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Back to Basics: Insect identification, biology, and management in southeastern blueberries

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Southern Region Small Fruit Consortium

www.smallfruits.org

Entomology Portal

http://entomology.ces.ncsu.edu/

Blueberry Information Portal

http://blueberries.ces.ncsu.edu/

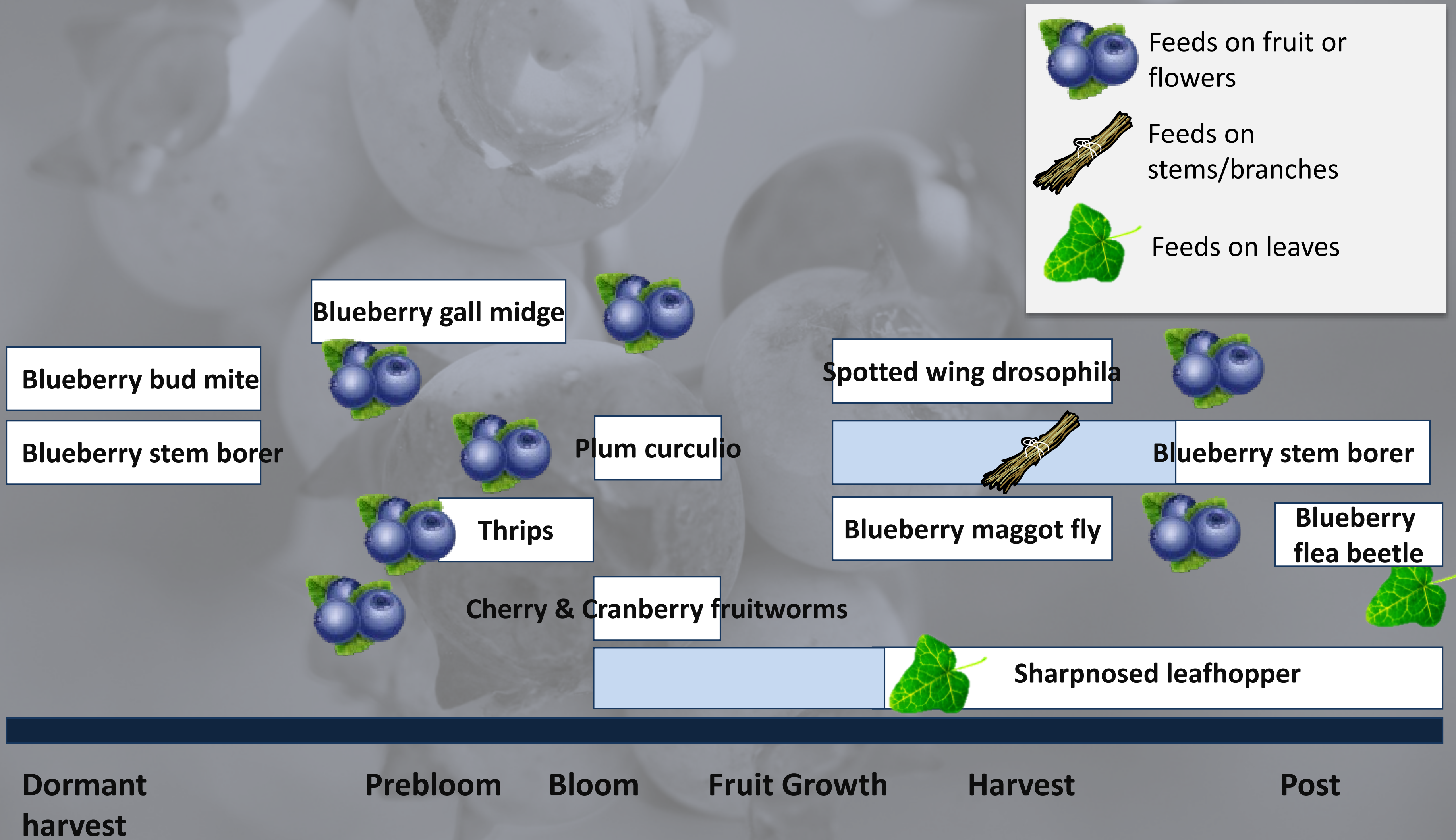
Key arthropod pests in blueberries

Spotted wing drosophila update

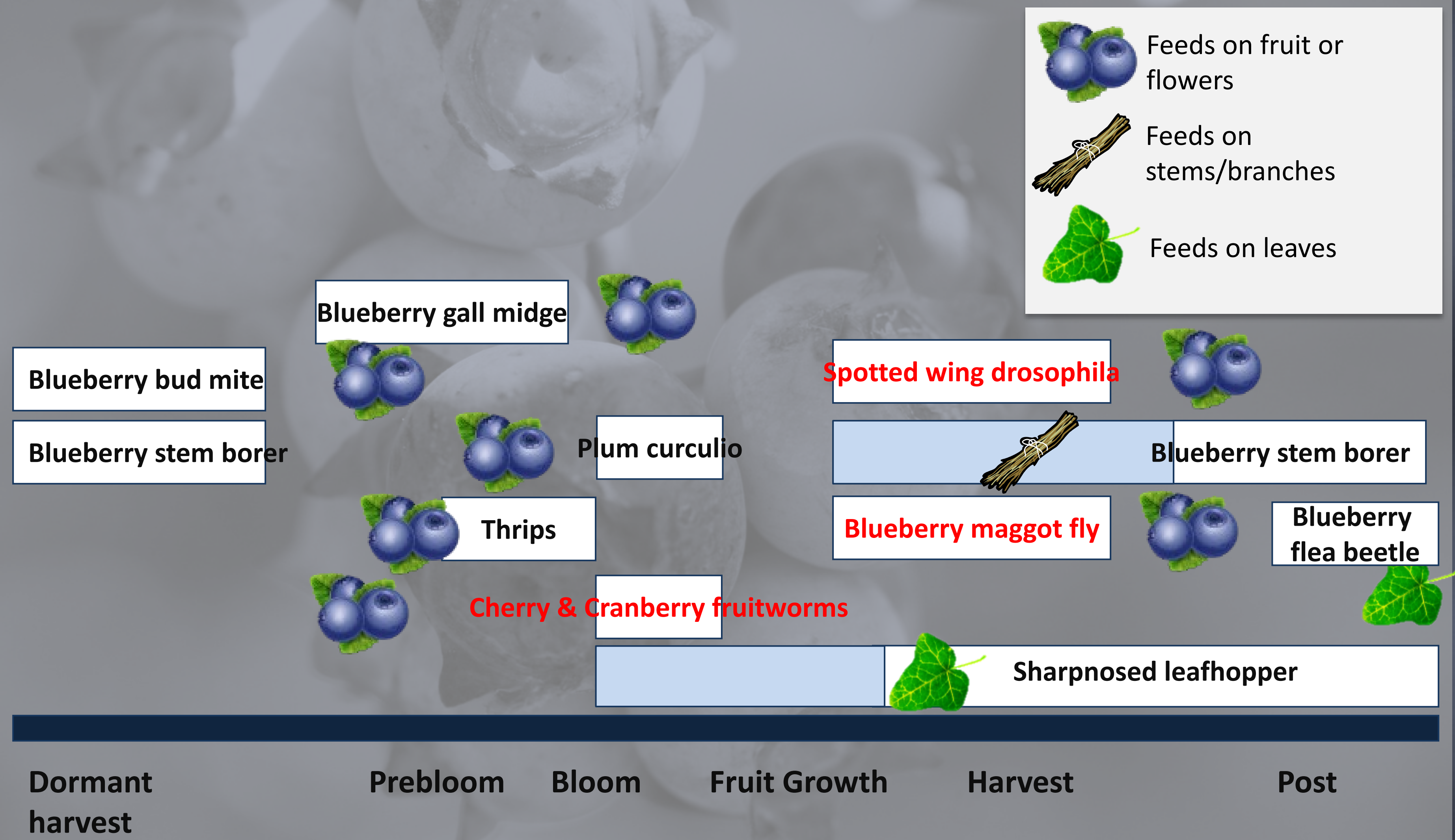
Emerging pest issues

Blueberry pollinators

Key insect pests in blueberries



The Big Four – Fruit Feeding Pests



Blueberry stem borer

Images via Jim Baker

Pruning most effective control measure

Blueberry bud mite

Post harvest pruning appears to be an effective cultural control

Prevents movement of mites into new buds

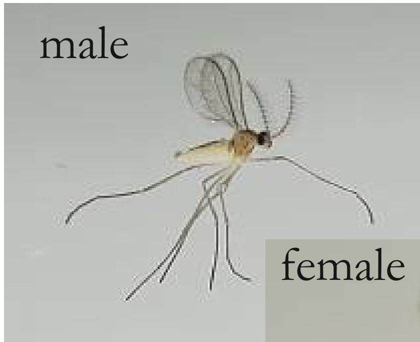
Blueberry gall midge – significance and management

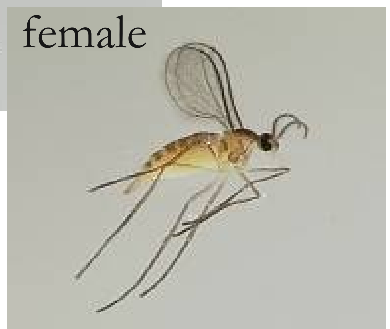
Figure 2. Blueberry gall midge infested bud (Credit: Little & Sial, University of Georgia)

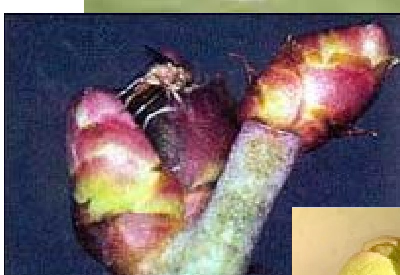
Figure 3. Blueberry buds placed in a zip-lock bag. The inset magnified to show the blueberry gall midge larvae that just emerged out of the infested buds (Credit: Little and Sial, University of Georgia)

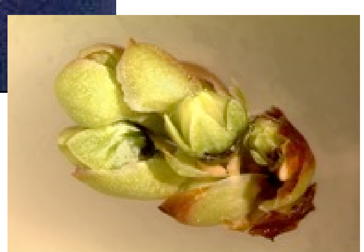
Damages flower buds in FL/GA rabbiteye

Damages new vegetative growth in upper Midwest (and in NC)





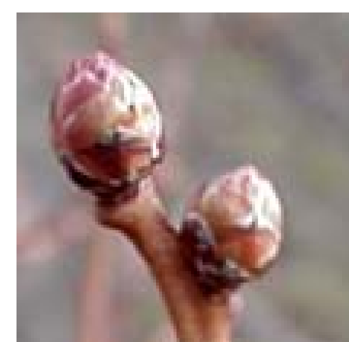




Blueberry Gall Midge ~3 mm

- Females lay eggs in flower & vegetative buds as bud scale separate, late Stage 2
- Flower buds are susceptible in stages 2, 3 (February to March for Rabbiteye)
- Up to 80% flower bud loss (Lyrene, FL 2004)
- Midge injury is easily underestimated: Midge-aborted flower buds are readily mistaken for cold injury or poor pollination

Via Ash Sial, University of Georgia



Blueberry Gall Midge ~3 mm

Monitoring:

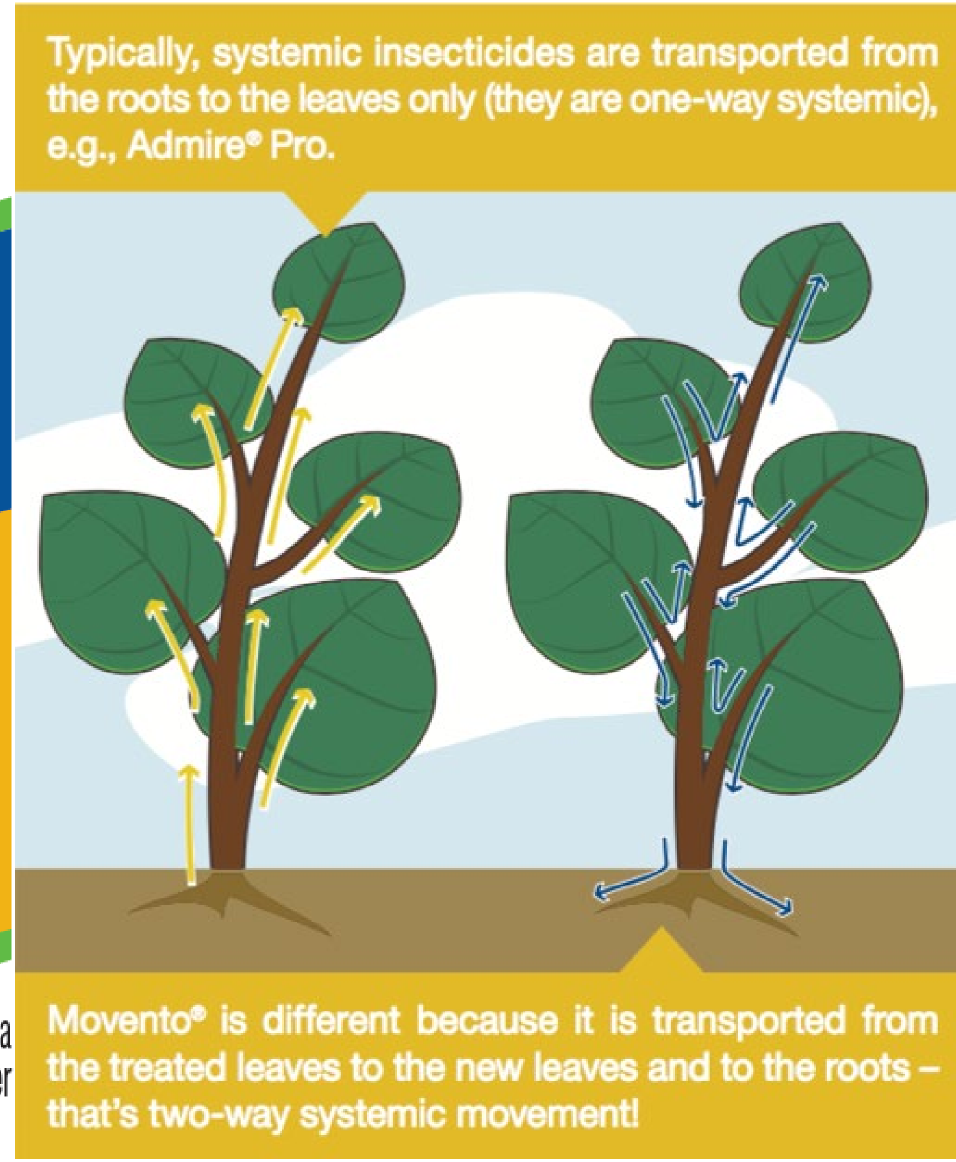
- Collect flower buds 2- to 3-Xs/week,
- Place them in zip-lock bags to monitor for larval infestation
- Use bucket traps to monitor adult emergence

Control:

- Diazinon early, followed by SpinTor/Entrust, Delegate or Assail
- Midge insecticides are protectants, they do not clean up existing larval infestations, thorough coverage is a must
- Flower bud stage-2 to bloom/fertilization is the window of vulnerability, must protect stage-2 up to bloom when weather is mild
- Spray to protect buds you think can be carried to harvest; petal-fall apps protect the late blooms

Spray timing is the key to gall midge control

Via Ash Sial, University of Georgia



Via Ash Sial, University of Georgia

BUSHBERRY SUBGROUP
LOW GROWING BERRY SUBGROUP

Crops of Crop Subgroups 13-07B and 13-07H Including: Aronia berry, Bearberry, Bilberry, Blueberry (highbush and lowbush), Chilean guava, Cloudberry, Cranberry, Currant (black, buffalo, native, and red), Elderberry, European barberry, Gooseberry, Edible honeysuckle, Jostaberry, Juneberry, Muntries, Lingonberry, Partridgeberry, Salal, Sea buckthorn, and cultivars, varieties, and/or hybrids of these.

Pests Controlled		Product Rate	
		(fl oz/A)	(lb ai/A)
Aphids Blueberry Gall Midge	Cranberry Tipworm Thrips (larvae)	8.0 - 10.0	0.13 - 0.16
Pests Suppressed		**Product Rate**	
		(fl oz/A)	(lb ai/A)
Blueberry Maggot Leafhoppers	Scales? Mealybugs? Budmites?	10.0	0.16

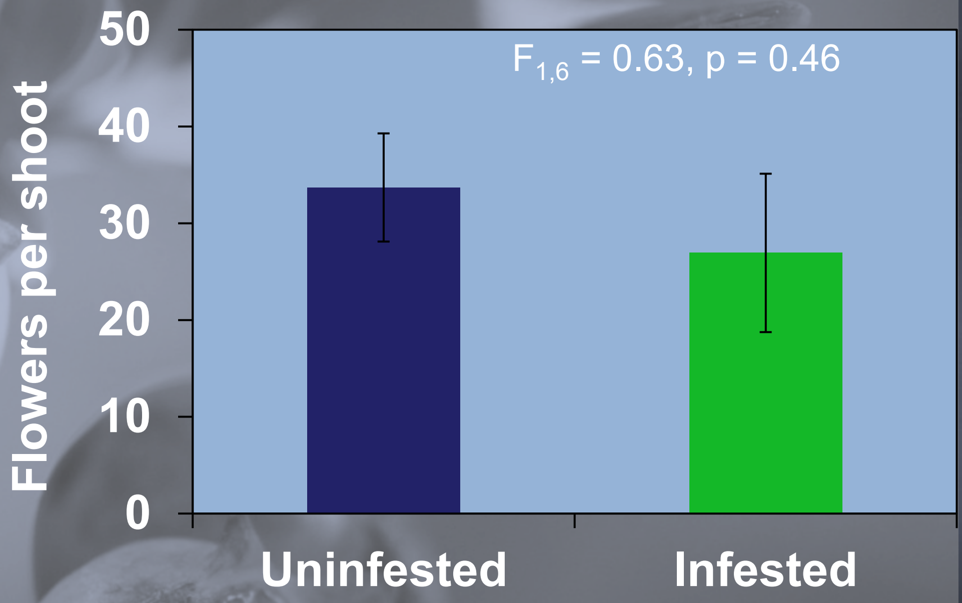
Foliar Application Restrictions:
Pre-Harvest Interval (PHI): **7 days**
Minimum interval between applications: **7 days**
Maximum MOVENTO allowed per calendar year: **30 fl oz/A**
Maximum spirotetramat per crop season: **0.47 lb ai/A**
Do not apply until after petal fall

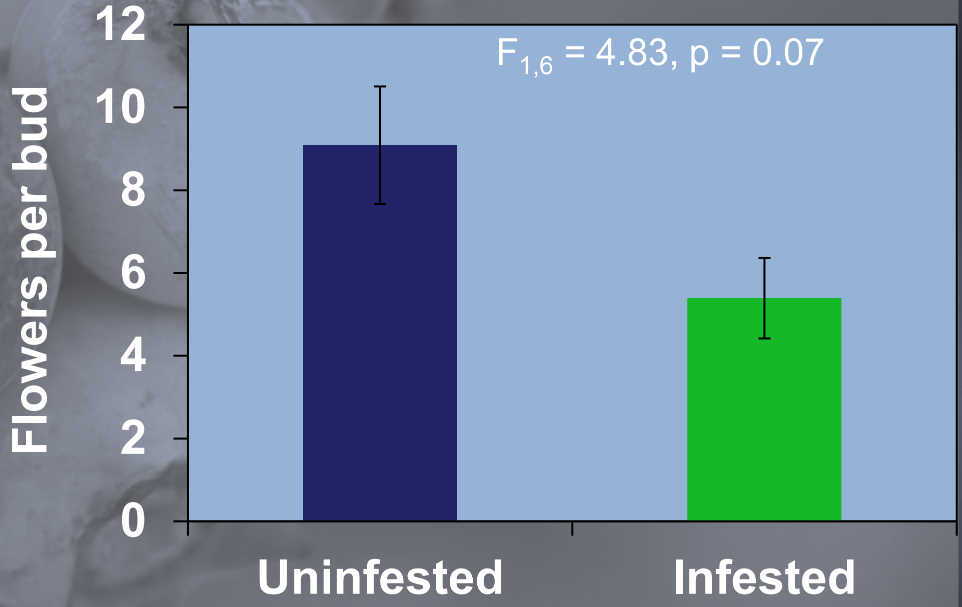
- **7 day PHI**
- **Do not apply until after petal fall**
- **Is foliage necessary for efficacy?**

Via Ash Sial, University of Georgia

Vegetative damage

- No significant difference in the number of fruit buds and flowers on infested and uninfested shoots
- Flower counts in 2011
- Trend for reduction in flowers produced per bud





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Flower Thrips (1-2 mm)

- Many species found in *blueberry* (*Frankliniella spp.)*
- Thrips feed on leaf and flower surfaces
- Active before, during, and after bloom (May move from other flowers to blueberry)
- Feed on the internal parts of flowers, preferring style tissues, reducing pollination and fruit set
- Damage to Southern highbush up to 60% lower set (GA)
- Cause tight curling and malformation of leaves

Via Ash Sial, University of Georgia

Flower Thrips (1-2 mm)

Monitoring:

- Sample 2 to 3 times per week beginning with Stage 3
- Place bloom clusters in sealed bags to drive thrips out

Thresholds: < 2/bloom OK
> 2/bloom becoming problematic
> 6/bloom quite injurious

Control:

- **Diazinon early, followed by SpinTor/Entrust, Delegate or Assail, and Sivanto**

Adjust spray timing to protect pollinators

Via Ash Sial, University of Georgia

Chilli Thrips ~ 1.2mm

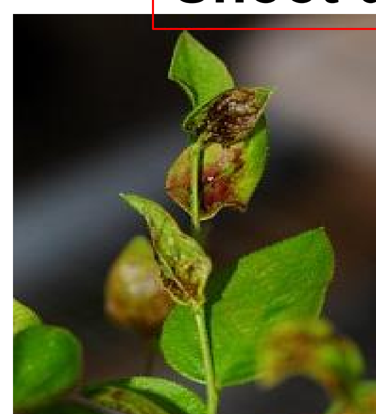
(*Scirtothrips dorsalis* Hood)

- Established in FL
- First detected in GA blueberries in 2017
- Outbreaks occur usually during postharvest
- Feed on foliage and rarely cause economic damage
- Monitor weekly and apply insecticides if more than 5% field is infested
- Effective materials include: Assail, Delegate, and synthetic pyrethroids

Via Ash Sial, University of Georgia

Leaf bronzing

Shoot die-back



Fruitworms: Identification

Figures 1-2. Adults of CFW (1) and CBFW (2)

Eggs laid in calyx cup on young fruit


Figure 13. Webbing (arrow) and premature ripening of fruit caused by feeding larvae.

Larvae overwinter in hibernaculae in soil (CBFW) or in pruning stubs/dead leaves (CFW)

Pupation occurs in spring, and adults emerge around bloom

Fruitworms: Identification


Cranberry fruitworm = more than two damaged fruit


Cherry fruitworm = two damaged fruit, stuck together

Cherry fruitworm moths

Left – male on trap

Right - male on trap (top) with contaminant moth below.

Moth = 8-10 mm long

Cranberry fruitowrm moths

Left – male with wing opened

Right – male on trap

Moth = 15-18 mm long

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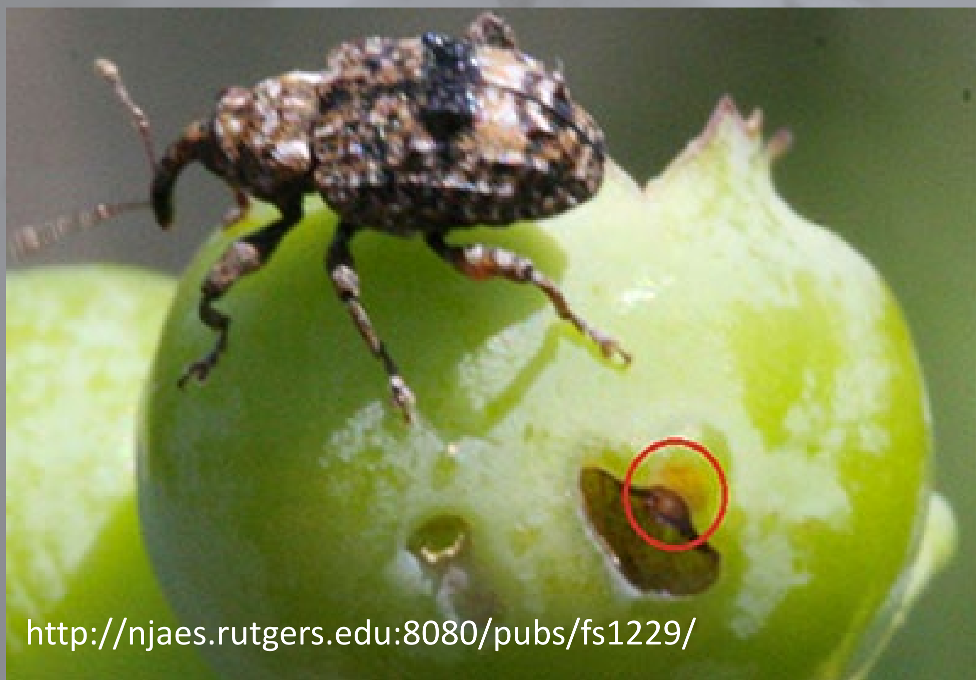
Fruitworms: Management recommendations

In locations with adult trap captures, treatments should be timed to egg hatch (~3 days after peak trap capture), typically around petal fall

Select materials selective for caterpillars (Bt, Intrepid, Confirm, Knack, etc)

Unless plum curculio is a concern…

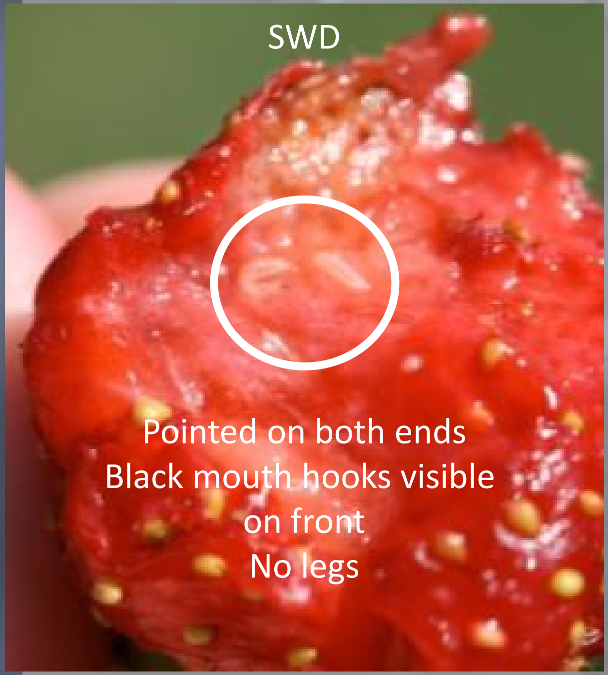
Integrating plum curculio control

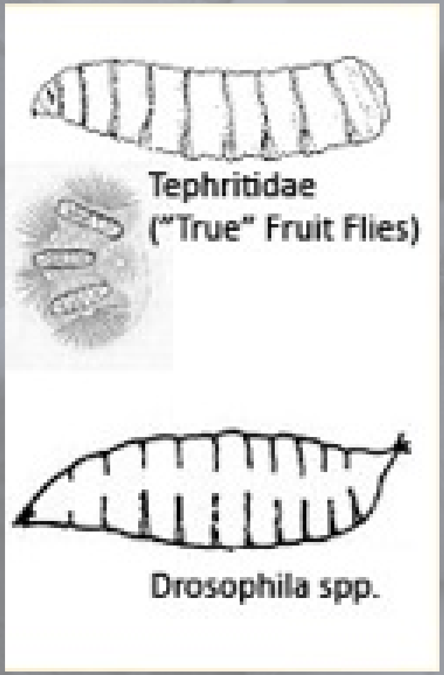


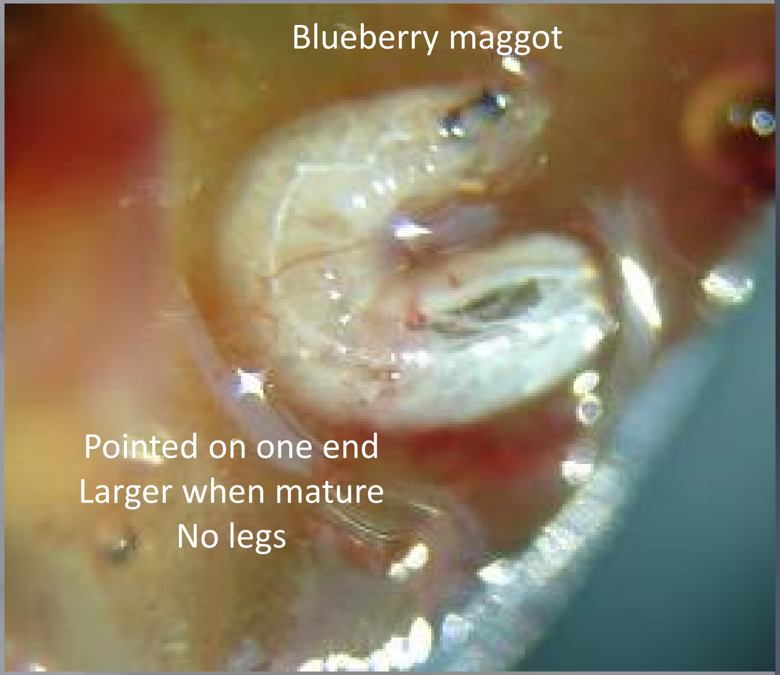
Unless plum curculio is a concern…

*In which case, Avaunt is effective against both, but is **not acceptable** for export to Canada*

Blueberry maggot identification







Blueberry maggot identification

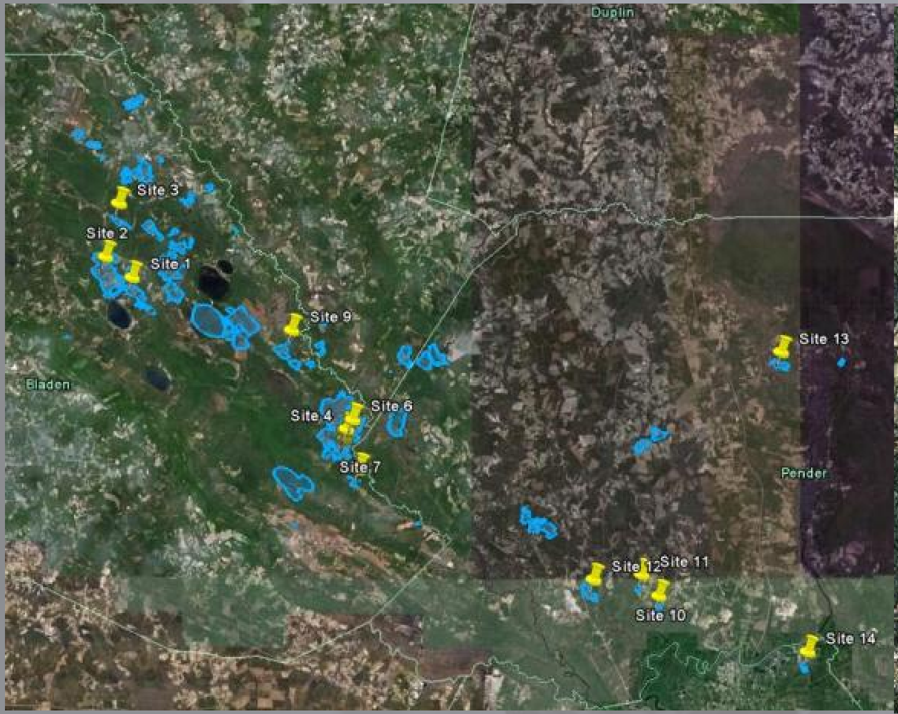
Blueberry maggot adults are roughly 50% bigger than spotted wing drosophila

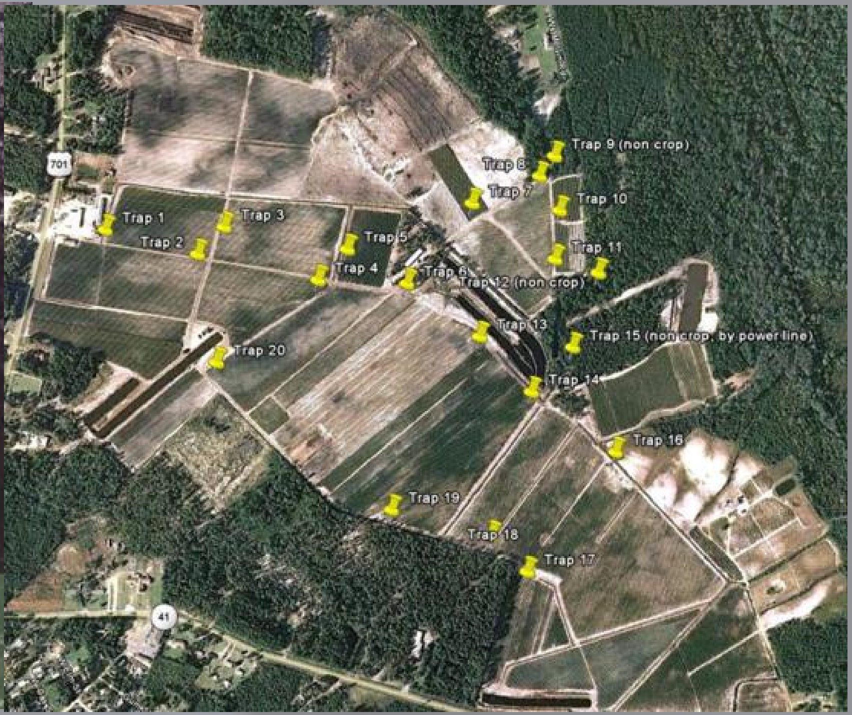
Blueberry maggot monitoring

Monitoring methods

- *Yellow sticky (AM) traps baited with external ammonium bicarbonate lures*
- *DO NOT use prebaited traps, use AM-NB*
- *Check and change bait at least weekly*
- *Hang with fold facing down*

Blueberry maggot monitoring





Blueberry maggot monitoring

Site	Size (acres)	County	Number of traps	Weeks observed	Total *R. mendax* captured
1	270	Bladen	20	12	0
2	300	Bladen	26	13	1
3	40	Bladen	5	13	0
4	73	Bladen	9	13	0
5	153	Bladen	13	13	1
6	55	Bladen	7	13	0
7	27	Bladen	5	11	0
8	80	Bladen	9	12	0
9	165	Bladen	13	13	0
10	80	Pender	9	12	0
11	30	Pender	5	10	0
12	220	Pender	16	13	1
13	65	Pender*	9	11	0
14	1	New Hanover*	3	13	0
Total	1559		149		3
15 (validation site)	5	Rockingham*	4	8	165

Key arthropod pests in blueberries

Spotted wing drosophila update

Emerging pest issues

Blueberry pollinators

Drosophila suzukii

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NC COOPERATIVE EXTENSION

Challenges for management

- **Fast life cycle → Overlapping generations**
- **High fecundity**
- **Highly mobile adults**
- **Wide range of crop and non-crop hosts**

>130 known hosts
31 plant families

Monitoring & risk assessment for *Drosophila suzukii*

Traps

Traps are inefficient at predicting infestation

- Traps indicate presence/ … adult flies
- Traps may be usef… g the start of treatments in some crop…
- <u>No</u> a… g system has been demonstrated to … well with fruit infestation
- … standard lures; no lures more attractive than fruit yet

Hamby et al. 2014, Burrack et al. 2015

Need for an efficient larval assessment

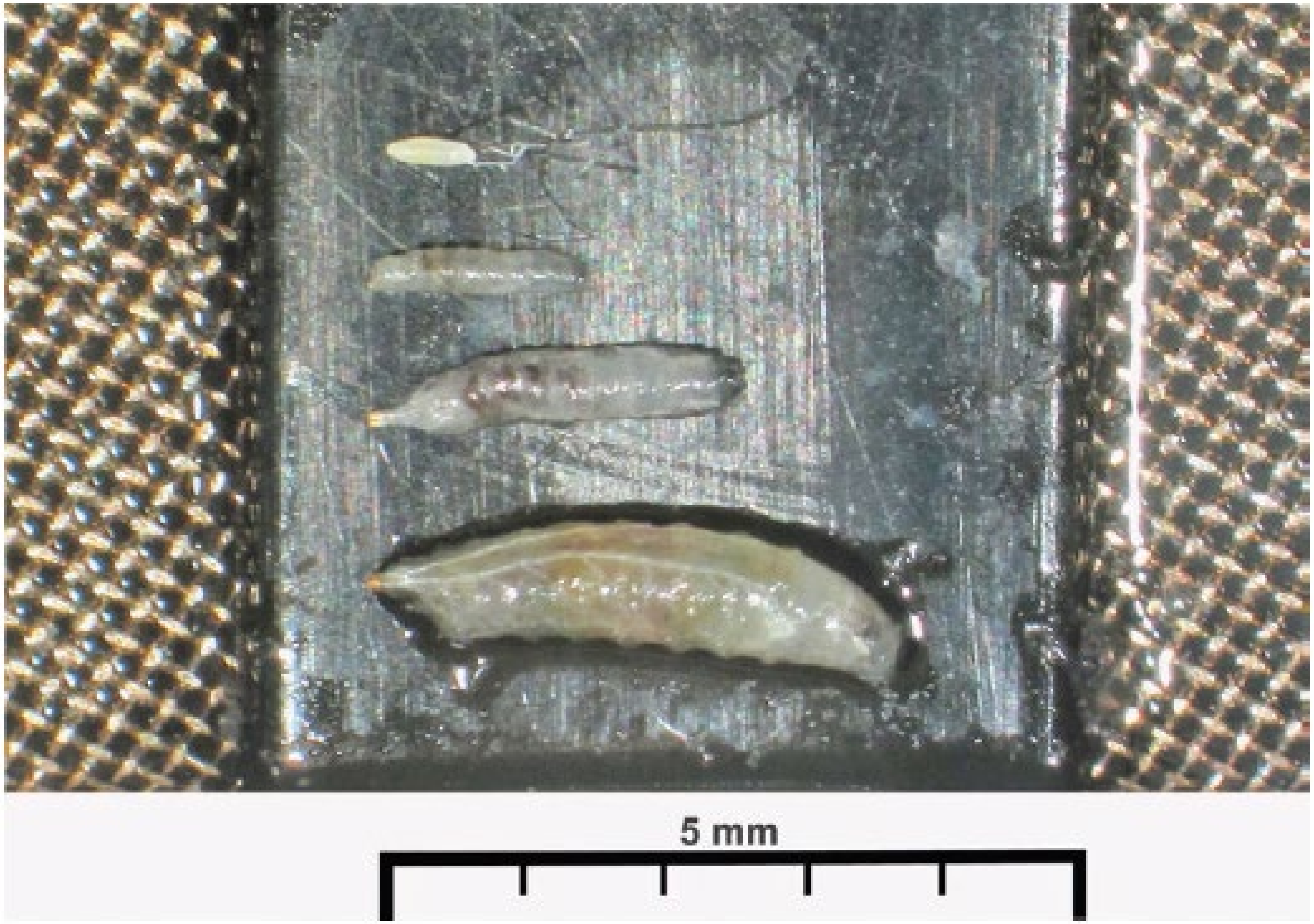
- **Research**
  - **Lack of consistency across research groups**
  - **Rearing is only way to detect eggs, small larvae, & ensure species identity**
- **Grower/Scout**
  - **Need easy tool that is cost efficient**
  - **Ability to detect infestation sooner can aide in management decisions**

Filter salt test methods

Maybe not the best for sampling strawberry…

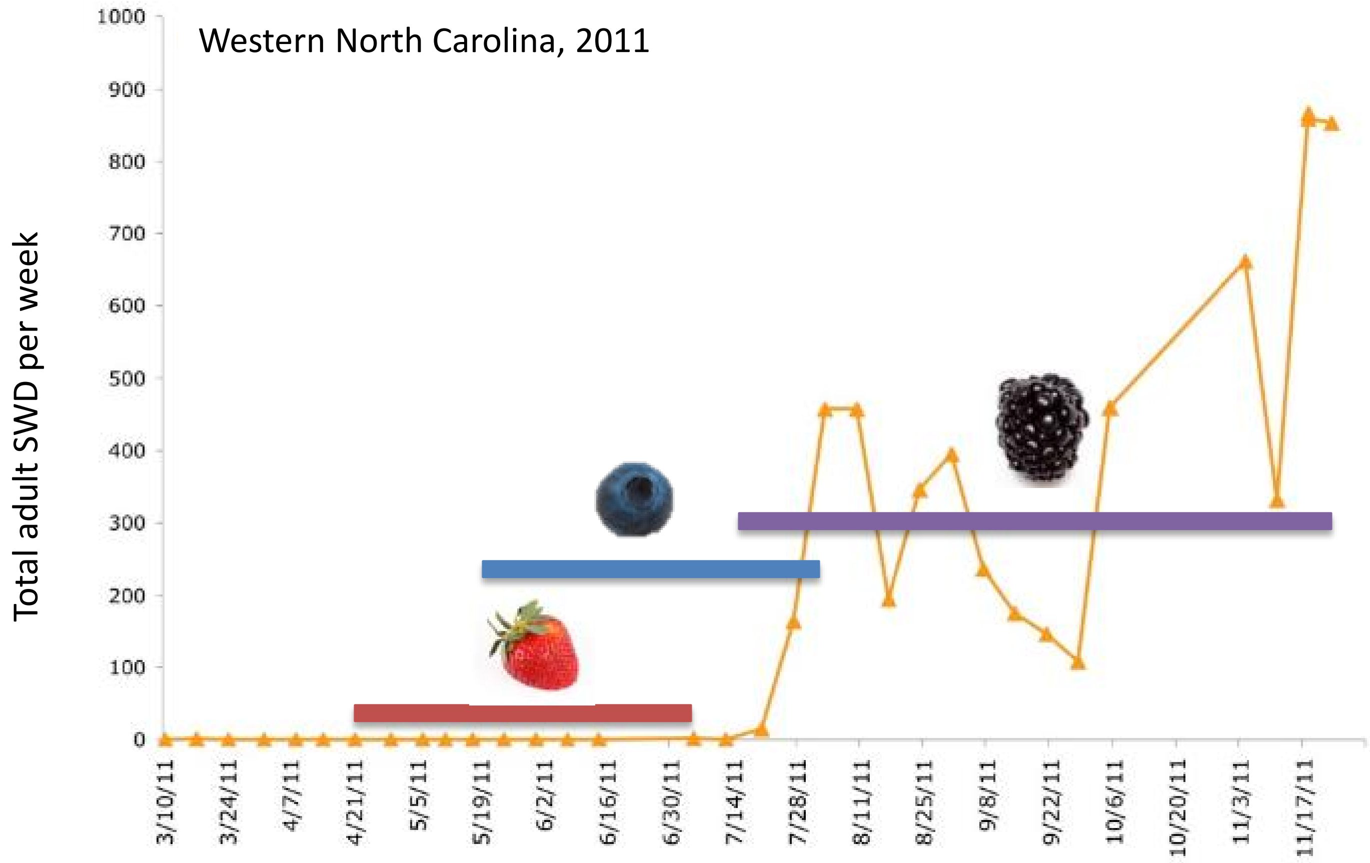
Van Timmeren et al. 2017, Figure 1a

Larval ID: Instars (Field ID)

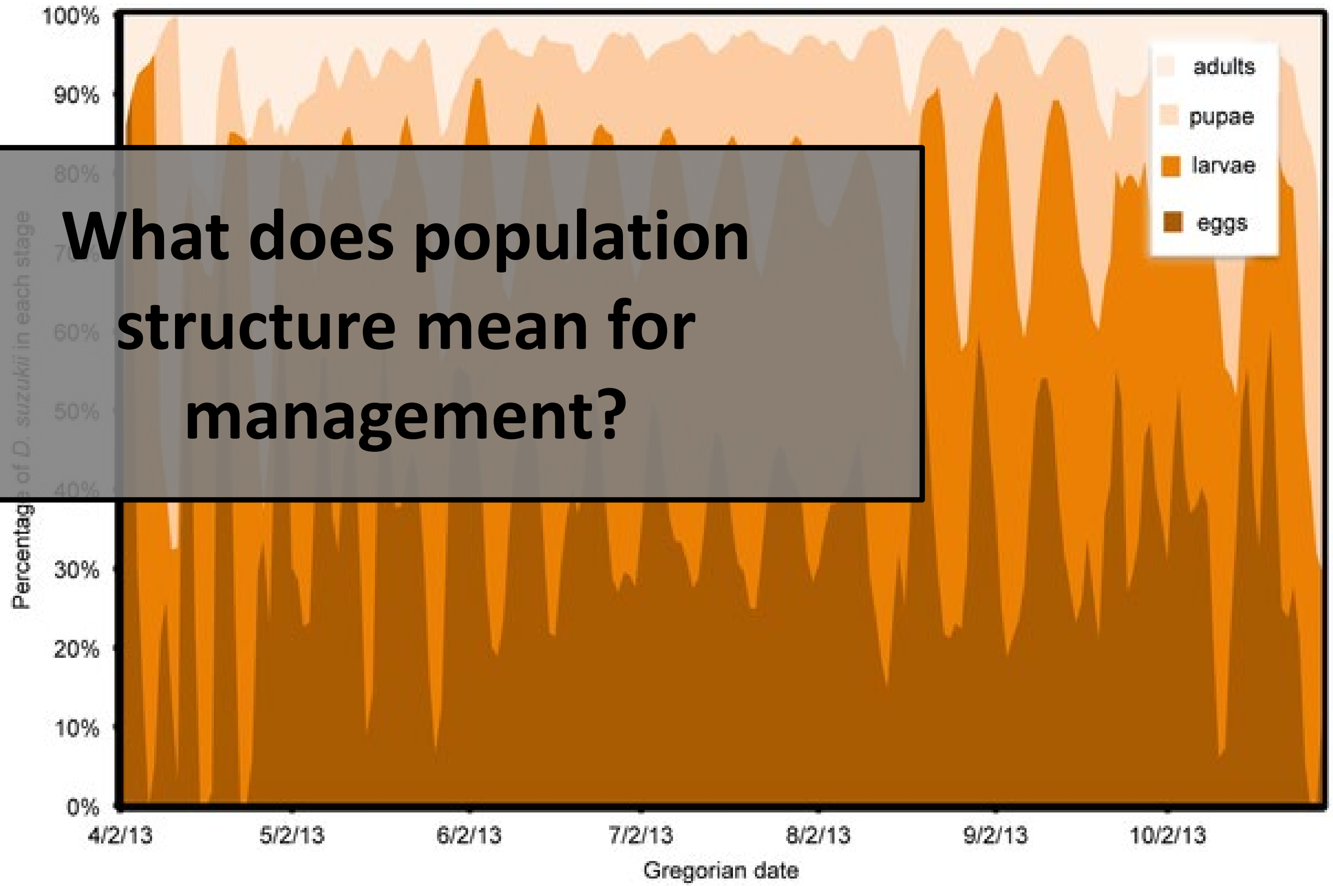


Van Timmeren et al. 2017, Fig. 2

Incorporating seasonal biology into management



Population structure influences crop risk *and* may influence management efficacy for insecticide-based programs



What does population structure mean for management?

Estimates of SWD population structure in Wilmington (North Carolina), US during 2013.

Oregon State UNIVERSITY OSU

Wiman et al. 2014. PLoS Computational Biology.

Potential sources of early-season flies

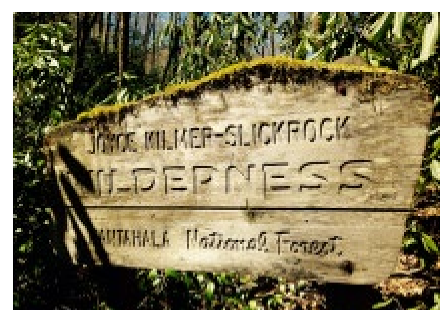
Fruit waste / Compost

Bal et al. 2017

Briem, F. et al. 2016. *J Pest Sci*

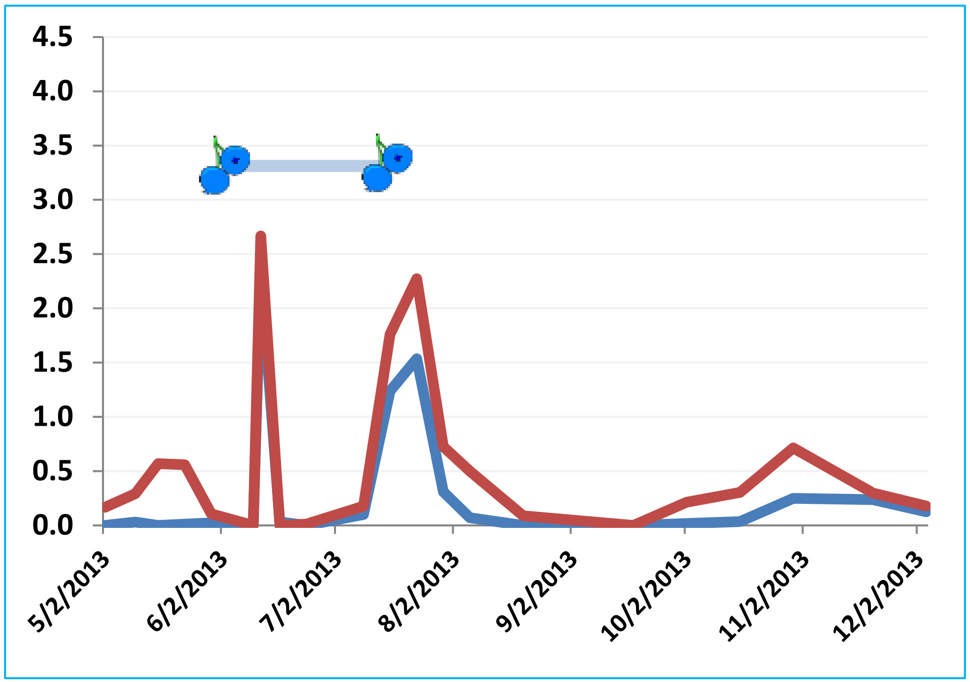
Winter fruits (mistletoe)

Wilderness areas



Elsensohn and Burrack *unpub.*

Potential sources of early-season flies: Do they survive local winter conditions?



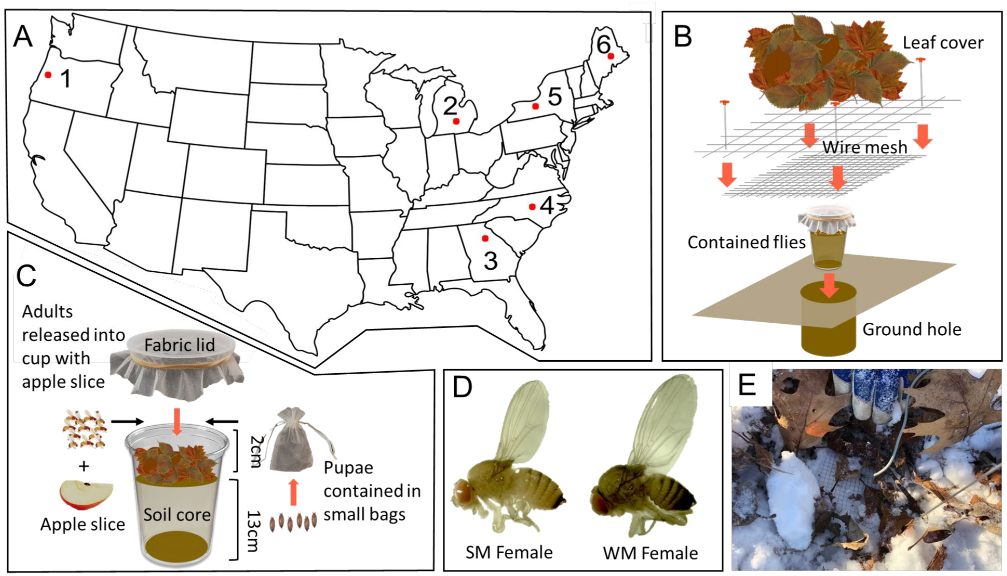
NC Blueberry, 2013 *Unpub data*

- -flies present after harvest
- -trapped throughout winter
- -WHAT is going on?

Potential sources of early-season flies: Do they survive local winter conditions?

PROJECT 1: MULTISTATE OVERWINTERING FIELD TRIAL

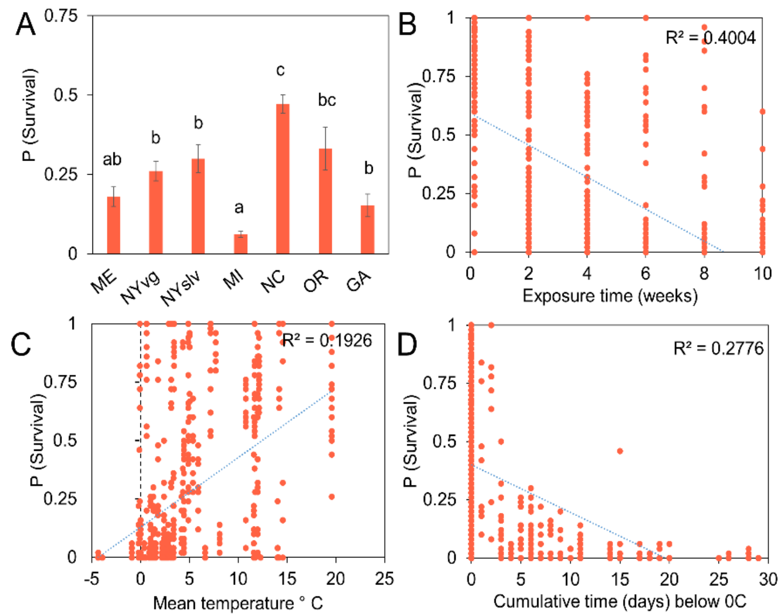
- Determine the likelihood of SWD overwintering success in the Northern and Southern U.S.
- Assessed effects of sex, lifestage, and phenotype on survival in OR, MI, NY, ME, NC, and GA.



Test sites (A), deployment method in field (B,C), phenotype differences (D), and snow pack covering flies in the field (E).

CONCLUSIONS & IMPLICATIONS

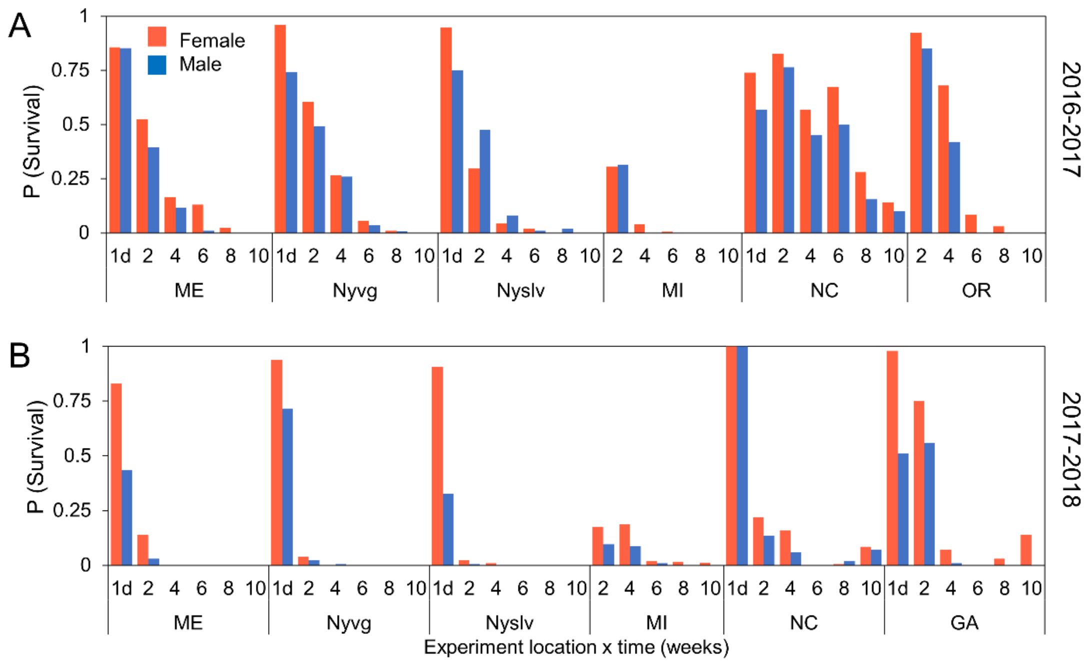
1. Adult female WM flies are the most likely to overwinter
2. Extended durations below 0 C associated with high mortality
3. Protected refuge is likely critical for survival of D. suzukii



Differences in overall survival (proportion alive) at each field site (A). Different letters indicate statistically significant differences in overall survival. Survival (proportion alive) plotted against total exposure time (B), cumulative time below zero (C), and mean exposure temperature (D) pooled for both test years and all field sites.

Potential sources of early-season flies: Do they survive local winter conditions?

PROJECT 1: MULTISTATE OVERWINTERING FIELD TRIAL



Differences in mean survival over time at each test site in 2016-2017 (A) and 2017-2018 (B). Samples were collected in 2 week intervals. Females are shown in red. Males are shown in blue. Test site abbreviations refer to the following: Maine (ME), Nyvg (New York Vignoles site), Nyslv (New York Silverthread site), Michigan (MI), North Carolina (NC), Oregon (OR), and Georgia (GA).

CONCLUSIONS & IMPLICATIONS

1. Adult female WM flies are the most likely to overwinter
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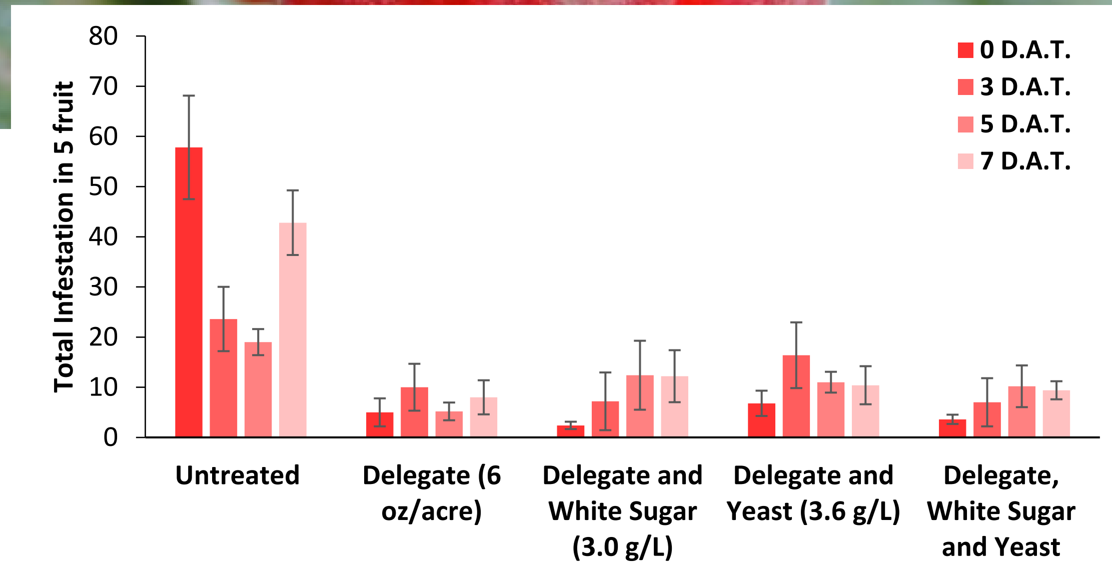
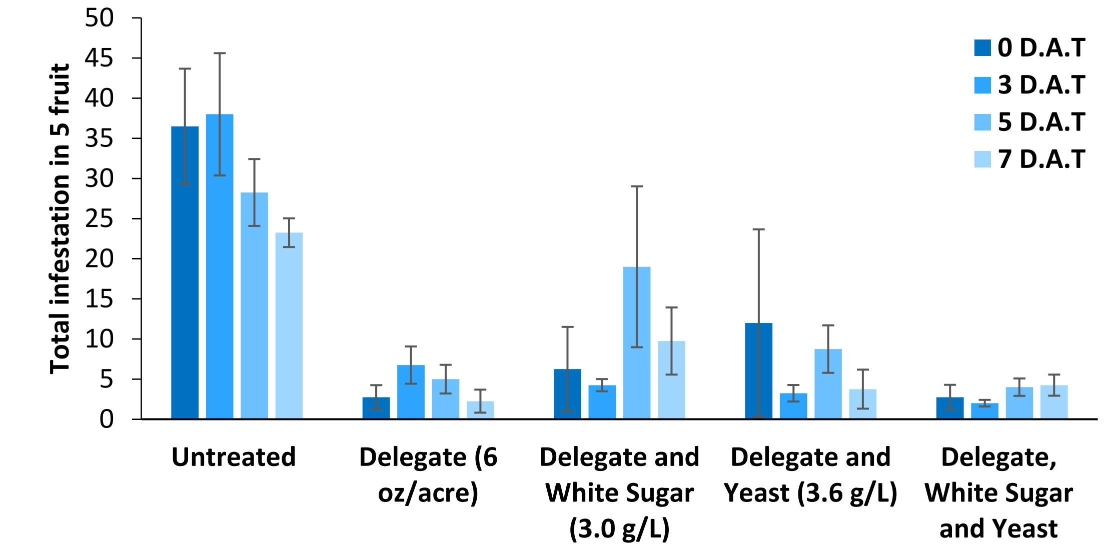
3. Protected refuge is likely critical for survival of D. suzukii

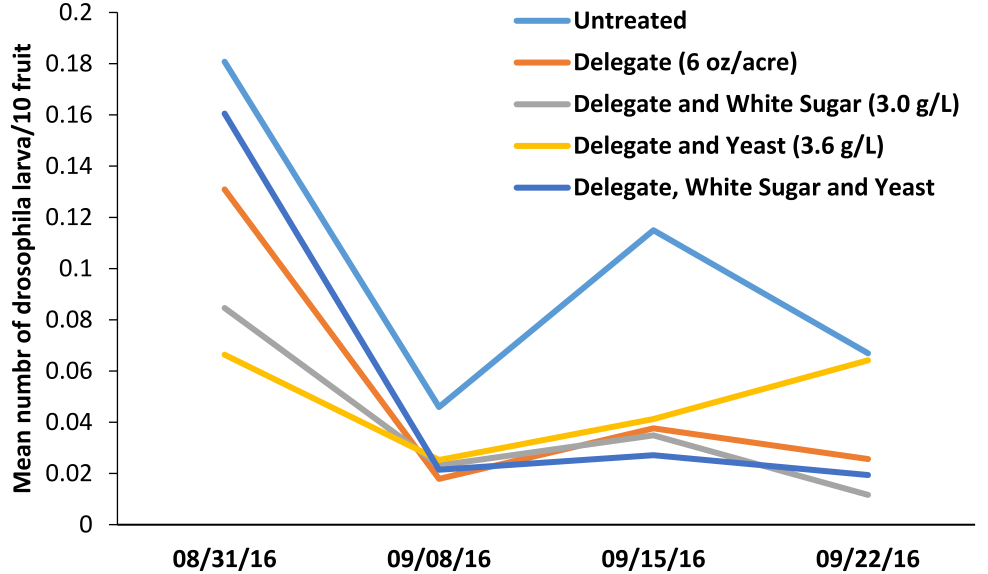
Phagostimulants– No benefit of sugar or yeast in semi-field assays

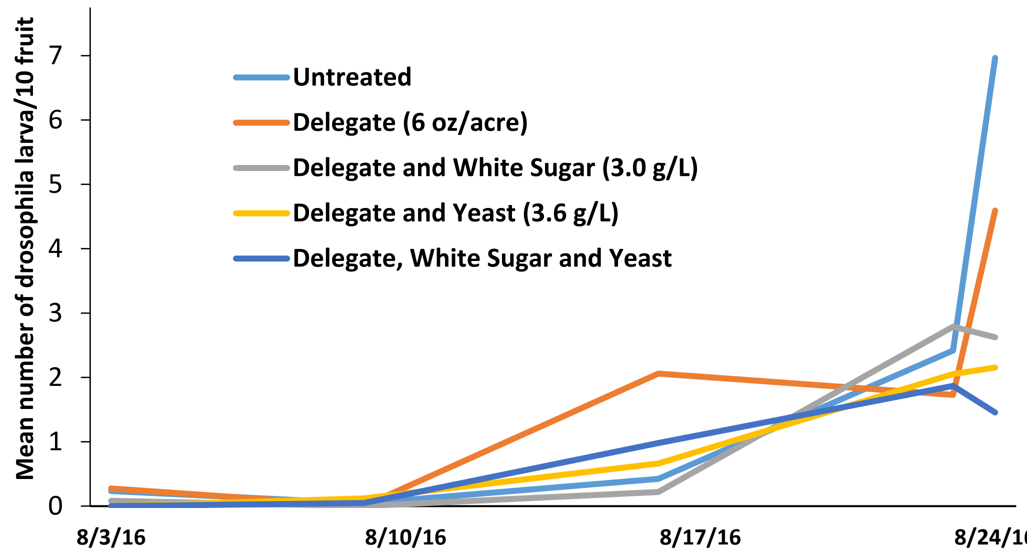




Isaacs lab, MSU
Frank Drummond, Maine

Phagostimulants– Limited benefit in the field





Isaacs lab, MSU
Frank Drummond, Maine

2017 Best Management Trials
NC Blackberry

Rotation

Delegate & Malathion

+/- adjuvant NuFilm P

Floricane

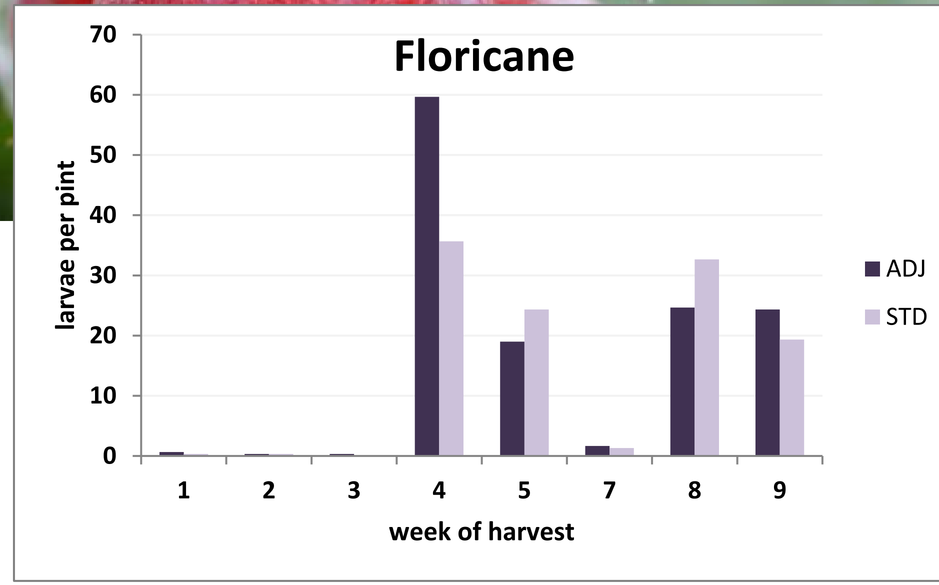
No difference in infestation

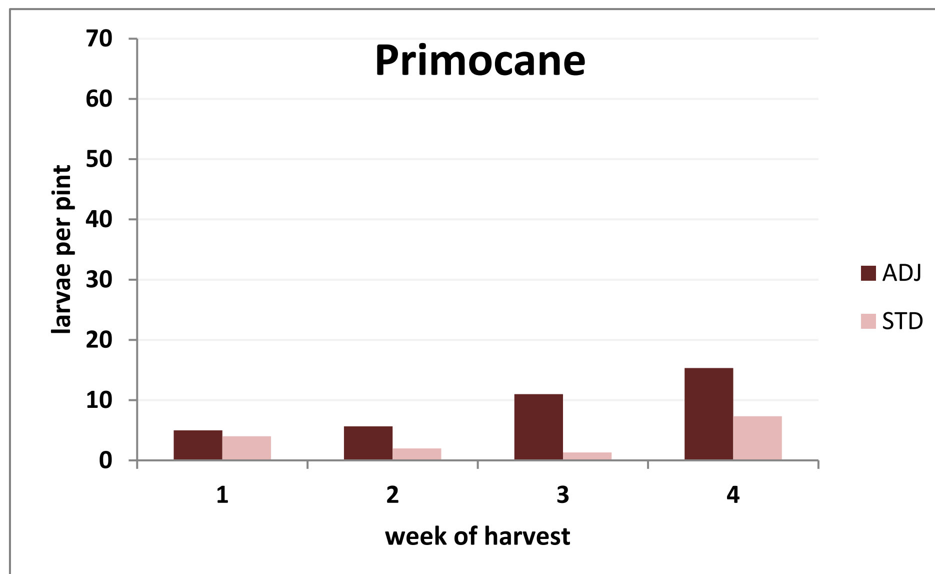
($F_{1,30}$ =0.16, p =0.693)

Primocane

More infestation in plots with adjuvant

($F_{1,14}$ = 6.72, p = 0.0213)



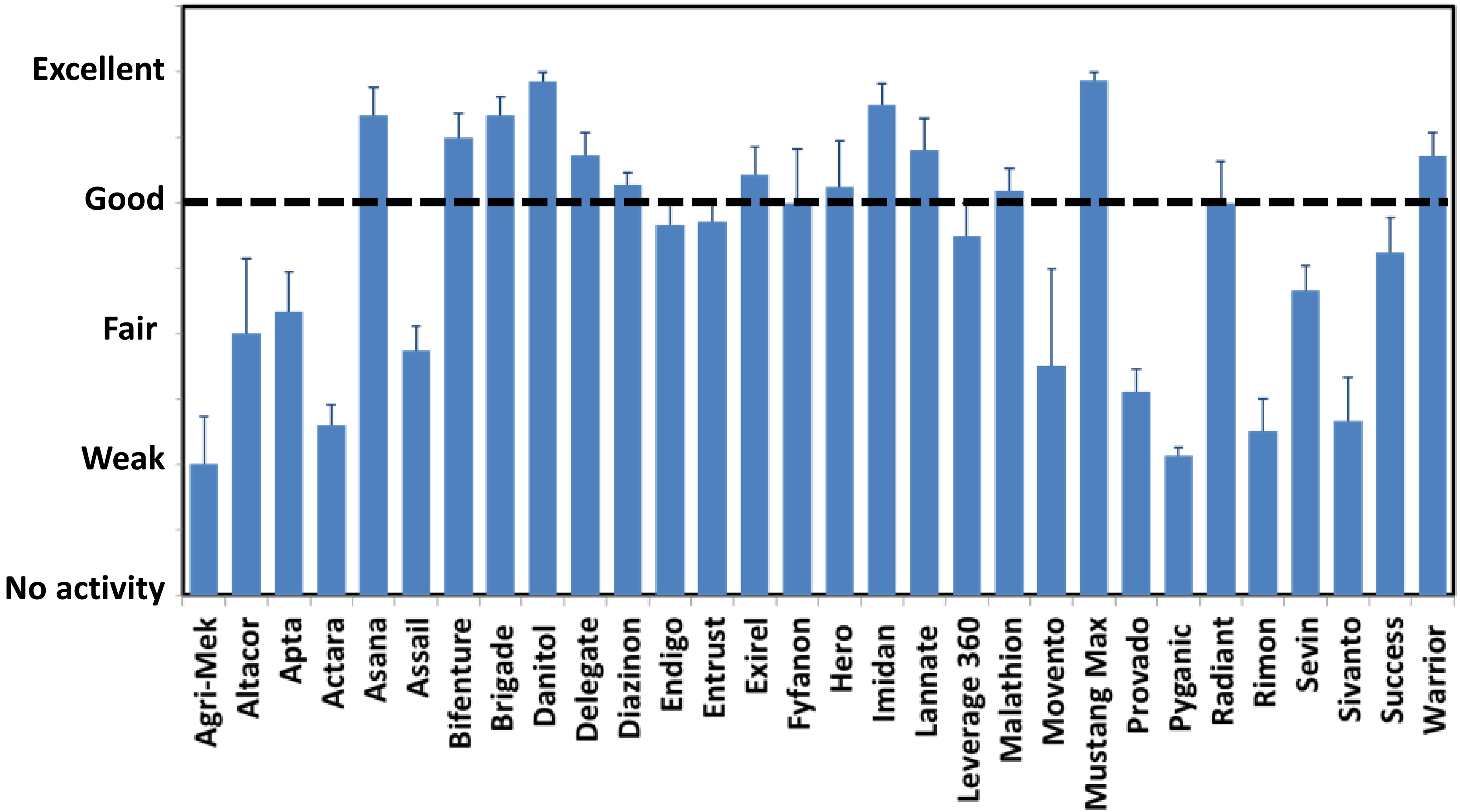


Summary rankings of insecticide efficacy against *D. suzukii*

10 states, 20 state x crop combinations

CA, OR, WA, MI, ME, NY, NJ, NC, GA, FL

Rufus Isaacs
MSU



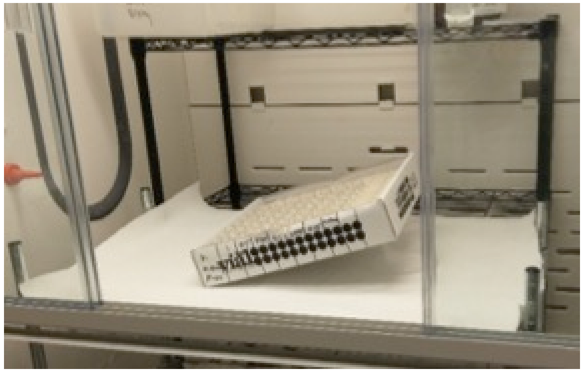
Efficacy of currently used insecticide tools

Rufus Isaacs
MSU

Ash Sial
U of GA

Glass vial assays

- Field collected populations from areas treated with target pesticides
- Assessed mortality of 5 male, 5 female *D. suzukii* after 6 h of exposure



Efficacy of currently used insecticide tools

- 2017 screening at LC99x2 indicates high susceptibility, with some populations needing follow-up testing
- 2018 screening at LC90x8 th… indicates high suscep…

No evidence of resistance observed in field-collected flies in the Southeast!

State	Site	Managt.	Female malathion	Female methomyl	Female spinetoram	Female spinosad	Female zeta-cyp	Male malathion	Male methomyl	Male spinetoram	Male spinosad	Male zeta-cyp
CA	A	No spray										
	B	Organic										
	C	Organic										
	D	Organic									93.3	
	E	Orga…									89.2	
	F										90.0	
FL								100		100	100	
								100		100	100	
						100	100	100	100	100	100	100
						100	100	100	100	100	100	100
					100	100	100	96.7	100	100	100	100
				96.7	100	100	100	100	100	100	100	100
			76.7	83.3	100	100	100	100	93.3	100	100	100
		…ganic	100					100				
		Conv H	100					100				
	C	Conv H	100					100				
MD	A	Organic				100	100				97.5	100
	B	Conv H				93.8	93.3				100	100
	C	Conv H				93.8	100				100	95.0
	D	Conv H				100	100				100	100
MI	A	No spray	100	100	100	100	100	100	100	100	100	100
	B	No spray	100	100	100	100	100	100	100	100	100	100
	C	No spray	100	100	100	100	100	100	100	100	100	100
	D	Conv H	100	100	93.3	100	100	100	100	100	100	100
	E	Conv H	100	100	100	100	66.7	100	100	100	100	66.7
	F	Conv H	100	100	100	100	100	100	100	100	100	100
NJ	A	No spray	100	65.9		100	100.0	100	69.7		100	100
	B	Conv H	96.0	70.7		100	87.6	100	74.0		100	97.1
	C	Conv H	93.8	52.2		100	84.7	100	82.7		100	100
	D	Conv L	100	77.0		100	100.0	66.7	76.0		100	100
	E	Conv H	64.3	48.2		100	65.3	81.7	89.3		100	100
NC	A	Conv H	100			100	100	100			100	100
	B	Conv H	100			100	100	100			100	100
	C	Conv H	100			100	100	100			100	100
	D	Conv H	100			100	100	100			100	100

State	Site	Managt.	Female malathion	Female methomyl	Female spinetoram	Female spinosad	Female zeta-cyp	Male malathion	Male methomyl	Male spinetoram	Male spinosad	Male zeta-cyp
GA						100	93.10					
	B					100	100					
	C					100	96.67					
	D		100			100	96.55					
	E	…v H	100			100	96.67					
	F	Conv H	100			93.3	100					
	G	Conv H	100			96.67	96.55					
	H	Conv H	100			100	96.55					
	I	Conv H	100			100	96.55					
	J	Conv H	96.3			100	100					

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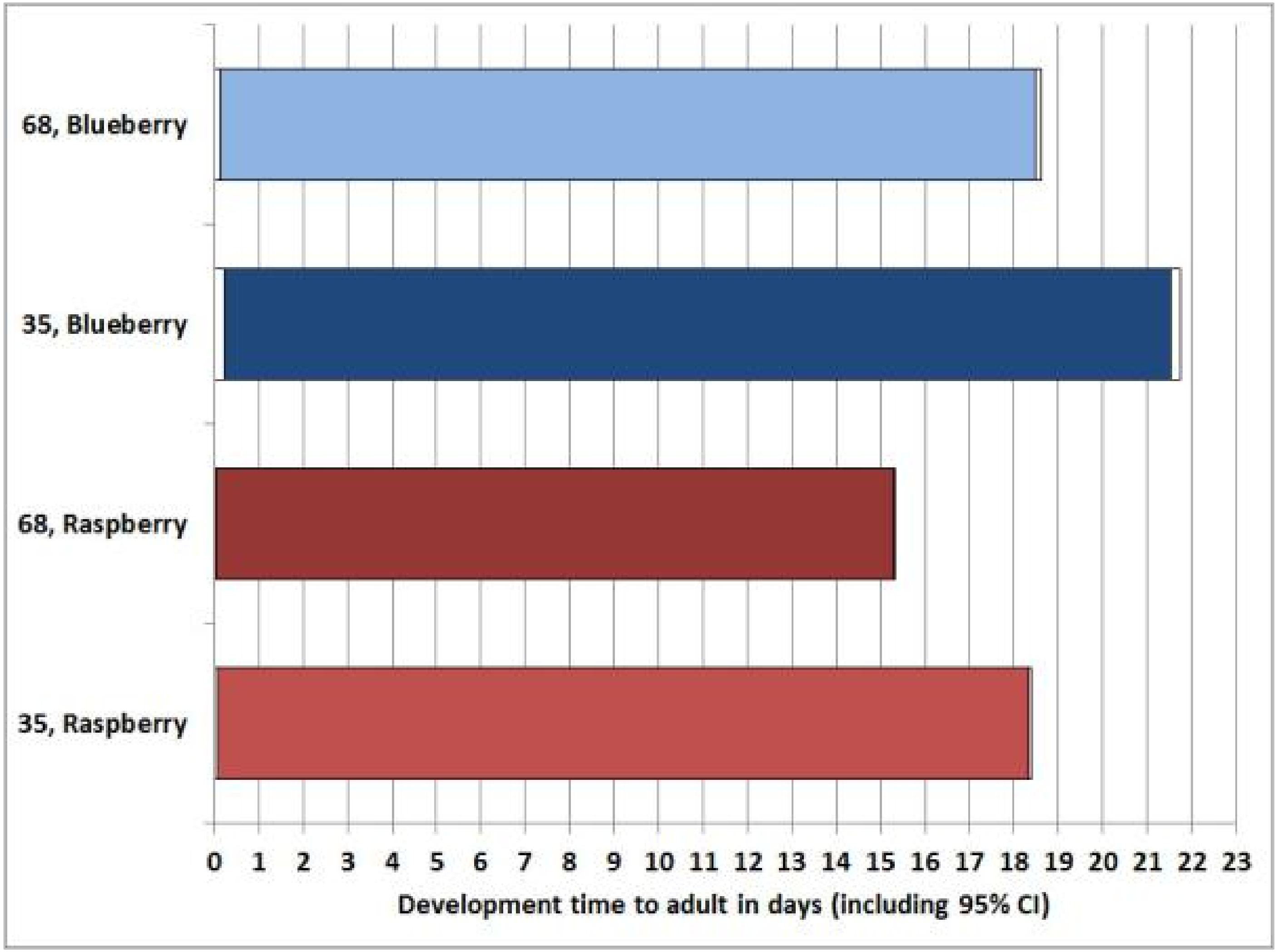
Post harvest cold storage



Development took at least 3 days longer in cold treated fruit, meaning larvae did not develop at 35F

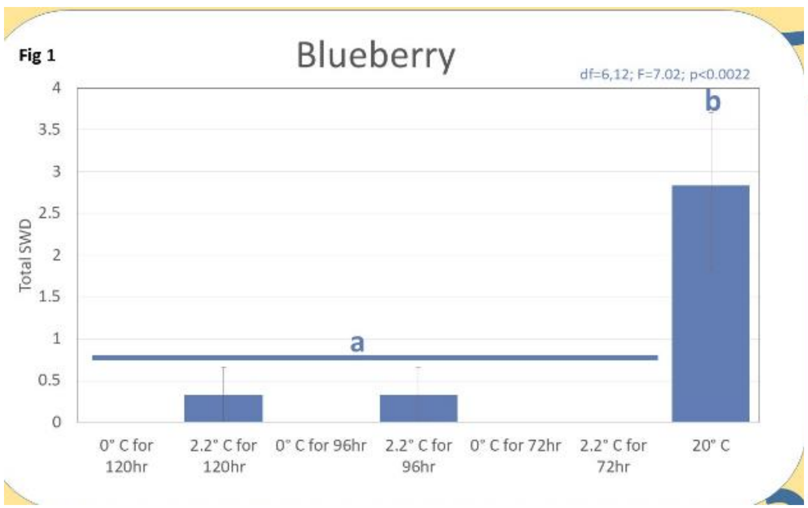
Development was faster in raspberries than in blueberries

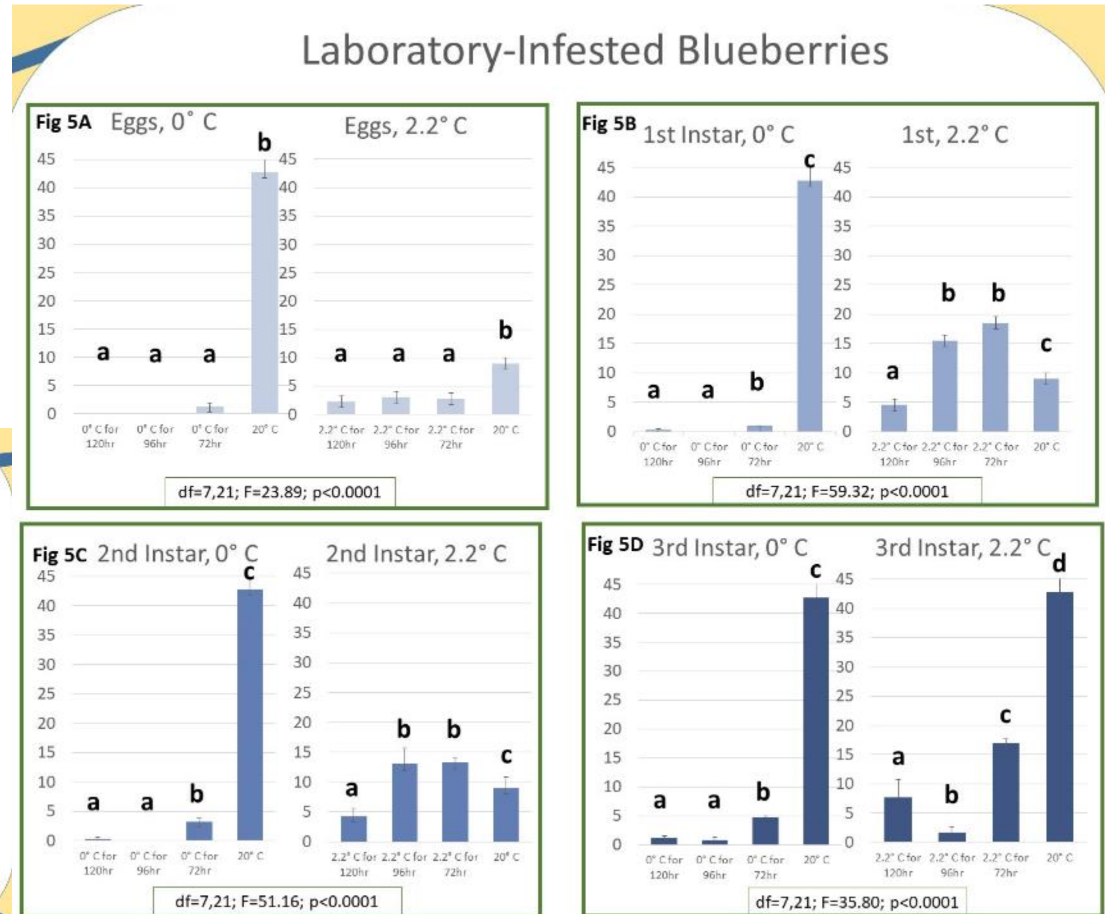
Aly et al. 2017 J Econ Ent

Post harvest cold storage

Variable effects of cold storage in immature SWD of different ages in blueberries

Differences between temperatures
Differences between stages
Additional experiments needed to address unclear patterns





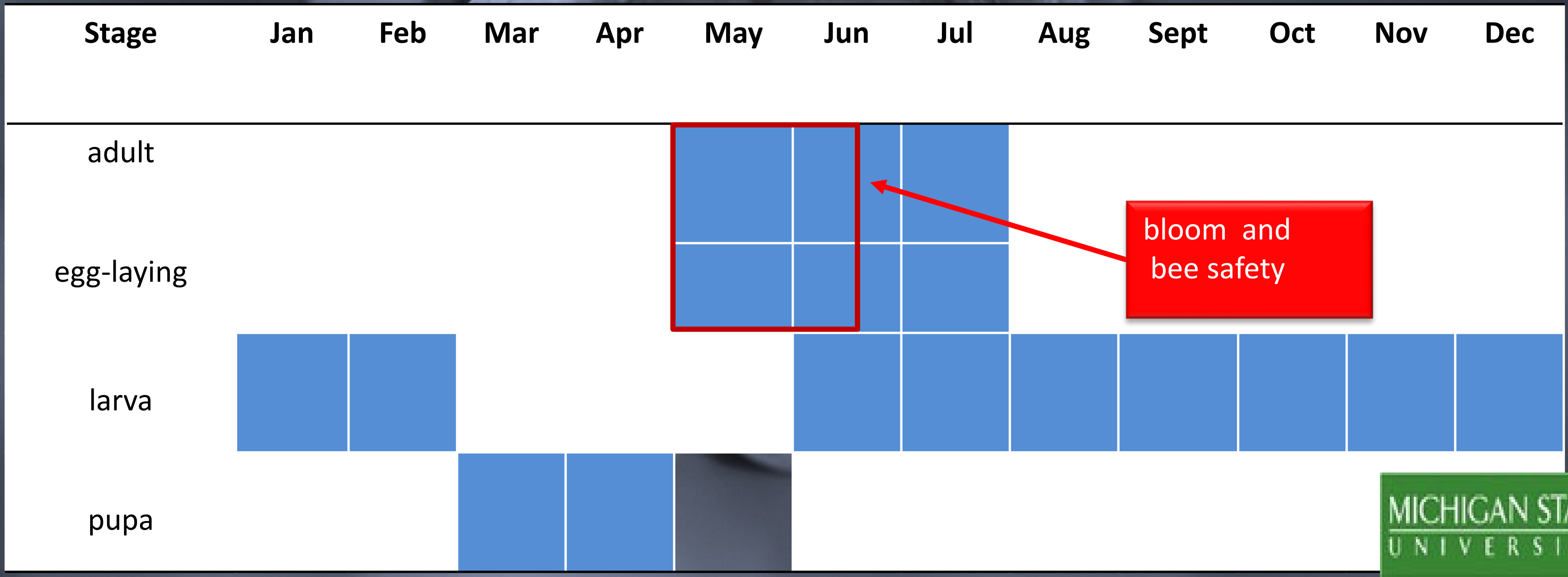
Key arthropod pests in blueberries

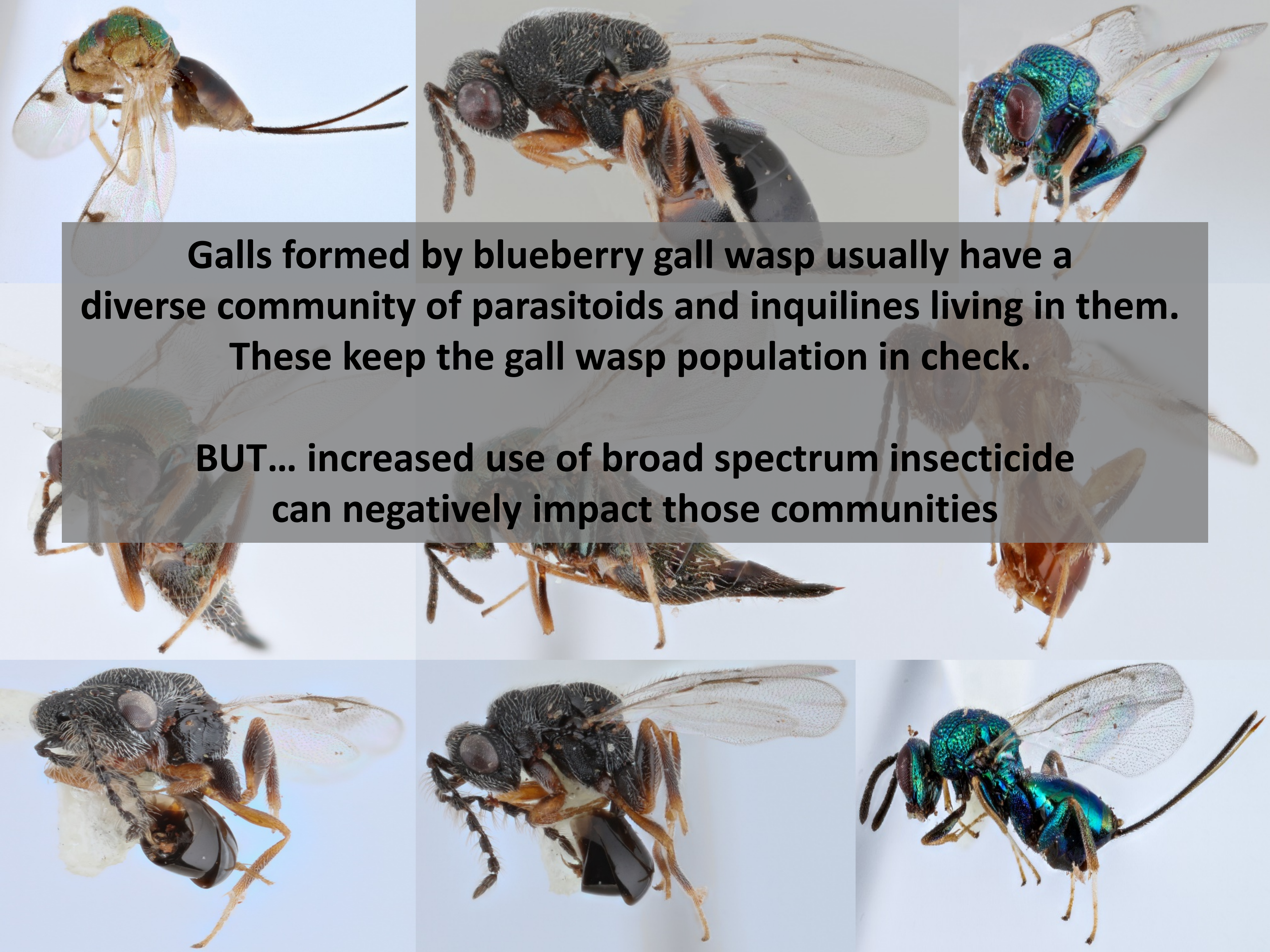
Spotted wing drosophila update

Emerging pest issues

Blueberry pollinators

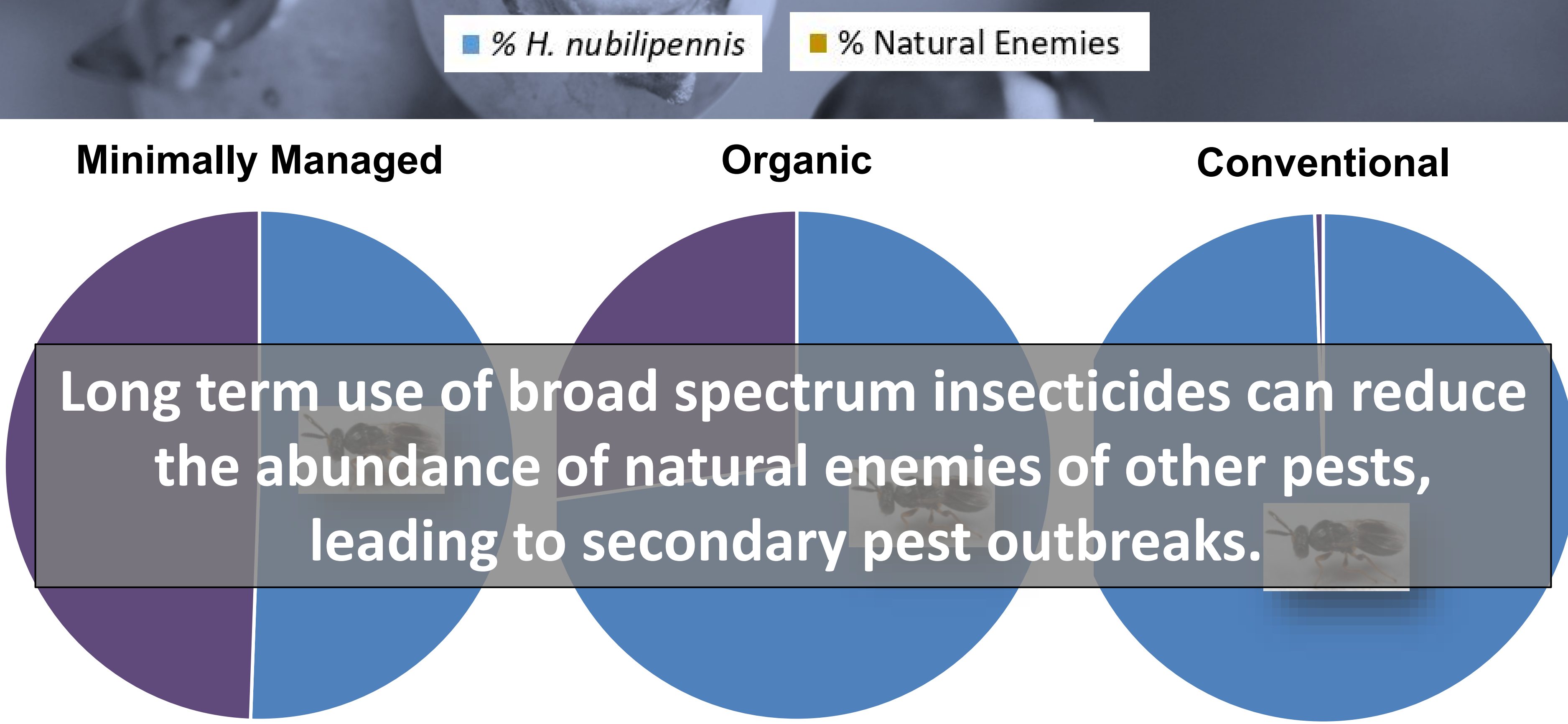
Blueberry stem gall wasp, *Hemadas nubilipennis* native to the USA




Galls formed by blueberry gall wasp usually have a
diverse community of parasitoids and inquilines living in them.
These keep the gall wasp population in check.
BUT… increased use of broad spectrum insecticide
can negatively impact those communities

Composition of Gall Populations, 2016

Galls collected from Minimally Managed (n=5), Organic (n=3) and Conventional (n= 16), sites



Long term use of broad spectrum insecticides can reduce the abundance of natural enemies of other pests, leading to secondary pest outbreaks.

Fanning & Isaacs, *Unpub data*

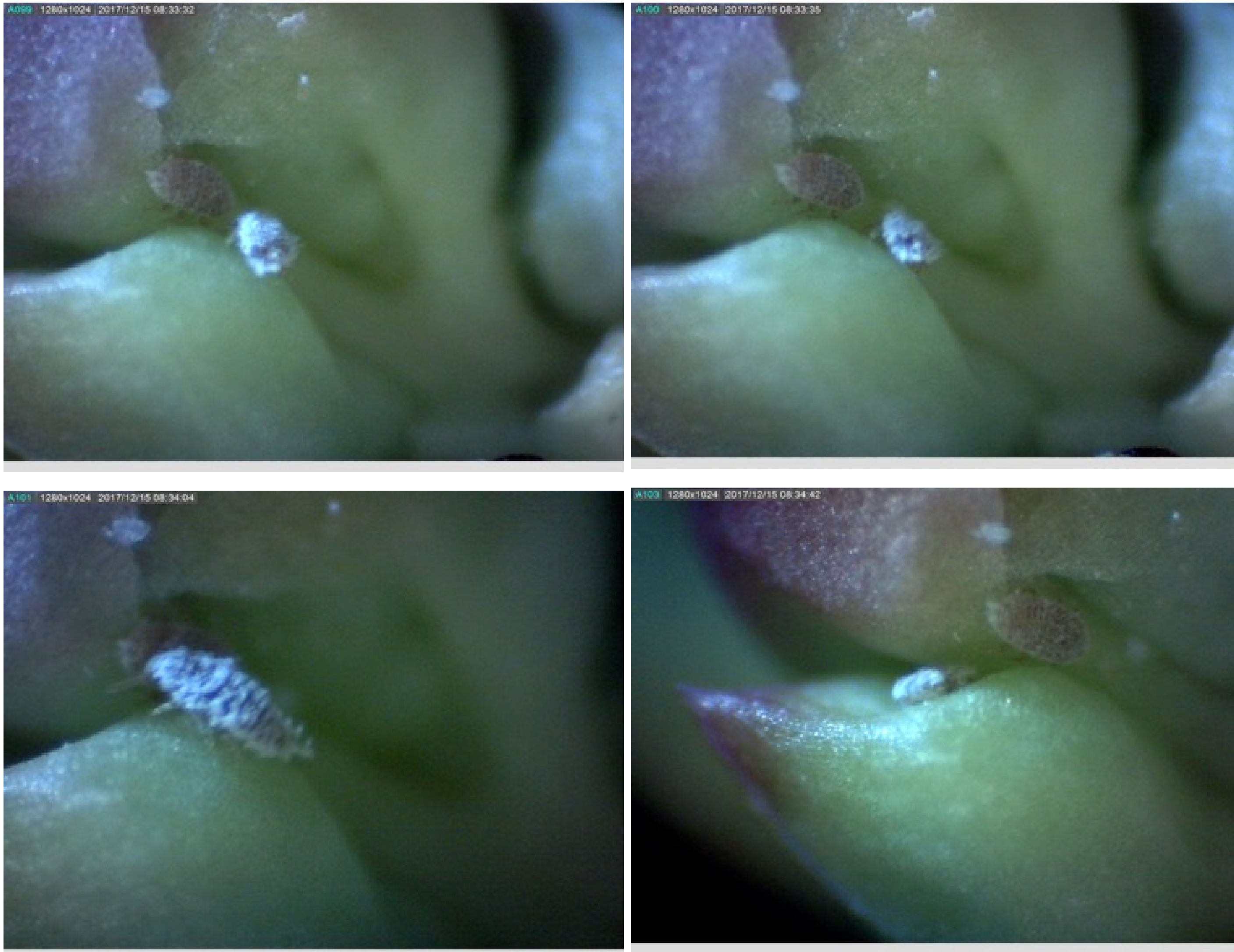
Potential and emerging pests
Whiteflies


Larvae and “pupae”


Adults

Bearberry whiteflies can be very abundant in blueberries post harvest
No known damage associated with even very high populations

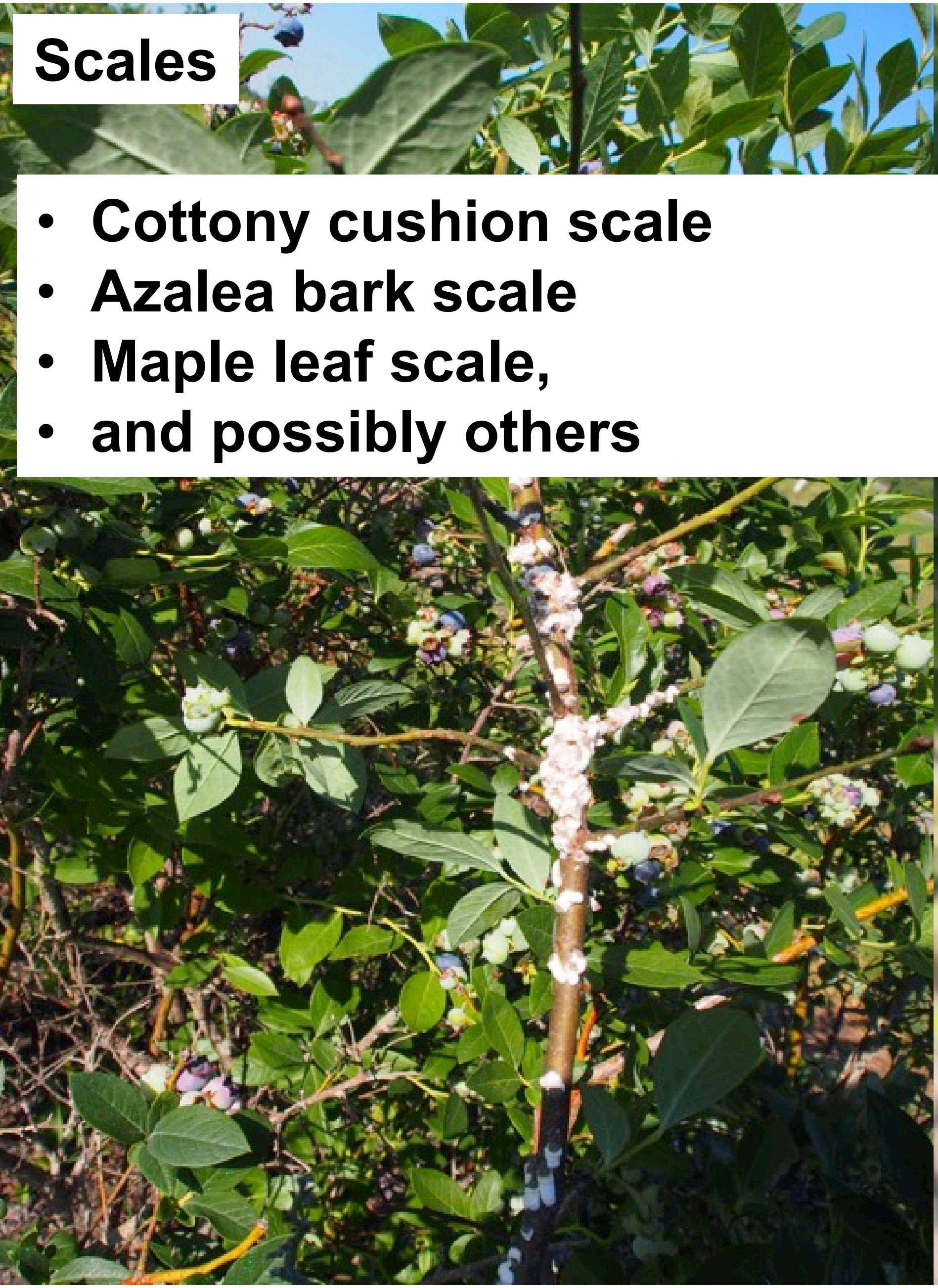
Blueberry mealybugs



Via Ash Sial, University of Georgia

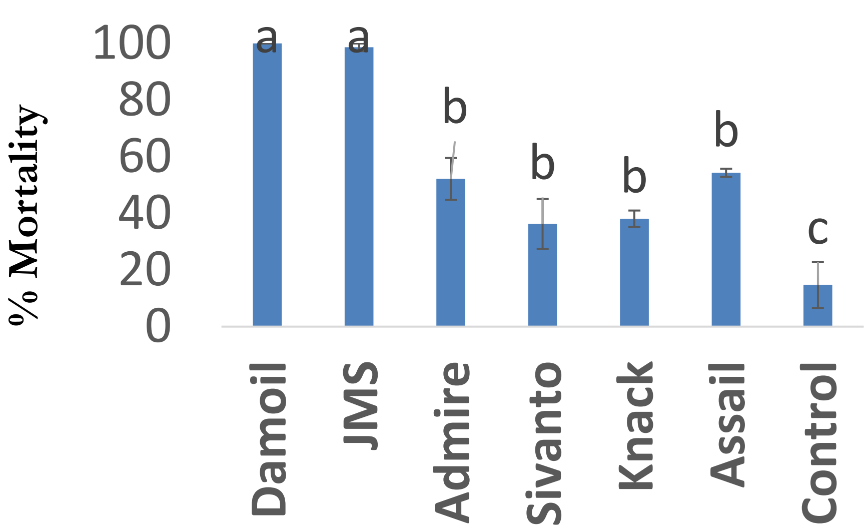
Scales

- Cottony cushion scale
- Azalea bark scale
- Maple leaf scale,
- and possibly others

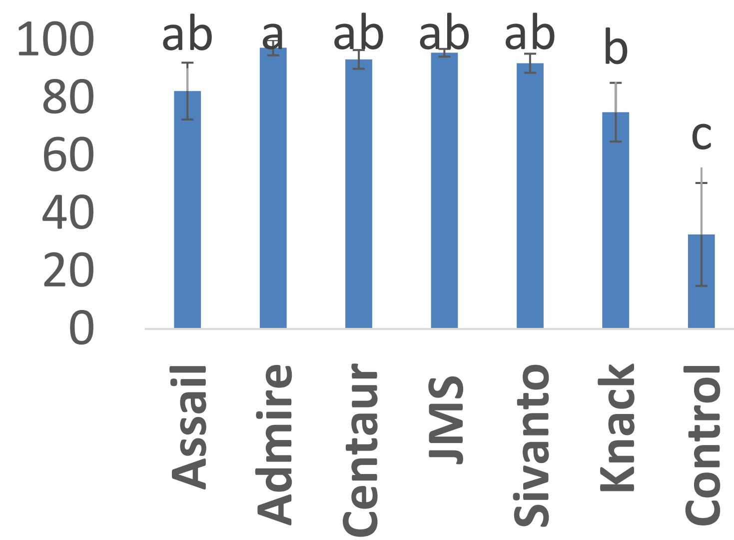



Via Ash Sial, University of Georgia

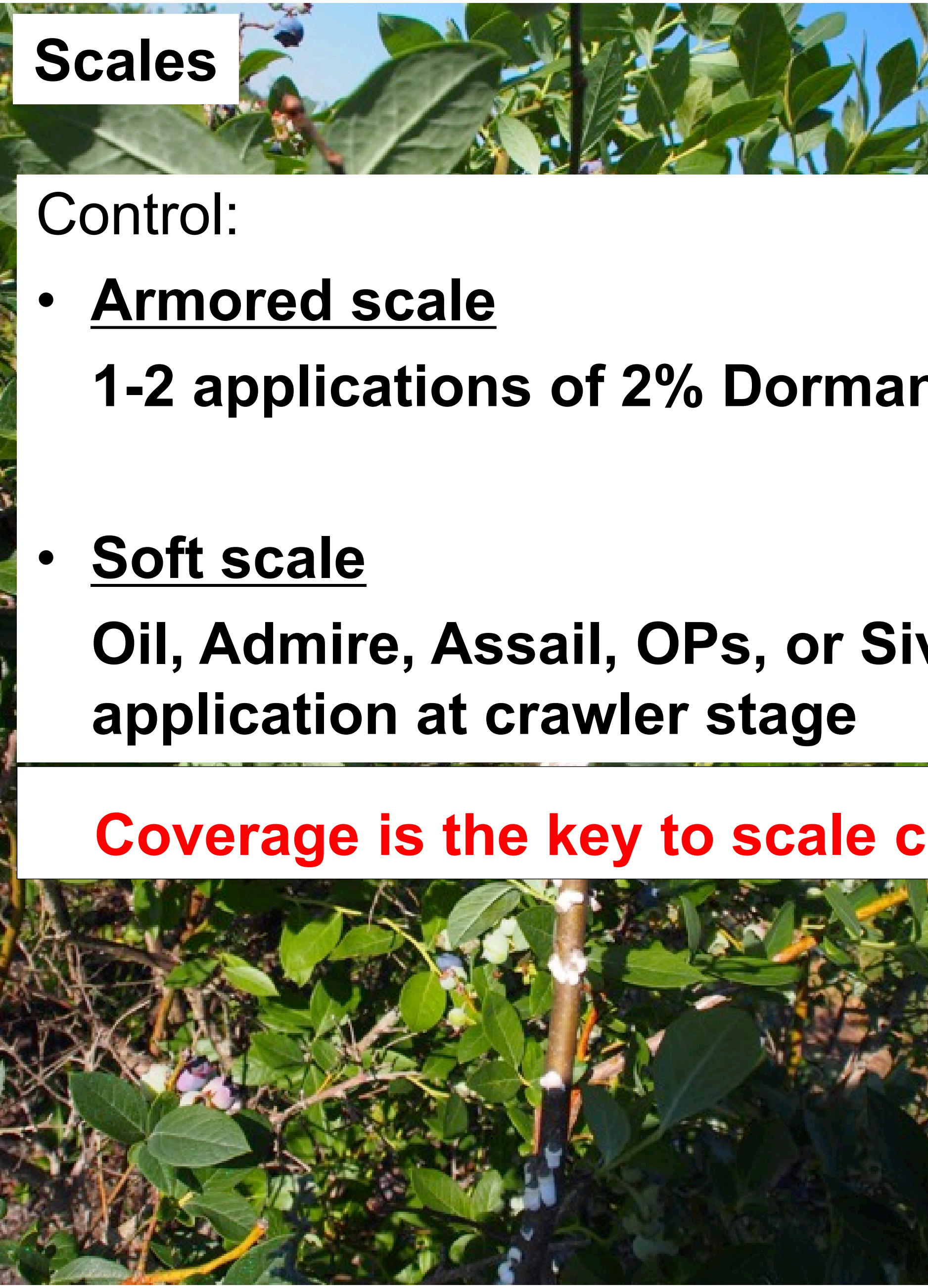
Scale mortality
(Treatments applied in November)



Scale mortality
(Treatments applied in August)



Via Ash Sial, University of Georgia



Scales

Control:

- **Armored scale**

  1-2 applications of 2% Dormant Oil

- **Soft scale**

  Oil, Admire, Assail, OPs, or Sivanto application at crawler stage

Coverage is the key to scale control

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Blueberry pollinators

Blueberry pollinators

Apis mellifera – honey bees

Bombus spp. – bumble bees

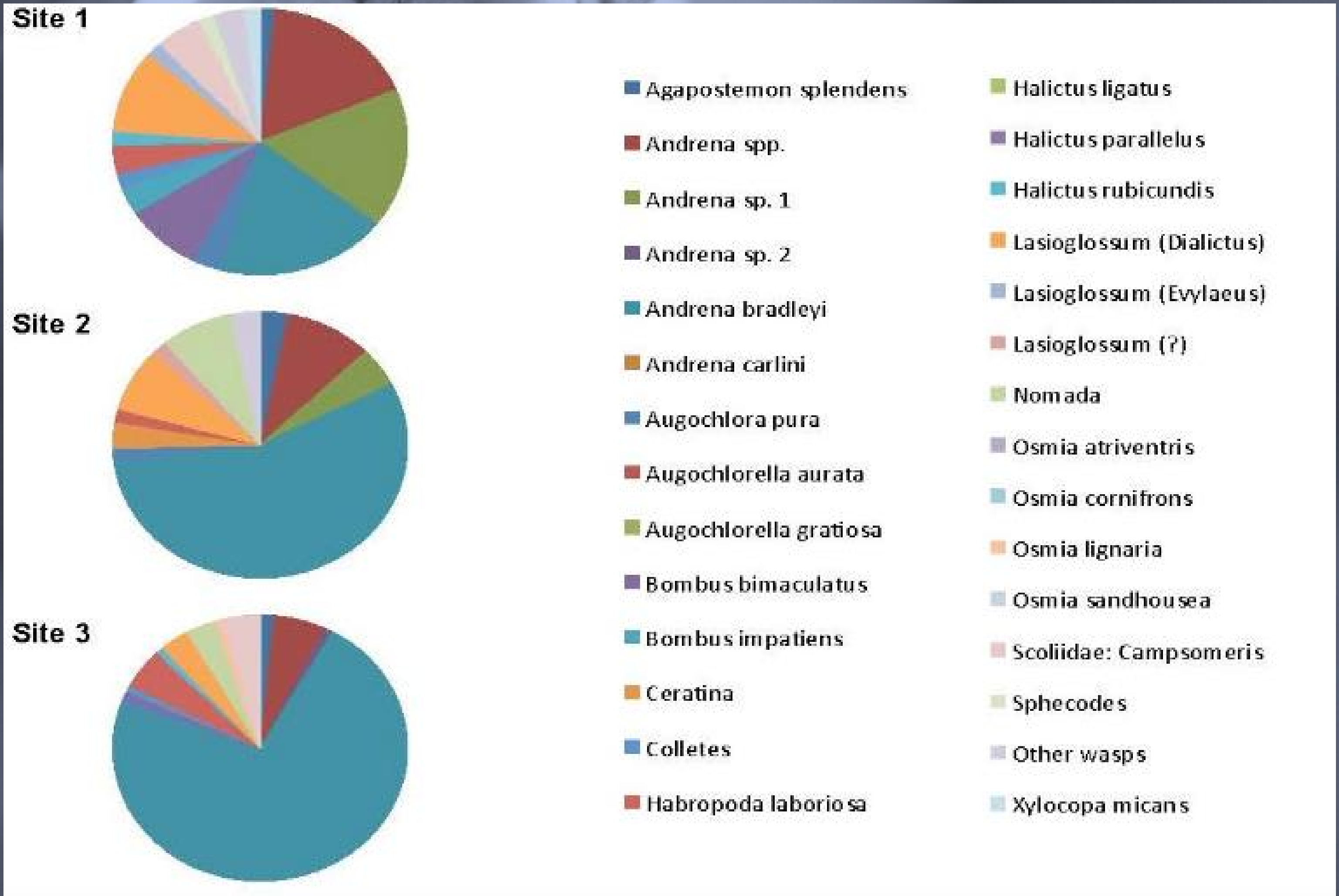
Habropoda laboriosa – southeastern blueberry bees

Xylocopa virginica – carpenter bees

Small native bees
- Andrenidae
- Halictidae

Osmia cornifrons – orchard bees

Blueberry pollinator diversity



Blueberry pollination services

Criteria	Description
Abundance	Number of actively foraging bees in an agroecosystem (Winfree et al. 2008, Tuell et al. 2009)
Per-visit efficiency	Amount of pollination provided by a bee in a single visit to a flower (Inouye et al. 1994, Ne'eman et al. 2010, Artz and Nault 2011)
Activity patterns	Foraging activity that may be dependent on weather (Dogterom 1999, Tuell and Isaacs 2010), seasonal phenology (Cane and Payne 1993), and spatial aspects of bee foraging behavior (Dogterom 1999, Gathmann and Tscharntke 2002, Ratti et al. 2008)
Visitation rate	Number of flowers (or plants) visited over a period of time (Cane and Payne 1988, Ne'eman et al. 2010, Artz and Nault 2011)
Interspecific influence	Interactions between bee groups that may reduce or enhance visitation rates or per-visit efficiency (Maloof and Inouye 2000, Greenleaf and Kremen 2006, Rogers et al. 2013)

Blueberry pollination services

	Abundant?	Efficient?	Activity limits?	Visitation rate?
Optimal bee	Yes	Yes	No	Faster
Apis mellifera	Yes	No	Yes	Slower
Bombus spp.	No	Yes	No	Faster
Habropoda laboriosa	Yes	No	No	Faster
Xylocopa virginica	No	No	Yes	Slower
Small native bees	Sometimes	Yes	No	Slower
Osmia cornifrons	No	Yes	Unknown	Unknown