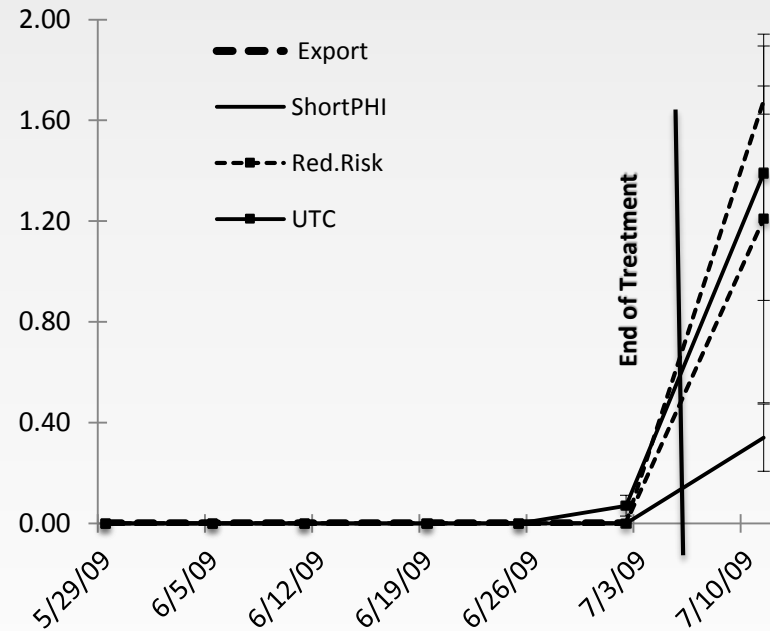
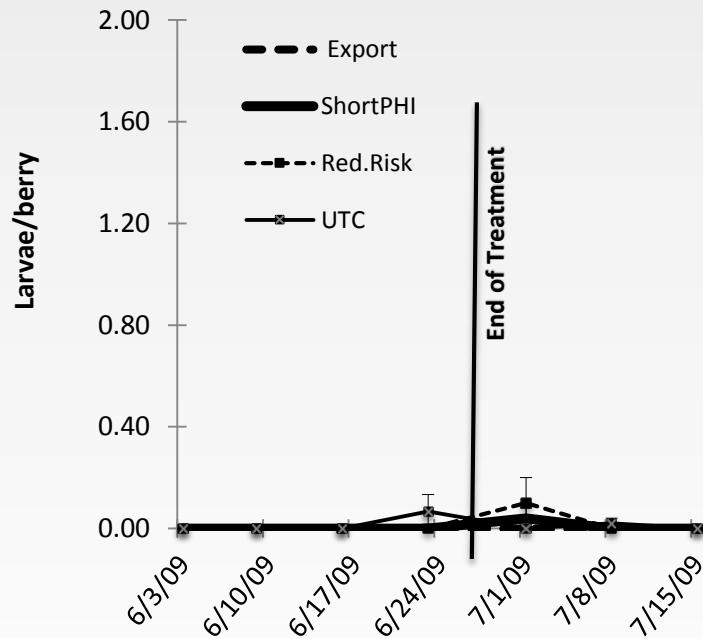
No significant differences in oviposition or developmental success in laboratory

Seasonal biology

Populations during the growing season

NC Site 1

NC Site 2





Spotted wing drosophila

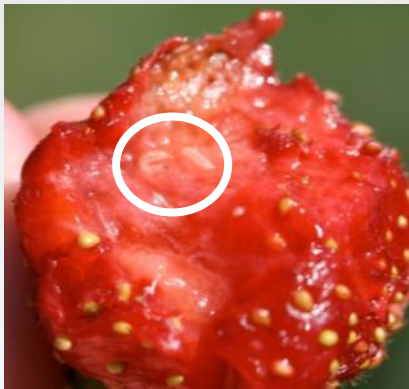
Topics

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Impacts

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Spotted wing drosophila significance

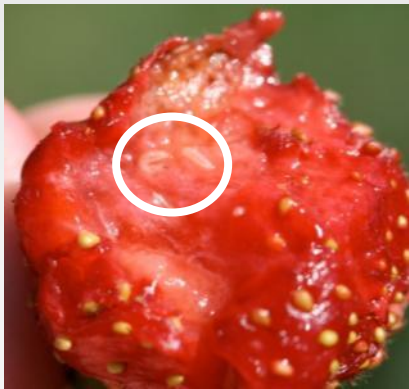


Damage is cryptic & seasonally difficult

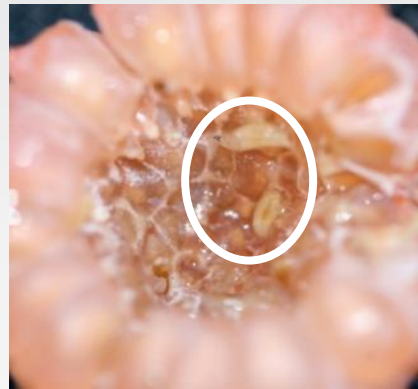
Limited effective chemical management tools

Non chemical tools have unclear benefit & are potentially costly

Impacts in the southeast



- Limited, if any, reports of infestation in spring fruiting strawberries
- Reports of “soft berries” in NC day neutral plantings turned out to be SWD



- Most significantly impacted crop
- 15% loss in NC in 2012, \$2.14 million
- Virtually all growers have experienced at least one infestation “incident”



- Crop losses variable
- Damage in NC observed in processing fruit during 2013



Doug Pfeiffer, Virginia Tech

- No reports of infestation in NC vineyards to date

Impacts in the southeast

Impact assessments for the eastern US indicate that crop loss *potential* for SWD is \$207 million annually

\$511 in potential crop loss in western US

Actual observed damage in 2012 between \$45 and \$56 million in eastern US



Stakeholder impact assessment *2013 Preliminary Survey*

60% of respondents increased management efforts in to control SWD as compared to previous years

We need your input! Please complete the survey provided today and hand it to me at the end of the presentation.

SWD Working Group

swd.ces.ncsu.edu



Spotted wing drosophila

Topics

Biology and invasion history

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Hosts and susceptibility

Host preference

What do SWD like to eat?

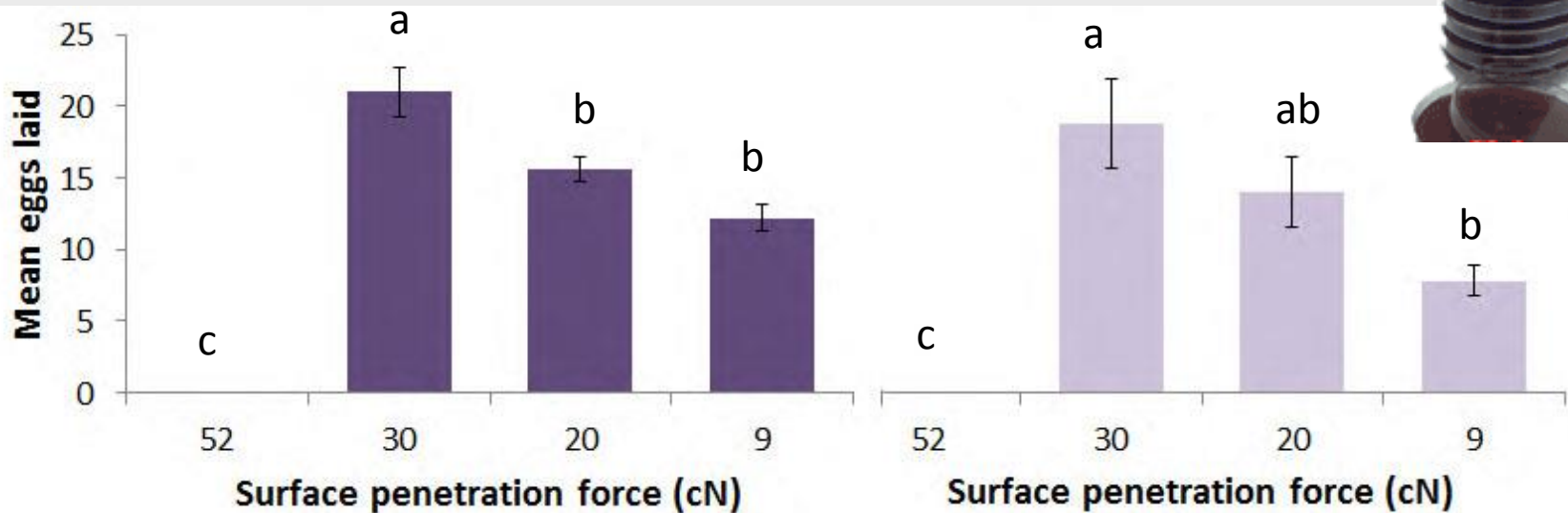
More eggs are laid in raspberries than other fruit in the lab and the field

	Eggs laid in ca. 20g fruit	Proportion survival to adult	Larval development time (days)	Penetration force (cN)
Blackberry	31.75 (\pm 7.28) bc	0.42 (\pm 0.11)	5.80 (\pm 0.06) b	32.19 (\pm 0.85) a
Blueberry	23.25 (\pm 0.85) c	0.32 (\pm 0.04)	6.38 (\pm 0.09) a	31.06 (\pm 0.68) a
Raspberry	60.75 (\pm 3.40) a	0.73 (\pm 0.03)	5.72 (\pm 0.05) c	9.39 (\pm 0.29) b
Strawberry	43.25 (\pm 6.07) b	0.53 (\pm 0.16)	5.77 (\pm 0.06) bc	33.15 (\pm 0.88) a

Larvae develop more quickly in raspberries than in other fruit, at least partially because they are softer, and more larvae per berry may be able survive in raspberries than other fruit

Host preference

What do SWD like to eat?



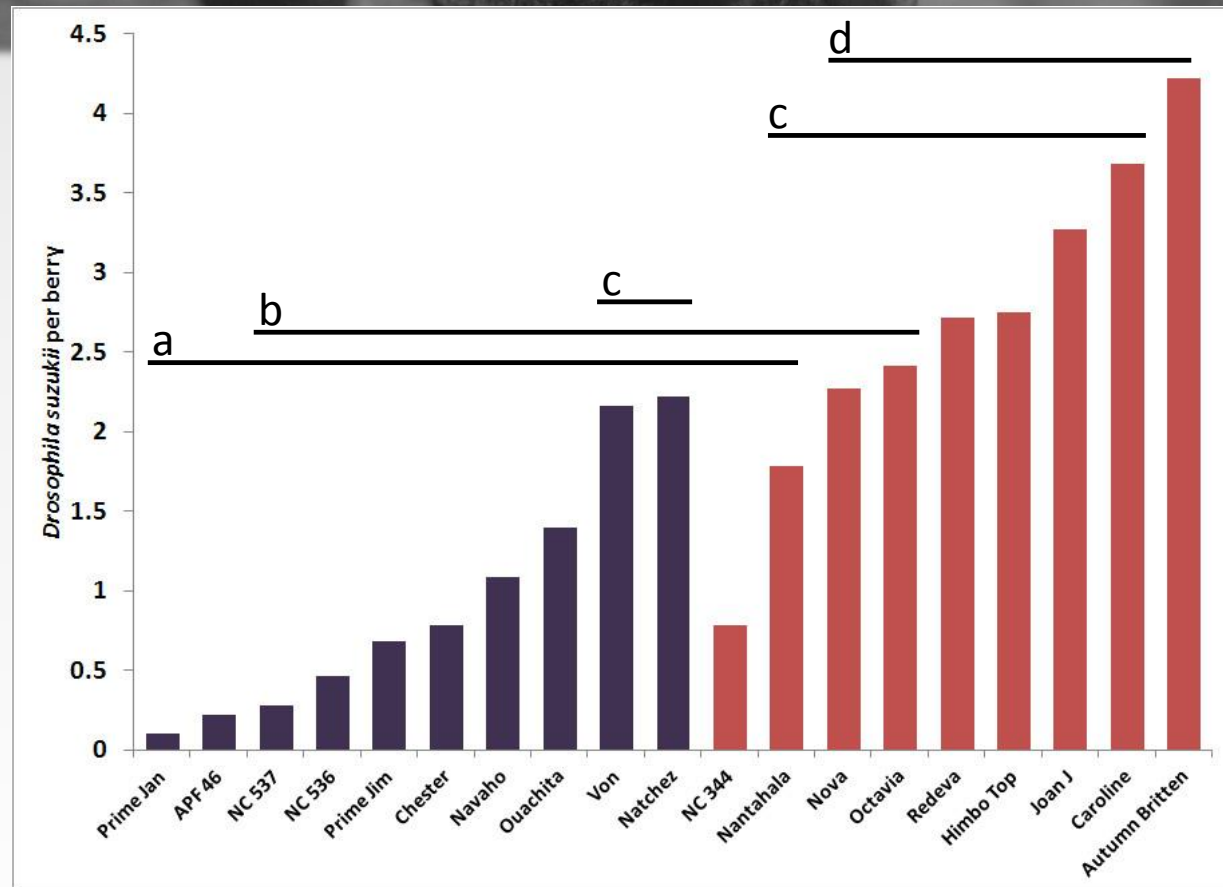
In both no choice (left) and choice (right) assays, SWD female laid **no eggs** in artificial media with a surface penetration force exceeding 52.00 cN

Host preference

What do SWD like to eat?

Infestation rate differs between raspberry and blackberry varieties when flies have free choice

The same pattern does not appear to hold for blueberries (2012-2013) or strawberries (2013, day neutral)



variety: $F_{18,435}=2.28$, $p = 0.0021$; date, year random

How does an infestation develop?

Big question: Does proximity to non-crop habitat affect fruit infestation levels?



How does an infestation develop?



Transects ≥ 20 m apart

Traps

Yeast sugar water bait in 32 fl oz cups; ~ 20 m apart

Fruit collection

~ 40 ripe fruit around each trap

Sites

2 commercial blackberry fields

How does an infestation develop?

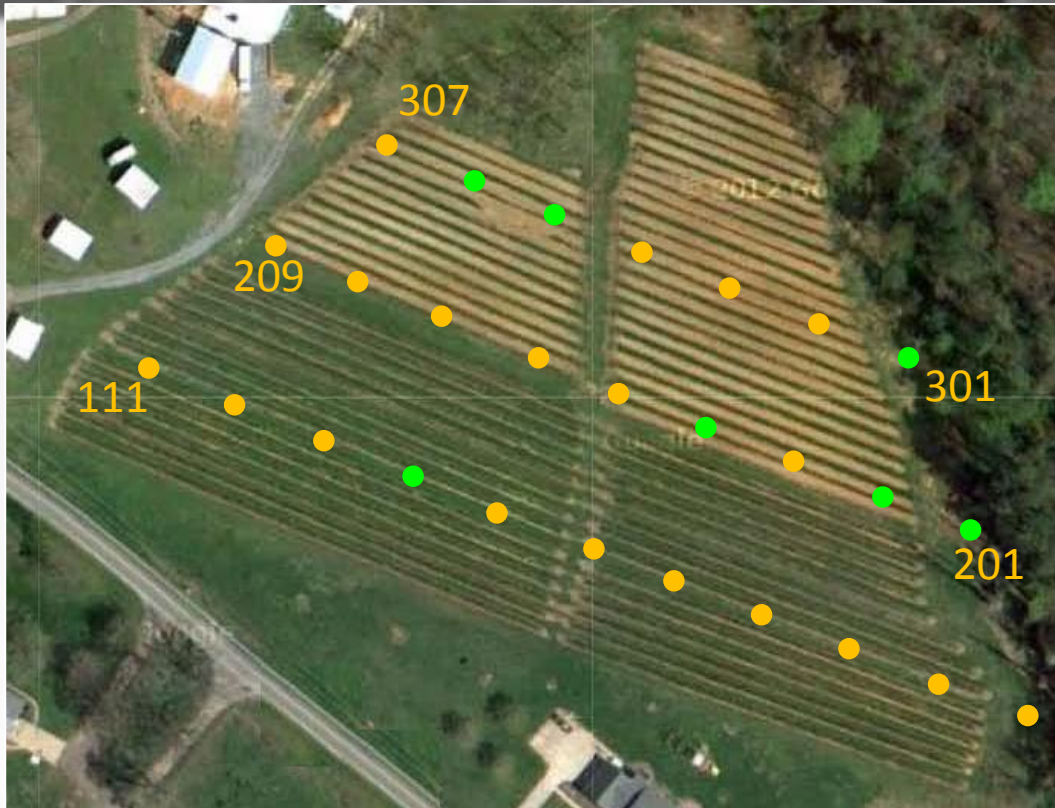
Fruit Infestation



- Date
 - 2 July- no infestation

How does an infestation develop?

Fruit Infestation



- Date
 - 2 July- no infestation
 - 9 July- 1-2 pupae/40 fruit

How does an infestation develop?

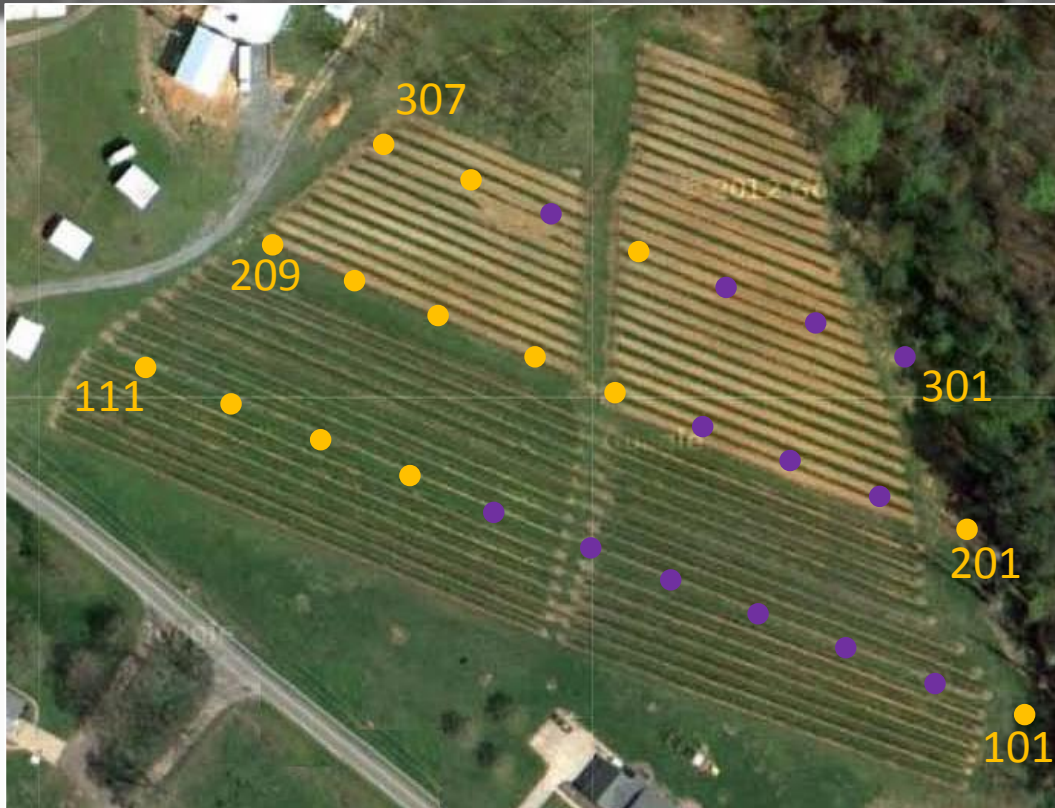
Fruit Infestation



- Date
 - 2 July- no infestation
 - 9 July- 1-2 pupae/40 fruit
 - 16 July- ≤ 44 pupae/40 fruit

How does an infestation develop?

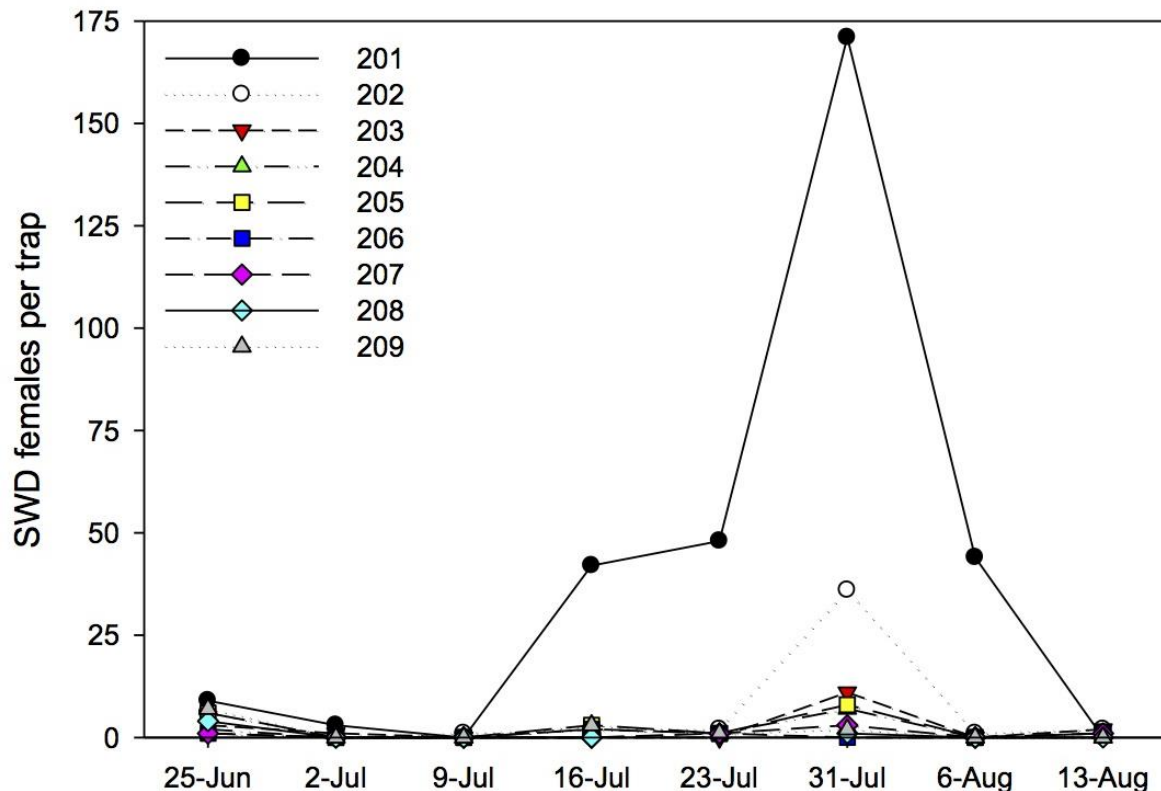
Fruit Infestation



- Date
 - 2 July- no infestation
 - 9 July- 1-2 pupae/40 fruit
 - 16 July- ≤ 44 pupae/40 fruit
 - 23 July- fewer pupae than 16 July

How does an infestation develop?

D. suzukii females in traps for one transect



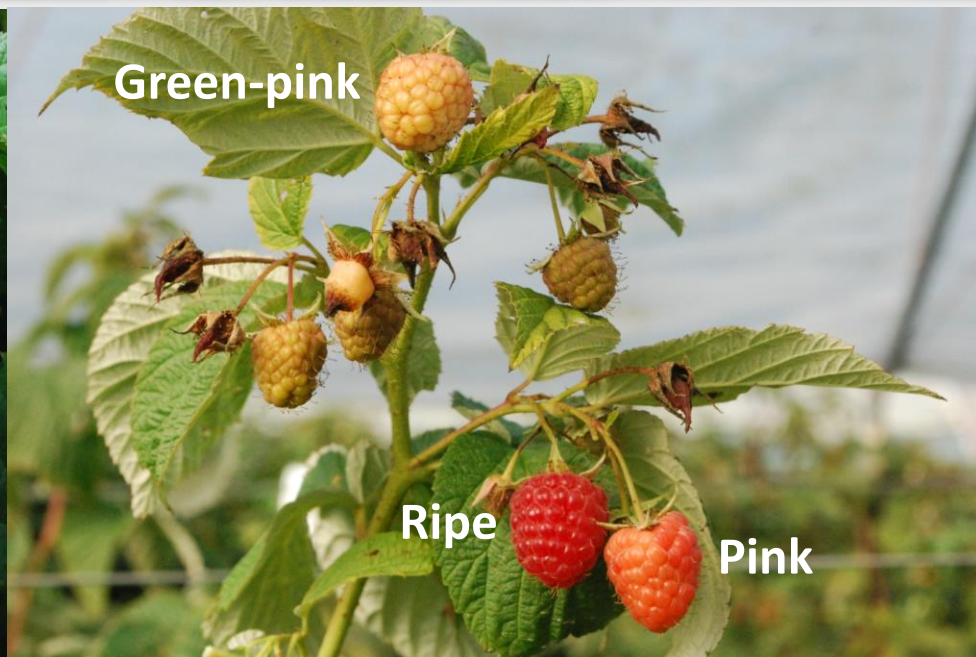
- No obvious pattern to initial infestation (July 9th)
- After July 9th, comparatively high numbers of females were caught in traps adjacent to the crop
- In general, very few females were caught in traps within the crop fields
- Similar patterns were observed at the other site
- **Results are preliminary**

Katie Swoboda, PhD student

When can infestation develop in blackberries & raspberries?



Blackberry ripeness stages



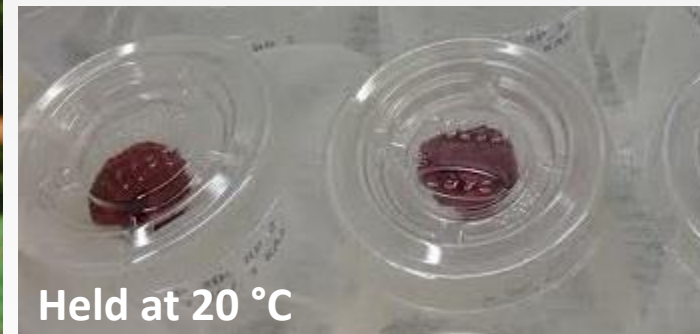
Raspberry ripeness stages

When can infestation develop in blackberries & raspberries?



Fruit caged at target ripeness stage and removed when ripe

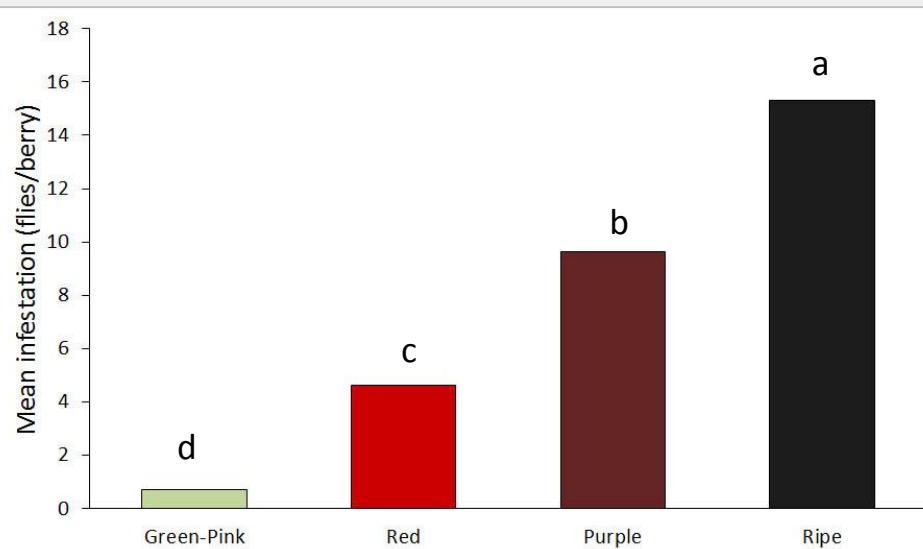
Held individually until all flies emerged



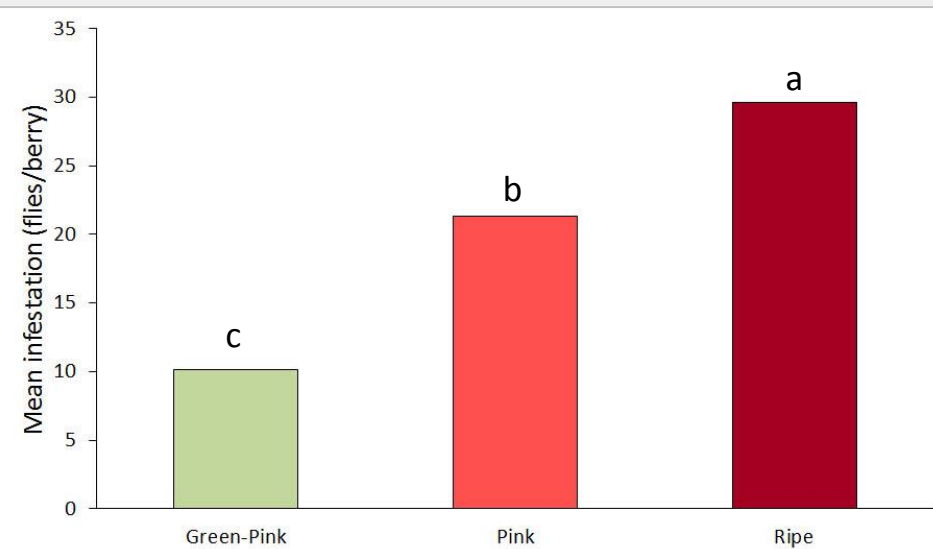
When can infestation develop in blackberries & raspberries?

Infestation was highest in fully ripe fruit

But flies were able to infest and survive in fruit that was just beginning to change color

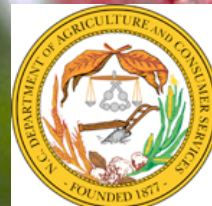


Infestation in blackberries by ripeness stage

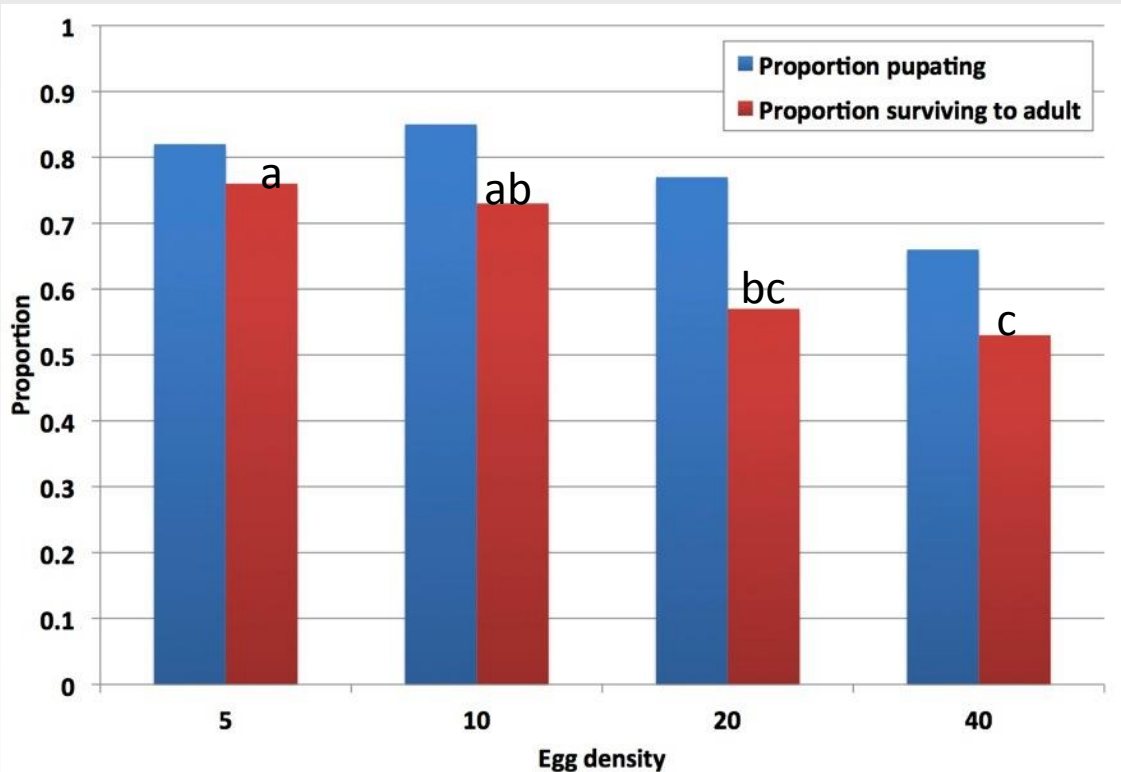


Infestation in raspberries by ripeness stage

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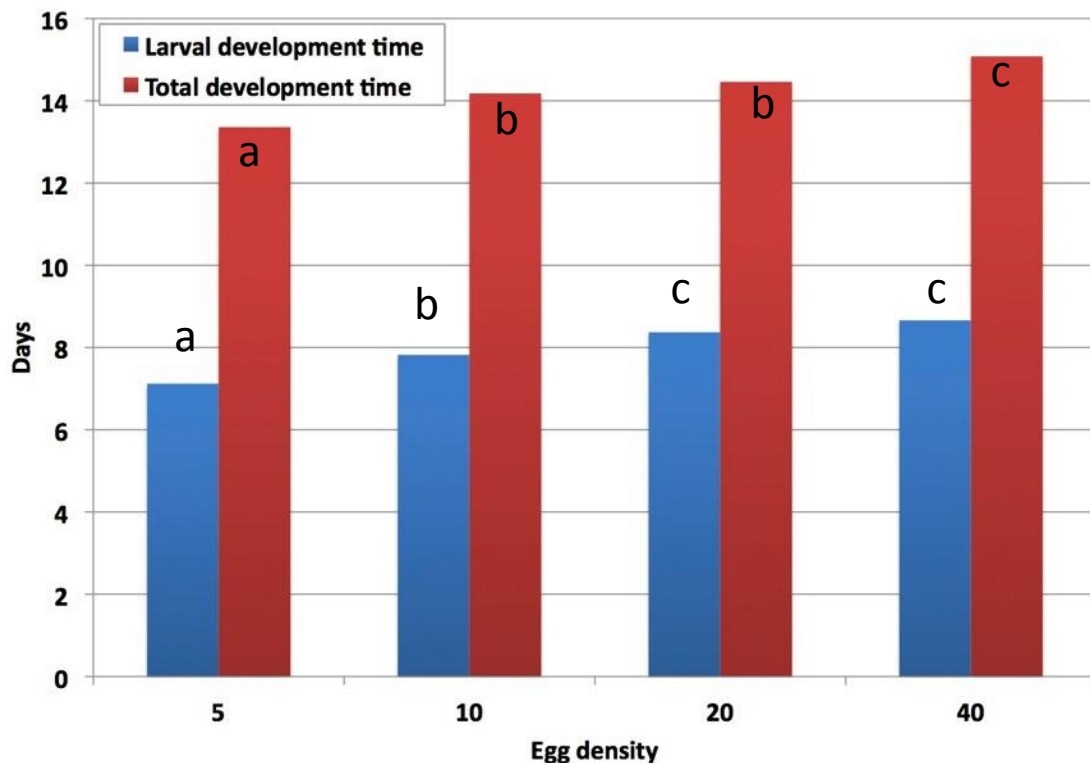
Effects of diet on intraspecific competition



In artificial diets, performance suffers as density increases

$$F_{df} = 6.25_{3,26}, p = 0.0024$$

Effects of diet on intraspecific competition



Larvae: $F_{df} = 42.44_{3,25}$, $p < 0.0001$

Total: $F_{df} = 32.82_{3,27}$, $p < 0.0001$

In artificial diets, performance suffers as density increases

Fruit observations

Larvae consistently performed better in raspberries despite densities of up to 3.5 eggs/g fruit

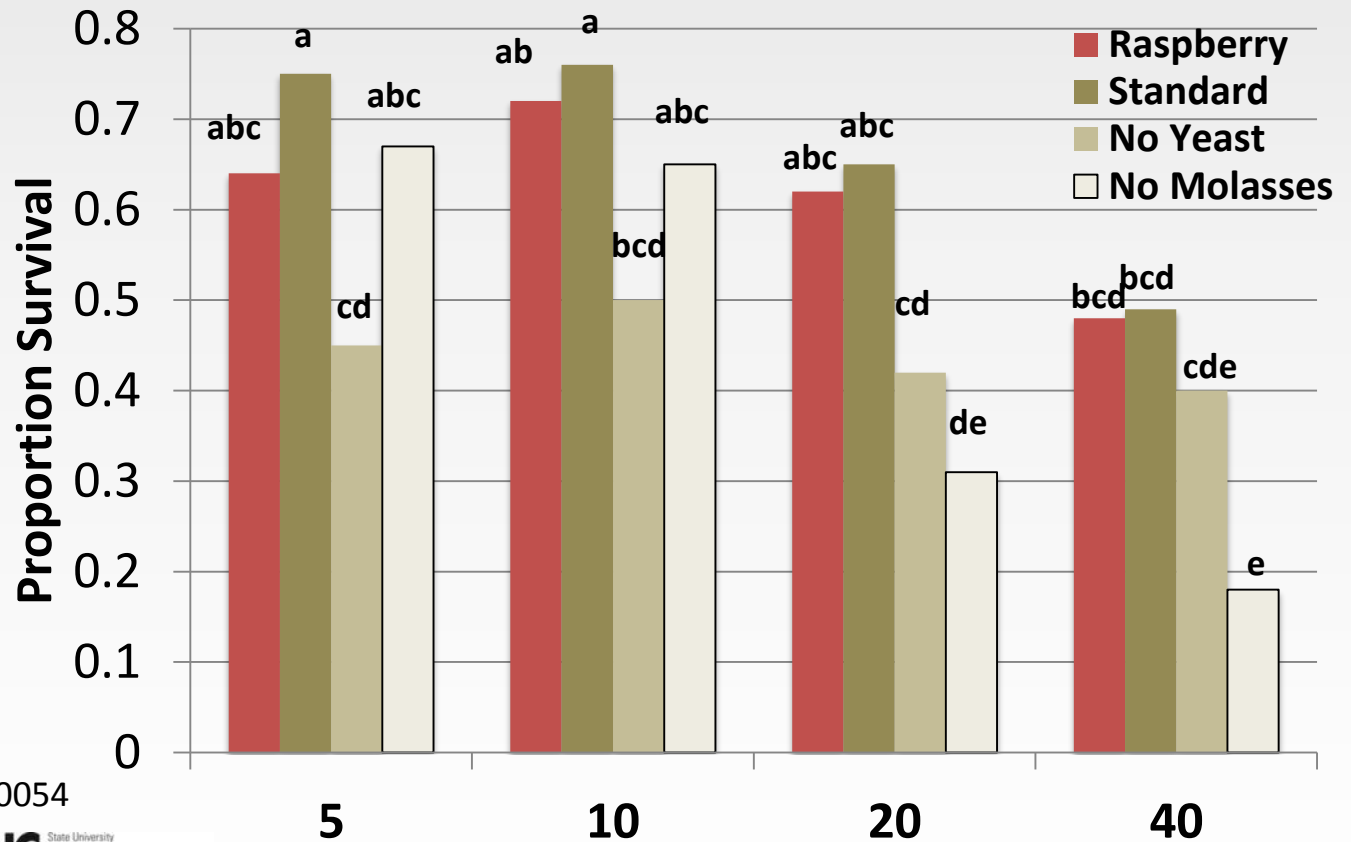
(40 larvae/10 ml = 3/g diet)

Effects of diet on intraspecific competition

Survival reduced in poor quality diets

Competition more acute in low carbohydrate diets

Standard diets and raspberry comparable



Diet*Eggs: $F_{9,403} = 2.65$, $p = 0.0054$

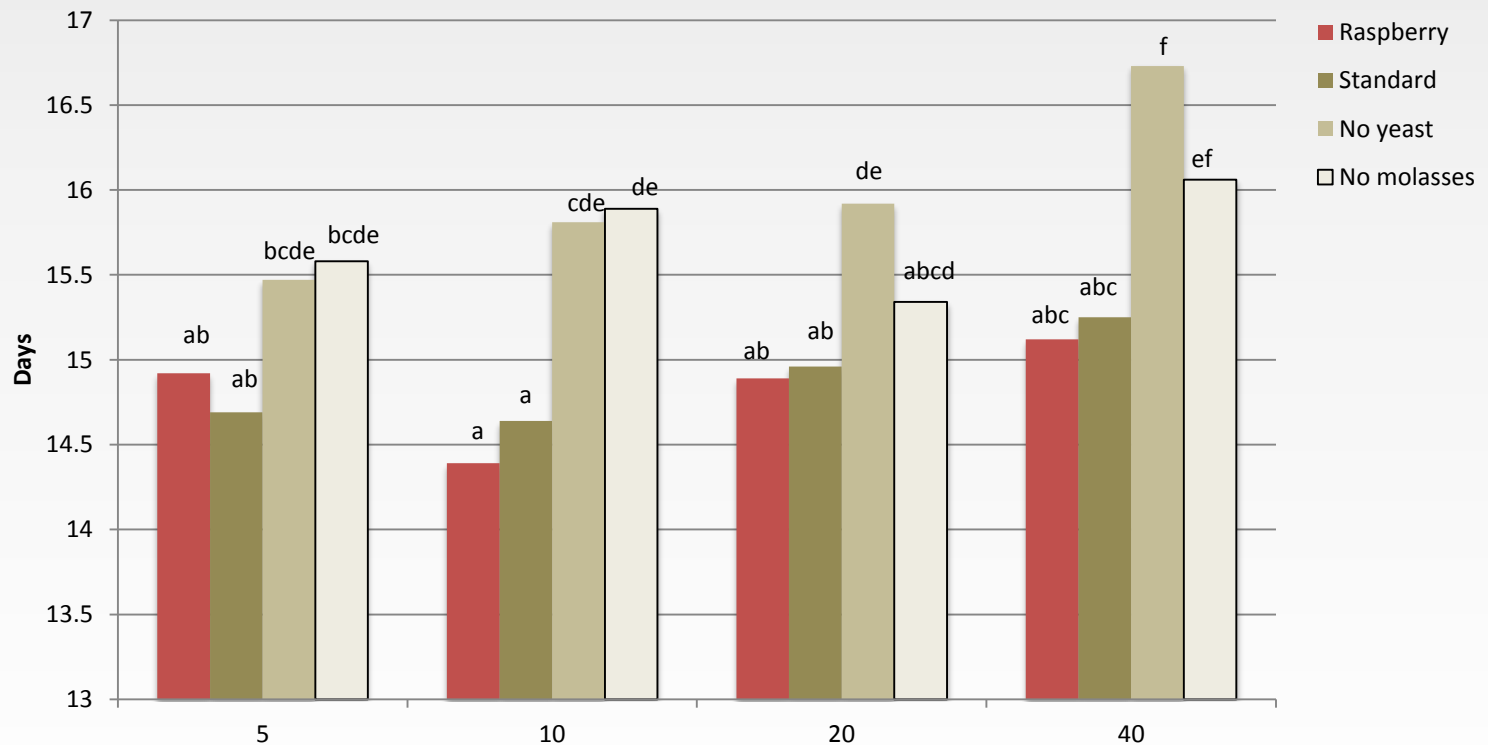
Effects of diet on intraspecific competition

Development time extended in poor quality diets

More acute in low amino acid diets

Standard diets and raspberry comparable

Total Development Time



Fruit coatings



PrimaFresh® 45

Carnauba Based Coating
for Stonefruits



Raynox®

Apple Sunburn Protectant



Pace International.



Tiger Industries
The "CALCIUM SOLUTION" to your growing problems

REFLECTIONS™
Liquid Shade



The CALCIUM SOLUTION
to your growing problems

PrimaFresh 45—Carnauba wax for stonefruits

Prevents desiccation; applied postharvest via drip/overhead spray; full strength (1 gal. /15,000-30,000 lbs. fruit)

Raynox—Carnauba wax and organically modified kaolin clay for apples

Reduces sunburn; applied preharvest; 1:20 to 1:40 suggested field application rate

Reflections—Calcium carbonate for fruit, vegetables, trees, & row crops

Reduces heat stress & sunscald; applied preharvest; 1:20 to 1:10 suggested field application rates

Fruit coatings - Methods



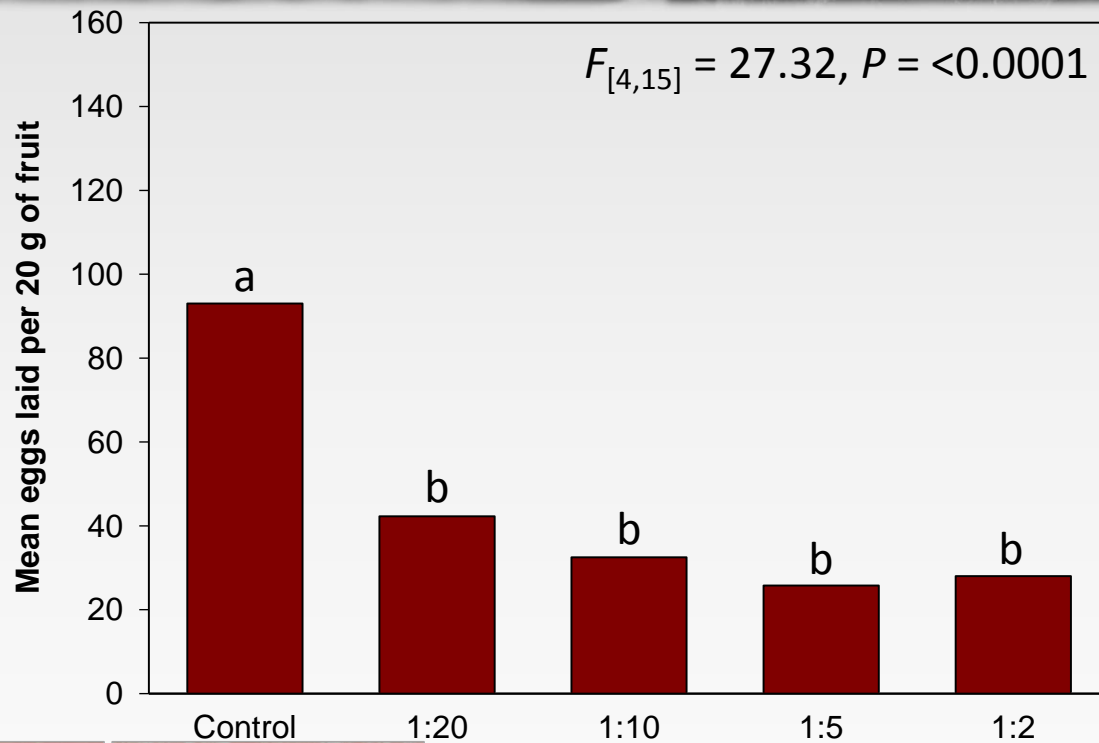
Fruit preparation

- 20 g of store-bought fruit
- Coated and allowed to dry overnight
- Tested several potential field dilution rates based on product recommendations



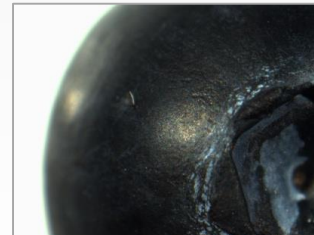
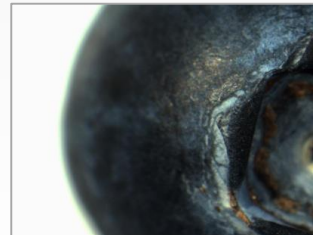
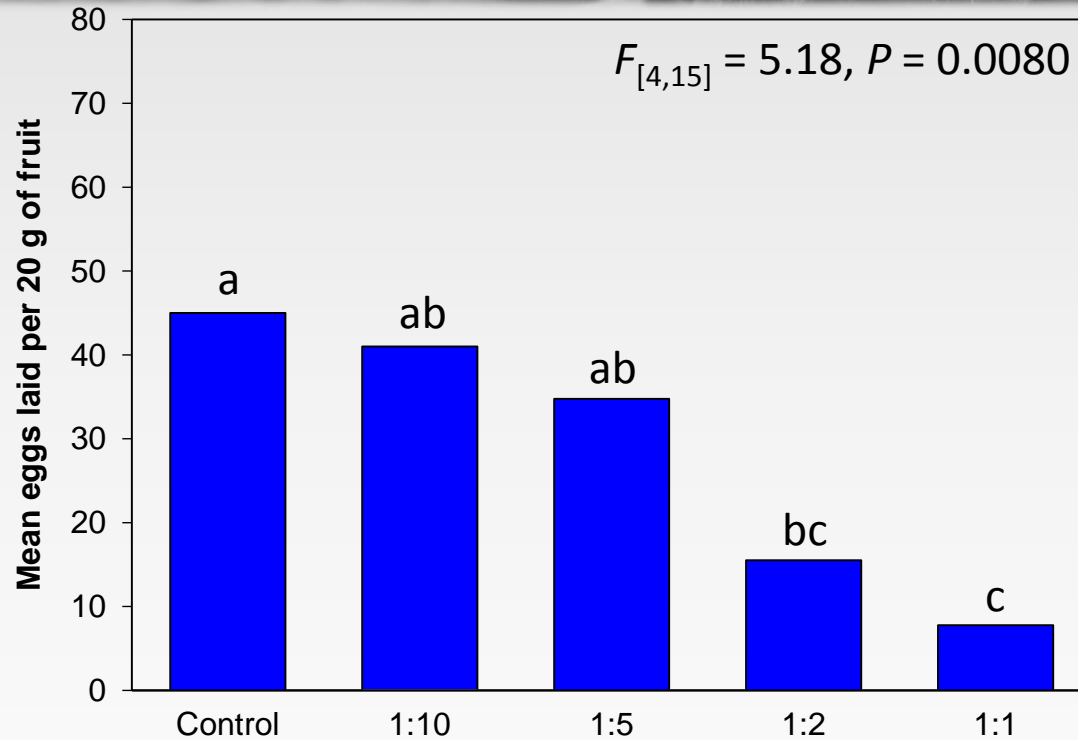
Fruit coatings

Raynox reduced oviposition in raspberries



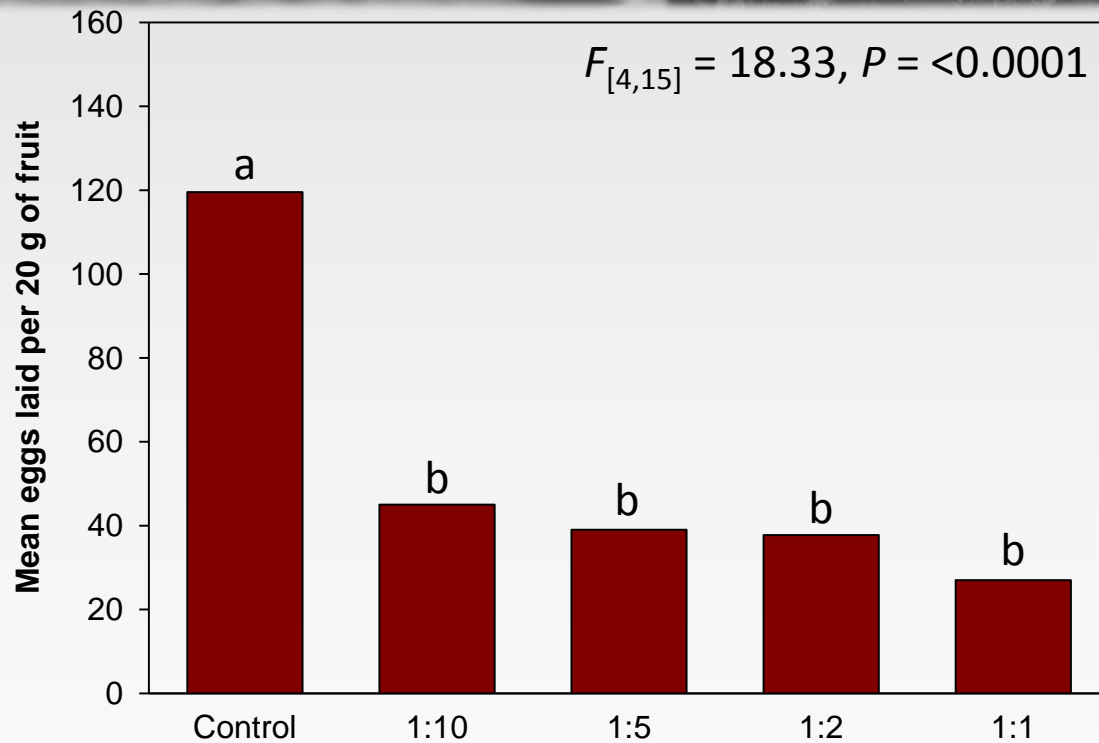
Fruit coatings

Raynox reduced oviposition in blueberries



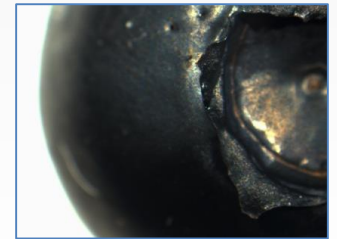
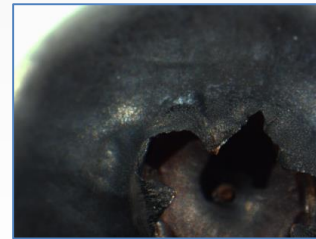
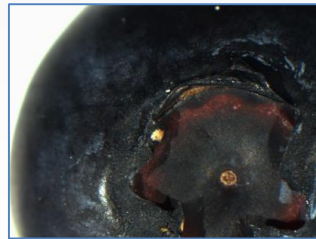
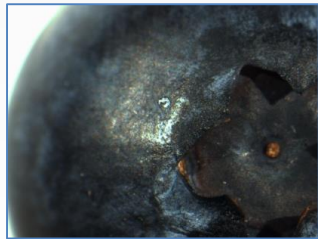
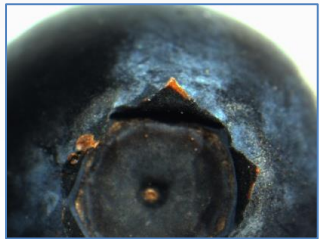
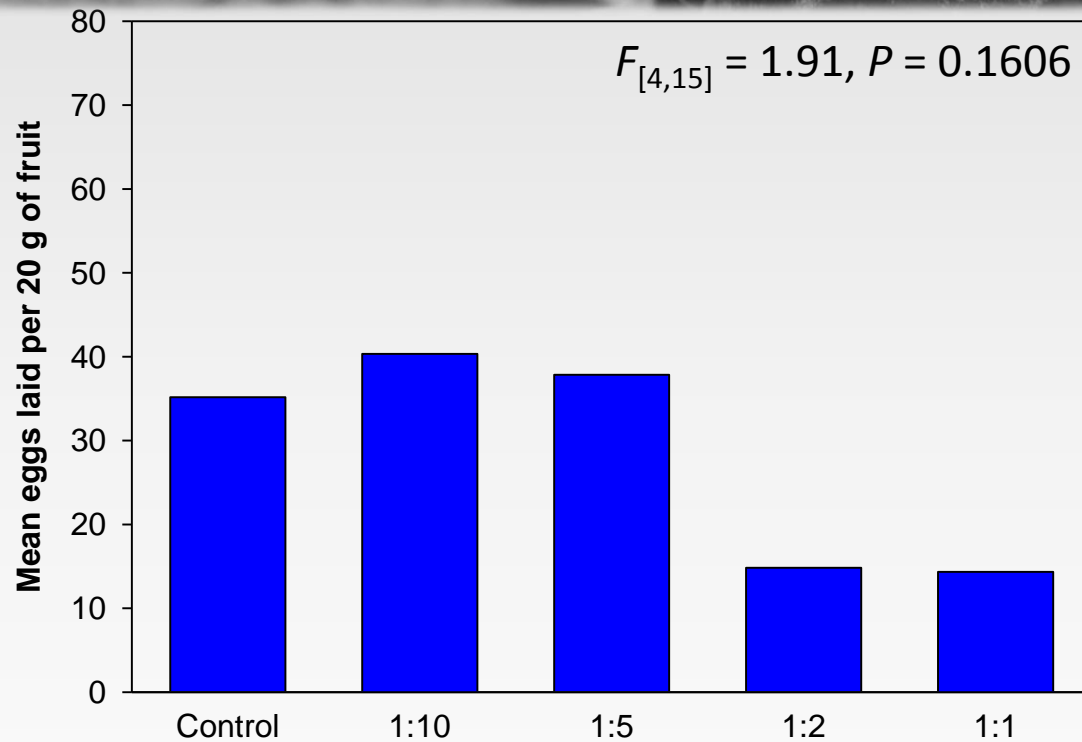
Fruit coatings

PrimaFresh 45 reduced oviposition in raspberries



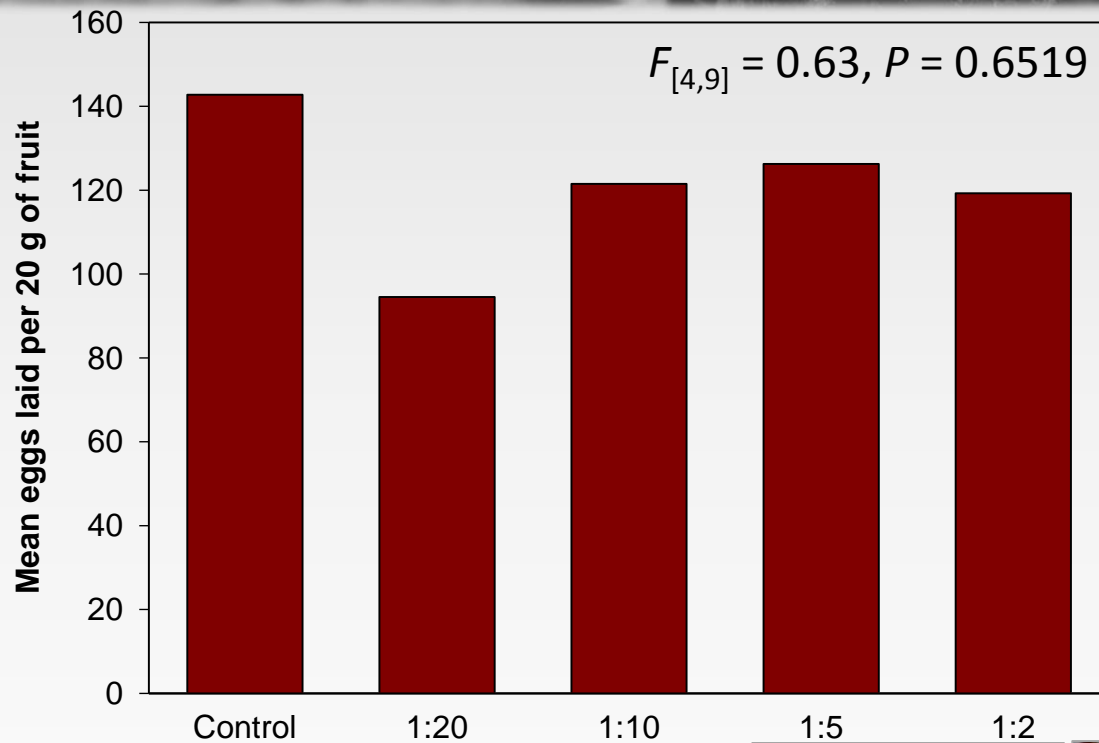
Fruit coatings

PrimaFresh 45 did not reduce oviposition in blueberries



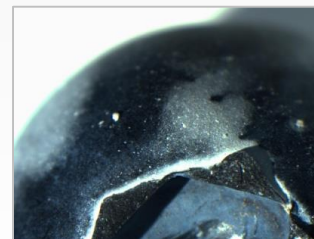
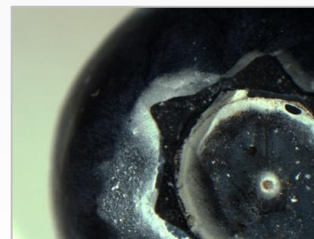
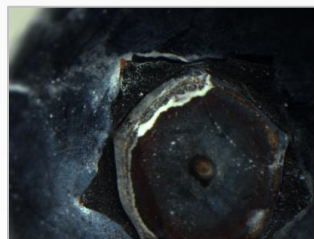
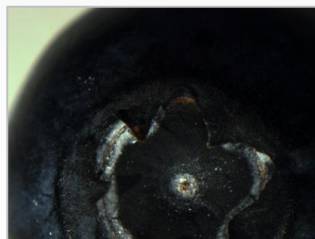
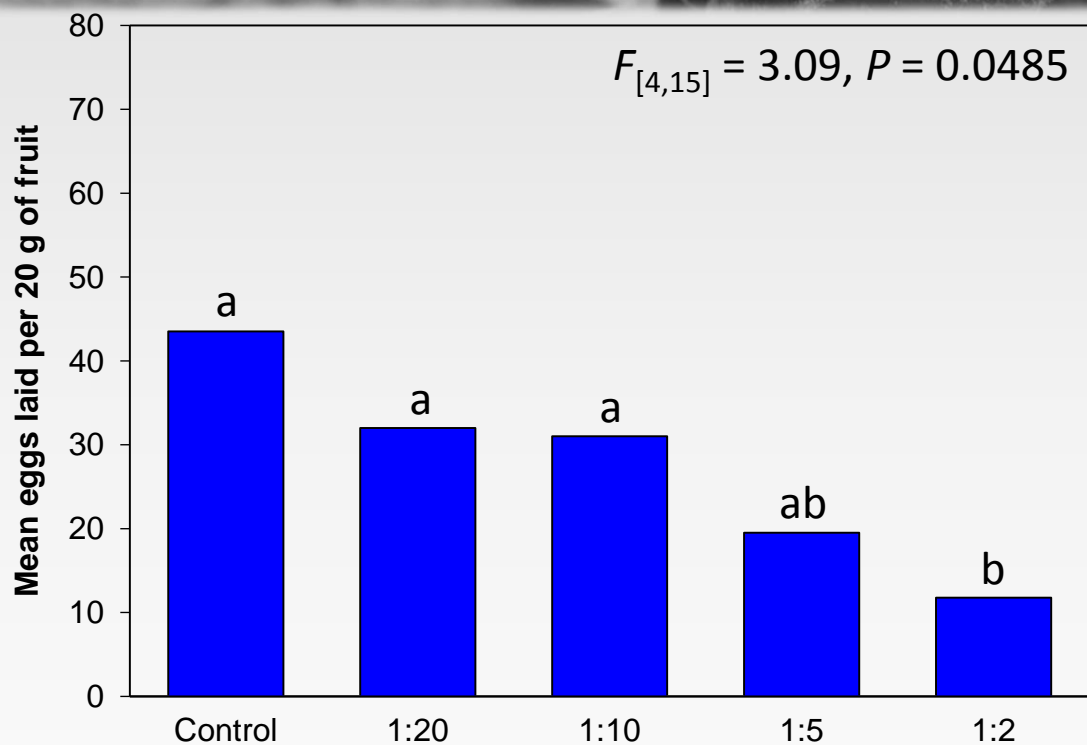
Fruit coatings

Reflections did not reduce oviposition in raspberries

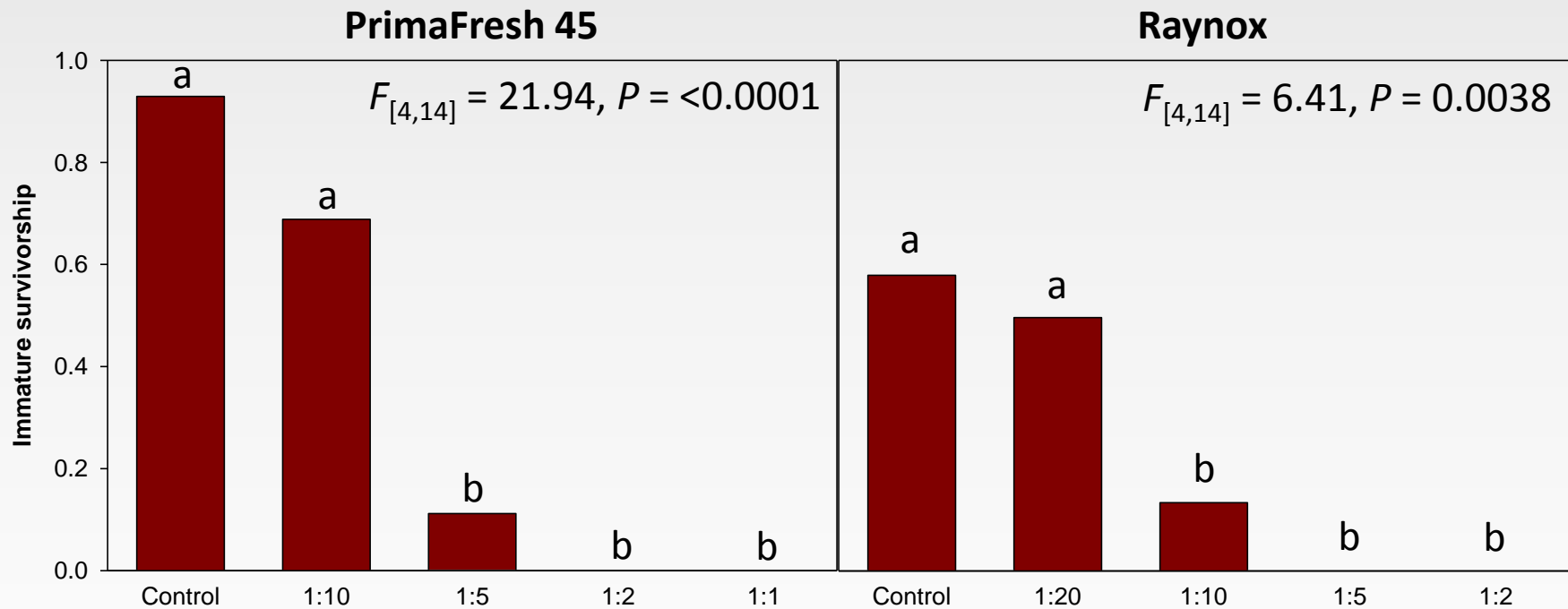


Fruit coatings

Reflections reduced oviposition in blueberries



PrimaFresh and Raynox decreased immature survivorship in raspberries



Fruit coating conclusions

Excellent coverage would be necessary to prevent infestation if fly populations are high

Post harvest effects of these materials unclear

Materials were “sprayable” but coverage varied

