Effects of Ray Petals and Disc Color on Pollinator Visitation and Seed Damage

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January 8, 2025
NSA Research Forum
Fargo, ND

Insects on sunflowers

Photos: Jeff Cluever (top); Andy Reago & Chrissy McClarren (middle)

Sunflower pollinators

- Bees can improve seed yields
- Central US: Pollinated by native bees, mainly specialists of sunflower and other species in family Asteraceae

Mallinger et al. 2019

Pests and pollinators can use visual cues to find host plants:

Color

Size

Pattern

Shape

Diversity in Sunflower

Rauf 2019

Cvejić et al. 2016

Petal and anthocyanin mutation

Biparental inbred line population

Anthocyanin< (Green disc)	Anthocyanin++ (Red disc)
	

Petal and anthocyanin mutation

Biparental inbred line population

Anthocyanin < (Green disc)		**Anthocyanin ++ (Red disc)**	
Petals + **(Normal)**	Petals --/< **(Apetalous)**	Petals **(Normal)**	Petals --/< **(Apetalous)**
			

Experiment with 4 Bloom Types

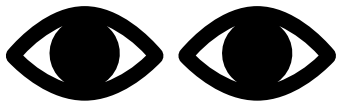
How does **color** and **petal presence**….

…affect pollinator visitation?

…affect insect seed damage?

Pollinator Visitation

Bees have preferences for floral traits

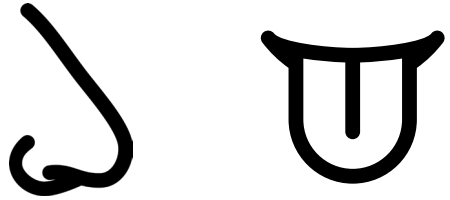


Color

Size

Shape

Pattern



Corolla Depth

Nectar Sugar

Pollen Amount

Odor

Experiment with 4 Bloom Types

Bee preference for:

Color x Petal presence

Experiment with 4 Bloom Types

Bee preference for:

Color x Petal presence

Temperature →

→ Bees like warmer flowers

- At colder temps
- In the morning

Questions:

Do bees have a preference for sunflower disc color?

Or for petal presence?

Does floret temperature differ between bloom types?

Does variation in floret temperature explain bees' preferences?

Methods

Plant Date: May 29, 2024

Location: Casselton, ND

Randomized design

Planted lines in field (20 plants/ range)

Methods

Plant Date: May 29, 2024

Location: Casselton, ND

Randomized design

Planted lines in field (20 plants/ range)

Green Normal
N = 10

Green Apetalous
N = 6

Red Normal
N = 10

Red Apetalous
N = 10

Methods: Walking Counts

	Walking Counts
Morning: (~9AM)	(8:40 – 9:30)
Midmorning: (~11AM)	(11:00-11:30)

1 minute counts:

- # of actively pollinating insects
- # of pollinators/ head

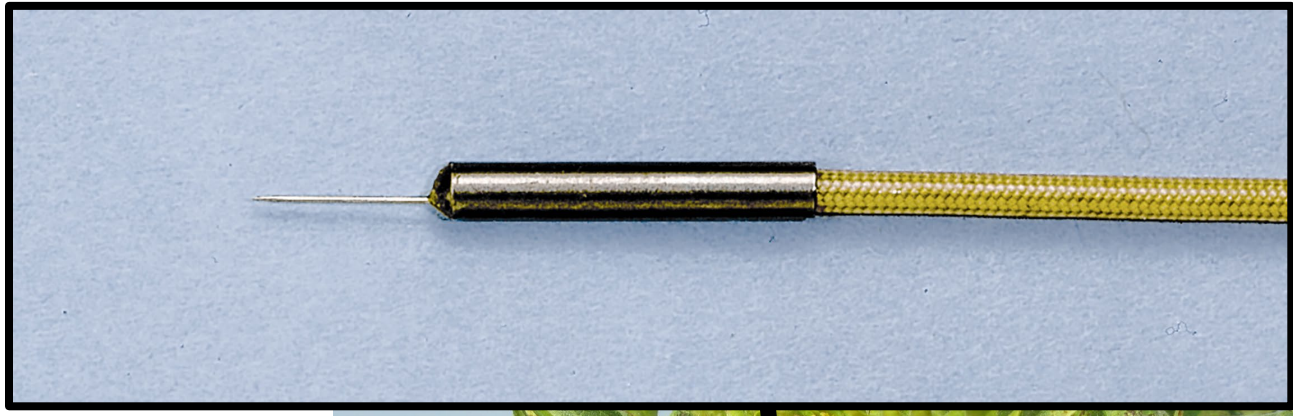
Suitable Conditions:

- Period: Aug 4 – 21, 2024
- Line had ≥ 50% Heads in Bloom
- Temperature: 57 °F +
- Wind: < 19 mph
- No rain

Methods: Temperature

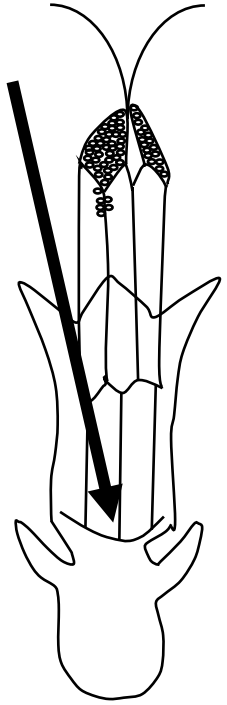
	Bee Counts	Temperature Recordings
Morning: (~9AM)	(8:40 – 9:30)	
		(9:30 – 10:50)
Midmorning: (~11AM)	(11:00-11:30)	
		(11:30-12:50)

Measuring Average Temperature



- Microprobe (Physitemp)
- Found intra-floret temperatures
- 1 plant/line

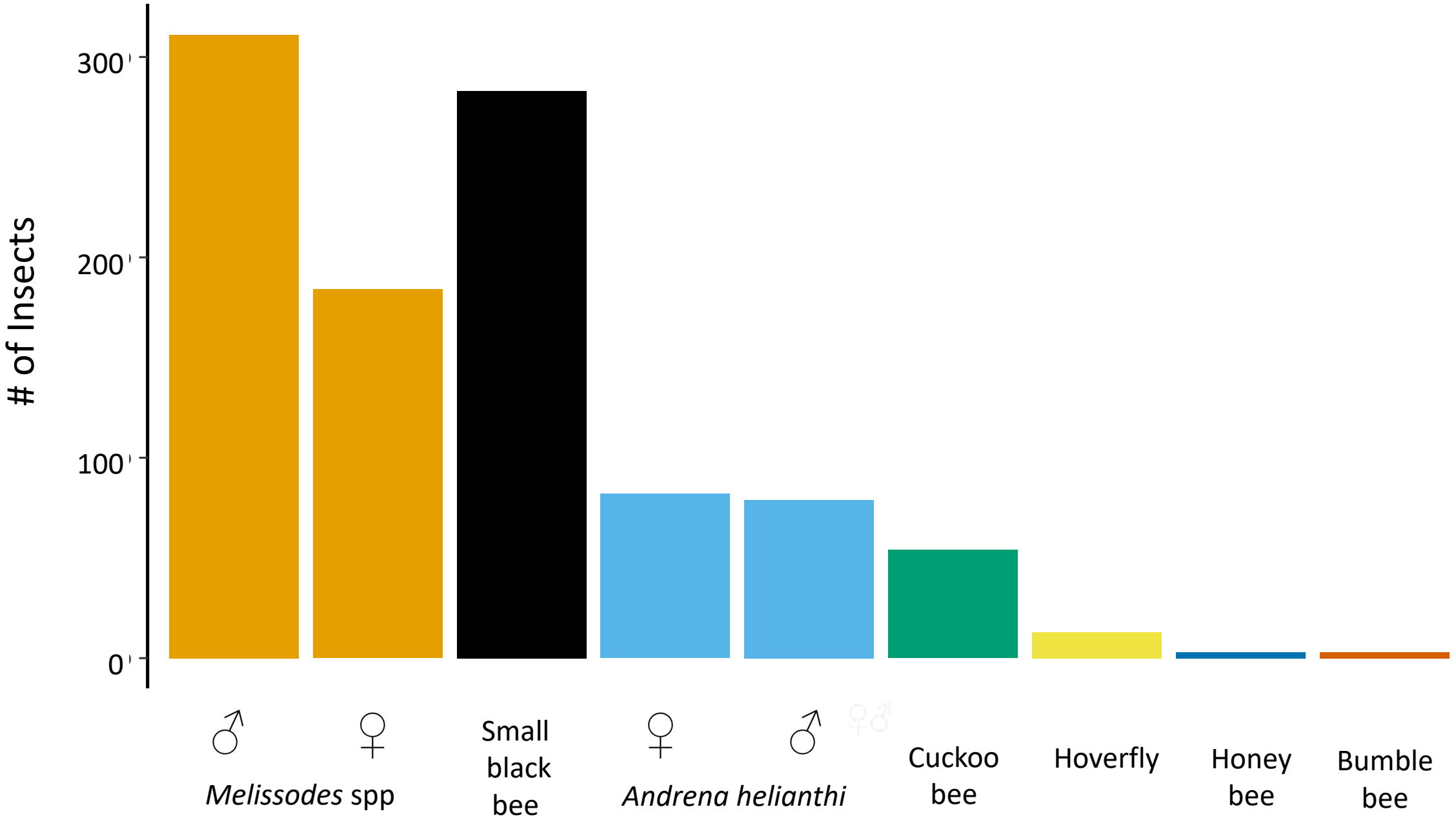
- Ambient temperature data from nearby weather station (< 2 miles)



Average Floret Temp – Ambient Temp = **Excess Floret Temp**

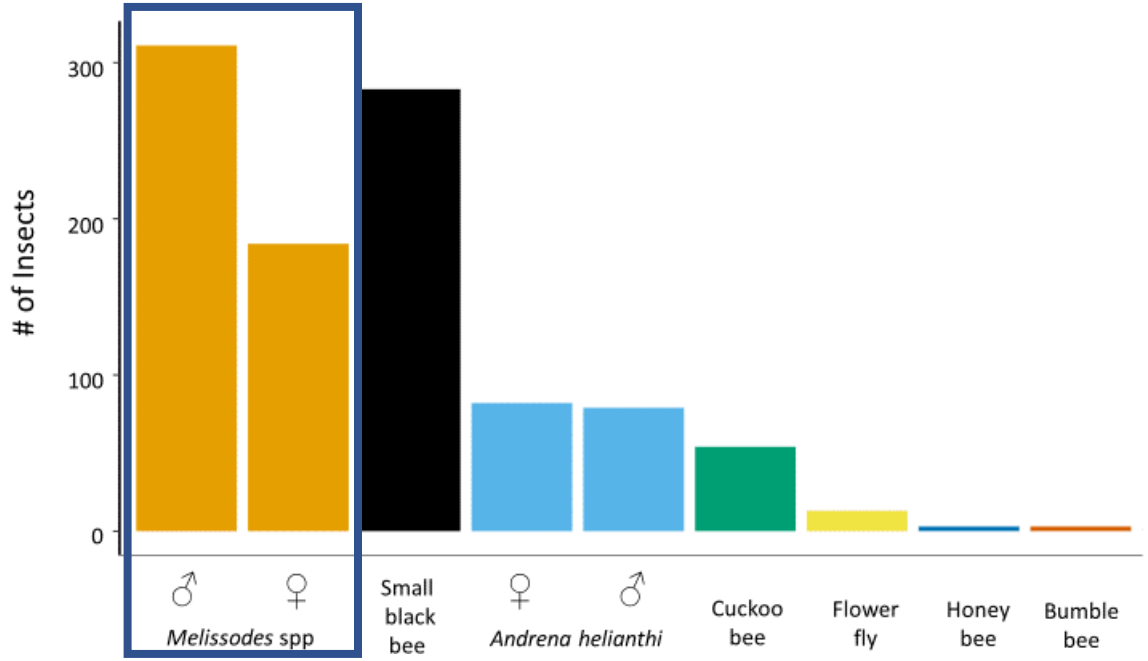
Results

Identity of pollinators



Most abundant pollinators

Long horned bees (*Melissodes* spp.)



2nd Most Abundant Pollinators

Small Black Bees

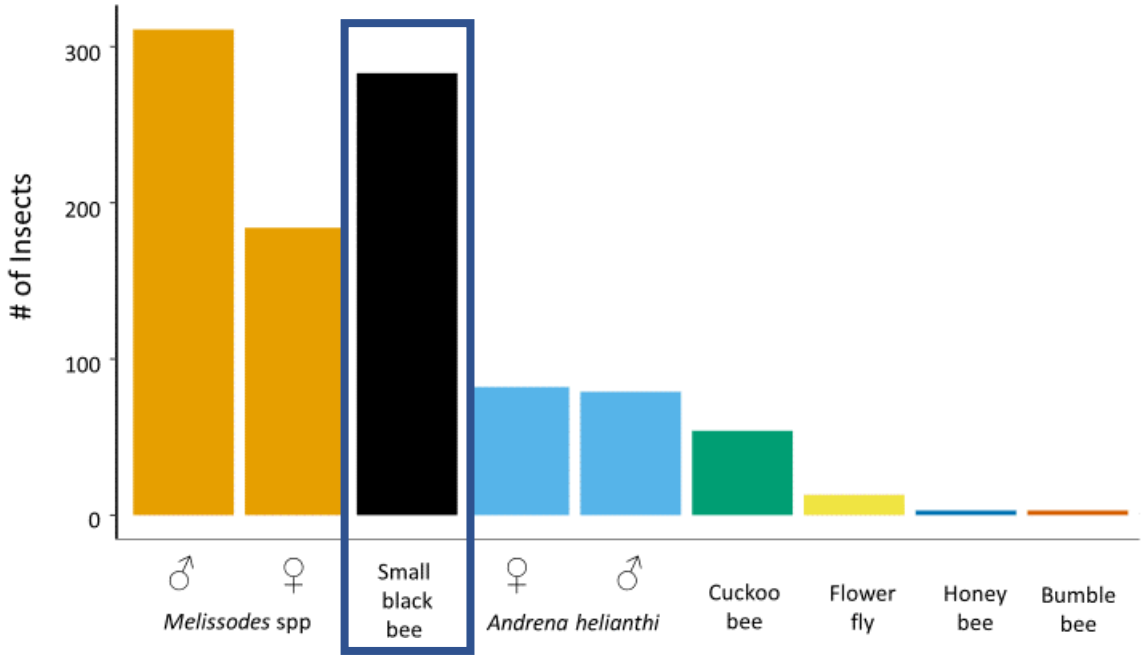
Probably includes:

Family Andrenidae:

Pseudopanurgus labrosiformis

Family Halictidae:

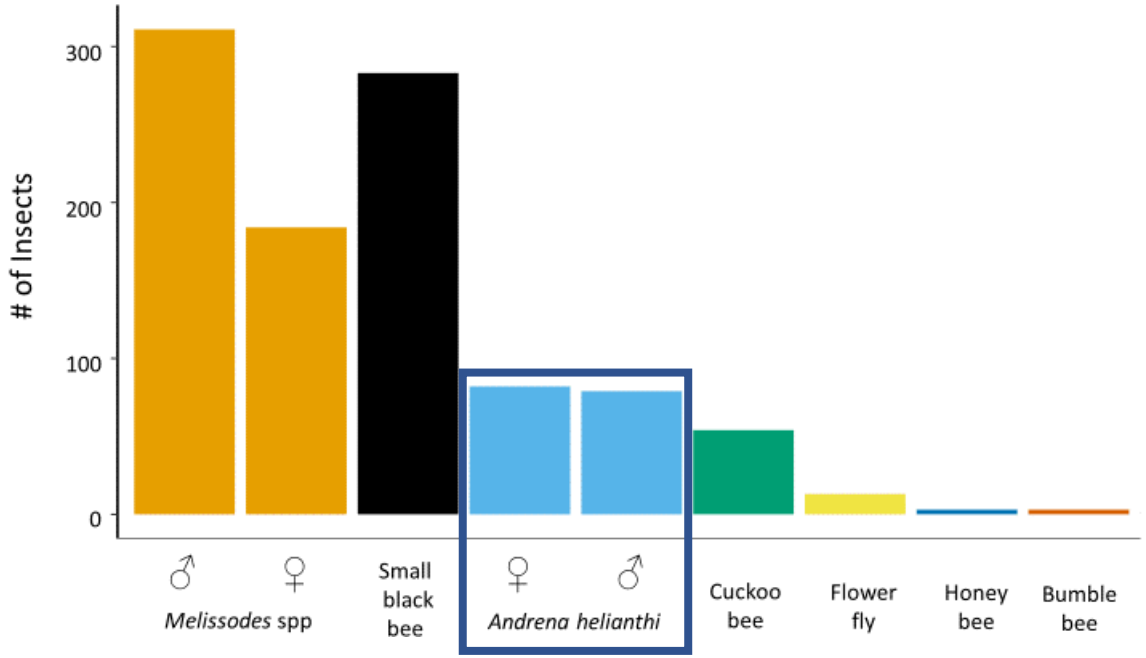
Lasioglossum spp.



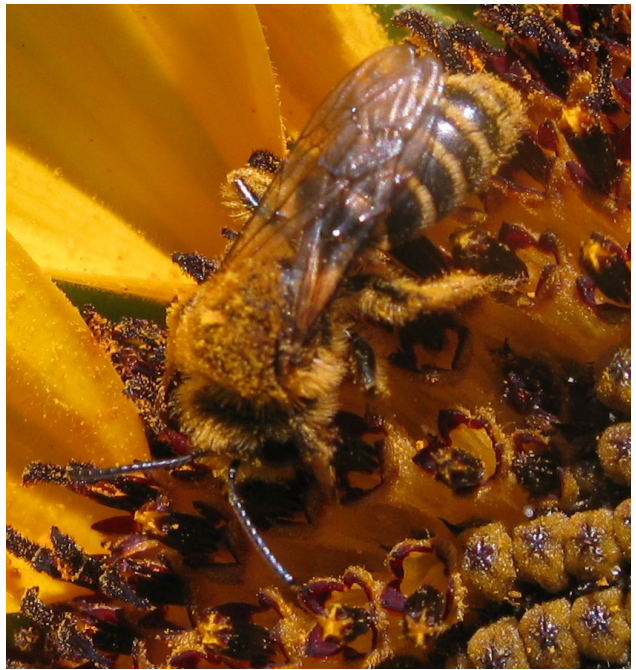
Ferguson et al. 2021

3rd Most Abundant Pollinators

Sunflower miner bee (*Andrena helianthi*)



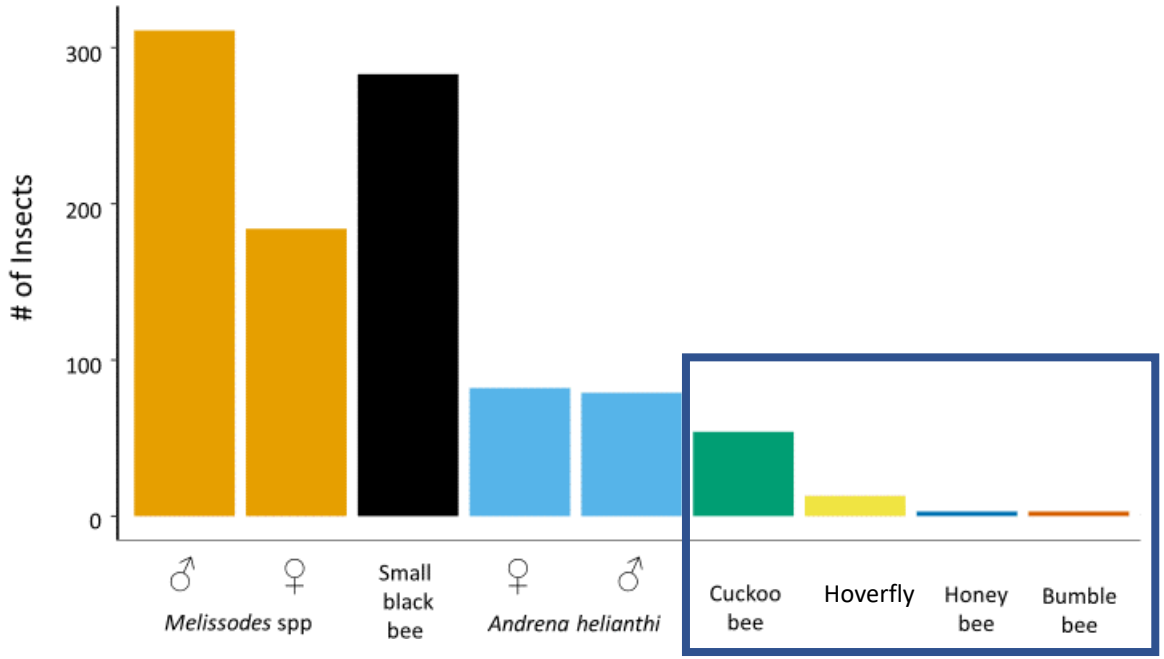
Female



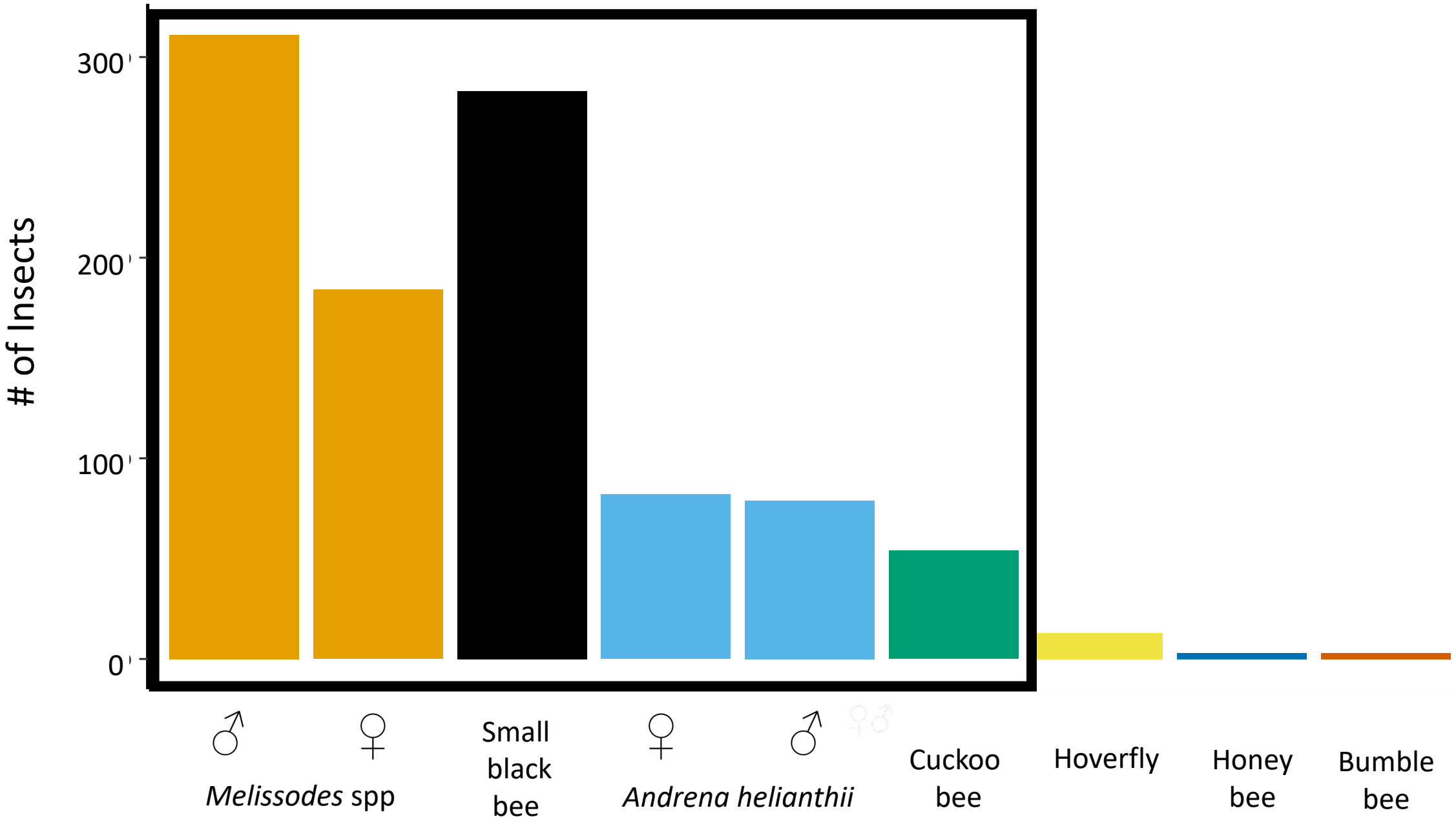
Male

Other pollinators:

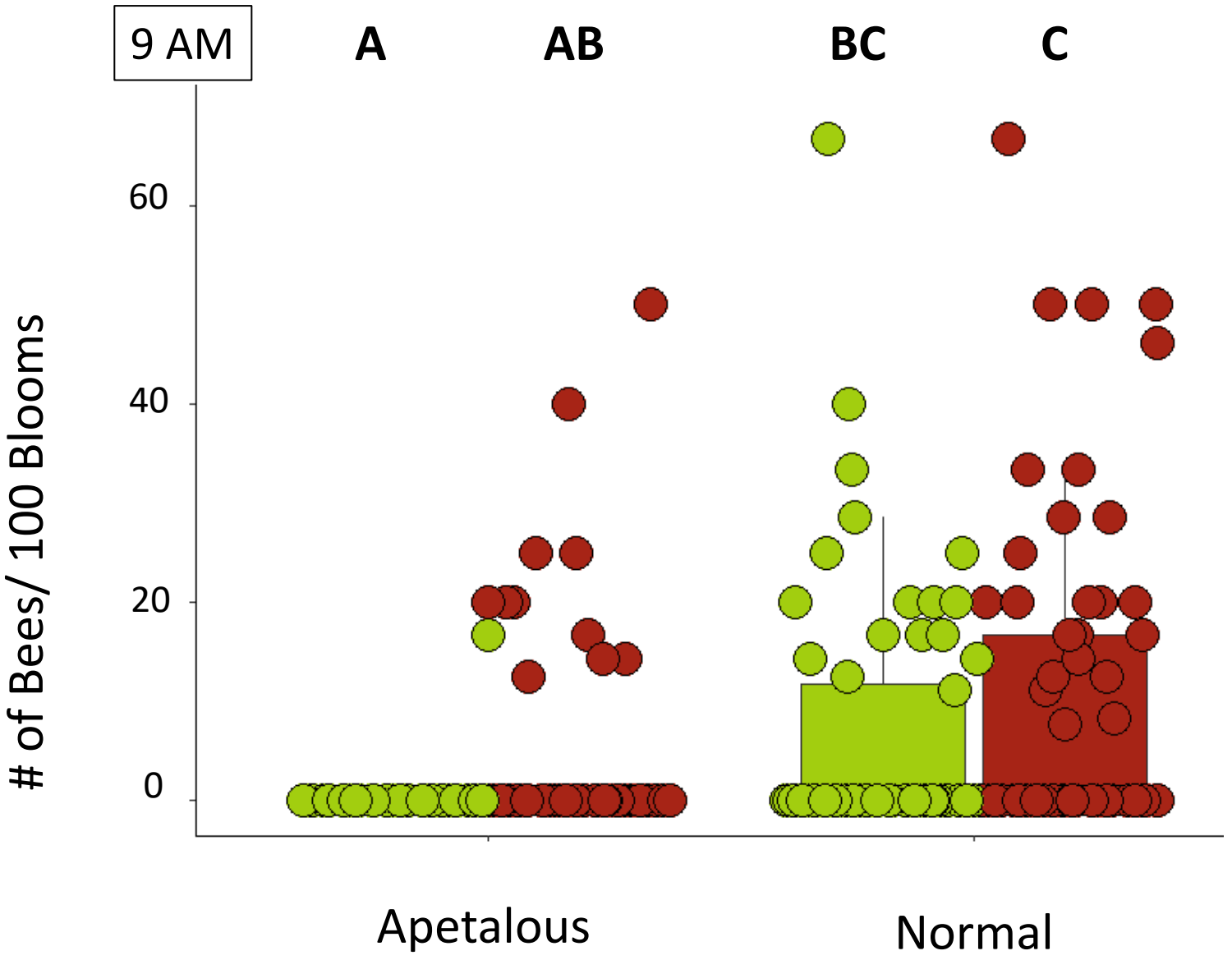
- Cuckoo bees
- Hoverflies (Syrphids)
- Honey bees
- Bumble bees



Main pollinators are solitary bees



Bees prefer lines with petals over apetalous lines



Kruskal-Wallis Test:

Petal:
$X^2 = 15.88$
$p < 0.001$

Color:
$X^2 = 1.74$
$p = 0.188$

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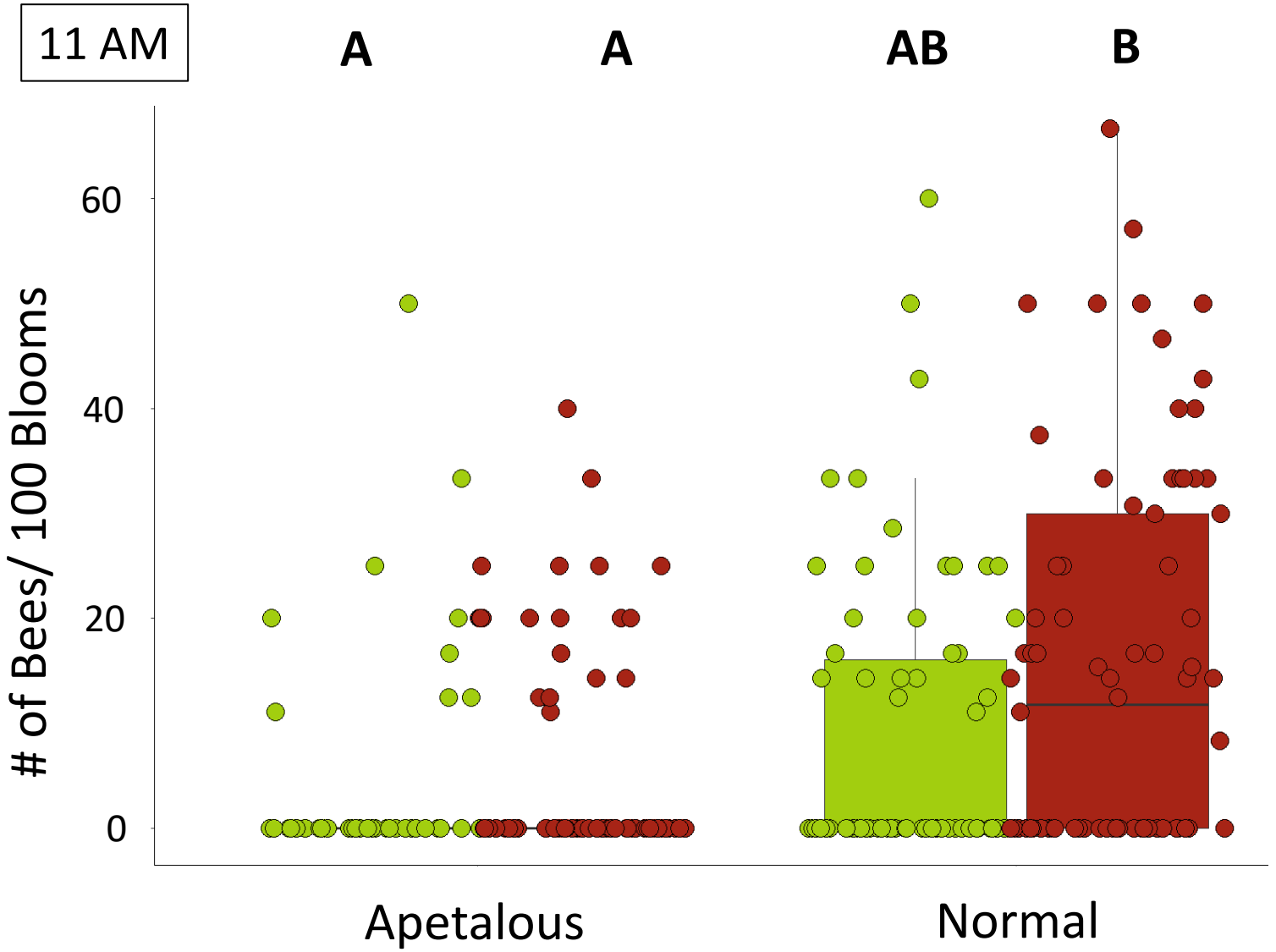


Green Disc

Red Disc

Kruskal-Wallis Test:

Petal:

$X^2 = 17.46$

$p < 0.001$

Color:

$X^2 = 2.21$

$p = 0.137$

Summary

Do bees have a preference for sunflower disc color? **NO**

Or for petal presence? **YES, bees prefer sunflowers with petals**

Does floret temperature differ between bloom types?

Does variation in floret temperature explain bees' preferences?

Questions:

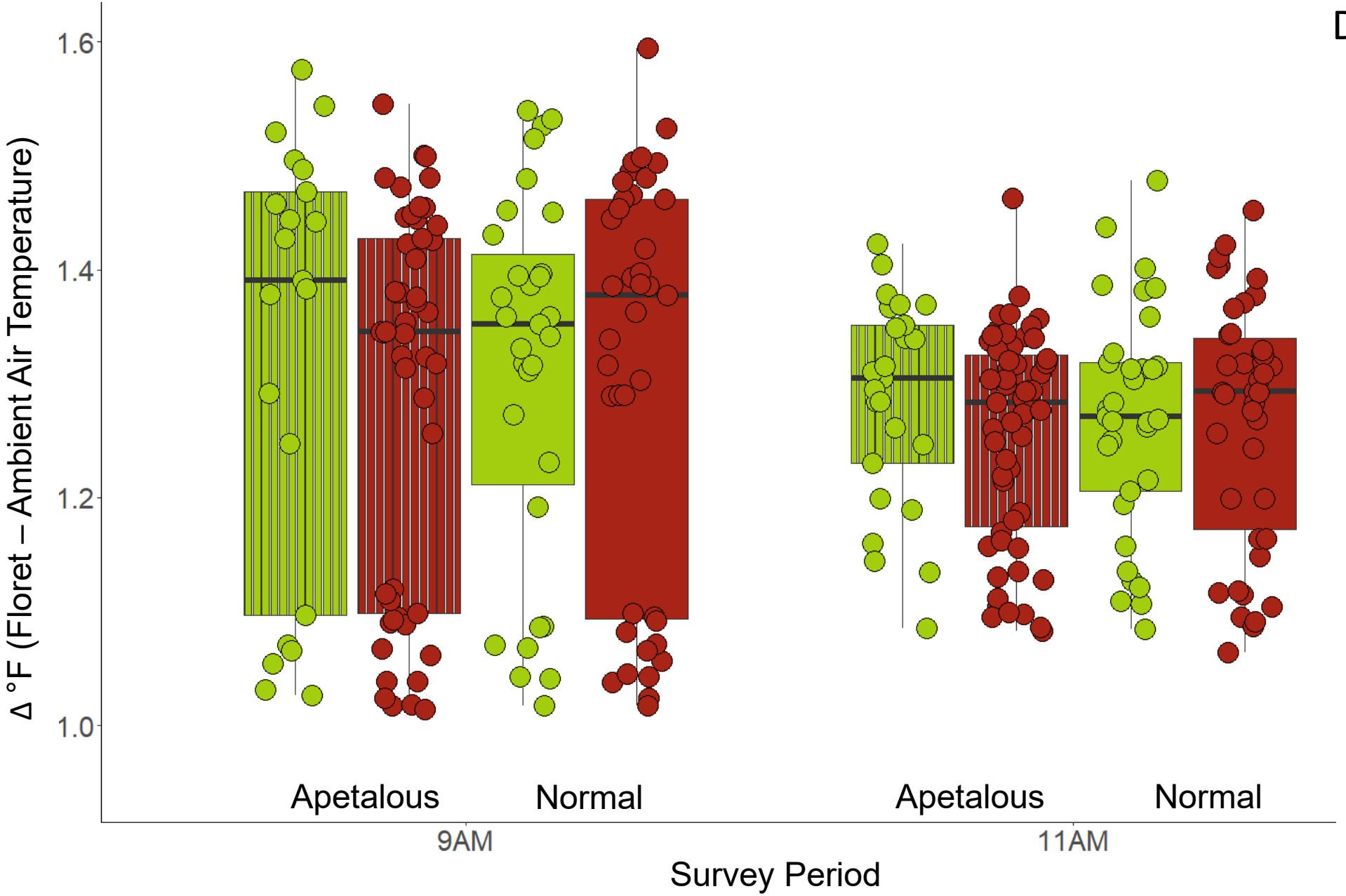
Do bees have a preference for sunflower disc color? **NO**

Or for petal presence? **YES, bees prefer heads with petals**

Does floret temperature differ between bloom types?

Does variation in floret temperature explain bees' preferences?

Bloom type does not influence change in floret temperature



Disc Color:

Green

Red

Kruskal-Wallis Test:

9AM	11AM
Petal:	Petal:
$X^2 = 0.05$	$X^2 = 0.06$
$p = 0.82$	$p = 0.80$
Color:	Color:
$X^2 = 0.45$	$X^2 = 0.63$
$p = 0.50$	$p = 0.43$

Summary

Do bees have a preference for sunflower disc color? **NO**

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NO

Does variation in floret temperature explain bees' preferences?

Summary

Do bees have a preference for sunflower disc color? **NO**

Or for petal presence? **YES, bees prefer heads with petals**

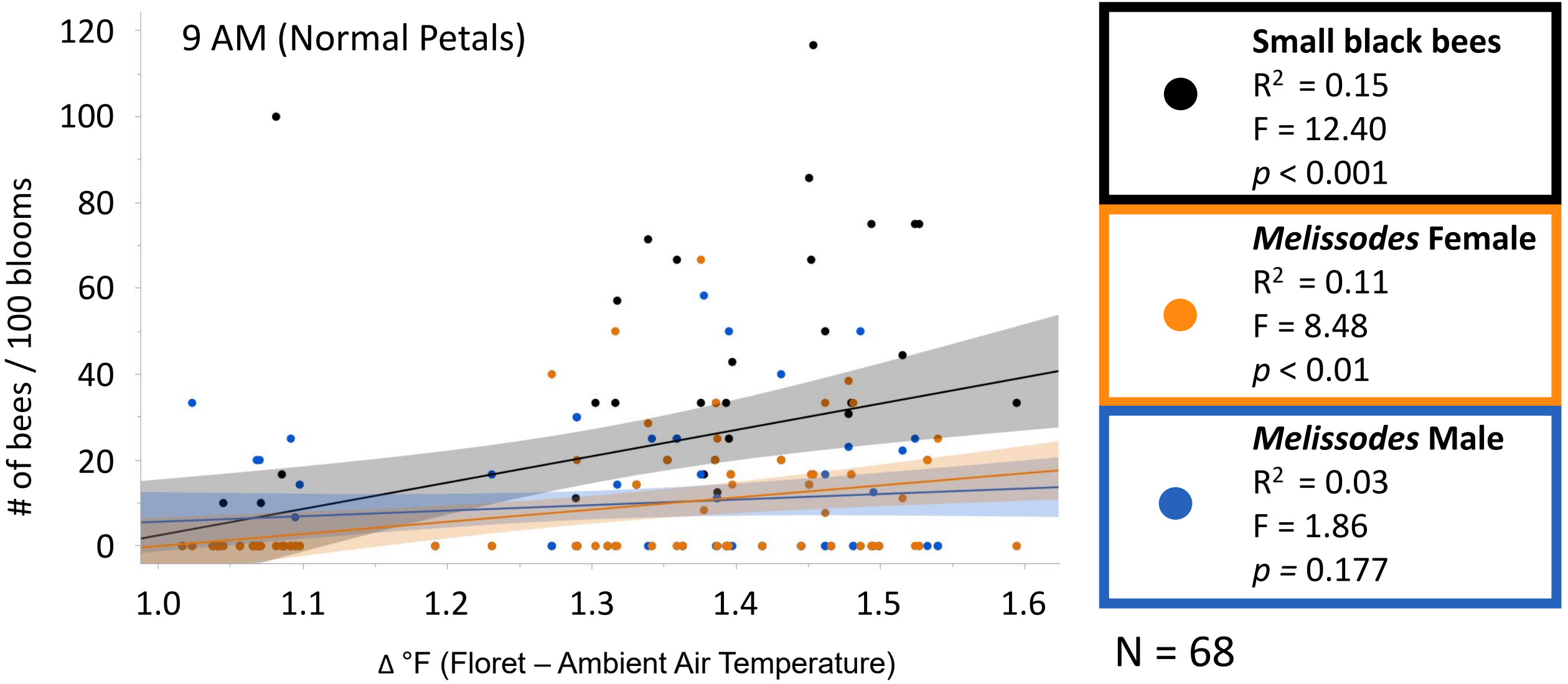
Does floret temperature differ between bloom types?

NO

Does variation in floret temperature explain bees' preferences for bloom type?

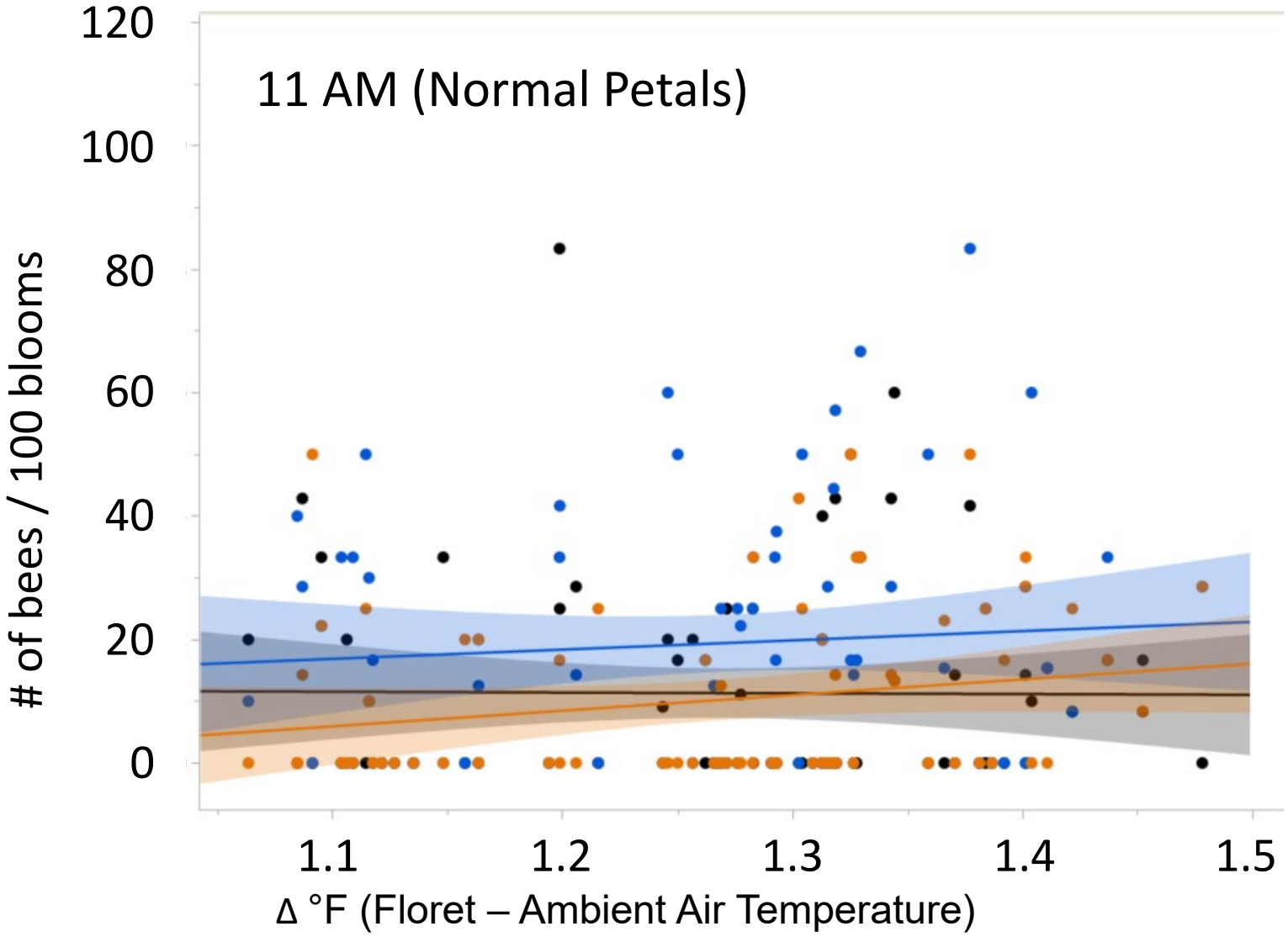
NO

Small bees and *Melissodes* ♀ visit relatively warmer normal heads in the morning



N = 68

Change in flower temperature does not affect bee visitation at 11 AM



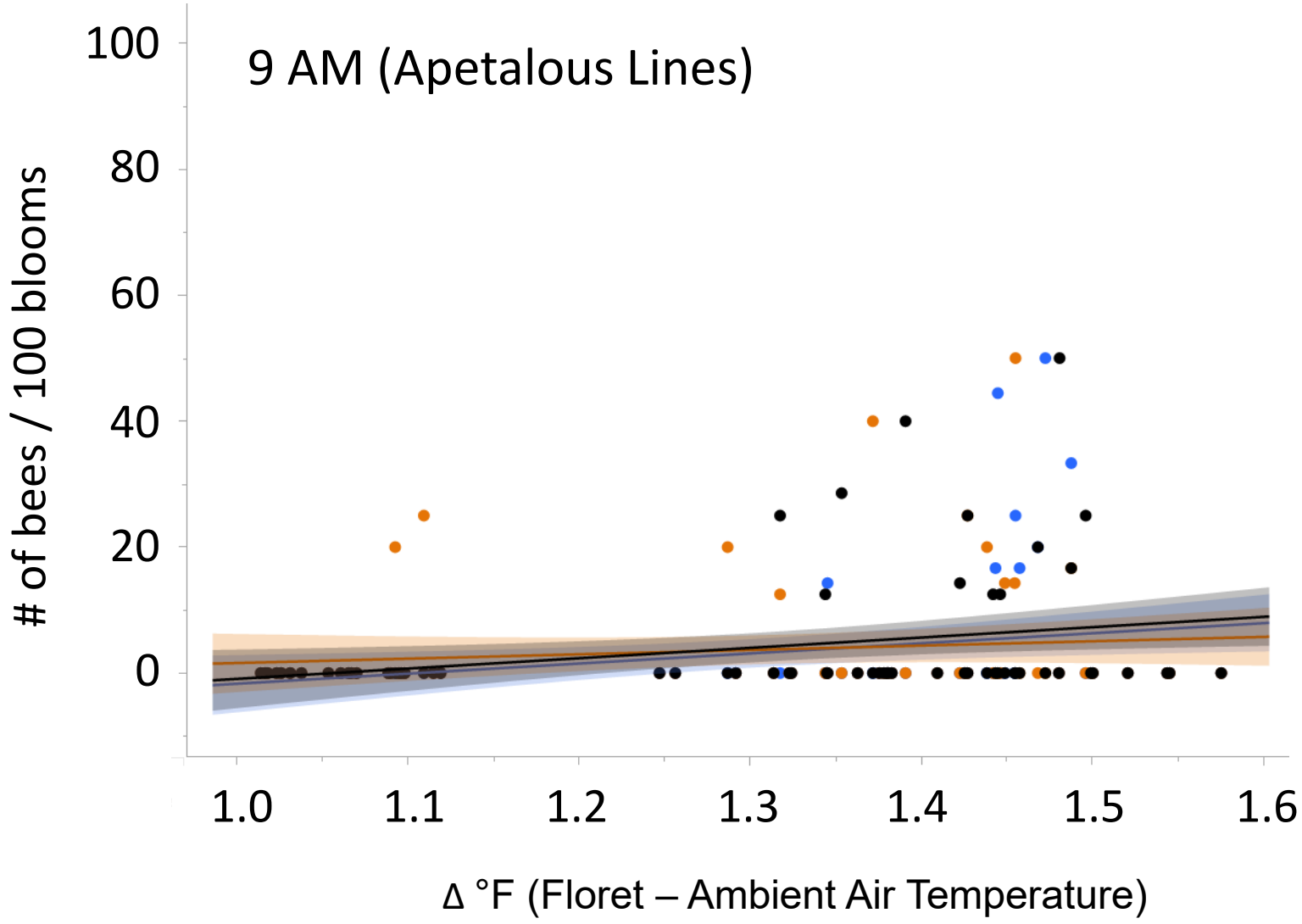
Small black bees
R^2 = 0.00
F = 0.29
p = 0.592

***Melissodes* Female**
R^2 = 0.04
F = 2.94
p = 0.091

***Melissodes* Male**
R^2 = 0.02
F = 1.12
p = 0.293

N = 78

Change in flower temperature does not affect bee visitation on apetalous lines



Small black bees
R^2 = 0.08
F = 5.56
p = 0.021

***Melissodes* Female**
R^2 = 0.01
F = 0.73
p = 0.395

***Melissodes* Male**
R^2 = 0.08
F = 6.14
p = 0.015

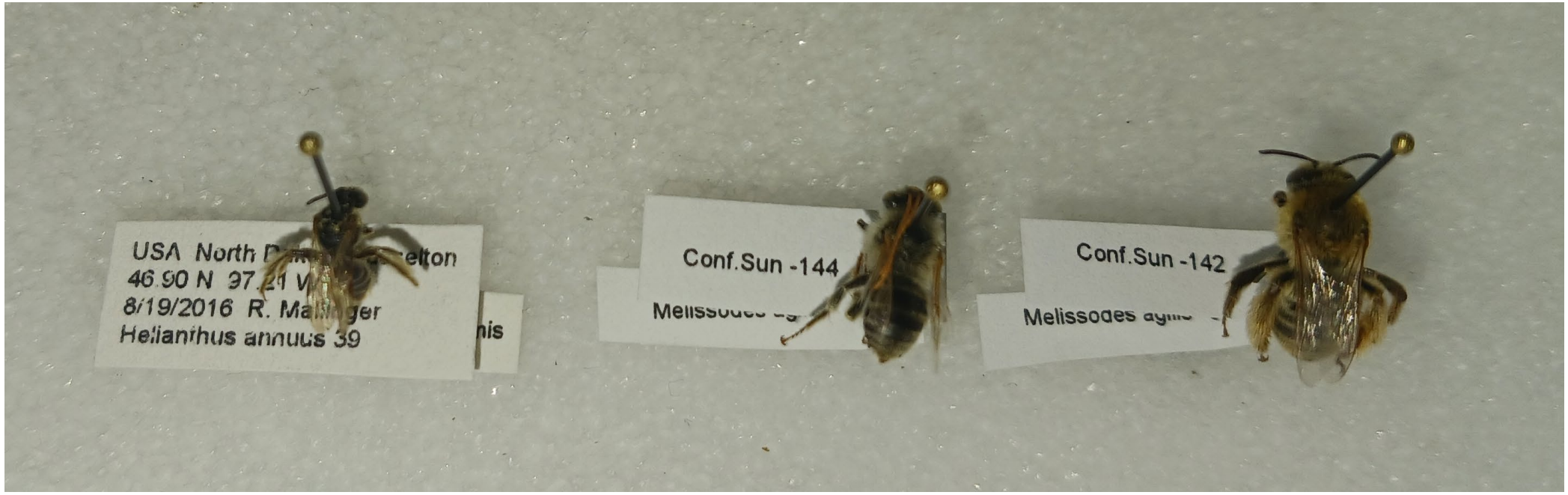
N = 68

Size does not explain pattern

Small black bee:
Pseudopanurgus labrosiformis

Male
Melissodes

Female
Melissodes



Pollinator Summary

- Bees prefer sunflowers with petals but show no preference for disc color
- Floret temperature does not explain bee’s preferences for petals
- Some bees visit flowers more as florets grow warmer than ambient conditions

Seed Damage

Weevil preferences for color

Color of :

Pollen

Seeds

Petals?

Disc?

Gao & Brewer 1998

Experiment with 4 Bloom Types

Pest preference for:
Color x Petal presence

Differences between pests?

Red Sunflower Seed Weevil

Photo:
Jeff Cluever

Banded Sunflower Moth

Photo:
Andy Reago &
Chrissy McClarren

Differences in when pests lay eggs

Red Sunflower Seed Weevil

Lays eggs **during** bloom period

Banded Sunflower Moth

Lays eggs **before** bloom period (R-3)

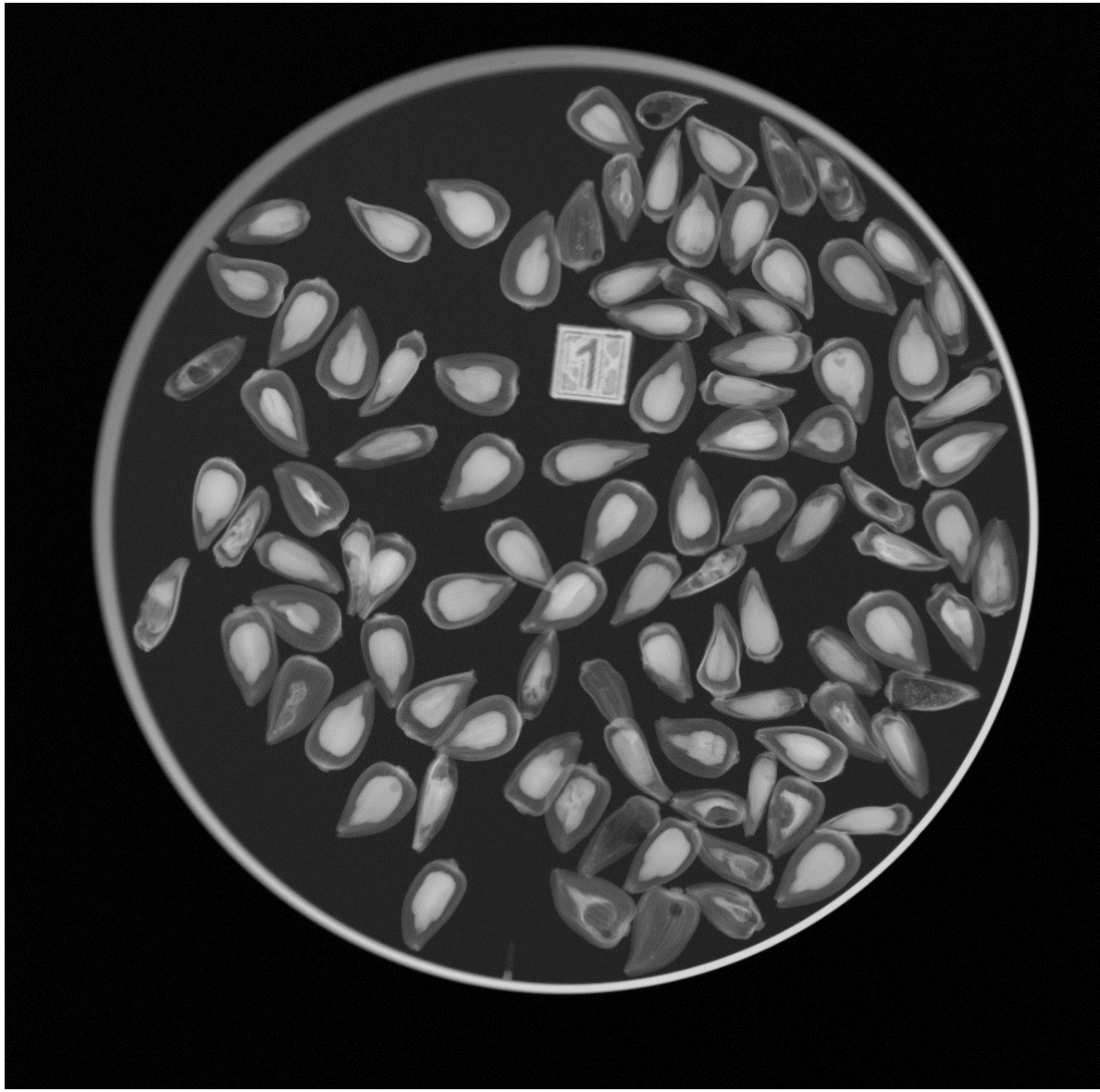
Photo:
NDSU Extension

Methods: Seed Damage

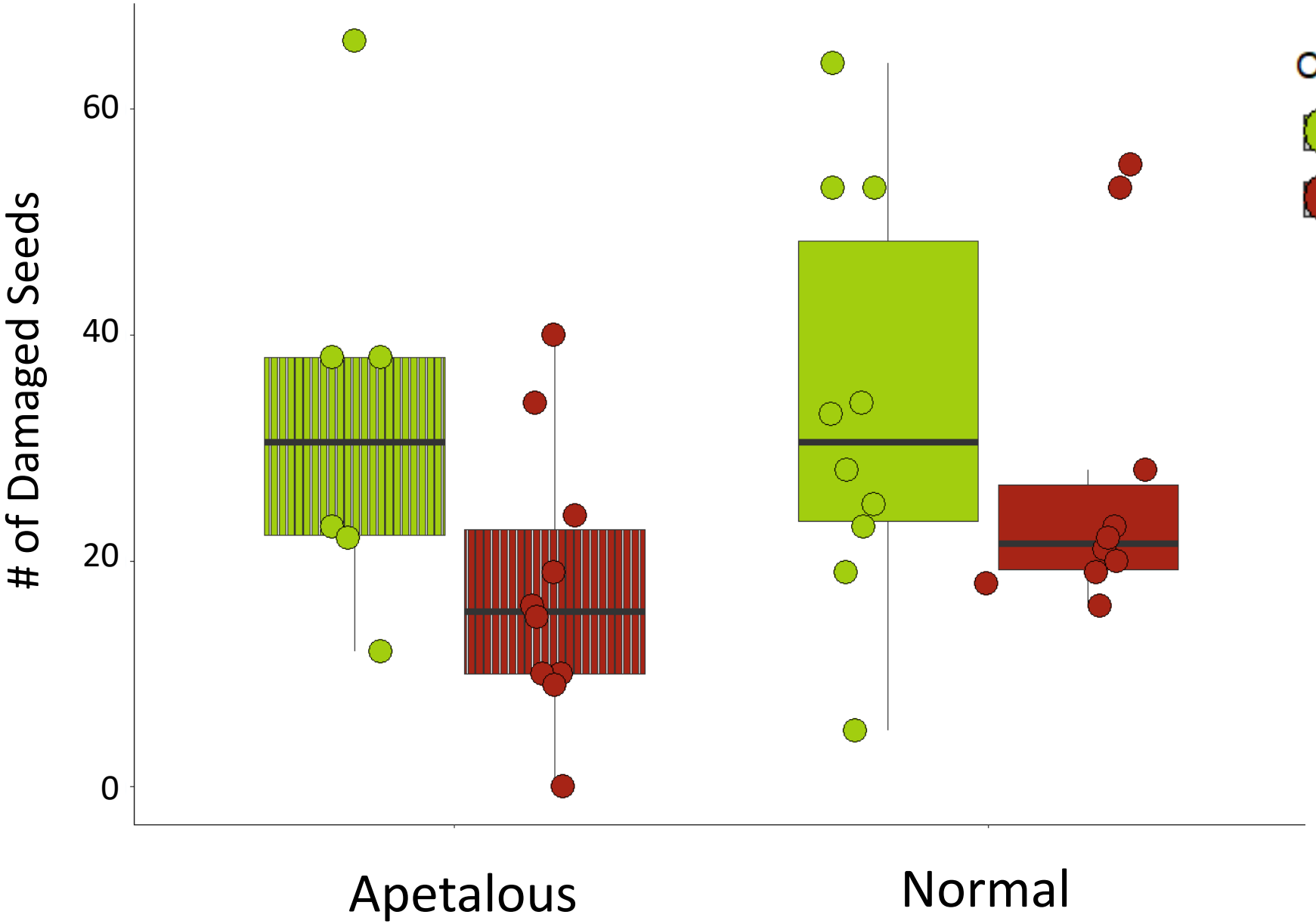
- September: Bagged 5 heads/line
- Dried & Threshed
- X-rayed 100 seeds/line
- Assessed for larval damage

Red Sunflower Seed Weevil

Banded Sunflower Moth



Green lines suffered more seed damage



Kruskal-Wallis Test:

Petal:

$X^2 = 1.25$

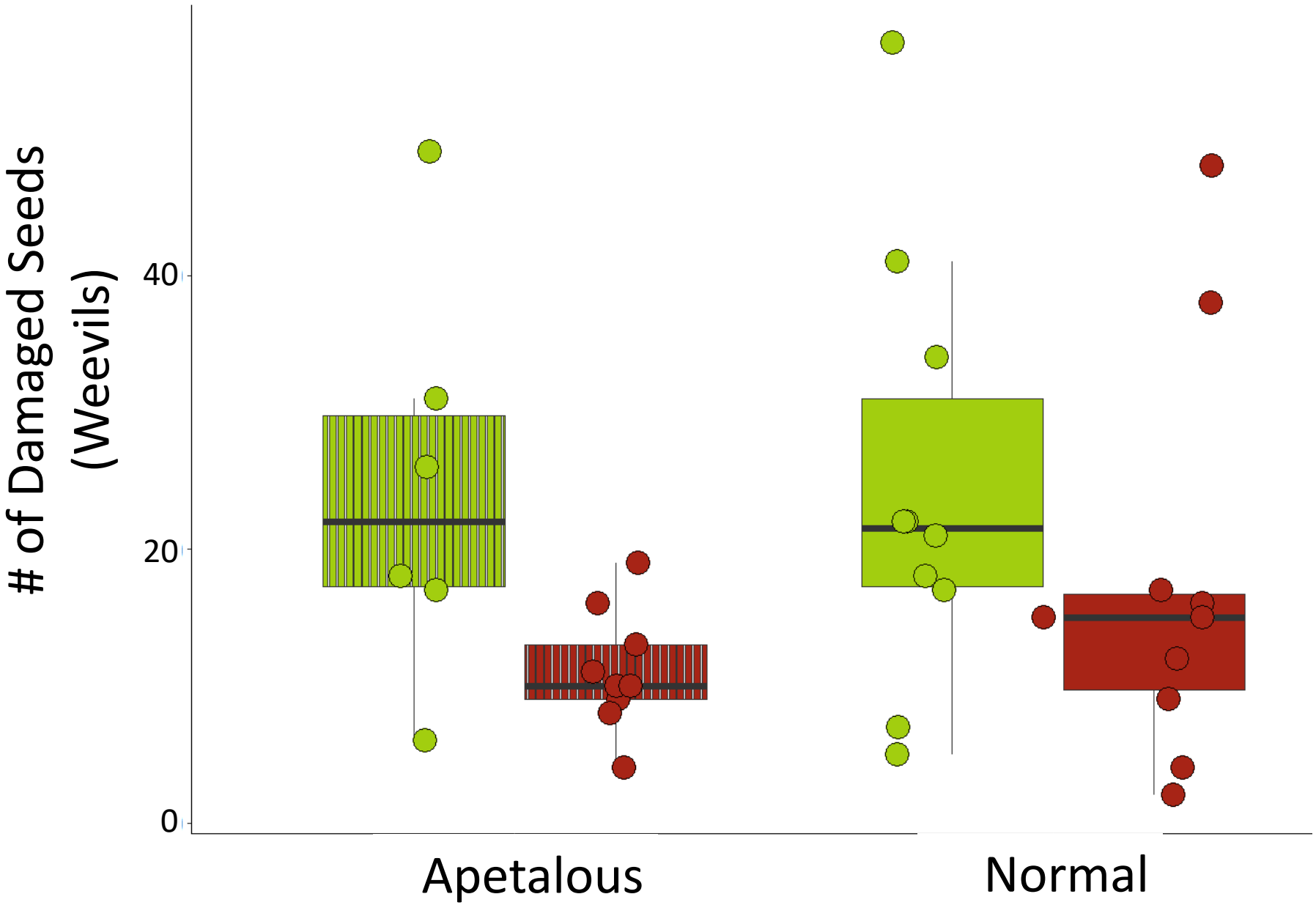
$p = 0.264$

Color:

$X^2 = 3.89$

$p = 0.049$

Green lines suffered ~60% more weevil damage



Color
Green
Red

Kruskal-Wallis Test:

Petal:

$X^2 = 0.70$

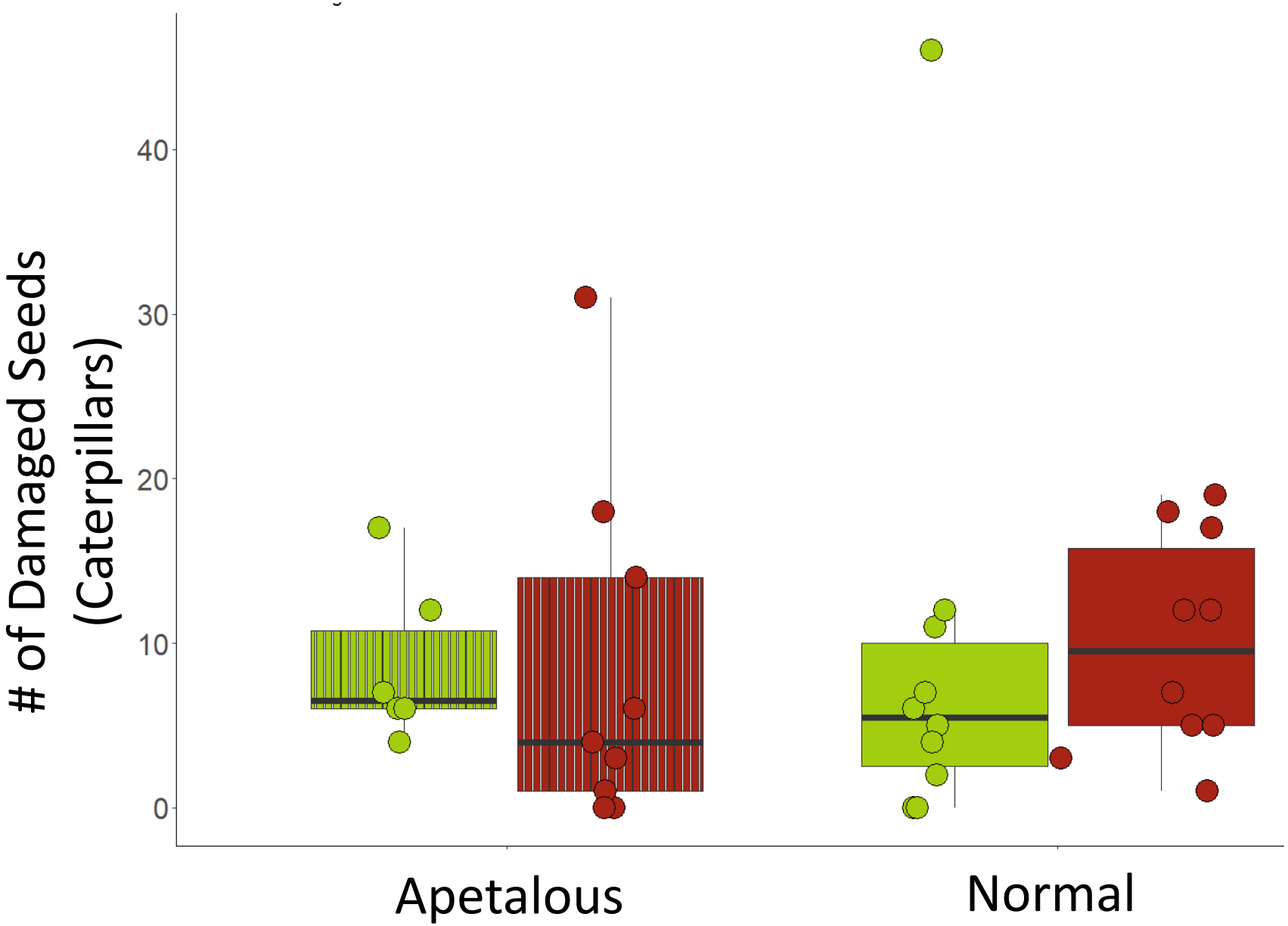
$p = 0.40$

Color:

$X^2 = 6.83$

$p < 0.01$

Similar banded sunflower moth damage between bloom types



Kruskal-Wallis Test:

Petal:

$X^2 = 0.05$

$p = 0.815$

Color:

$X^2 = 0.05$

$p = 0.816$

Seed Damage Summary

- Green sunflowers have more seed damage than red sunflowers
- Petal presence does not affect seed damage
- Differences in damage levels are driven by weevils, not banded sunflower moth

Conclusion

- Pollinators and seed predators use different cues to choose sunflower hosts
- Bees prefer sunflowers with petals
- Insects cause more seed damage to green sunflowers, due to increased weevil activity

Thank you!

Rebecca Foy

Brady Koehler

Michael McWood

Greenlee Lab

André Szejner-Sigal

Meredith Johnson

Madison Floden

Jacob Pithan

Korie DeBardablan

Ava DeMars

Lukas Sokalski

Alex Humphreys

Fargo Insect Cryobiology and Ecophysiology Unit

Funding:

NDSU NORTH DAKOTA STATE UNIVERSITY

USDA Agriculture Research Service

CERL CONSTRUCTION ENGINEERING RESEARCH LABORATORY

Questions?