Sweet Corn Pest Management Workshop

February 25, 2020

Belle Glade, FL

Corn silk fly identification, sampling, and management

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UF | IFAS UNIVERSITY of FLORIDA

Corn silk fly management in sweet corn

- Frequent pyrethroid applications between first silk and harvest
  - PBO frequently added to increase efficacy
- Scouting, no formal action threshold
  - Decision based primarily on adult presence
  - 3 fly species practically considered equivalent
- Management failures and load rejections occur: Need to improve corn silk fly sampling and management with insecticides

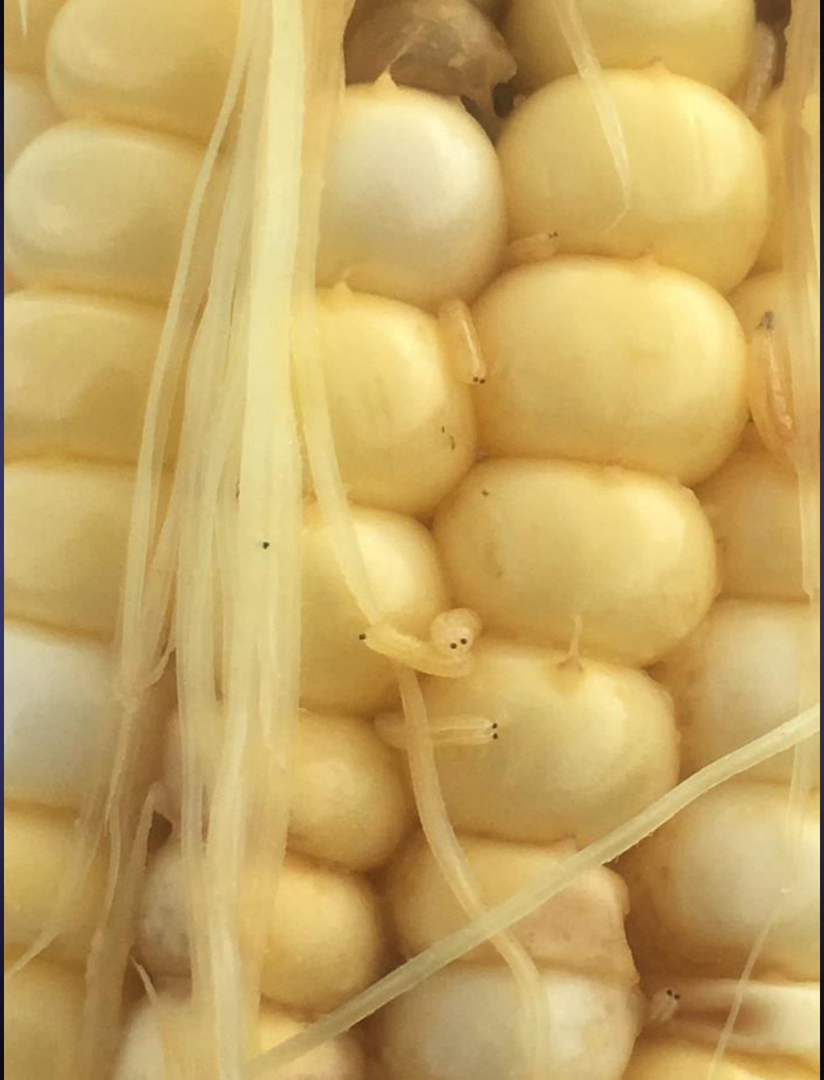
Corn silk fly identification

Eggs

Maggots

Pupae
(soil)

Adults




Euxesta stigmatias

Euxesta eluta

Chaetopsis massyla

Photos: Gaurav Goyal, UF/IFAS

Euxesta stigmatias

Euxesta eluta

Chaetopsis massyla

Euxesta stigmatias

Euxesta eluta

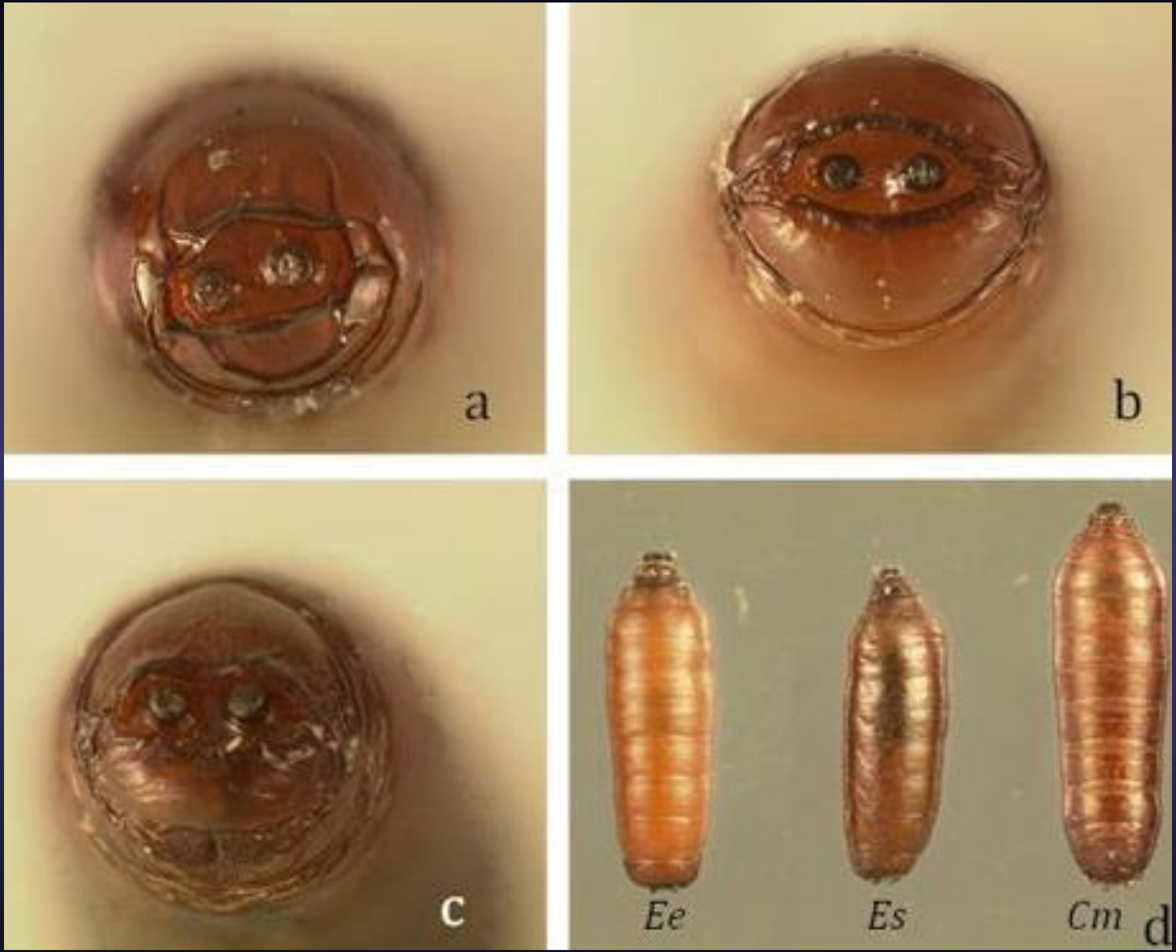
Chaetopsis massyla

Silk fly pupae

a. *C. massyla*

b. *E. eluta*

c. *E. stigmatias*



Photos: Gaurav Goyal, UF/IFAS

Why is species identification important?

- Until the late 2000s, only *E. stigmatias* was considered a sweet corn pest
  - *Euxesta eluta*, *Chaetopsis massyla* relatively common
  - *Euxesta annonae*
- The 3 species are not interchangeable pests
  - Geographical range (*E. stigmatias* not in northern FL)
  - Adult behavior (*E. stigmatias* prefers silks for oviposition)
  - Insecticide susceptibility (*E. stigmatias* less susceptible)
- Species identification should improve management decisions

Adult silk fly sampling

Lures for monitoring adult corn silk flies

Evaluation of lures for monitoring silk flies (Diptera: Ulidiidae) in sweet corn

David Owens[1,], Ron Cherry[1], Michael Karounos[1], and Gregg S. Nuessly[1]*

Abstract

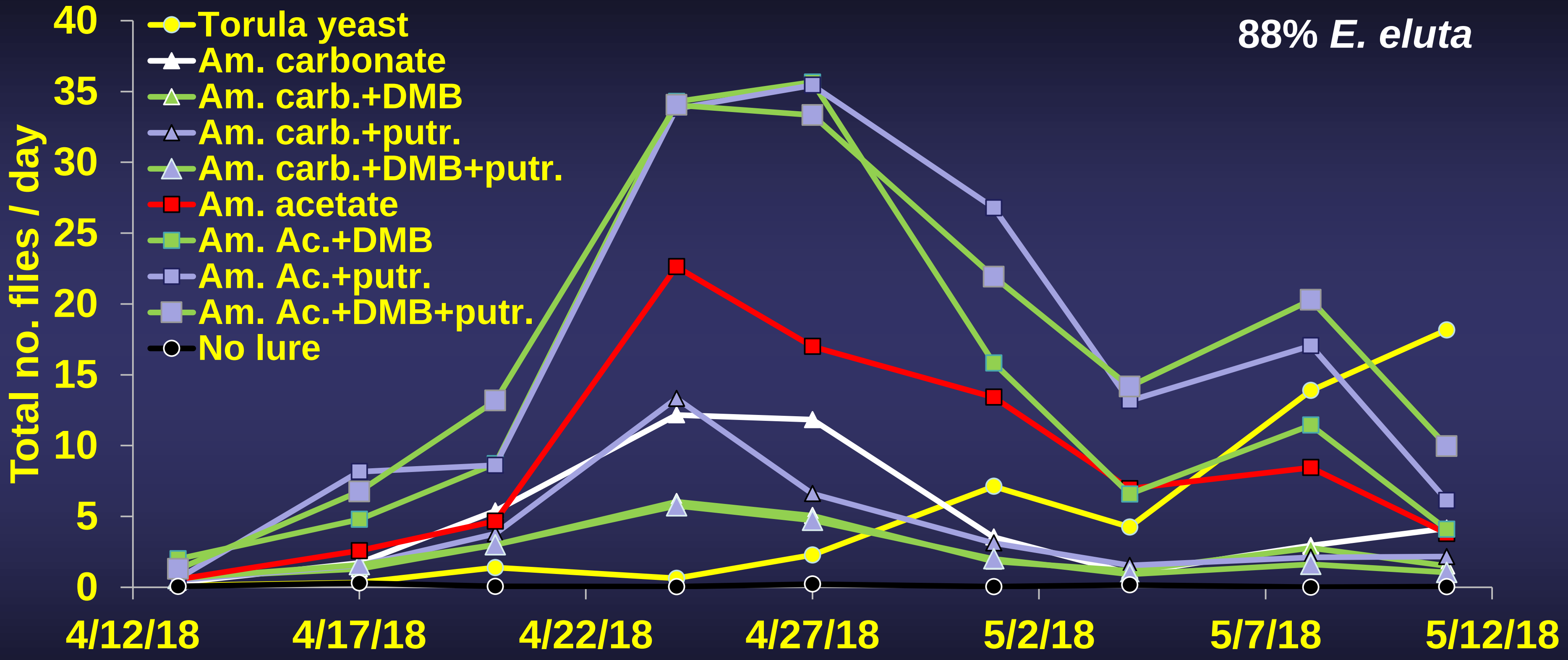
Several morphologically similar species of picture-winged flies (the silk fly complex, Diptera: Ulidiidae) are severe primary pests of sweet corn (*Zea mays* L.; Poaceae) in Florida. Monitoring traps for these pests may aid threshold development and species complex determination in the field. This study evaluated floral lures, some previously used to monitor pest Lepidoptera, and liquid protein baits, used for other pest Diptera, for efficacy in attraction of silk flies. Baited universal moth traps were deployed for several weeks and placed in a summer fallow field (field trial 1), a fall sweet corn field (field trial 2), and a spring sweet corn field (field trial 3). Flies were removed weekly during each experiment. In field trial 1, traps baited with 1,4-dimethoxybenzene captured the most flies. The majority of flies captured were *Chaetopsis massyla* Walker. In field trial 2, aged torula yeast–baited traps captured more flies than other treatments, (1,4-dimethoxybenzene, geraniol, phenylacetaldehyde, and fresh torula yeast). The majority of captured flies were *Euxesta stigmatias* Loew. In field trial 3, the aged torula yeast treatment resulted in greater fly capture than all other treatments (1,4-dimethoxybenzene, acetoin, anisole, and benzaldehyde). *Euxesta eluta* Loew was the dominant species captured in the spring. More females than males were captured from all 3 experiments and all treatments. These experiments demonstrate that all 3 silk fly species can be captured in traps currently used for pest monitoring. Torula yeast was the best attractant evaluated, and further semiochemical investigations of torula yeast are warranted.

Owens et al. 2017. Fla. Entomol. 100: 251-256

Lure combinations for corn silk flies

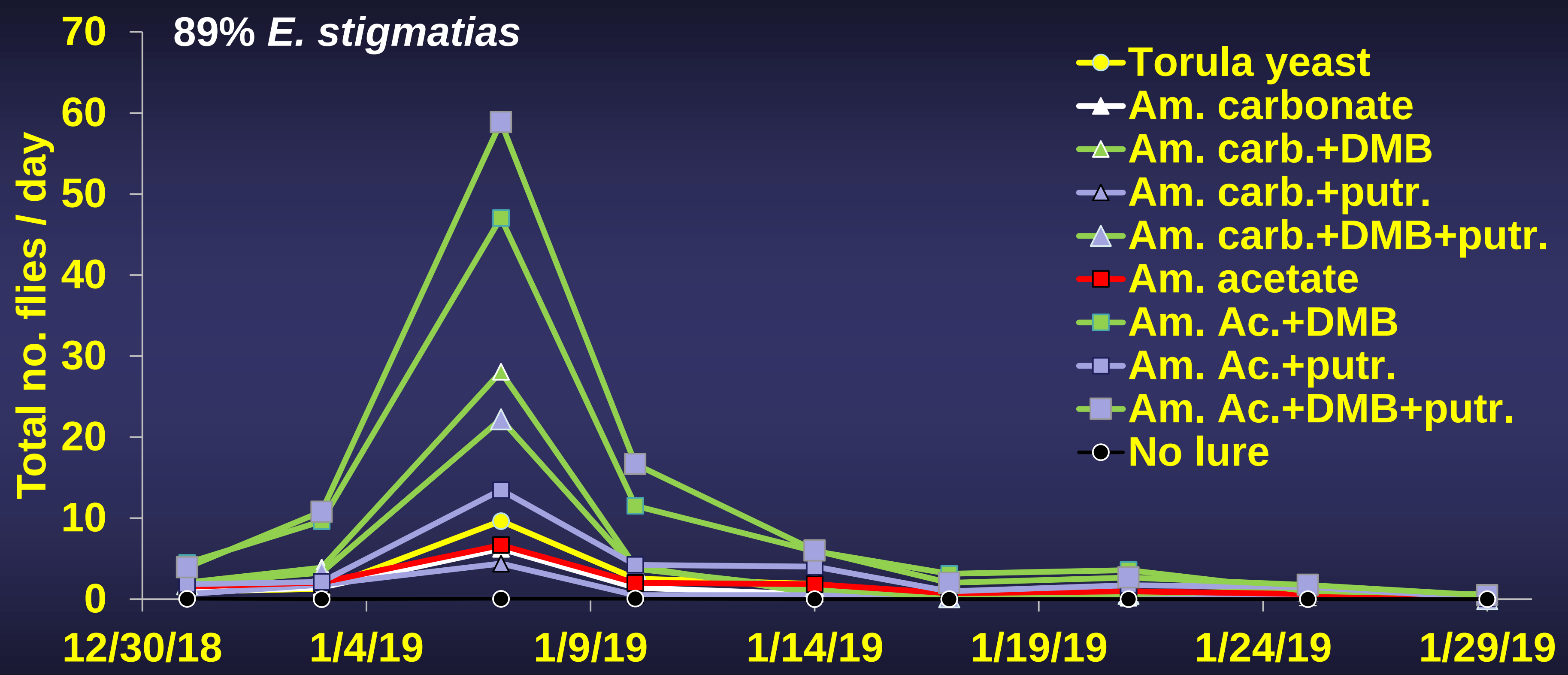
- Spring 2018 and winter 2019
- Green/Yellow/White bucket traps
- Nine lures
  - Torula yeast
  - Ammonium carbonate
  - Am. carbonate + DMB, + putrescine, + DMB + putrescine
  - Ammonium acetate
  - Am. acetate + DMB, + putrescine, + DMB + putrescine
- Randomized complete block design with 6 blocks (traps 50 ft apart)

Lure combinations for corn silk flies

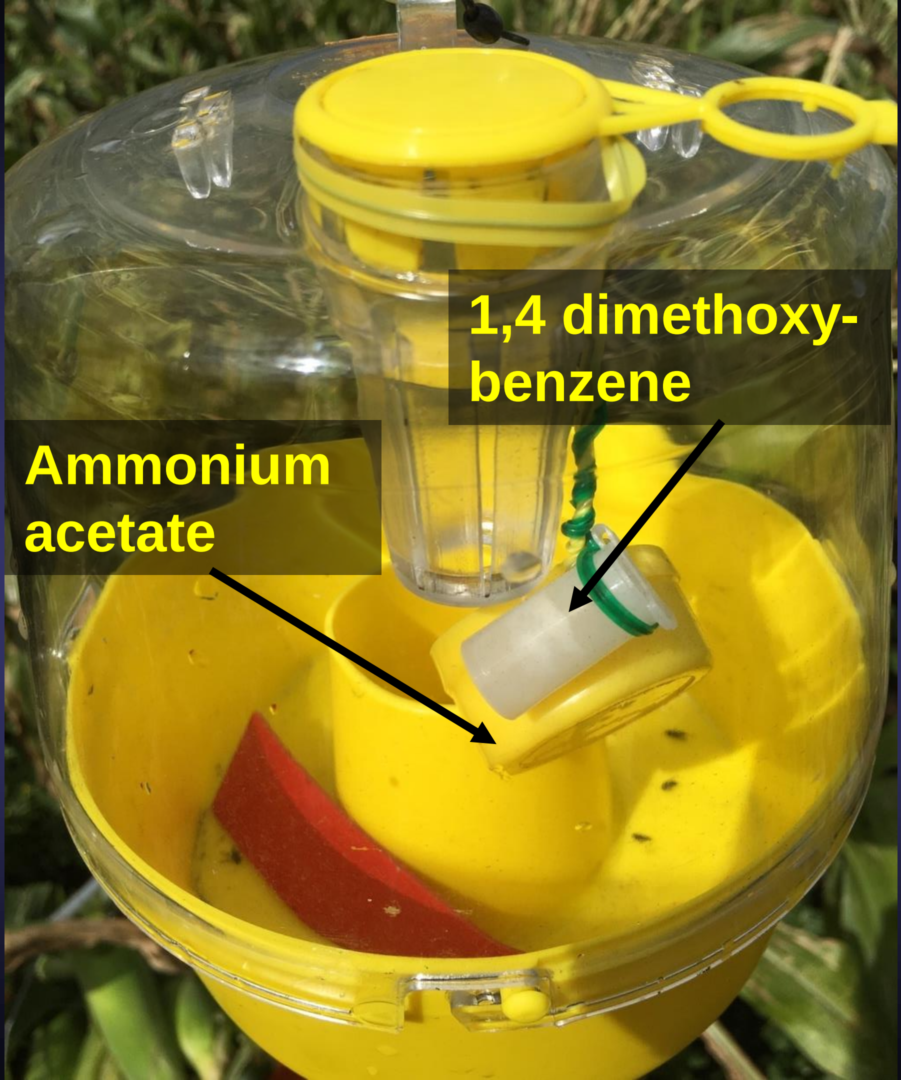


Repeated measures ANOVA (SAS PROC GLIMMIX): Lure $P < 0.001$, Date $P < 0.001$, Lure*Date $P < 0.001$

Lure combinations for corn silk flies



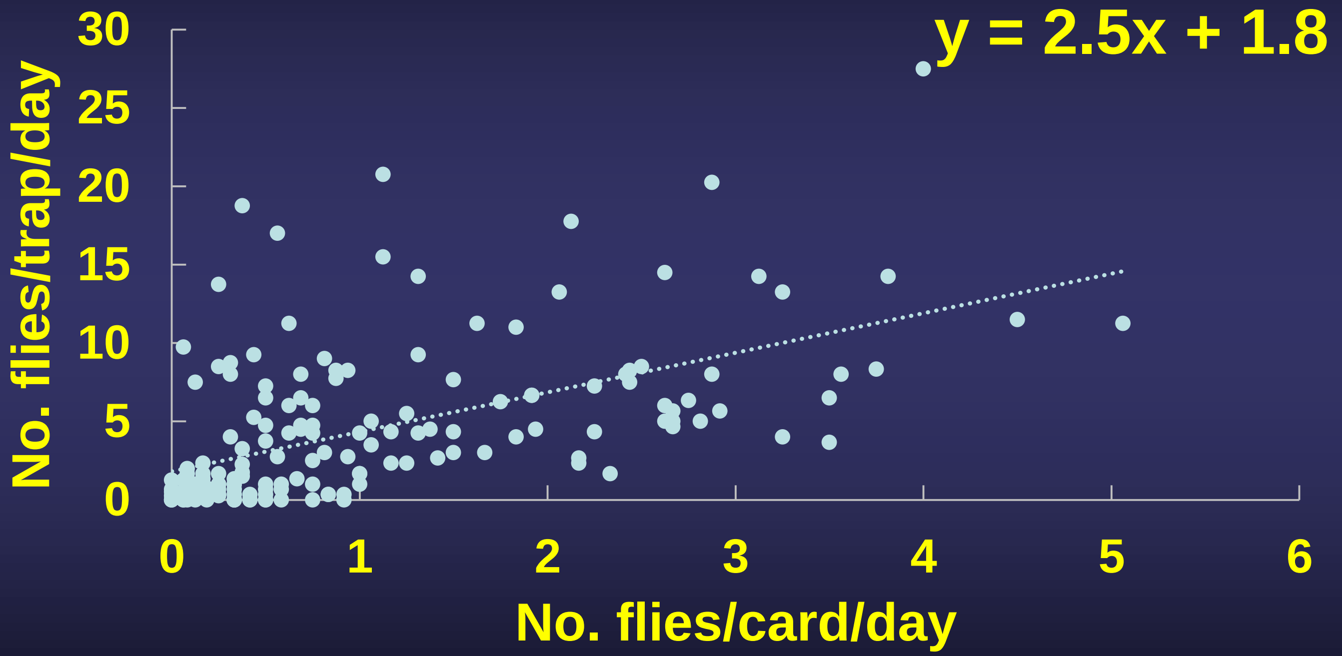
Repeated measures ANOVA (SAS PROC GLIMMIX): Lure *P* < 0.001, Date *P* < 0.001, Lure*Date *P* < 0.001


1,4 dimethoxy-
benzene
Ammonium
acetate

Relationship between trap captures and corn silk fly observations, spring & fall 2019

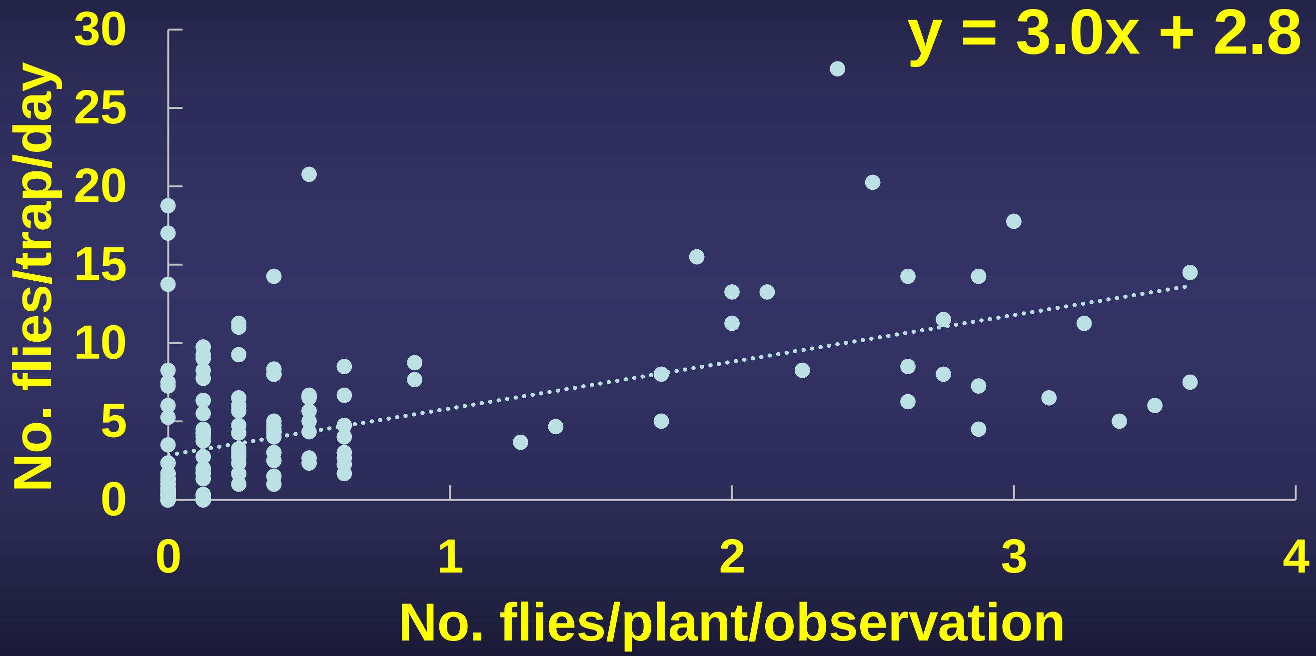
- 24 or 16 plots (60’ * 60’) established in a sweet corn field (480’ * 72 rows) at tassel push
- Each plot
  - 1 trap at the center
  - 4 yellow sticky cards (3” * 5”), 15’ from trap
  - 2 plants adjacent to each sticky card (8 plants total)
- 7 or 8 samplings, every 3-4 days
- 4 or 5 pyrethroid applications within a week, between the 3rd and 5th samplings

Relationship between trap captures and sticky card observations, spring 2019 (3 species)



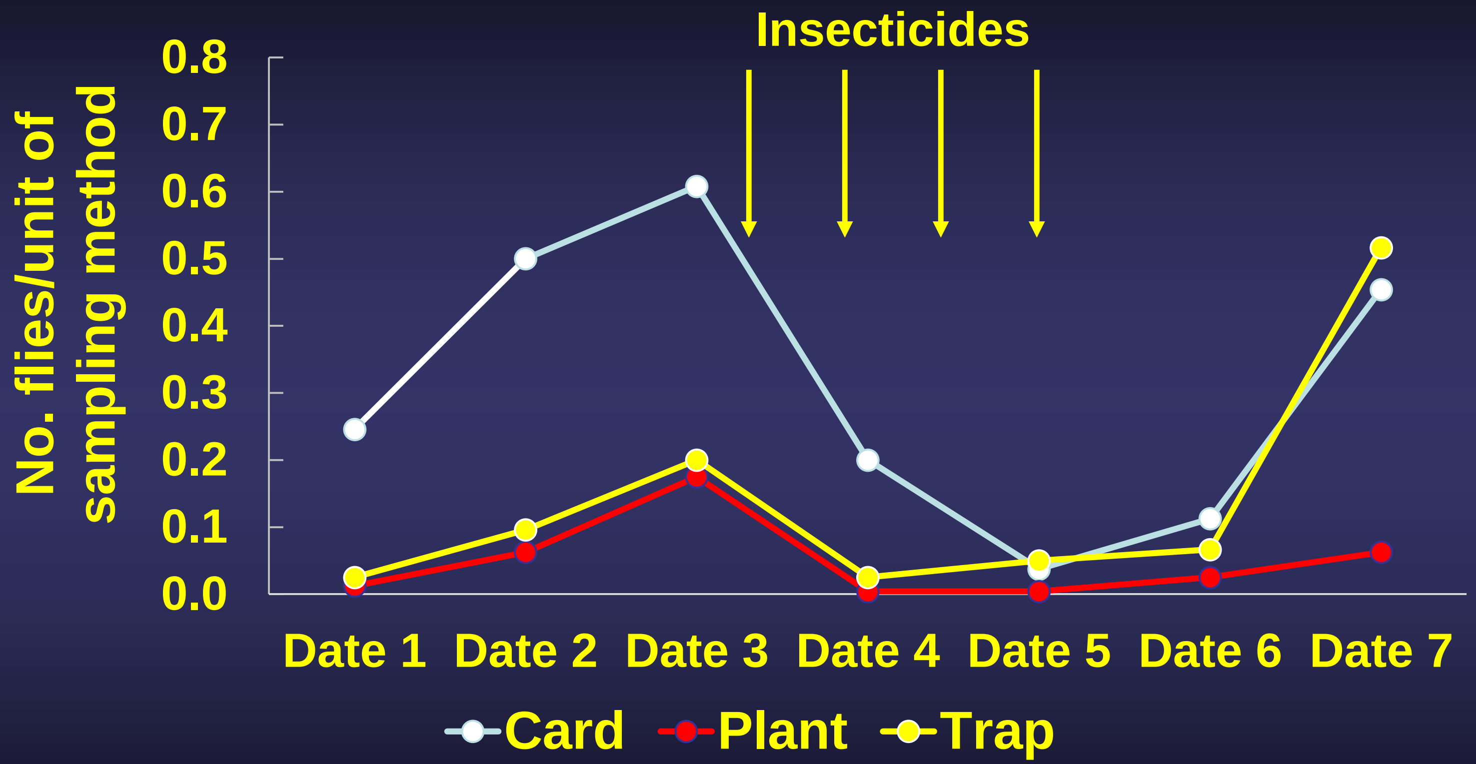
Linear regression (SAS PROC REG): $P < 0.001$, $R^2 = 0.302$

Relationship between trap captures and plant observations, spring 2019 (3 species)



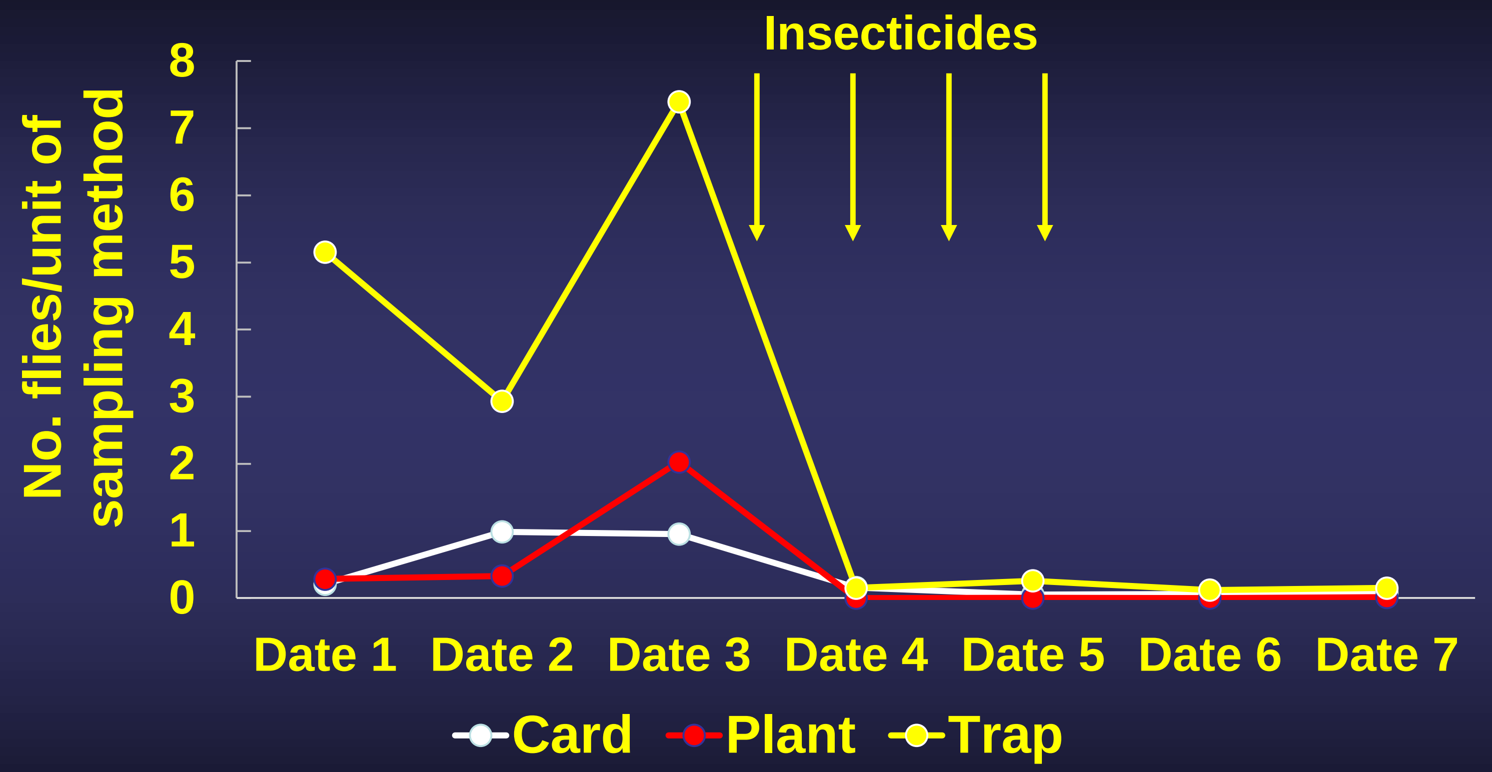
Linear regression (SAS PROC REG): $P < 0.001$, $R^2 = 0.313$

Comparison of *C. massyla* observations, spring 2019



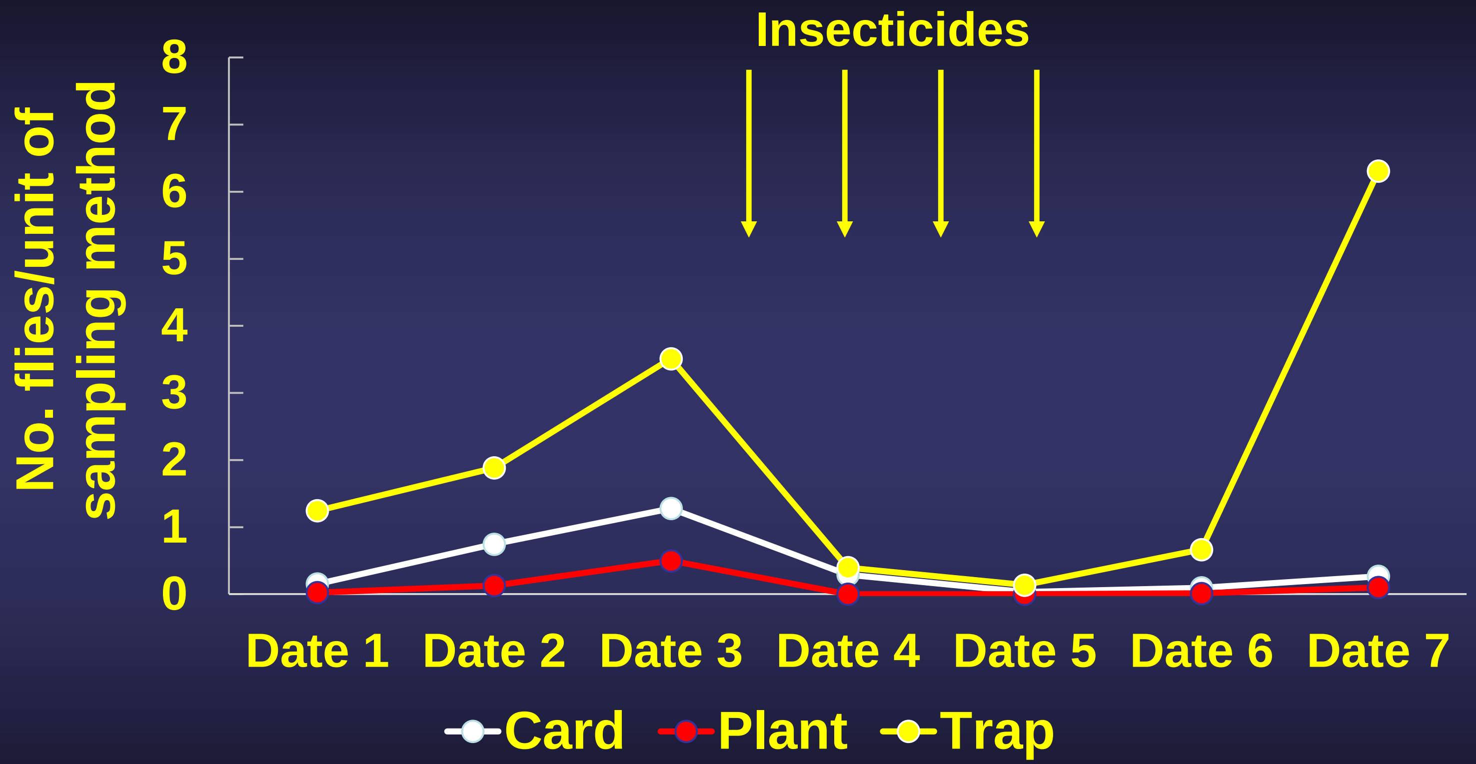
Repeated measures ANOVA (SAS PROC GLIMMIX): Sampling method $P < 0.001$, Date $P < 0.001$, Sampling method * Date $P < 0.001$

Comparison of *E. eluta* observations, spring 2019



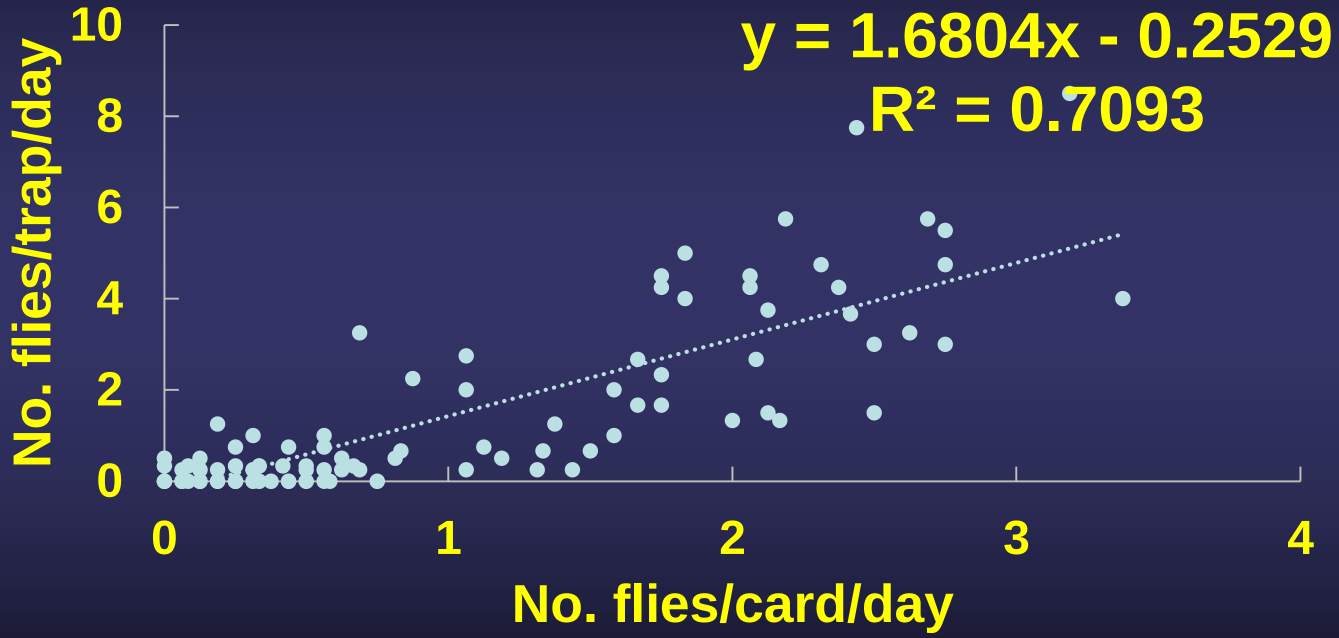
Repeated measures ANOVA (SAS PROC GLIMMIX): Sampling method *P* < 0.001, Date *P* < 0.001, Sampling method * Date *P* < 0.001

Comparison of *E. stigmatias* observations, spring 2019



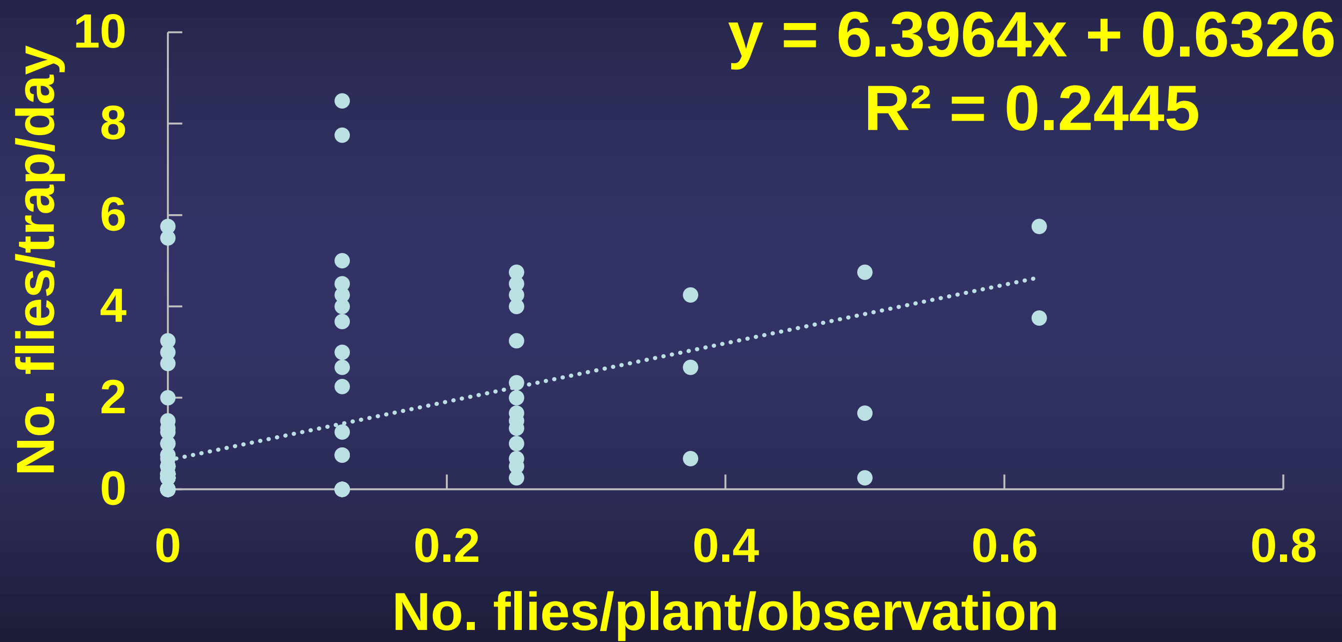
Repeated measures ANOVA (SAS PROC GLIMMIX): **Sampling method *P* < 0.001, Date *P* < 0.001, Sampling method * Date *P* < 0.001**

Relationship between trap captures and sticky card observations, fall 2019 (3 species)



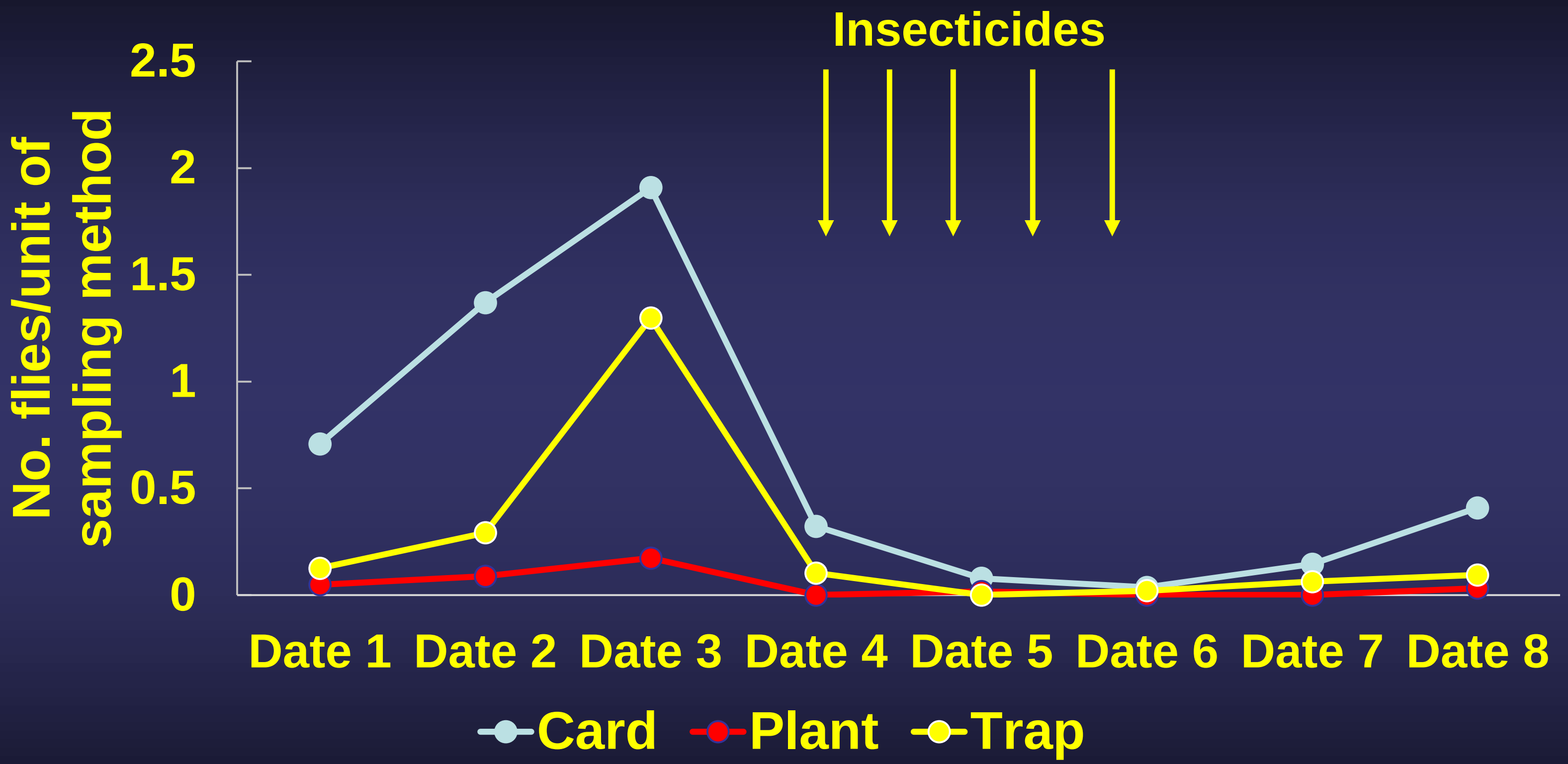
Linear regression (SAS PROC REG): $P < 0.001$, $R^2 = 0.709$

Relationship between trap captures and plant observations, fall 2019 (3 species)



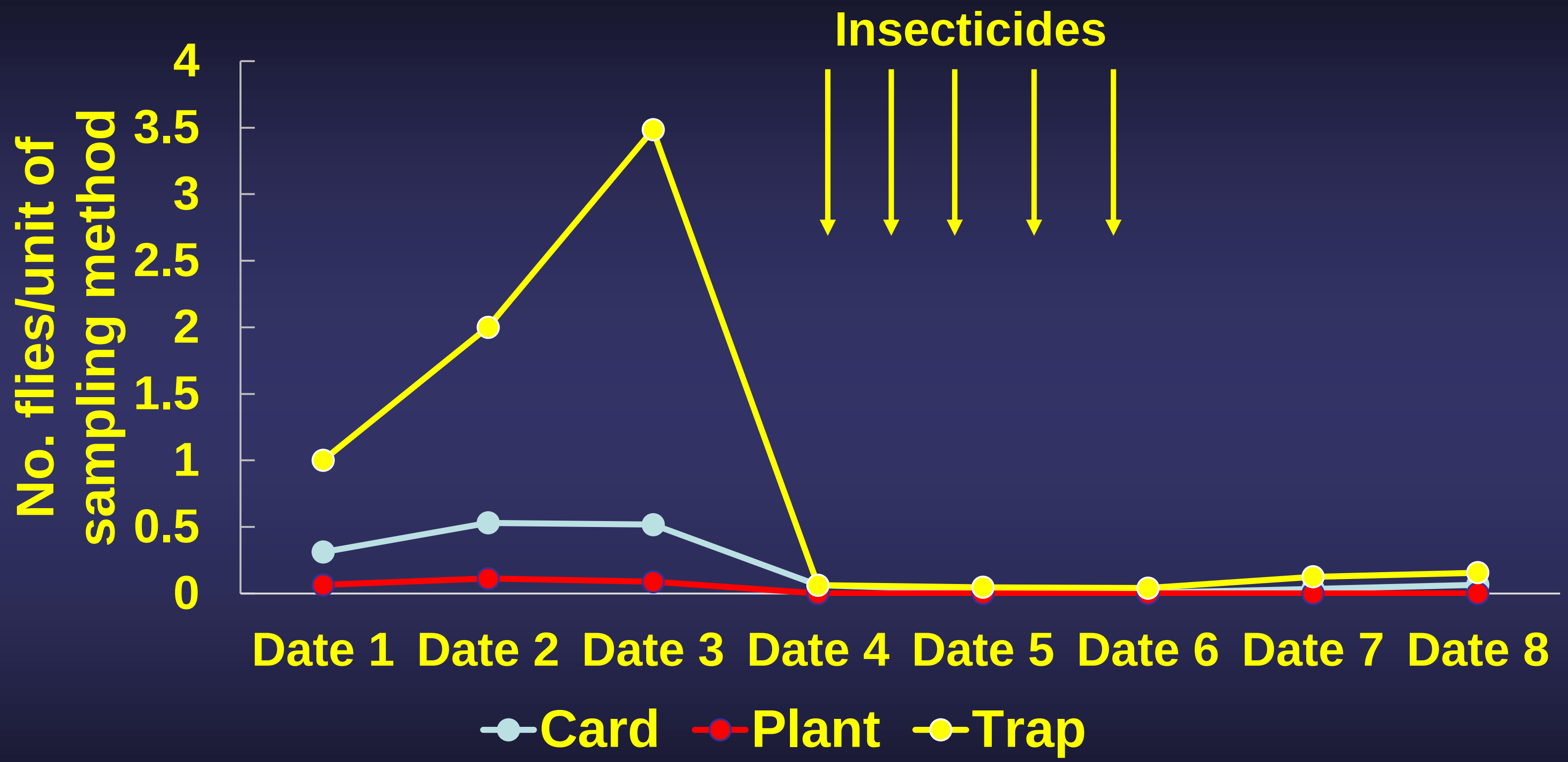
Linear regression (SAS PROC REG): $P < 0.001$, $R^2 = 0.248$

Comparison of *C. massyla* observations, fall 2019



Repeated measures ANOVA (SAS PROC GLIMMIX): Sampling method *P* < 0.001, Date *P* < 0.001, Sampling method * Date *P* < 0.001

Comparison of *E. stigmatias* observations, fall 2019



Repeated measures ANOVA (SAS PROC GLIMMIX): Sampling method *P* < 0.001, Date *P* < 0.001, Sampling method * Date *P* < 0.001

Conclusion: Traps for corn silk fly population monitoring

- Traps may assist with scouting.
- Further work is needed to better understand the relationship between trap captures and observations in the field.

Corn silk management with insecticides

E. stigmatias: Insecticide susceptibility

- **Spray booth (2013-2015)**

Insecticide	Mortality	Morbidity	Alive
24 h			
Control	3.0 ± 1.1g	0.0f	97.0 ± 1.1a
Chlorpyrifos	100.0a	0.0f	0.0e
Methomyl	65.7 ± 5.7b	22.6 ± 4.0b	11.7 ± 3.6cde
Carbaryl	8.7 ± 4.6fg	0.0f	91.3 ± 4.6a
Esfenvalerate	48.7 ± 5.3bcd	25.0 ± 2.7abc	26.3 ± 3.4bc
Beta-cyfluthrin	33.2 ± 8.1de	34.0 ± 5.7ab	32.8 ± 4.2b
Bifenthrin	34.5 ± 9.5cdef	41.7 ± 7.7a	23.7 ± 8.6bc
Lambda-cyhalothrin	54.9 ± 5.9bcd	22.0 ± 5.7abcde	23.2 ± 11.1bcd
Zeta-cypermethrin	64.3 ± 6.0bc	24.3 ± 6.5abcd	11.4 ± 6.0cde
Zeta-cypermethrin + bifenthrin	76.5 ± 5.3ab	21.4 ± 6.3bcd	2.0 ± 1.3de
Carbaryl	8.7 ± 4.6fg	0.0f	91.3 ± 4.6a
Flubendiamide	3.0 ± 1.2g	2.3 ± 2.1def	94.7 ± 2.3a
Chlorantraniliprole	2.8 ± 1.3g	0.0f	97.2 ± 1.3a
Acetamiprid	3.9 ± 1.1g	0.0f	96.1 ± 1.1a

Owens et al. 2016. J. Econ. Entomol. 109: 1283-1288.

E. eluta: Insecticide susceptibility

- Spray booth (2013-2015)

Insecticide	Mortality	Morbidity	Alive
24 h			
Control	0.4 ± 0.3g	0.0f	99.6 ± 0.3a
Chlorpyrifos	100.0a	0.0f	0.0e
Methomyl	95.8 ± 1.9a	4.2 ± 1.9ef	0.0e
Carbaryl	20.0 ± 13.7fg	1.7 ± 2.0ef	78.3 ± 15.5bc
Esfenvalerate	32.7 ± 4.0ef	59.1 ± 5.1a	8.2 ± 2.3e
Beta-cyfluthrin	62.5 ± 4.8cd	36.5 ± 4.4bc	1.0 ± 0.5e
Bifenthrin	98.8 ± 1.1a	1.2 ± 1.1ef	0.0e
Lambda-cyhalothrin	47.2 ± 6.6de	48.9 ± 5.5ab	3.9 ± 1.8e
Zeta-cypermethrin	76.5 ± 4.8bc	22.5 ± 4.5cd	1.0 ± 0.4e
Zeta-cypermethrin + bifenthrin	81.9 ± 1.6ab	18.1 ± 1.6de	0.0e
Flubendiamide	6.8 ± 2.6g	14.5 ± 7.3def	78.7 ± 8.3bc
Chlorantraniliprole	0.8 ± 0.8g	0.9 ± 0.9ef	98.3 ± 1.0ab
Acetamiprid	16.1 ± 4.6fg	50.0 ± 3.4ab	33.9 ± 7.5d

Owens et al. 2016. J. Econ. Entomol. 109: 1283-1288.

C. massyla: Insecticide susceptibility

- Spray booth (2013-2015)

Insecticide	Mortality	Morbidity	Alive
24 h			
Control	2.9 ± 1.2e	2.8 ± 1.3e	94.3 ± 2.1a
Chlorpyrifos	100.0a	0.0e	0.0d
Malathion	100.0a	0.0e	0.0d
Methomyl	97.7 ± 1.5a	1.5 ± 0.9e	0.8 ± 0.8d
Carbaryl	21.3 ± 8.2de	9.0 ± 6.0cde	69.7 ± 12.7a
Esfenvalerate	43.5 ± 8.1cd	25.9 ± 1.8b	29.8 ± 7.3bc
Beta-cyfluthrin	57.5 ± 3.1bc	40.9 ± 2.6a	1.6 ± 1.6cd
Bifenthrin	43.6 ± 9.0cd	18.5 ± 3.2bc	37.9 ± 8.4b
Lambda-cyhalothrin	57.4 ± 2.4bcd	41.0 ± 3.3a	1.6 ± 1.6cd
Zeta-cypermethrin	83.9 ± 3.9ab	16.1 ± 3.9bcd	0.0d
Zeta-cypermethrin + bifenthrin	86.7 ± 1.9ab	13.3 ± 1.9bcde	0.0d
Flubendiamide	2.5 ± 1.5e	6.8 ± 1.6cde	90.7 ± 2.5a
Chlorantraniliprole	5.3 ± 1.5e	2.3 ± 1.5e	92.4 ± 2.8a

Owens et al. 2016. J. Econ. Entomol. 109: 1283-1288.

Consider the use of PBO with pyrethroids

- PBO (piperonyl butoxide), a synergist to increases silk fly susceptibility to pyrethroids

	LC_{50} (ppm) β-cyfluthrin	LC_{50} (ppm) β-cyfluthrin + PBO	Increase in susceptibility
E. stigmatias	187	60	3.1-fold
E. eluta	23	14	1.7-fold
C. massyla	48	7	6.5-fold

LC_{50} is the insecticide concentration killing 50% of the population

Owens et al. 2016. J. Econ. Entomol. 109: 1283-1288.


Effect of pyrethroid application timing on silk fly injury and infestation levels
• Early AM, early PM, late PM, non-treated
- 50’ by 50’ plots, 6 replications
- 3 pyrethroid applications / week for 3 weeks
- 10 GPA at 30 PSI

Effect of pyrethroid application timing on silk fly injury and infestation levels

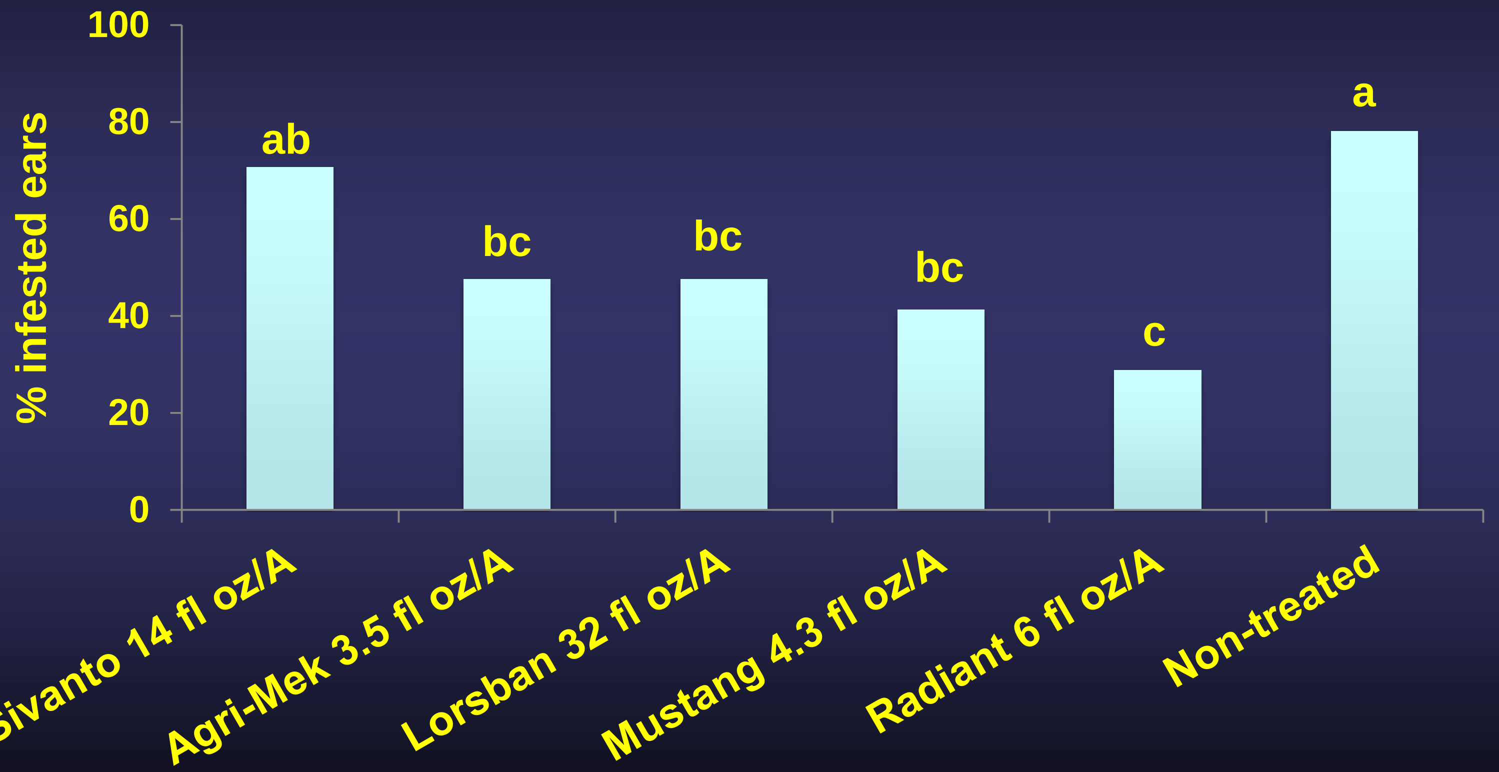
	Ear injury rating	% ear area injured	No. maggots /ear
Early AM	2.4b	1.3b	4.5b
Early PM	1.8bc	0.9b	3.3b
Late PM	1.7c	0.9b	3.3b
Non-treated	3.4a	5.8a	13.5a
F	28.2	7.9	5.9
P > F	<0.001	0.002	0.007

Means in a column followed by the same letter are not different (Tukey-Kramer adjustment, $\alpha = 0.05$)

Develop alternatives to pyrethroids

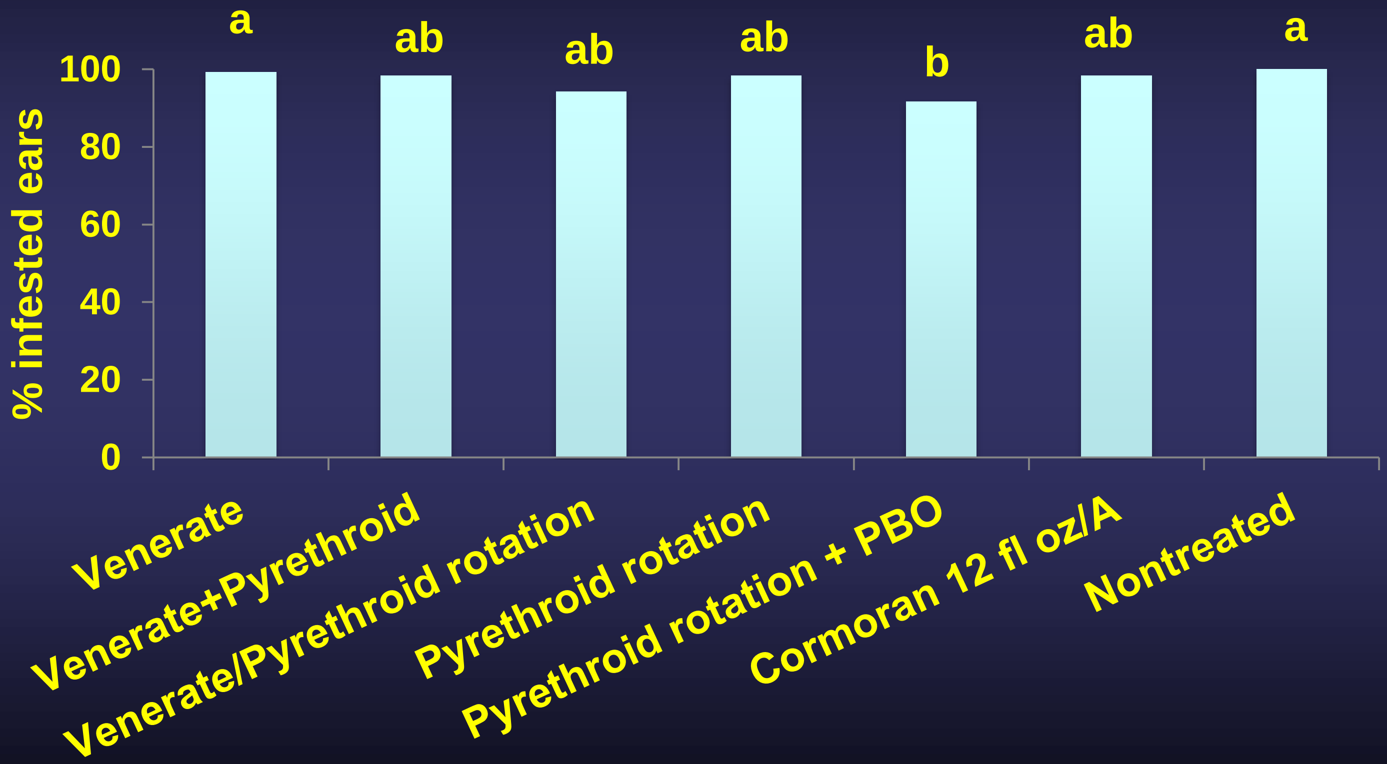
Photo: D. Larsen

Silk fly insecticide field evaluation, spring 2017, Belle Glade, FL



Bars with the same letter are not different (Tukey-Kramer test, *P* > 0.05)

Silk fly insecticide field evaluation, spring 2018, Belle Glade, FL



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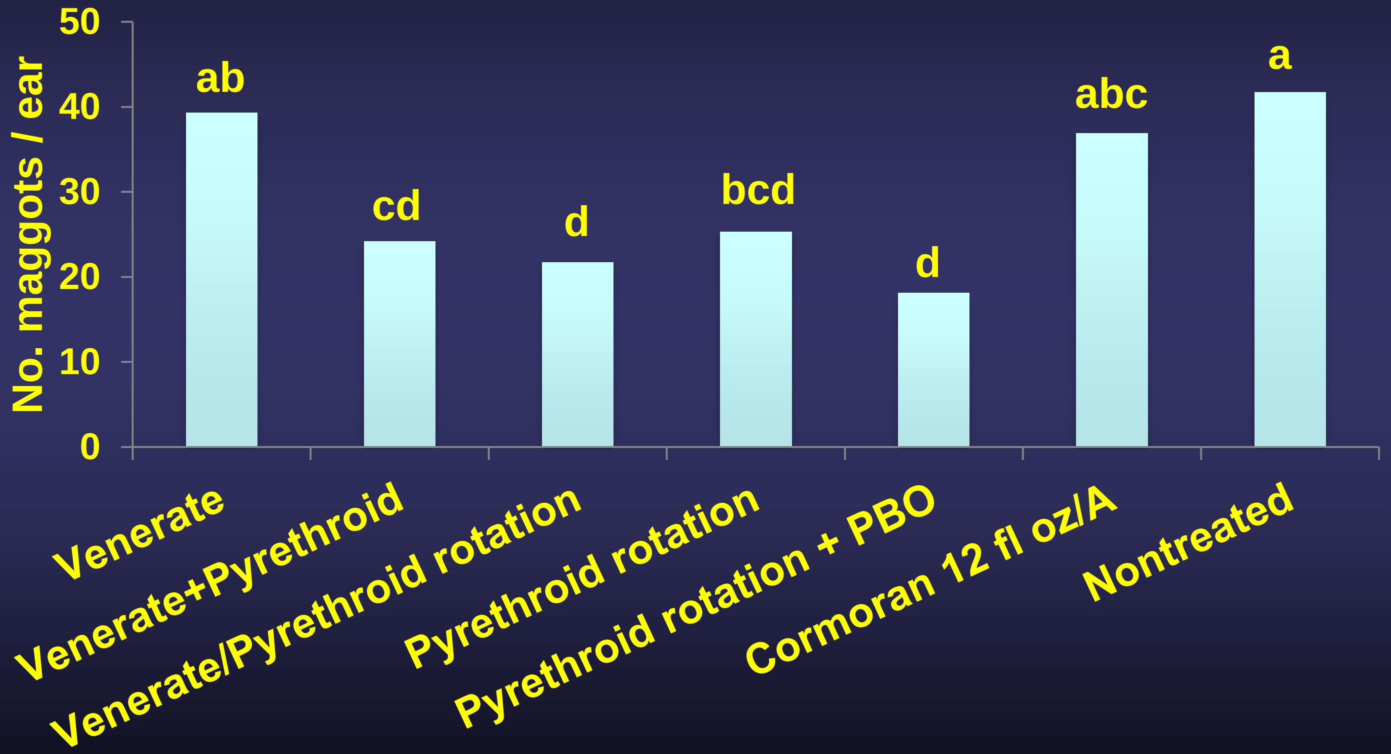
Silk fly insecticide field evaluation, spring 2018, Belle Glade, FL

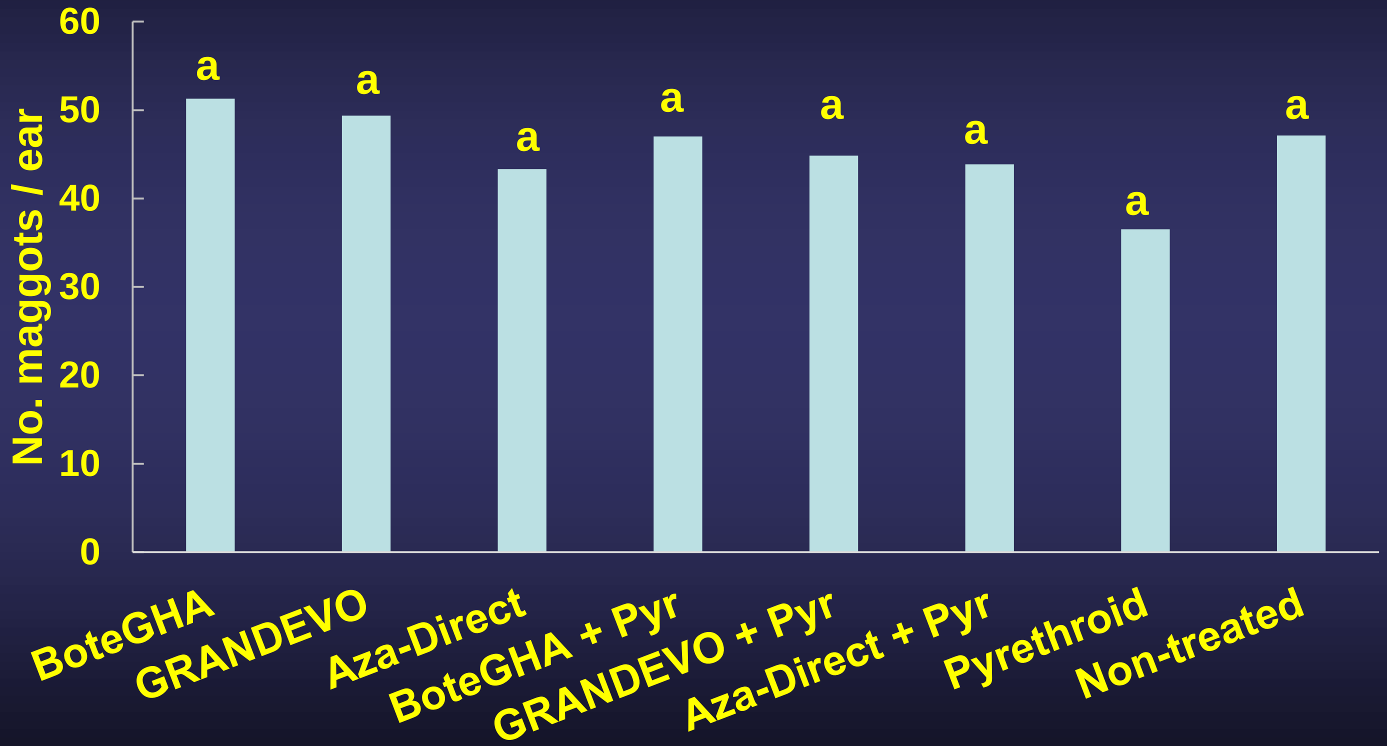


Bars with the same letter are not different (Tukey-Kramer test, $P > 0.05$)


55th Anniversary

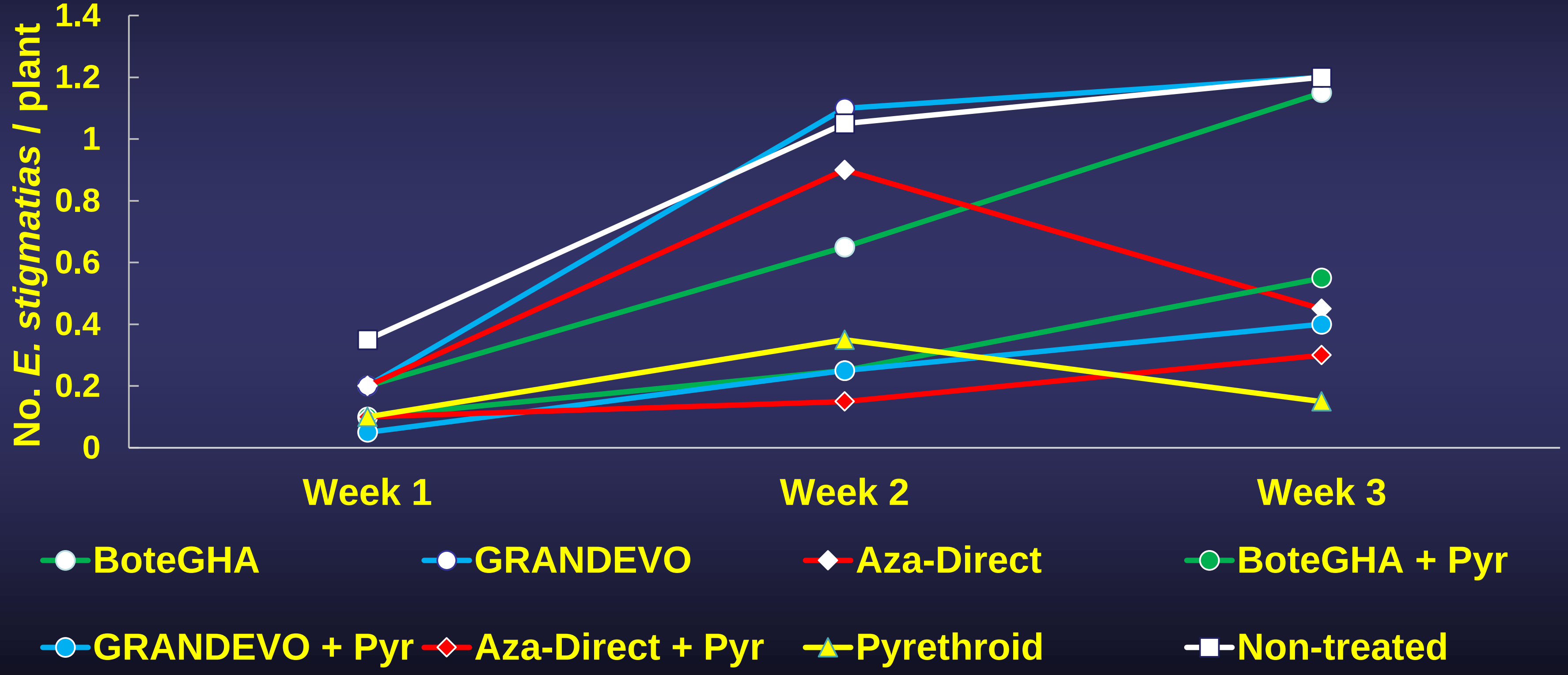

Everglades

Silk fly insecticide field evaluation, spring 2019, Belle Glade, FL – Ear infestations



Bars with the same letter are not different (Tukey-Kramer test, *P* > 0.05)

Silk fly insecticide field evaluation, spring 2019, Belle Glade, FL – Adults



Spray booth work, 2020-2021

Spray booth first results, February 2020

- *E. stigmatias* collected at EREC in early 2020
- 75% full rate applied to adults at 5 GPA

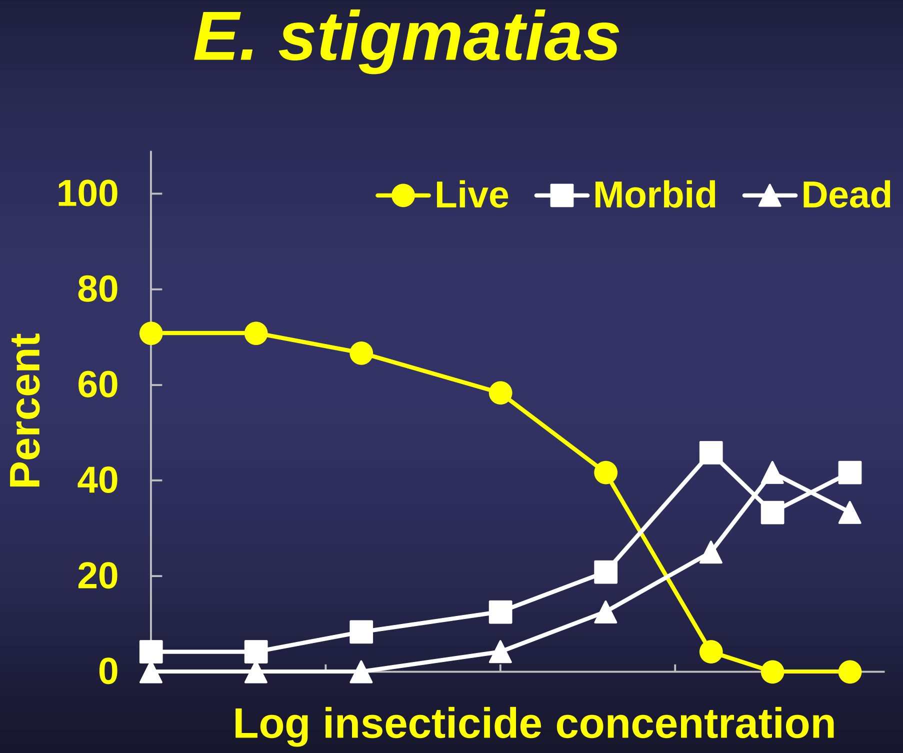
	% live	% moribund	% dead
Mustang Maxx	1.0c	3.0ab	96.0a
Brigade	7.3c	7.2a	85.6b
Radiant	89.4b	2.1ab	8.6c
Water check	99.0a	0.0b	1.0c
F	640.5	6.7	717.9
P > F	<0.001	0.012	<0.001

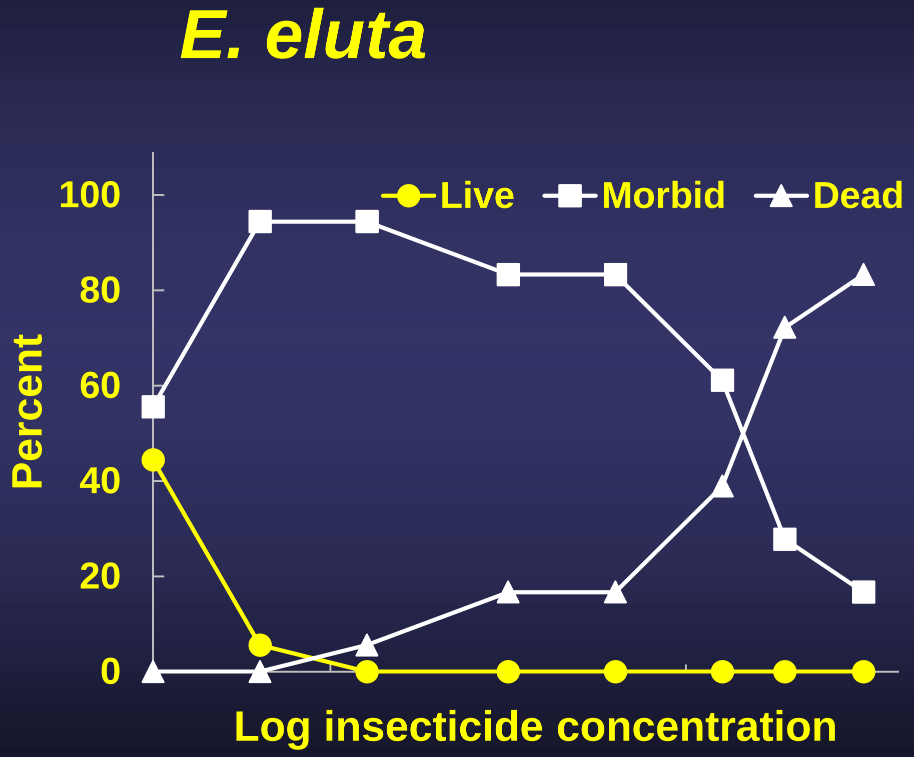
Means in a column followed by the same letter are not different (Tukey-Kramer adjustment, $\alpha = 0.05$)

Development of adult vial assays (AVTs)

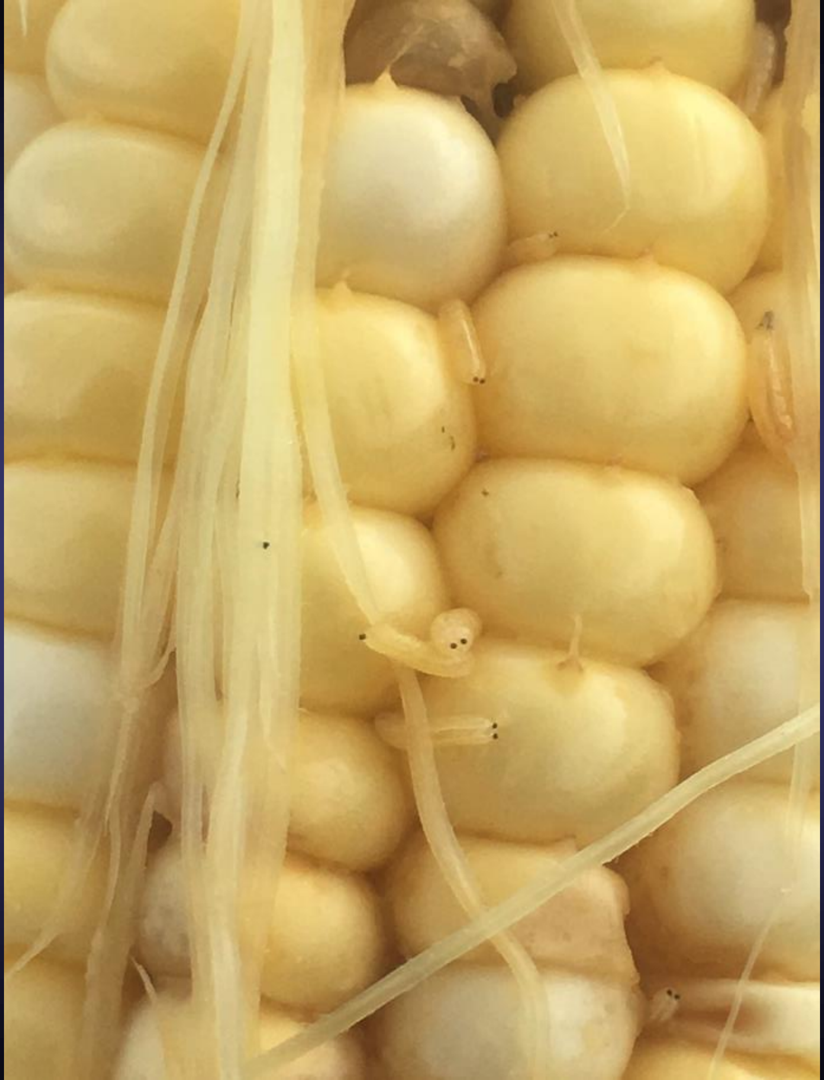
- Use glass vials treated with a pyrethroid to determine susceptibility in silk fly populations
  - Beta-cyfluthrin
- AVTs are: Simple, inexpensive, portable
- Determine pyrethroid susceptibility as affected by silk fly species, geographical region, and season: What is the threat of pyrethroid resistance?

Adult vial assay first results, February 2020





Corn silk management with cultural practices




Cultural practices for silk fly management

- Avoid late spring planting in problematic fields
- Avoid weedy fields and borders
- Avoid decaying crop residue, cull piles
- Consider prompt sweet corn crop residue destruction, flooding
  - Silk fly adults emerge from standing, harvested fields for >4-5 weeks
  - Max. emergence of >700 adults/sq. ft in a day

Owens et al. 2017. Fla. Entomol. 100: 422-425.

Silk fly-soil interaction laboratory studies

- *E. eluta* laboratory colony
  - UF/IFAS Everglades REC, Belle Glade, FL
  - Maintained at 26° C, 40-60% RH and a photoperiod of L12:D12
- 3 experiments (depth, soil type, flooding)
  - 4 treatments evaluated per experiment
  - 2 or 3 assays for each experiment
  - Treatments replicated 4 times in each assay (RBD)

Silk fly-soil interaction laboratory studies

1-quart plastic buckets

20 pupae / bucket

Silk fly-soil interaction laboratory studies

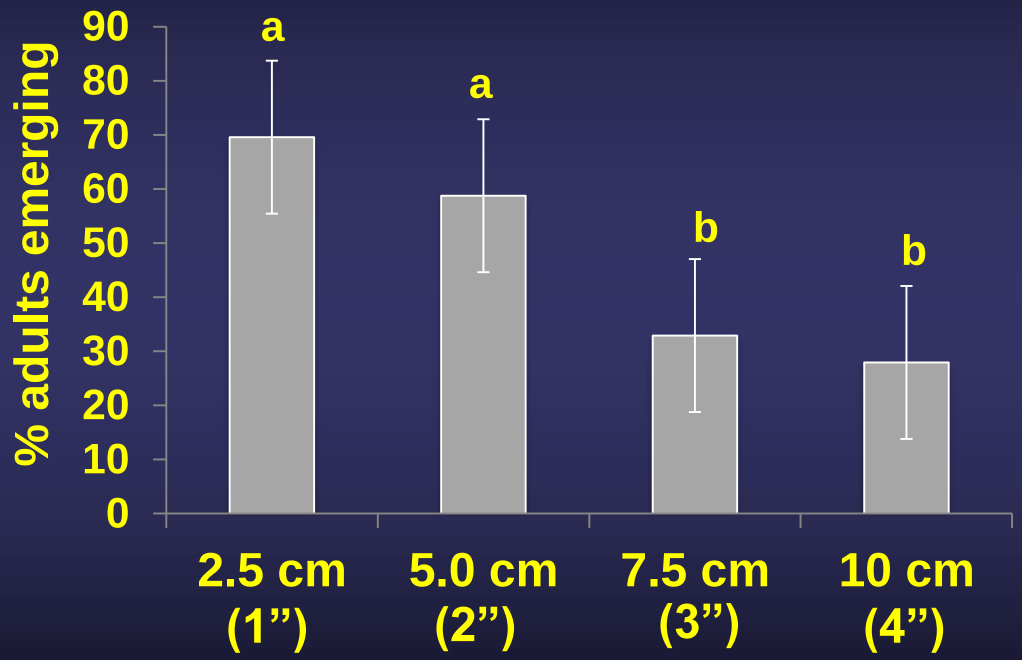
- Buckets were individually placed into screen cages

Adult emergence as affected by the depth of pupae in organic soil

- 4 depths from the soil surface
  - 1” (standard fly behavior)
  - 2”
  - 3”
  - 4”

- Local organic soil
  - > 65% organic matter
  - Dry and sifted

Adult emergence as affected by the depth of pupae in organic soil

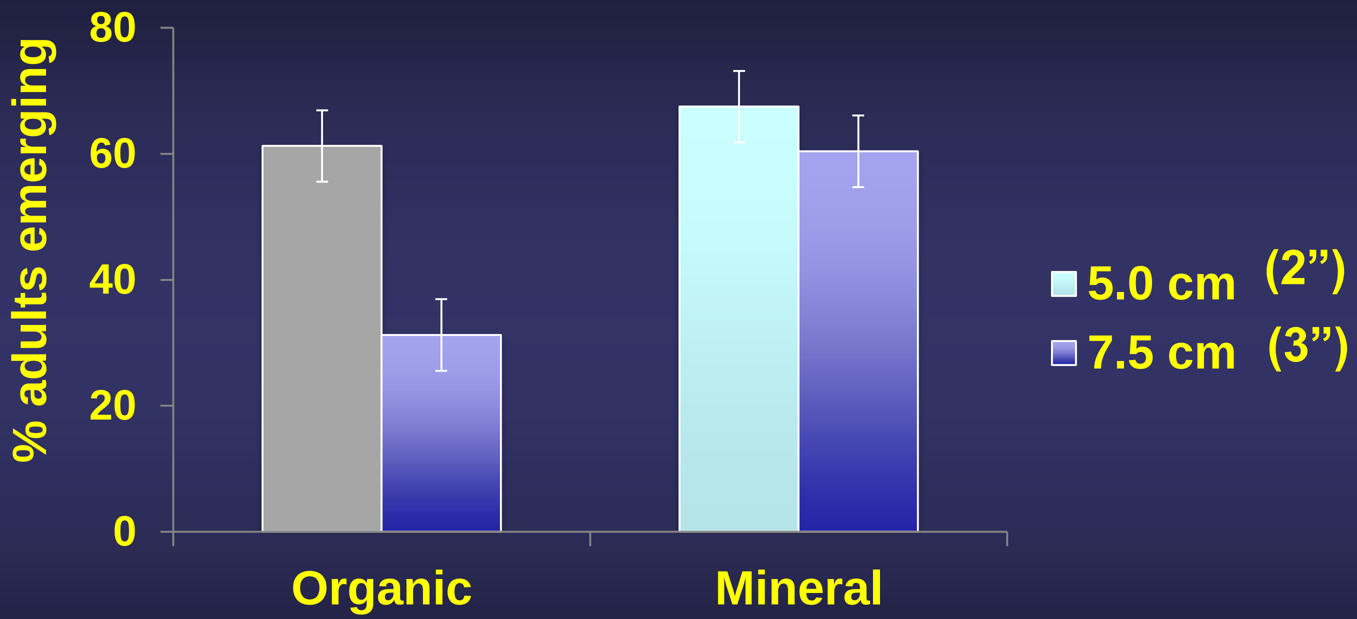


Linear mixed model (SAS PROC GLIMMIX): **Bars with the same letter are not different (Tukey-Kramer Adjustment, *P* > 0.05)**

Adult emergence as affected by soil type

- **2 soil types (dry, sifted)**
  - Local organic soil (> 65% OM)
  - Local mineral soil (< 10% OM)
- **2 depths for pupae**
  - 2”
  - 3”

Adult emergence as affected by soil type



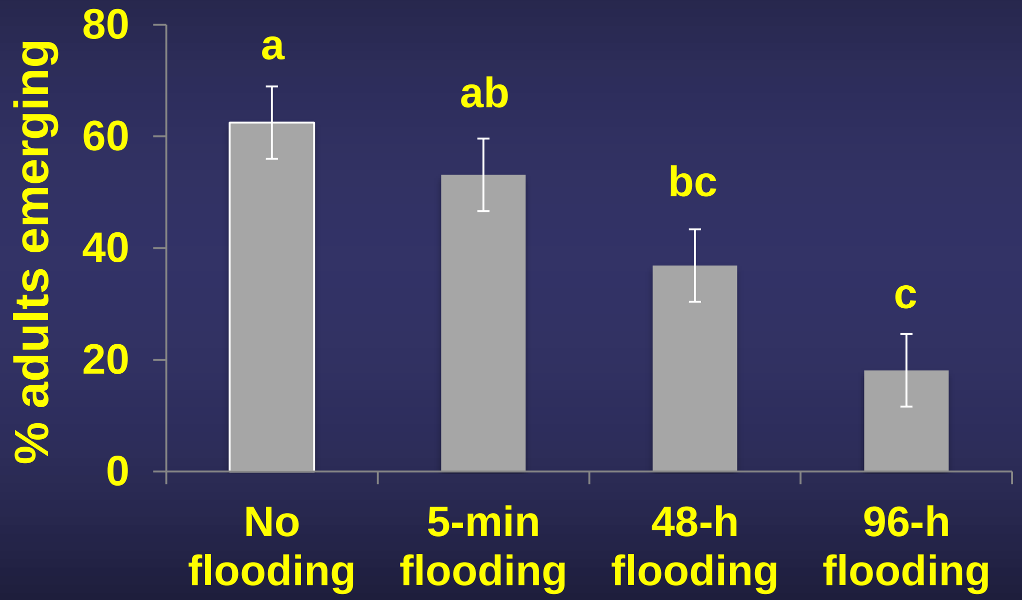
Linear mixed model (SAS PROC GLIMMIX): Soil type: F = 10.9; P = 0.002; **Depth:** F = 11.9; P = 0.001; **Soil type*Depth:** F = 4.6; P = 0.001

Adult emergence as affected by flooding in organic soil

- **4 flooding regimes**
  - No flooding
  - 5-min flooding
  - 48-h flooding
  - 96-h flooding

- **Local organic soil**

Adult emergence as affected by flooding in organic soil



Linear mixed model (SAS PROC GLIMMIX: **Bars with the same letter are not different (Tukey-Kramer Adjustment, *P* > 0.05)**

Corn silk fly-soil interactions and management

- Cultural practices burying late larval instars or pupae > 10 cm below the soil surface may substantially decrease adult emergence from organic soils
- Soil type influences silk fly adult emergence, with mineral soils providing more favorable conditions than organic soils
- Flooding $\geq$ 48 h decreases silk fly adult emergence from organic soils

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Corn silk fly identification, sampling, and management

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