Blueberry Insect Update

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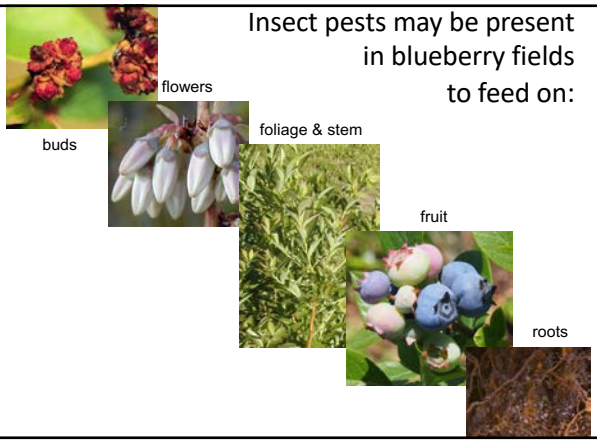
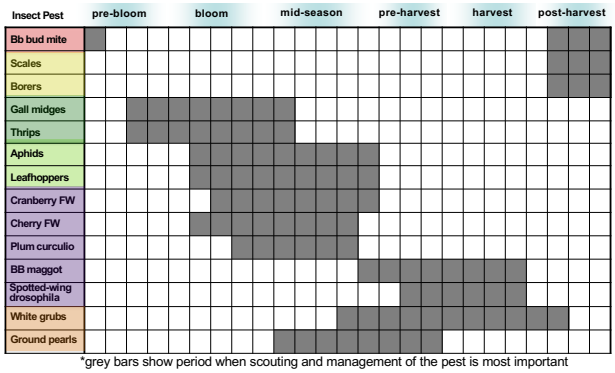
1

Insect pests may be present in blueberry fields to feed on:



2

Economically-important activity periods of arthropod pests*

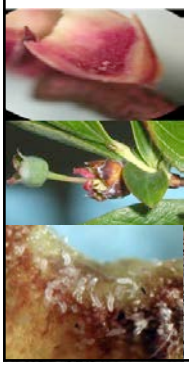


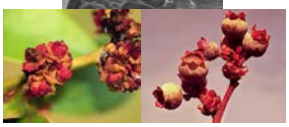
*grey bars show period when scouting and management of the pest is most important

3

Blueberry Bud Mite

(*Acalitus vaccinii* Keifer)





- Eriophyid family of mites
- White body, 1/128 inch long
- Sporadic pest. More important in southeast US
- Spend fall and winter under bud scales
- Leads to mis-formed flowers and fruit, poor yield
- Typically few mites per bud; but can be >50

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Blueberry Bud Mite

(*Acalitus vaccinii* Keifer)

Control

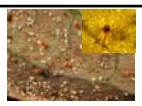
- Postharvest pruning and removing of old canes will reduce bud mite population
- Insecticides: Brigade, Danitol, Sevin, verdant horticultural oils
- Use high volume (~100 gal/A), high pressure (200 psi) applications of insecticide/miticide or horticultural oil

Spray timing and coverage are key to successful control

5

Spider Mite

Southern red mite
(*Oligonychus ilicis* McGregor)



- Spider mites are also known as web-spinning mites
- Southern red mite is common pest of blueberries in southern US
- Spider mites feed on plant tissues by sucking cell sap which compromises plant's ability to utilize sunlight for photosynthesis
- Leaf bronzing is the characteristic symptom of mite injury
- They can complete one generation in two weeks
- Can build up high populations in relatively short period of time and cause economic damage

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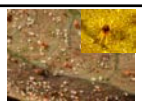
Spider Mite

Southern red mite
(*Oligonychus ilicis* McGregor)

CONTROL: 2020 Trial conducted in Atkinson County (Tony Barnes)

Treatment	Rate product/acre	#Eggs per 30 leaves 3 DBS 7-August	#Eggs per 30 leaves 3 DAS 13-August	#Eggs per 30 leaves 7 DAS 17-August	#Eggs per 30 leaves 14 DAS 25-August	#Eggs per 30 leaves 21 DAS 31-August
Control (Water + MSO)	1.0 pt/a	450.3	337.5	281	91.3	108.0
Oberon + MSO	16 fl oz/a + 1.0 pt/a	295.3	191	155.3	75.3	15.5
Portal + MSO	2.0 pt/a + 1.0 pt/a	92.3	40*	9.5*	3.0*	3.0*
Acramite (low rate+MSO)	354 mL/a + 1.0 pt/a	355.5	324.5	230.8	8.5*	8.0
Acramite (high rate+MSO)	473.2 mL/a + 1.0 pt/a	549.8	158.8	86.5	175.5	180.3
Acramite (2X rate + MSO)	946.4 mL/a + 1.0 pt/a	230.8	167.3	136	104.0	88.8

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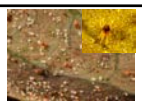
Spider Mite

Southern red mite
(*Oligonychus ilicis* McGregor)

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Control (Water + MSO)	1.0 pt/a	171.8	86.8	105.3	25.0	10.5
Oberon + MSO	16 fl oz/a + 1.0 pt/a	174.3	34.0	2.0*	2.5	0
Portal + MSO	2.0 pt/a + 1.0 pt/a	85.3	3.3*	0.8*	0.5	1.3
Acramite (low rate+MSO)	354 mL/a + 1.0 pt/a	137.3	23.5	49.0	0.3*	2.3
Acramite (high rate+MSO)	473.2 mL/a + 1.0 pt/a	259.3	31.5	23.3*	5.3	0.8
Acramite (2X rate + MSO)	946.4 mL/a + 1.0 pt/a	208.3	49.0	52.3	8.3	1.5

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Scales

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

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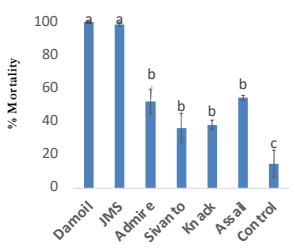
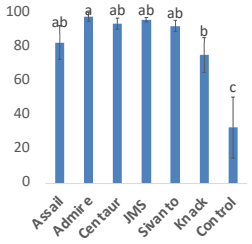
Scale mortality
(Treatments applied in November)



Scale mortality
(Treatments applied in August)



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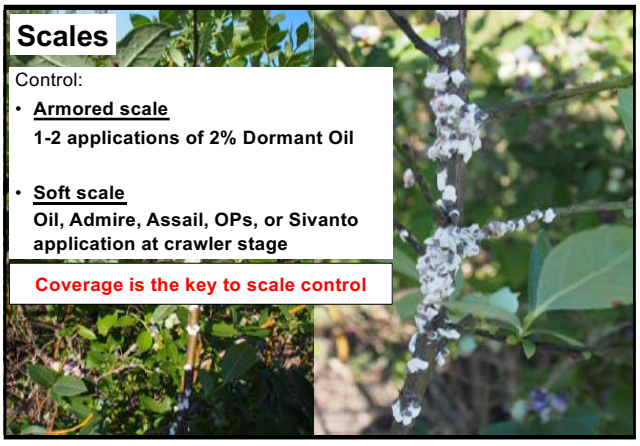
Scales

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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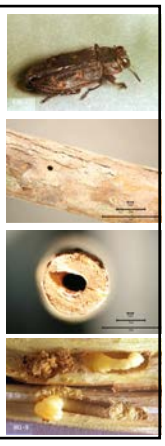
Flatheaded Borers

- Flatheaded borers are occasional pests of blueberries
- Adults are beautifully marked, metallic-colored beetles, about 1/2 inch long, have short antennae, large conspicuous eyes
- Damage occurs when larvae bore into the canes. They create galleries which may eventually completely girdle the canes causing stunted growth or death of the cane.
- Adults are attracted to stressed or damaged blueberry canes, particularly areas with pruning scars or sunburn.
- Keep the blueberry bushes healthy and vigorous.
- Preventing bushes from mechanical damage, wounds, sunscald, or drought stress can significantly reduce the flatheaded borer infestations.



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Flatheaded Borers

- **Once detected, flatheaded borers can be managed by pruning the bushes. Make sure to:**
  - **Remove old canes that exhibit borer damage**
  - **Prune at a time of year and in a manner that prevents sunburn of canes to reduce borer damage**
  - **After pruning, chip or remove prunings from the field**
  - **If high levels of infestation are observed during pruning, make a soil application of Admire**

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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

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Blueberry Gall Midge (~3 mm)

Monitoring:
- Collect flower buds 2 to 3 times per week,
- Place them in zip-lock bags to monitor for larval infestation
- Use double-sided sticky sheets
- Use bucket traps to monitor adult emergence (may be less efficient)

Control:
- Diazinon early, followed by Entrust or Delegate if necessary
- Midge insecticides are protectants, they do not control 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

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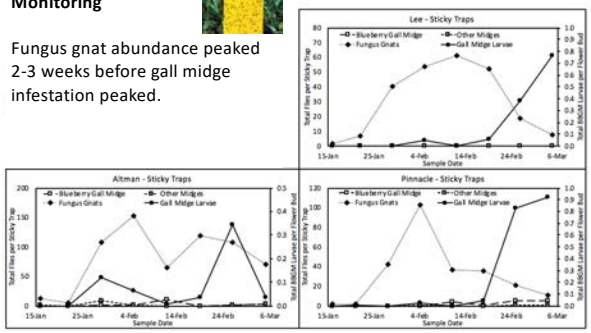
Blueberry Gall Midge Monitoring

Fungus gnat abundance peaked 2-3 weeks before gall midge infestation peaked.



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Flower Thrips (1-2 mm)

- **Many species found in blueberry 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, reducing pollination and fruit set**
- **Damage to southern highbush can cause up to 60% lower fruit set (GA)**
- **Cause tight curling and malformation of leaves**

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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 per cluster of eight flowers

Control:
- **Diazinon early, followed by Entrust, Delegate or Assail, and Sivanto**

Adjust spray timing to protect pollinators

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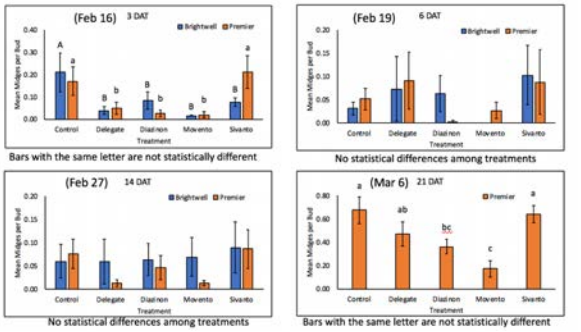
Gall Midge



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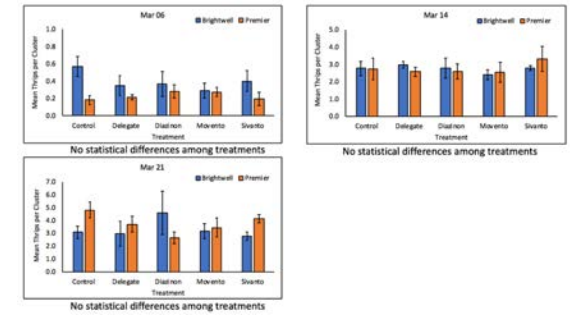
Flower Thrips



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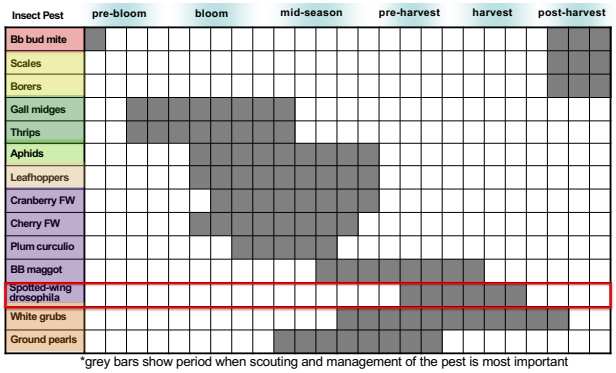
Economically-important activity periods of arthropod pests*



*grey bars show period when scouting and management of the pest is most important

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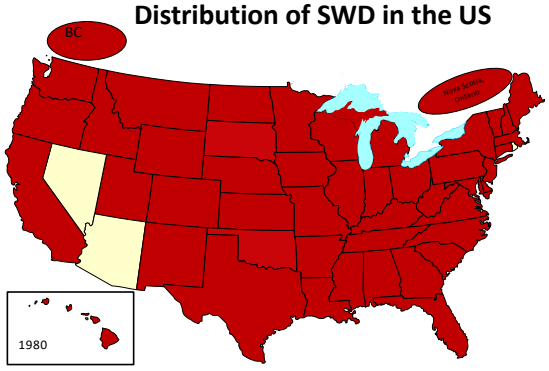
Spotted-Wing Drosophila (SWD)

Distribution of SWD in the US



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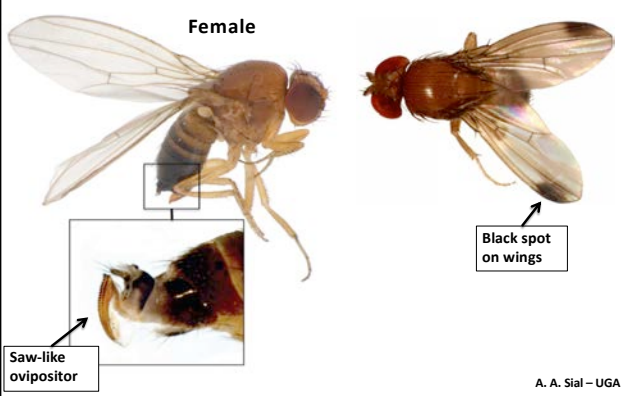

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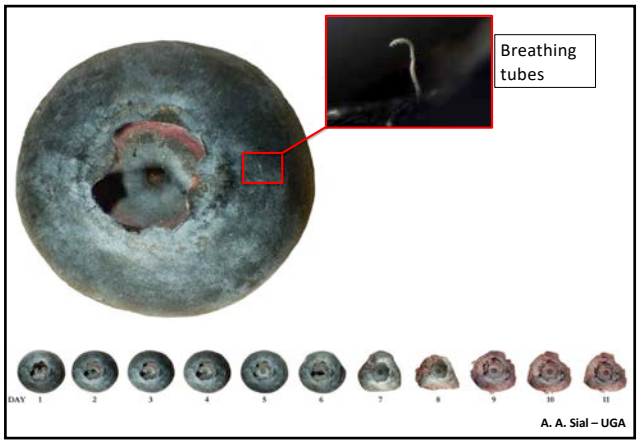

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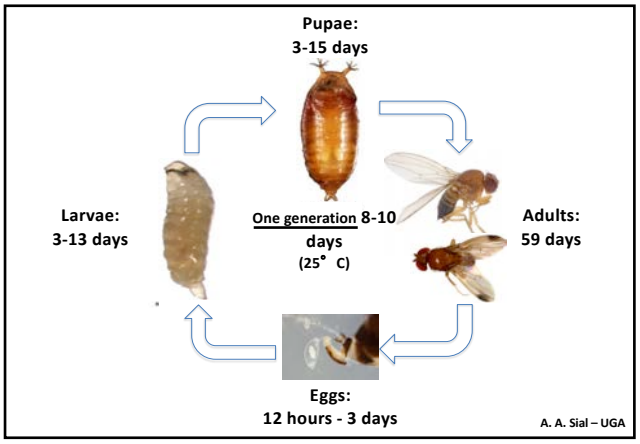

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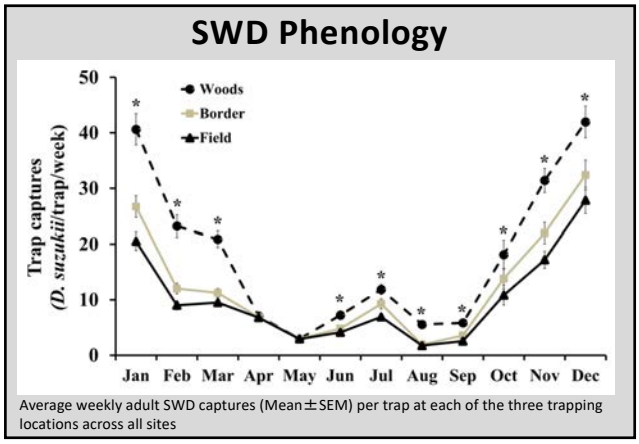

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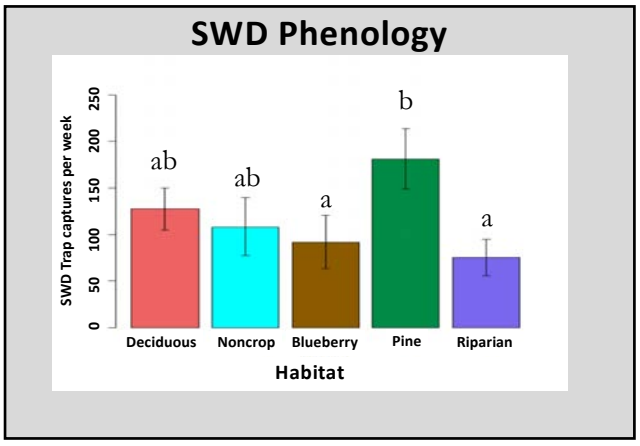

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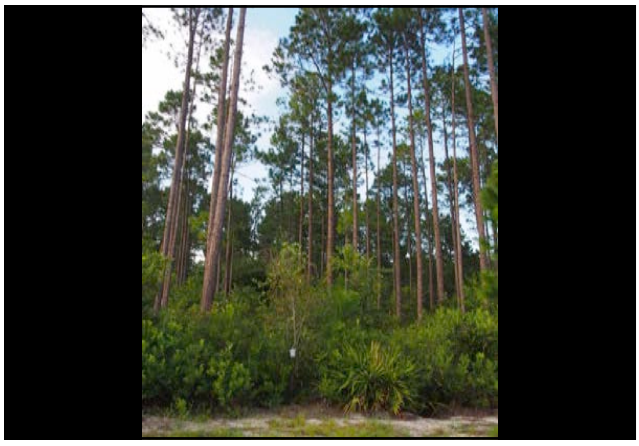

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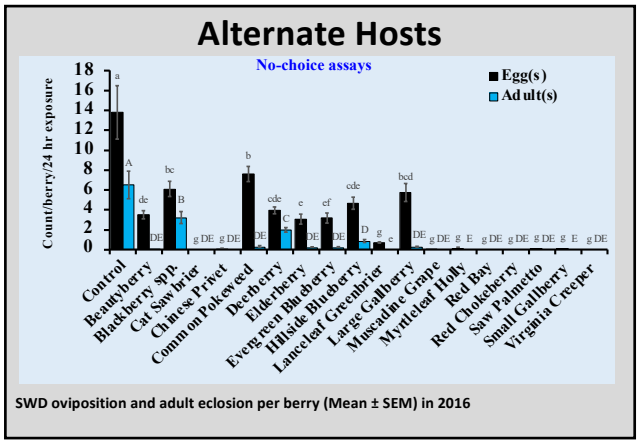

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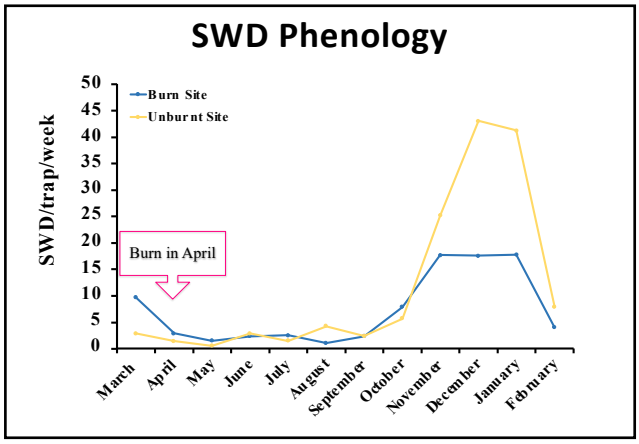

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SWD Management

- Biological control
- Behavioral control
- Cultural control
- Chemical control

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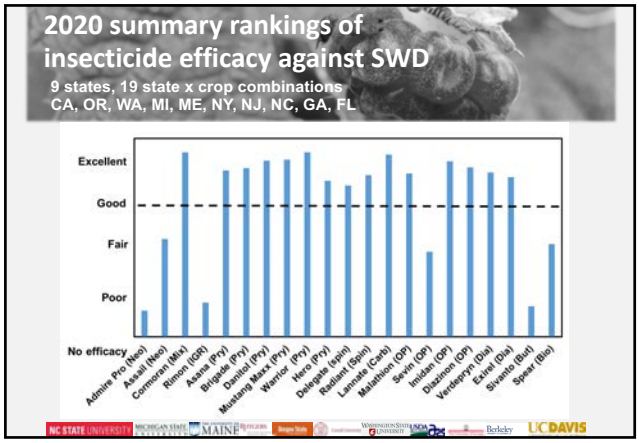

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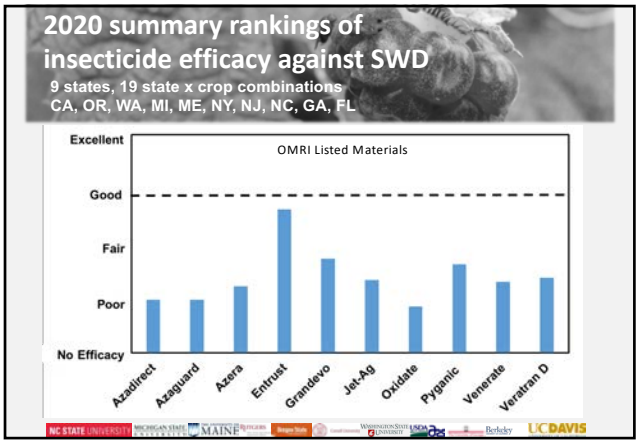

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Season-long Management Programs

Management Strategy	Weekly rotations
Export-friendly, maximum modes of action	Imidan, Malathion, Delegate, and Danitol
Short preharvest interval (PHI)	Mustang Max and Malathion
Reduced risk	Delegate and Exirel
Organic	Entrust, Grandevo, and Pyganic

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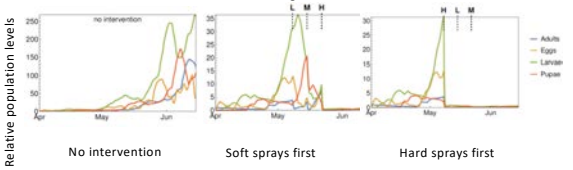
Population models and optimizing chemical control (led by Vaughn Walton Program)

Mortalities: Low= 12, Mid = 64, High = 98



No intervention | Soft sprays first | Hard sprays first

Hard sprays applied early in the season will result in lower population levels

Mermer et al. 2020. Impact of timing of insecticide sprays *on D. suzukii* life stage and populations

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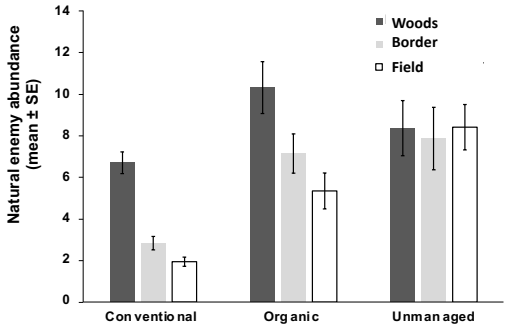
Impact of Management Practice on Natural Enemies



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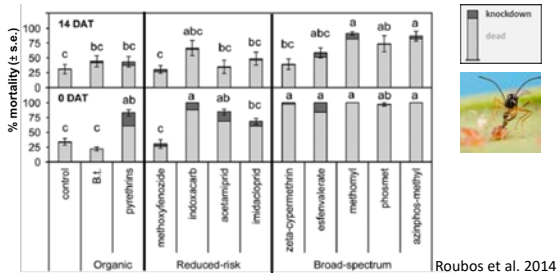
Insecticide effects on parasitoid wasp



Roubos et al. 2014

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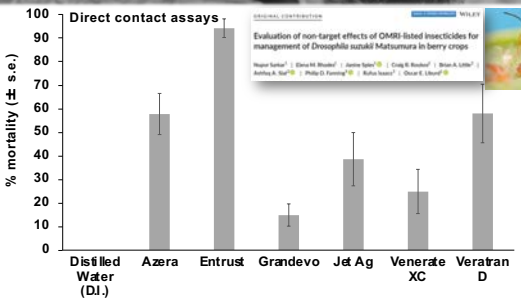
What about organic insecticides?



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Season-long Management Programs

1) FMP: Farmer's Management Program
2) BMP: Best Management Program

2017 Treatment Program		Week1	Week2	Week3	Week4
BMP	With Nu Film P®	Imidan	Delegate	Malathion	Danitol
	Without Nu Film P®	1.3lbs/acre	6oz/acre	2.5pt/acre	16oz/acre
FMP	With Nu Film P®	Malathion	Danitol	Malathion	Danitol
	Without Nu Film P®	2.5pt/acre	16oz/acre	2.5pt/acre	16oz/acre
2018 Treatment Program		**Week1**	**Week2**	**Week3**	**Week4**
BMP	With Nu Film P®	Imidan	Delegate	Malathion	Exirel
	Without Nu Film P®	1.3lbs/acre	6oz/acre	2.5pt/acre	20.5oz/acre
FMP	With Nu Film P®	Malathion	Malathion	Malathion	Malathion
	Without Nu Film P®	2.5pt/acre	2.5pt/acre	2.5pt/acre	2.5pt/acre

Note: Nu Film P® was applied at 6oz per acre. The malathion used was Malathion 8F

2019 Treatment Program		Treatment 1	Treatment 2	Treatment 3	Treatment 4	Treatment 5
BMP	Scanner	Malathion 2pt/acre	Delegate 6oz/acre	Grandevo 3lb/acre	Exirel 20.5oz/acre	Grandevo 3lb/acre
FMP	Scanner	Zeta-cypermethrin 4oz/acre	Malathion 2pt/acre	Zeta-cypermethrin 4oz/acre	Malathion 2pt/acre	

Note: Scanner was applied at 4oz per acre. The malathion used was Malathion 5EC

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Season-long Management Programs

1) FMP: Farmer's Management Program
2) BMP: Best Management Program

Treatment Program		2017	2018	2019
UTC		15.11 ± 3.74 a	13.75 ± 3.27 a	14.29 ± 3.75 a
BMP	With Nu Film P	76.67 ± 4.12 b	77.50 ± 8.85 b	52.37 ± 9.65 b
	Without Nu Film P	80.56 ± 3.74 b	85.00 ± 5.97 bc	
FMP	With Nu Film P	82.47 ± 3.95 b	100.00 ± 0.00 c	62.88 ± 11.53 b
	Without Nu Film P	86.11 ± 3.70 b	91.66 ± 8.33 bc	
Program: df, F, *p*		2:185, 89.39, <.0001	2:92, 143.334, <.0001	2:48, 9.932, 0.0002
Nu Film P: df, F, *p*		1:185, 0.147, 0.372	1:92, 0.003, 0.956	

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Screening of field populations for resistance

Site	n	slope ±SE	LC_{50} (mgL^{-1})	Resistance Ratio
2019 postseason				
Lab	105	2.214±0.559	27.646	1.000
CF1	104	3.950±0.978	88.360	3.196*
CF2	105	1.869±0.386	114.399	4.136*
CF3	98	2.423±0.487	46.725	1.689
CF4	204	1.645±0.251	55.192	1.995
OF1	222	2.044±0.302	95.447	3.453*
OF2	103	2.841±0.549	120.799	4.372*
OF3	106	2.190±0.399	70.483	2.545*

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Evaluation of Organic Insecticides in Blueberries

	Trade name	Field rate (maximum)	5 gal water
1	Entrust SC	6 fl oz/acre	17.7 ml
2	PyGanic EC 1.4	64 fl oz/acre	189.3 ml
3	Venerate XC	8 qrts/acre	757 ml
4	Azera	3.5 pints/acre	165.6 ml
5	OxiDate 2.0	128 fl oz/100 gal water	189.3 ml
6	Jet-Ag	1 gal/100 gal water	189.3 ml
7	AzaGuard	16 fl oz/acre	47.3 ml
8	Grandevo	3 lbs/acre	136 g

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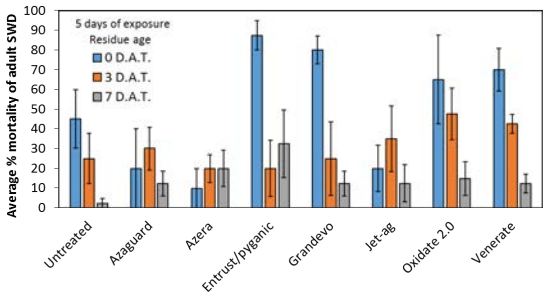
Evaluation of Organic Insecticides in Blueberries



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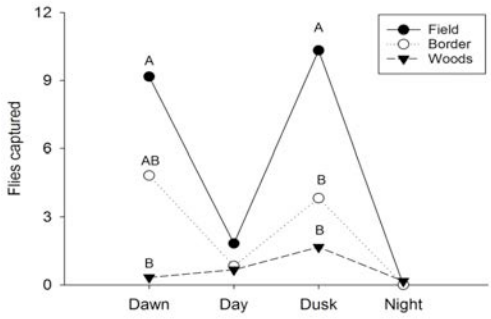
SWD Activity in the Field



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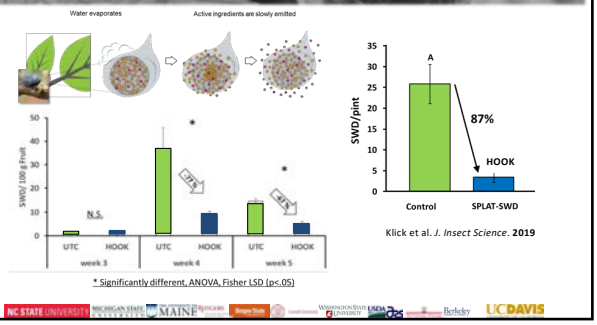
Behavioral Control Strategies

A slow-release "attract-and-kill" formulation (SPLAT/HOOK SWD) shows promise under field conditions.



Klick et al. *J. Insect Science*. **2019**

* Significantly different, ANOVA, Fisher LSD (p<.05)

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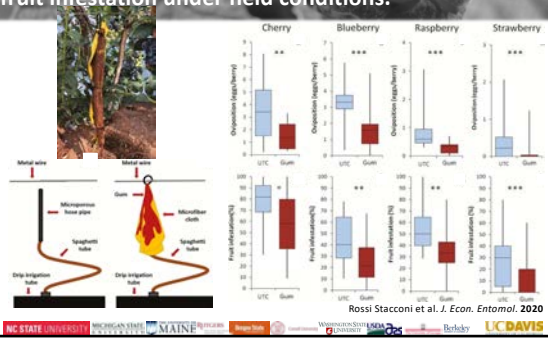
Behavioral Control Strategies

A new "Food-Grade Gum" reduces SWD oviposition and fruit infestation under field conditions.



Rossi Stacconi et al. *J. Econ. Entomol*. **2020**

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Cultural Control Strategies

Goal: Reduce Habitat Favorability

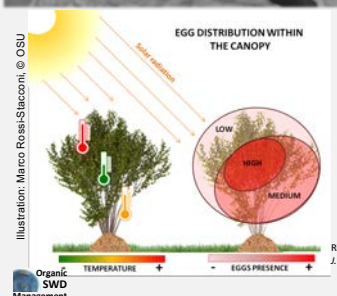

Illustration: Marco Rossi-Stacconi, © OSU

TEMPERATURE
Don't survive at constant temp >87.6˚ F; No egg laying at 95˚ F

RELATIVE HUMIDITY
Lifespan and egg production increase with relative humidity; Do better >70%RH

Rice et al. 2017 *J. Insect Behav.*; Diepenbrock and Burrack 2016 *J. Appl. Entomol.*; Rendon et al. 2019 *Pest Manag. Sci.*

Organic SWD Management

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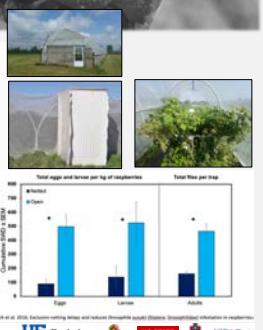
Physical Exclusion

Exclusion trials: AR, MI, MN, OR, NY

- If done right, mesh netting <1 mm works to exclude flies, reduce fruit infestation, and improve marketable fruit yield in raspberries and blackberries
- 100% control possible in blueberries
- If installed before fruit ripening/SWD susceptibility begins, will keep flies out of tunnels
- Tunnel grown fruit often higher quality
- May not be feasible for large farms due to high initial cost



Organic SWD Management

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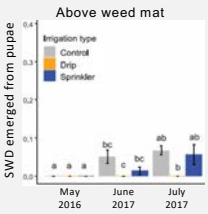
Irrigation

Exclusion trials: OR



- Drip irrigation reduces relative humidity

Organic SWD Management

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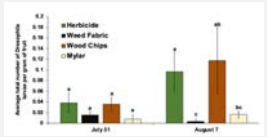
Mulching

- **Mulching trials**: CA, GA, MD, MI, MN, OR
- **Mulches such as weed fabric and mylar that provide physical barrier**:
  - Prevent SWD larvae from entering the soil to pupate
  - Increased surface temperature in some studies
  - Decreased SWD survival above the mulch & fruit infestation



Pine Bark | Black Weed Mat | Silver Reflective

Rendon et al. 2019 *Pest Manag. Sci.*

Organic SWD Management

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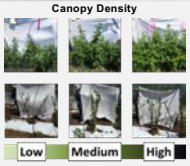
Pruning

- **Pruning trials: CA, GA, MD, MI, MN, OR**
- **Heavy pruning altered microclimate which affected habitat suitability for SWD**
  - Increased temperature & light intensity, decreased RH in canopy
  - Decreased oviposition and fruit infestation
  - May decrease marketable yield in some systems
  - May improve spray coverage and harvest efficiency

Canopy Density



Light Pruning | Medium Pruning | Heavy Pruning

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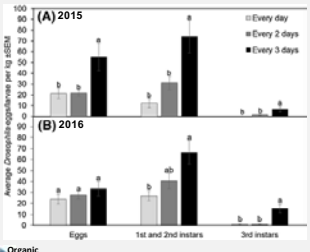
Harvest Frequency



- Removes resources for SWD from the farm
- Highest marketable yield per unit effort with a 2-day harvest interval

Organic SWD Management

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Sanitation

- Remove and destroy cull fruit
- Leave in a sealed container
- 2-3 days in direct sun
- Bury ≥ 2 ft deep

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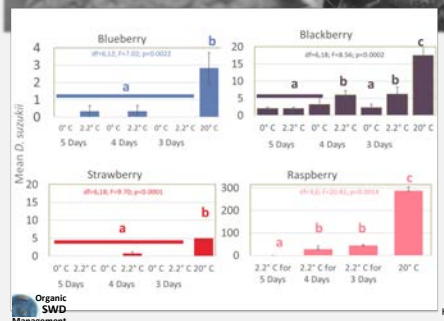
Postharvest Cold Storage



0° C = 32° F
2.2° C = 36° F
20° C = 68° F

Kraft, et al. 2020. *J. Econ. Entomol.*

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SUMMARY

- ✓ SWD remains to be the key pest
- ✓ Adult SWD flies can be trapped year-round in Southeast
- ✓ Wooded areas seem to serve as population reservoirs
- ✓ A number of wild plant species present in wooded areas can serve as hosts of SWD
- ✓ Burning in the wooded areas reduces SWD populations in the short-term
- ✓ A number of conventional insecticides are effective against SWD but repeated application may result in:
  - ➢ Insecticide resistance
  - ➢ Secondary pests
- ✓ Majority of SWD activity in the field occurs during dawn and dusk, and making insecticide applications during these times will result in much better control of SWD

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SUMMARY

- ✓ Organic management remains a challenge. A combination of organic insecticide applications and cultural strategies may be needed for effective control
- ✓ Bud mites, spider mites, scales, gall midge and flower thrips are the most important secondary pest issues
  - ✓ Frequent sampling is necessary to determine infestation levels and make control applications
  - ✓ A number of insecticides including JMS Stylet Oil, Damoil, and other oils are effectives against budmites and scales
  - ✓ Other insecticides including Assail, and the new products – Sivanto, Centaur, Movento are effective against most of the secondary pests
  - ✓ Spray timing and coverage are key to good control

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- ✓ Renee Holland _ Area Blueberry Agent
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- ✓ Grower Cooperators
- ✓ Georgia Blueberry Growers Association
- ✓ Blueberry Commodity Commission
- ✓ Georgia Department of Ag
- ✓ Southern Regional IPM Center
- ✓ Private Industry Collaborators
- ✓ MBG

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