OSU Honey Bee Lab Research Updates: Varroa, Nutrition and more

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OUR BUSY BEES

Presentation Overview

Oxalic Acid Study

Pollen Nutritional Composition Database

Impacts of fires and smoke

European Foulbrood

Varroa mite life cycle

(1) Phoretic Phase & (2) Reproductive Phase

- **Female mite enters a cell with larva about 12 hours prior to cell capping and hides beneath the larval food.**
- **Once the larval food is consumed by the larva the mite gets out and starts feeding on the larva.**
- **Lays first egg about 2.5 to 3 days after cell capping and subsequently one egg every 30 hours.**
- **Male and first female are ready to mate a week from hatching.**

Phoretic Phase

Reproductive Phase

Monitoring for Mites

www.youtube.com/watch?v=97OekT-6ziE

- **Alcohol Wash**

(percentage of mites)

- **Sugar Shake**

(percentage of mites)

- **Sticky Boards**

Current *Varroa* treatment options

Apivar (Amitraz)

MAQS and Formic PRO (Formic Acid)

Apiguard (Thymol)

Hopguard

Oxalic Acid

Oxalic Acid

- **Current Label:** ***Oxalic Acid can not be applied when honey supers are on.***

- **Potential New Label:** ***will allow Oxalic Acid use year-round***

Tolerance exemption for oxalic acid

USDA owns the federal registration for Oxalic Acid Dihydrate (EPA Reg. No. 91266-1)

API-Bioxal™ (EPA Registration Number 91266-1-73291) is currently the only legally registered oxalic acid dihydrate product in the United States that can be used to treat varroa mites.

https://www.ars.usda.gov/northeast-area/beltsville-md-barc/beltsville-agricultural-research-center/bee-research-laboratory/docs/oxalic-acid-faqs/

Currently, the only allowable application methods are a solution method, spraying package bees, and using a vaporizer method.

Oxalic Acid Vaporization Studies

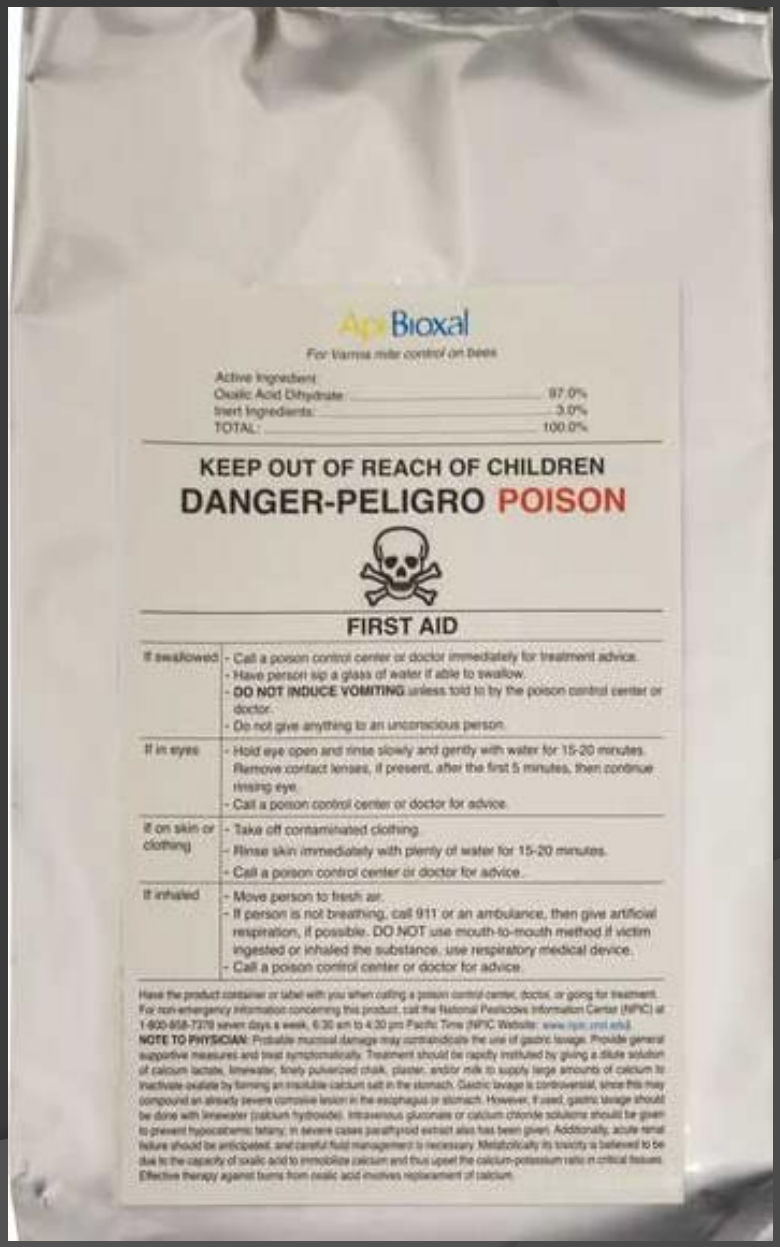
Registered for use in 2015

Oxalic Acid Dribble / Trickle

Vaporization / Sublimation

Can be used when honey supers are not present

Mode of action is not known



Questions regarding Oxalic Acid Vapors

Is 1 gm per brood chamber dose adequate?

How many times can OA vapors be used?

Do OA vapors damage brood, bees or queen?

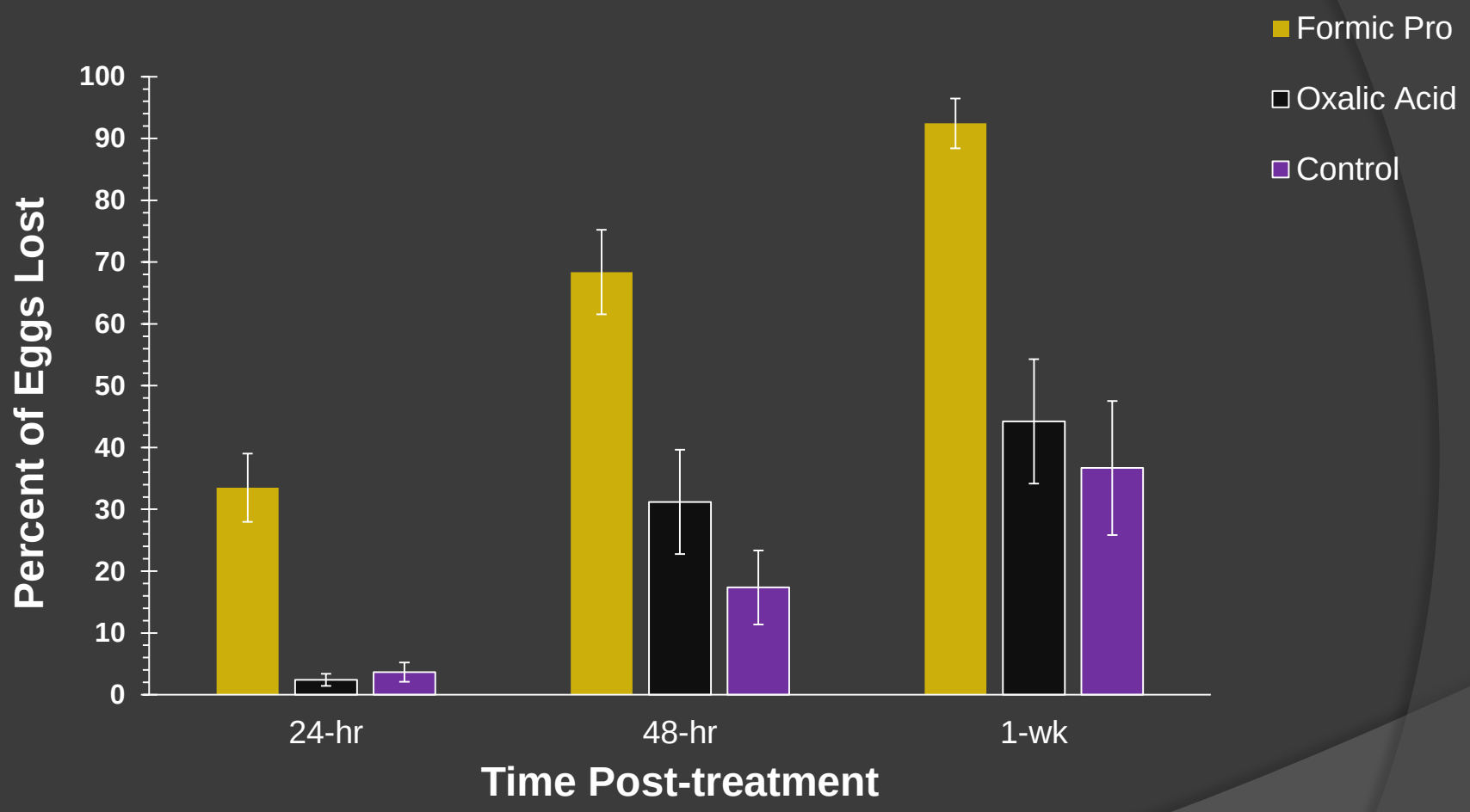
Objective

- **Evaluating brood mortality (eggs, larvae) when using oxalic acid vaporization method for *Varroa* control.**

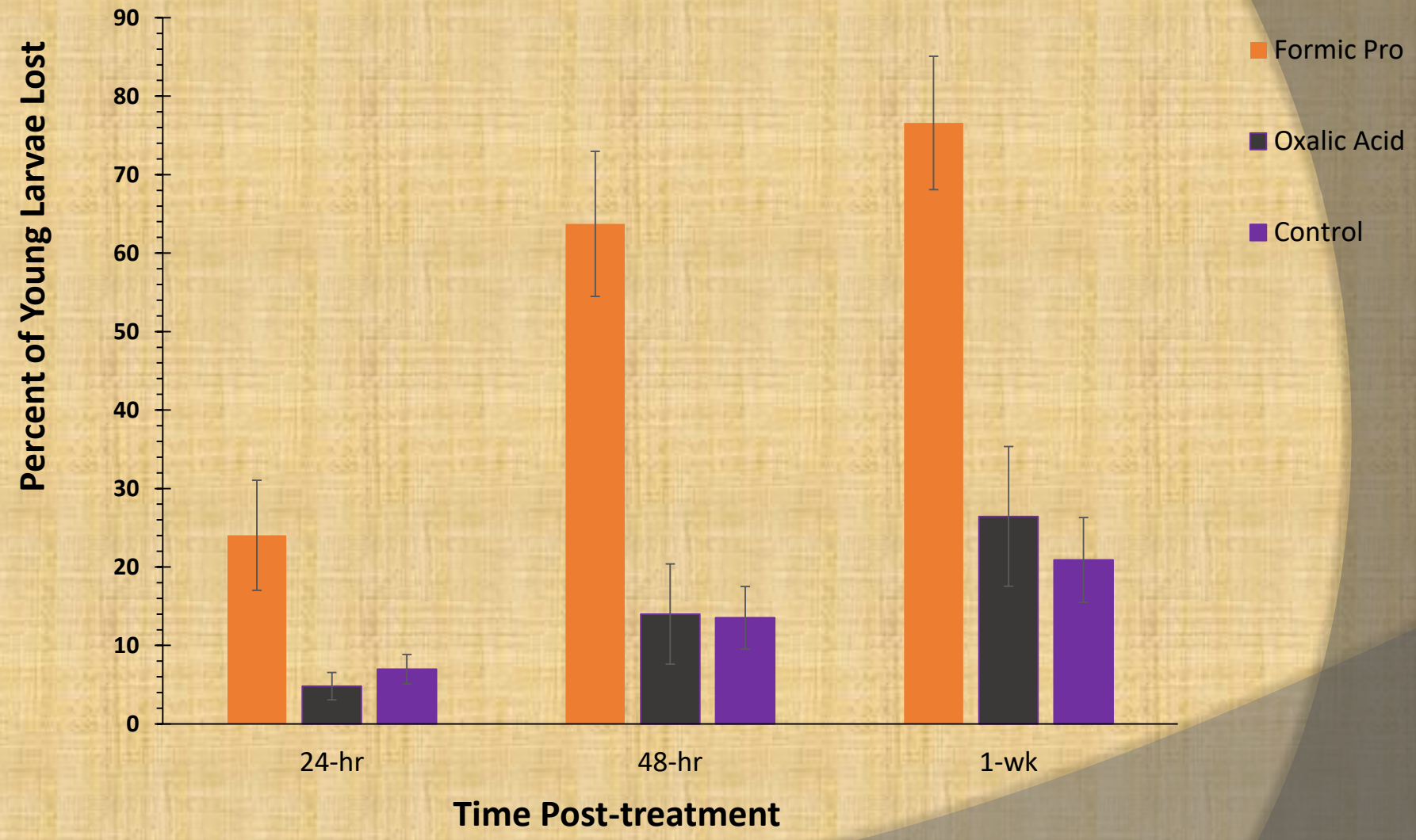
Monitoring fate of brood using acetate sheets


SUCRETS

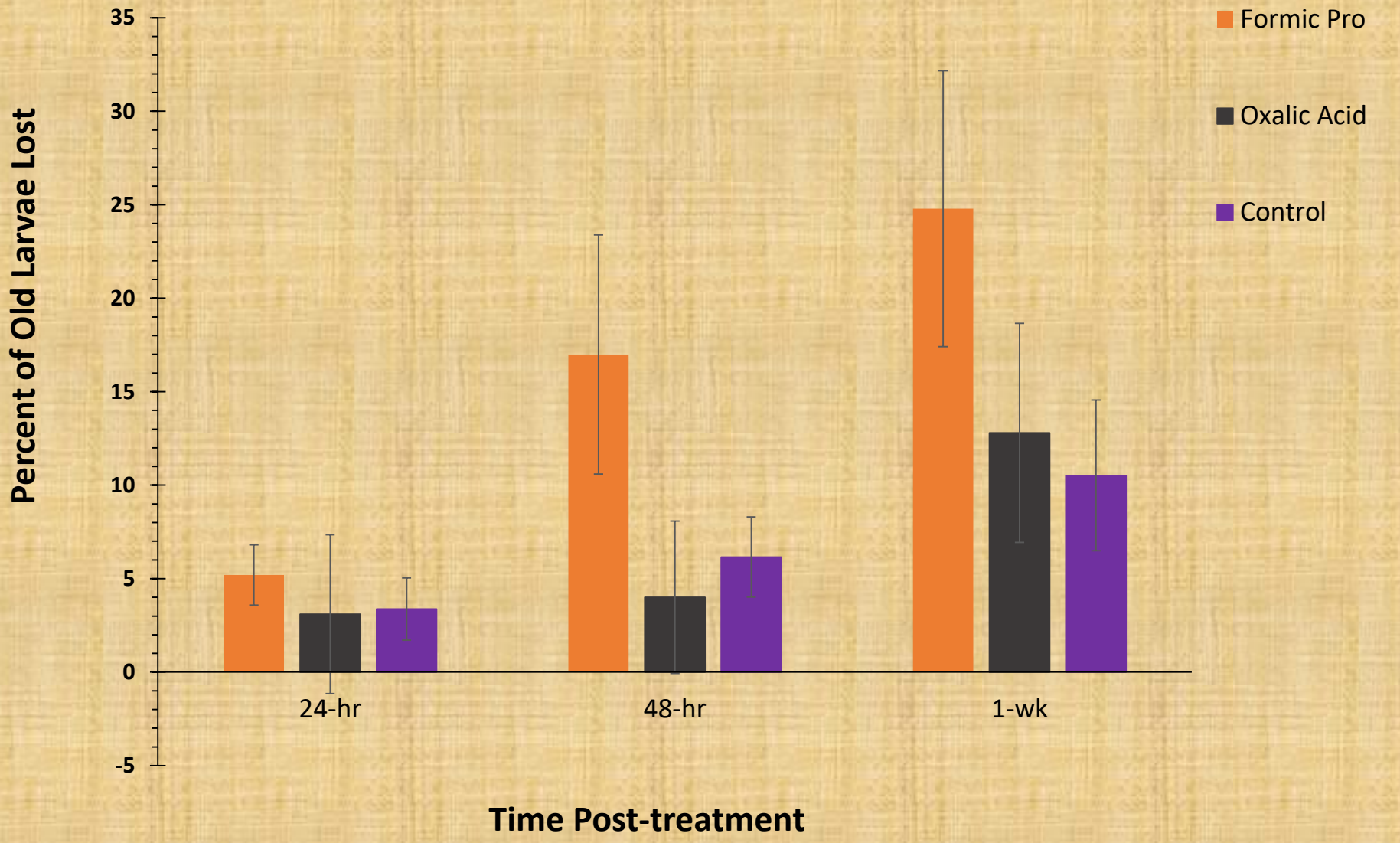
Fate of Eggs


Formic Pro
Oxalic Acid
Control
Percent of Eggs Lost
100
90
80
70
60
50
40
30
20
10
0
24-hr
48-hr
1-wk
Time Post-treatment

Fate of Young Larvae



Fate of old larvae



Take Home Message

- **Oxalic acid vaporization at recommended dose appears safe to the brood**

- **Formic acid treatment has negative impact on the brood, but is very effective in *Varroa* control.**

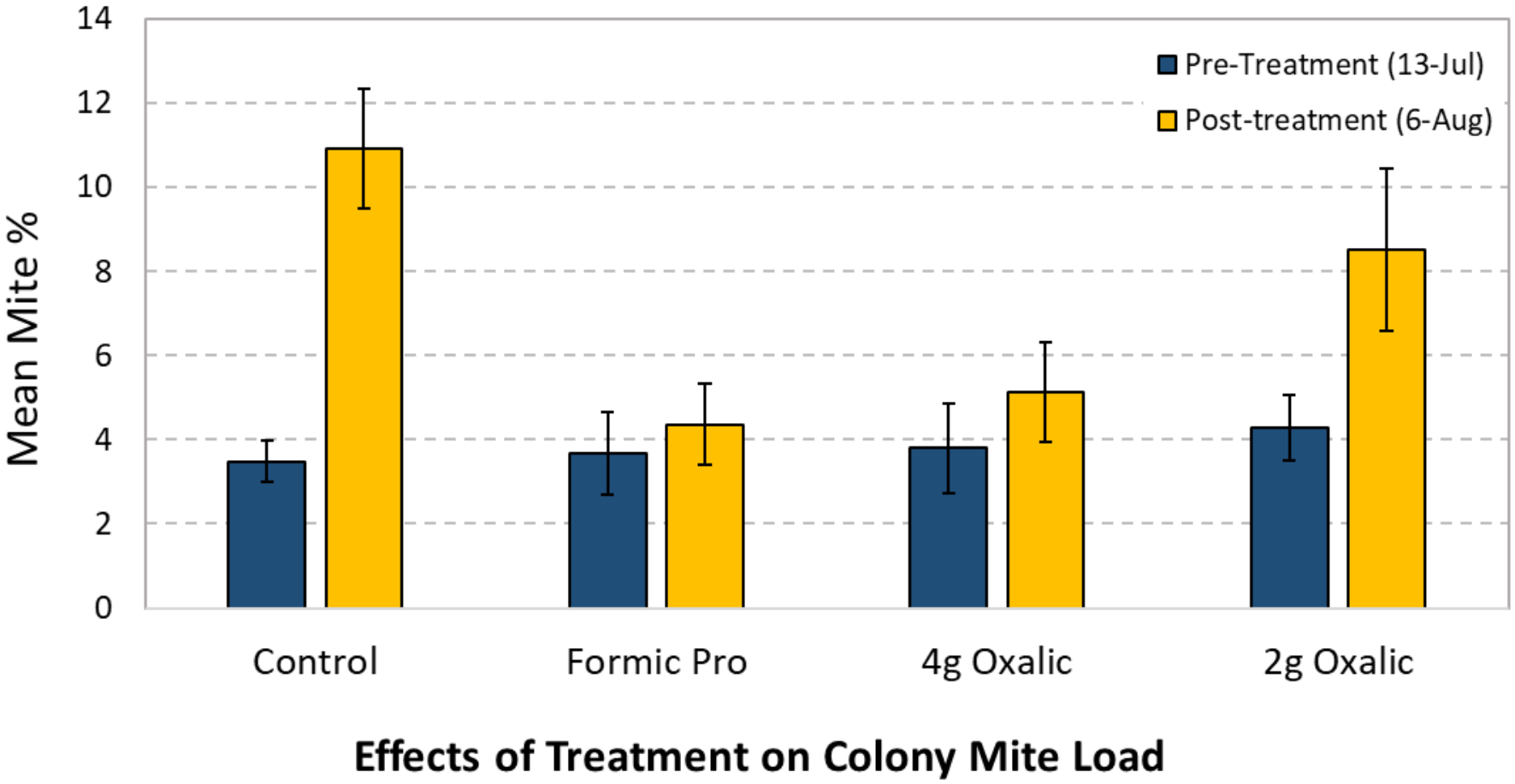
Efficacy of Oxalic Acid Vaporization (3 applications of OA)

Experimental Design

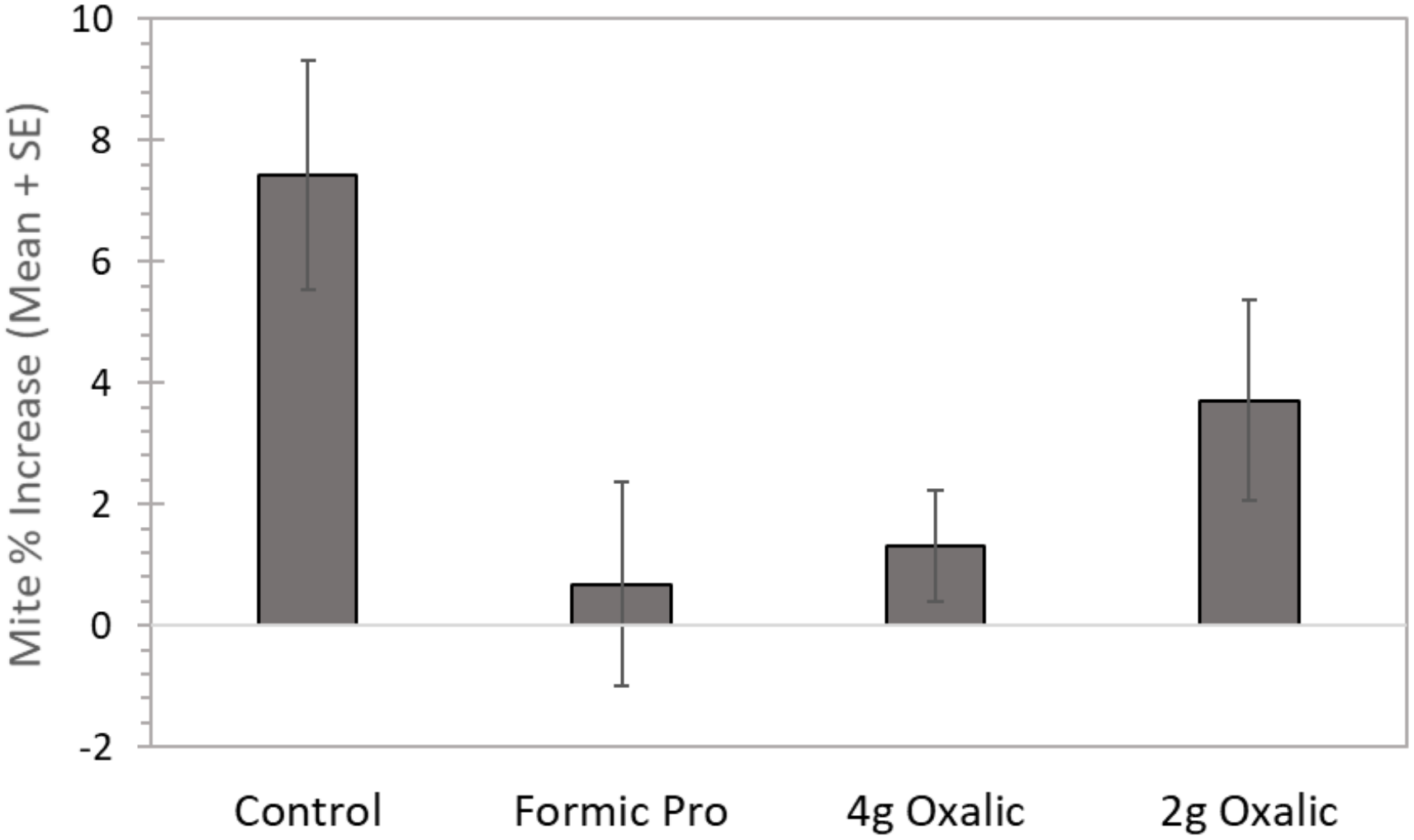
- **8 colonies: 2 grams OA on July 16, 23 and 30**
- **8 colonies: 4 grams OA on July 16, 23 and 30**
- **8 colonies: 1 strip Formic Pro on July 16 and 31**
- **8 colonies: No chemical treatment (Control)**

Parameters Measured

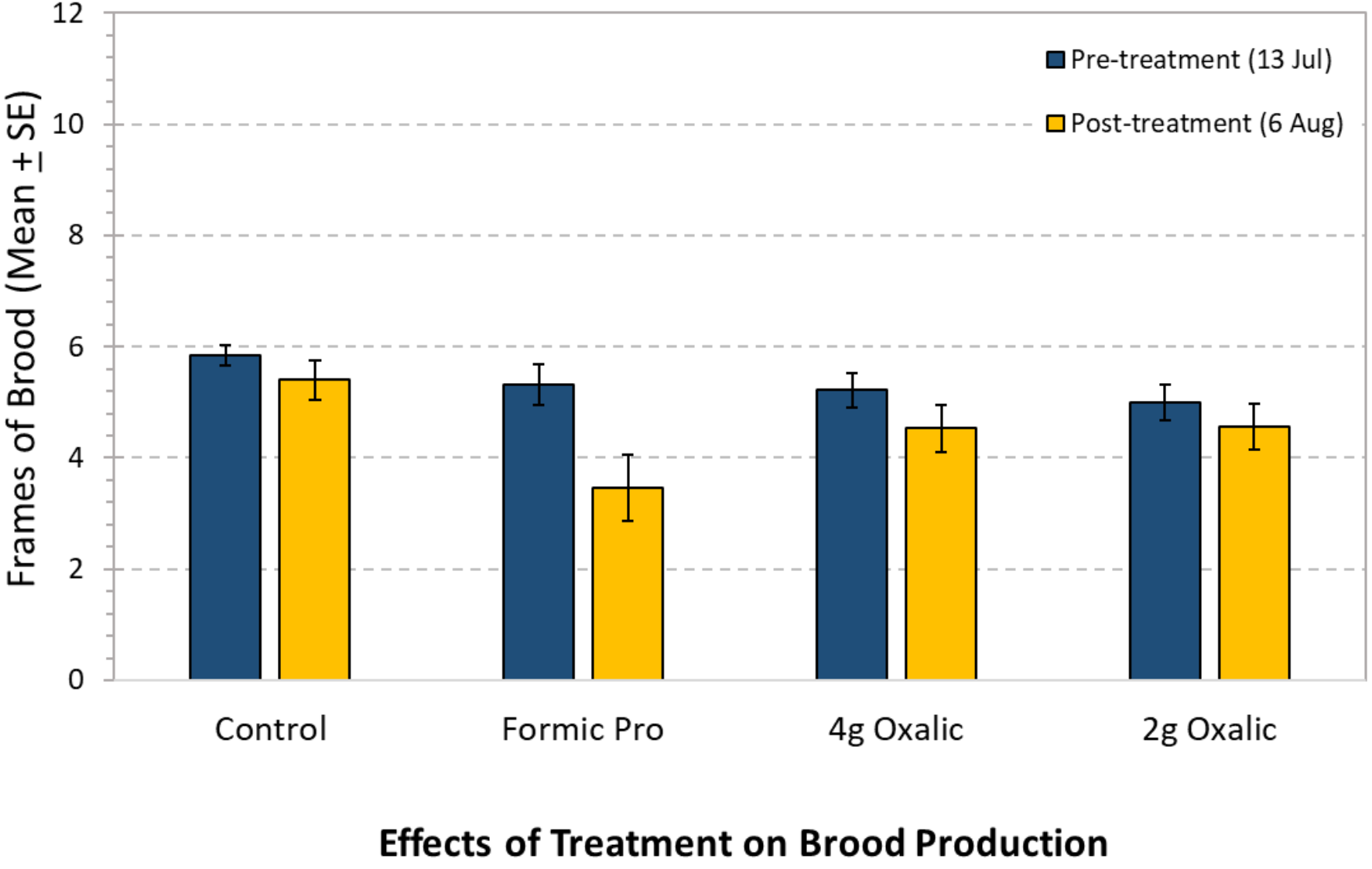
- ***Varroa*** **infestation (alcohol wash & sticky board)**
- **Number of frames of bees**
- **Brood area**
- **Oxidative stress and potential damage to appendages**

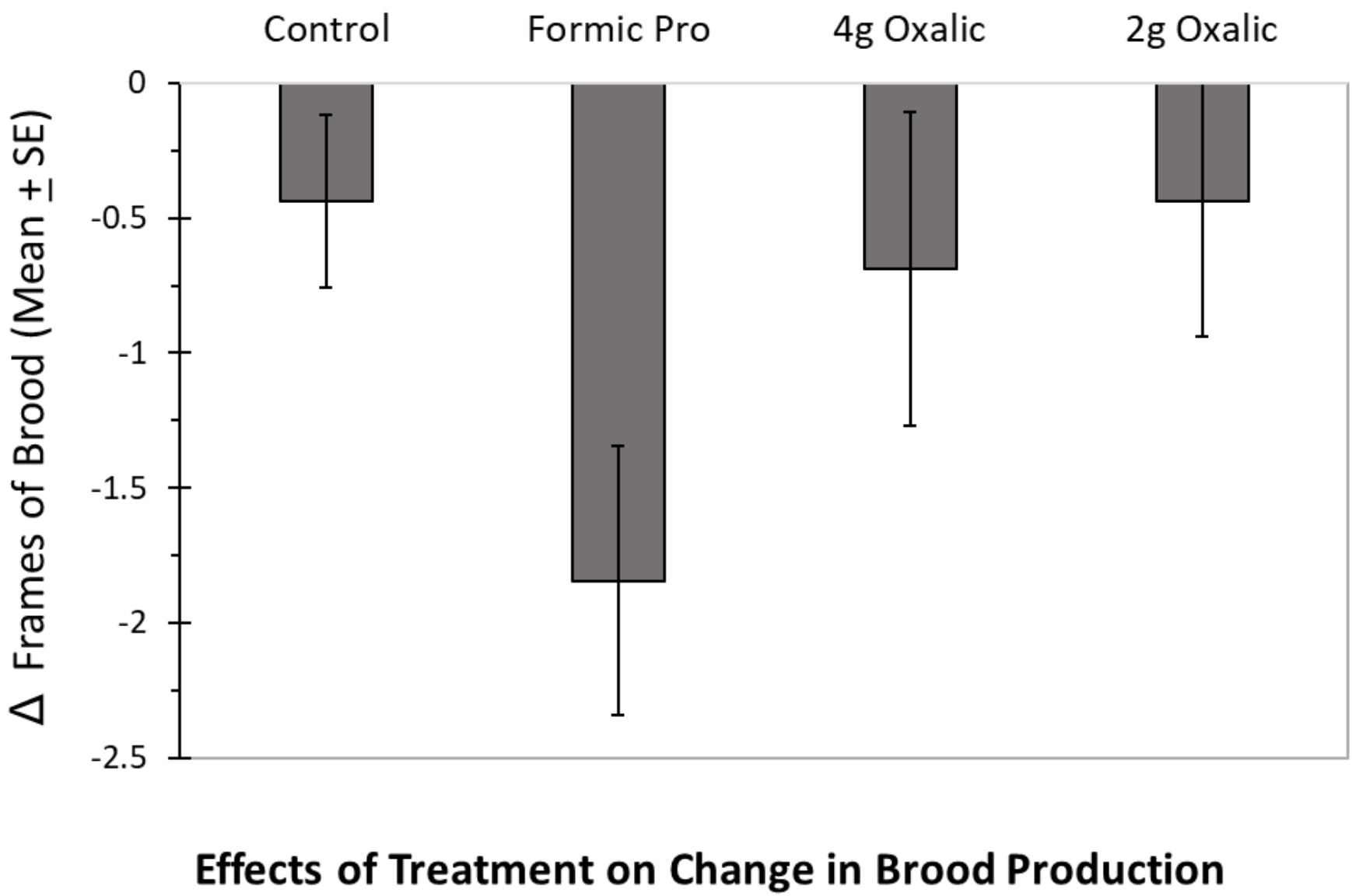


Effects of Treatment on Colony Mite Load



Effects of Treatment on Mite % Increase Over Time


12
10
8
6
4
2
0
Frames of Brood (Mean ± SE)
Pre-treatment (13 Jul)
Post-treatment (6 Aug)
Control
Formic Pro
4g Oxalic
2g Oxalic
Effects of Treatment on Brood Production


Control
Formic Pro
4g Oxalic
2g Oxalic
0
-0.5
-1
-1.5
-2
-2.5
Δ Frames of Brood (Mean ± SE)
Effects of Treatment on Change in Brood Production

Varroa: Sticky Board Data

Treatments	Day 1 Drop (# of mites)	Day 2 Drop (# of mites)	Day 3 Drop (# of mites)
Control	30	57	39
Formic Pro	31	112	92
Oxalic High	48	131	83
Oxalic Low	49	90	58

Further Pending Lab Analysis

- Examine oxidative stress in bees
- Evaluate potential physical damage to appendages

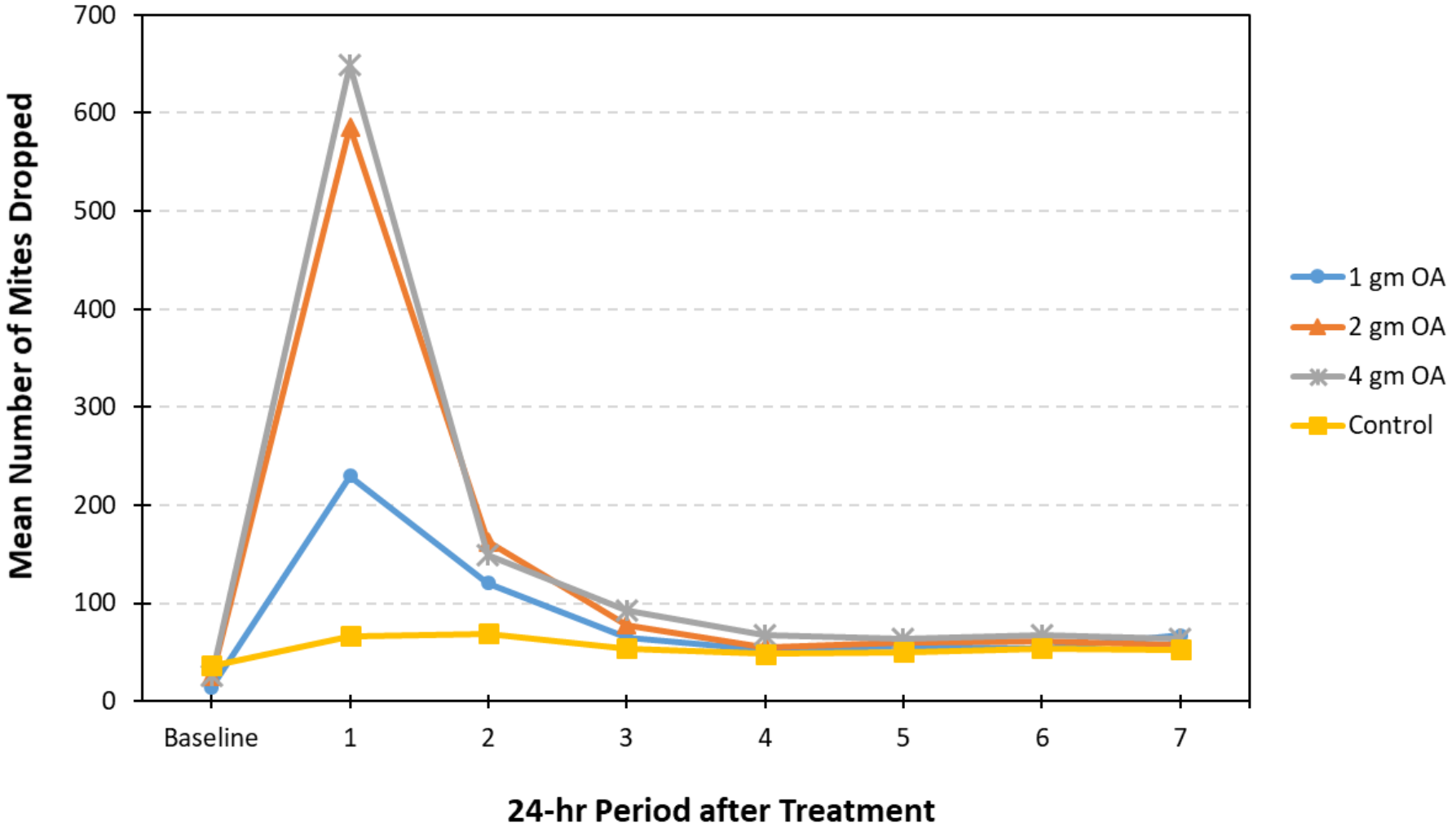
2021 Oxalic Vapor Study

- OA dosage tested: 1 gm, 2 gm and 4 gm per brood chamber
- 3 applications (one week apart)

- *Parameters measured:*
- Mite infestation (alcohol wash & sticky boards)
- Colony evaluations (bees and brood)
- Worker bees sampled to evaluate oxidative stress and damage to appendages
- Queens collected at the end of the study


ARROX


8


Mean Number of Mites Dropped
700
600
500
400
300
200
100
0
Baseline
1
2
3
4
5
6
7
24-hr Period after Treatment
1 gm OA
2 gm OA
4 gm OA
Control

Important Points in *Varroa* Control

- Monitor mite levels frequently.
- Monitor mite levels before and after treatment.
- Even a two week delay in applying mite treatments can cause significant damage.
- Treat all colonies in an apiary.
- Amitraz appears to be more effective during spring.
- Colonies may look robust in Fall even with high mite infestation……this could be misleading.

Tools for *Varroa* Management

By: Honey Bee Health Coalition

https://honeybeehealthcoalition.org/varroa/

- **Nutrition is the first line of defense**

- **Optimal nutrition boosts: (a) immune system and decrease susceptibility to pests/pathogens (b) detoxifying enzymes**

HONEY BEE NUTRITION

Macronutrients

Carbohydrates (nectar/honey)

Proteins (pollen)

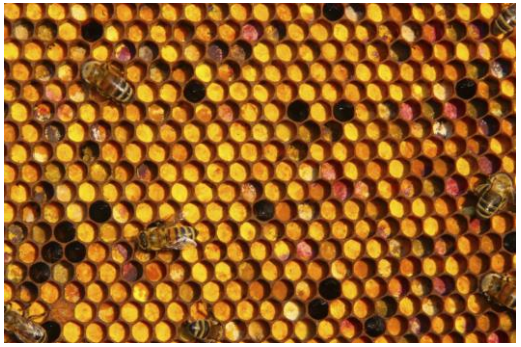
Micronutrients

Vitamins

Minerals

Lipids (e.g. *sterols*)

Honey bee suite



Wild flower meadows

Pollen (Protein)

Pollen is the primary source of protein

Crude protein and Amino acids

Most pollens: 10% to 40% protein

Also a source of lipids (e.g. Sterols), minerals, vitamins

Nutrition (especially protein) is crucial when the colonies are rearing winter bees (diutinus bees)

Develop a Pollen Nutritional Composition Data Base

We are seeking assistance from citizen scientists for pollen collection

INVESTIGATING EFFECTS OF FIRE AND SMOKE ON HONEY BEES EXPOSED TO WILDFIRES

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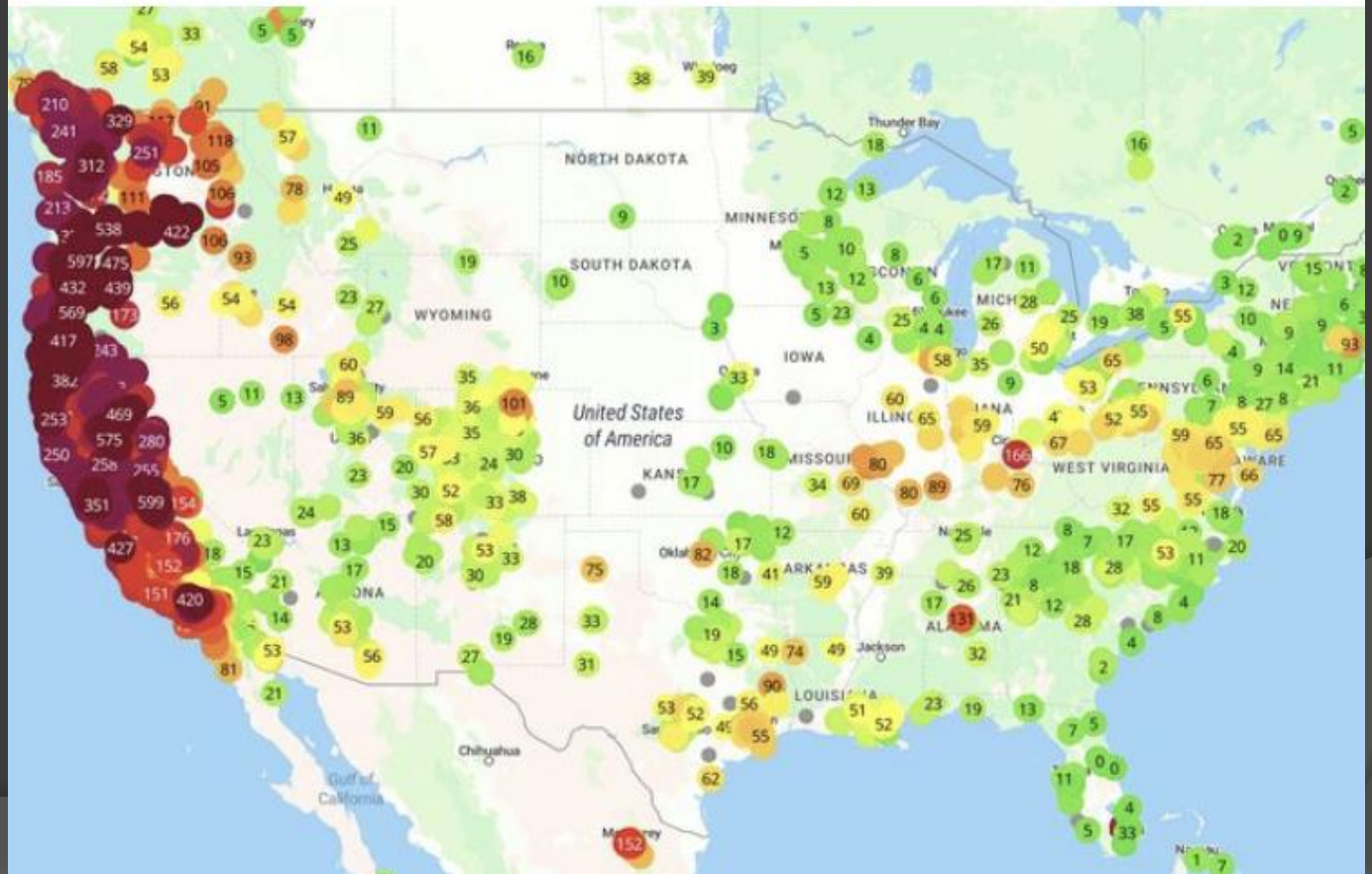
BREATHING FIRE: WEST COAST AIR WORST IN THE WORLD



Effects of fire / smoke on honey bees

Courtesy: Project Apis m / George Hansen

Background

The effects of smoke and fire on honey bees are not well understood.

Response of honey bee colonies to fires

Hypothesis

Honey bee colonies can escape fire (abscond).

Evidence in support of this hypothesis: engorging / imbibing of honey by bees in response to smoke/fire.

There is lack of evidence regarding absconding behavior in response to fire/smoke.

Alternate hypothesis: engorging is to sustain the foraging dearth in the aftermath of fire.

Other supporting arguments: (a) gravid honey bee queens will not be able to fly with the absconding swarm (b) swarm coordination will be difficult in a smoky environment.

Potential impacts of smoke / fire

SMOKE

- Impact insect respiratory system…block spiracles/trachea
- Impact on olfaction
- Impact other physiological processes (oxidative stress)
- Impact on orientation and navigation due to distortion of polarized light (Hegedus et al. 2007 Anomalous sky polarization caused by forest fire smoke)

Potential impacts of smoke / fire (cont.)

FIRE

- **Effects of high temperatures:** *Past studies have shown that stressors like heat-shock can reduce stored sperm viability and result in queen failure.*

- Ash with toxic material may impact survival (*Tan et al. 2018 Haze smoke impacts survival and development of butterflies*).

Objectives

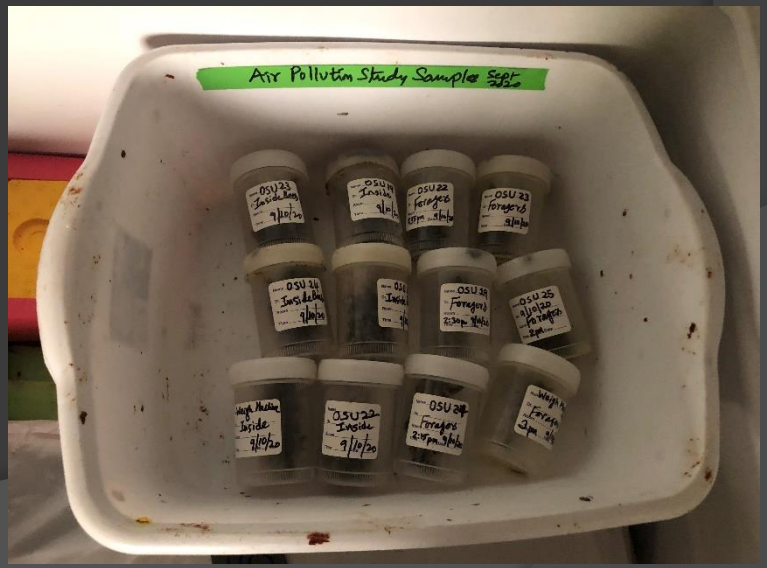
Evaluating impacts of wildfire smoke on honey bees.

Investigating effects of fire/smoke on honey bee queens.

Sampled forager and nurse bees

During period of smoke in September (Air Quality Index 275)

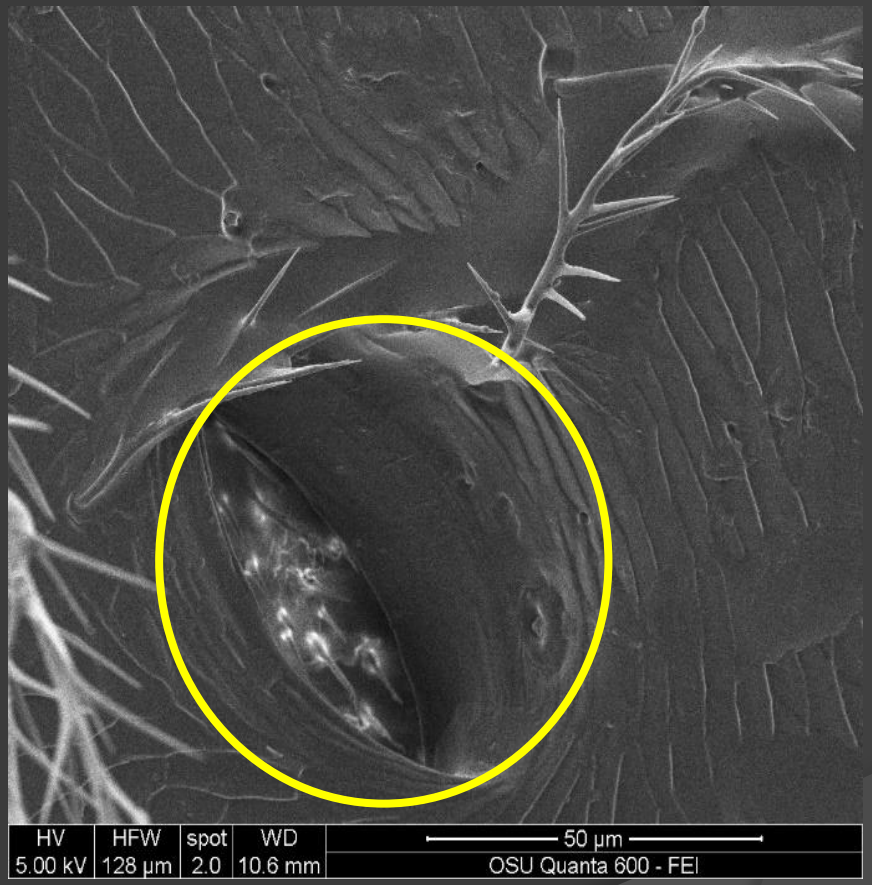
After wildfires in October (Air Quality Index 35)


Air Pollution Study Samples Sept 2020
OSU 23 Inside Bay 9/10/20
OSU 22 Foragers 9/10/20
OSU 24 Inside Bay 9/10/20
OSU 25 Foragers 9/10/20
OSU 22 Inside 9/10/20
OSU 24 Foragers 9/10/20

OSU Electron Microscopy Facility

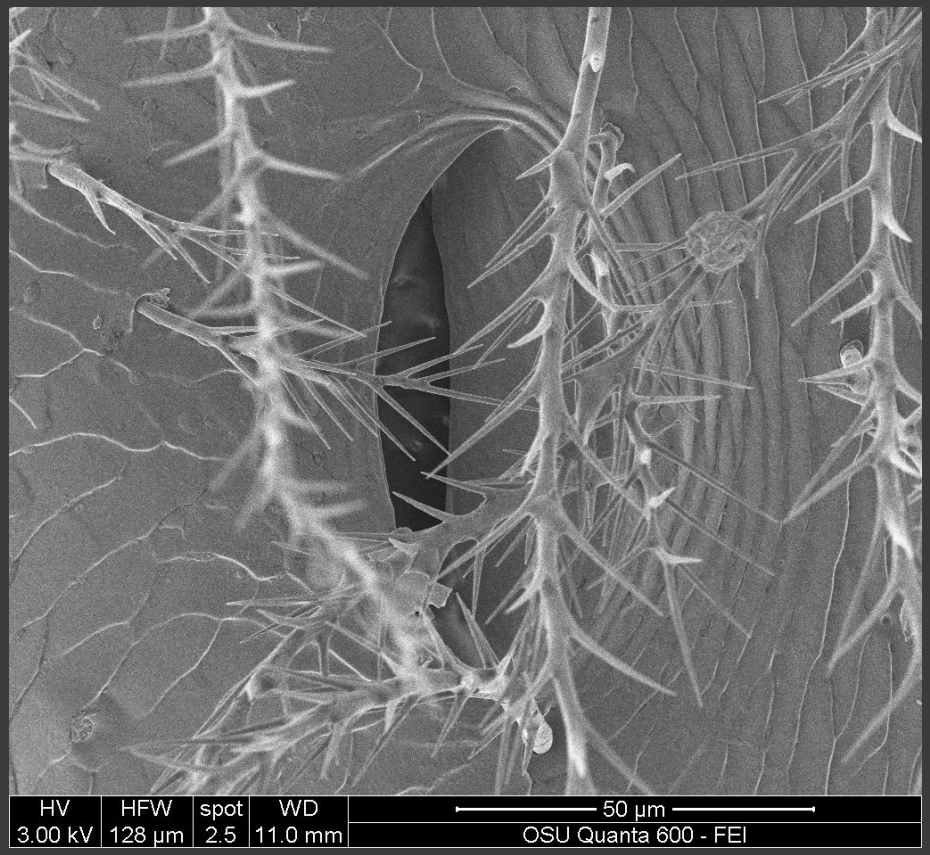
Scanning electron microscopy (SEM) of honey bee antenna, spiracles and compound eyes

SEM IMAGES OF HONEY BEE ANTENNA AND SPIRACLE

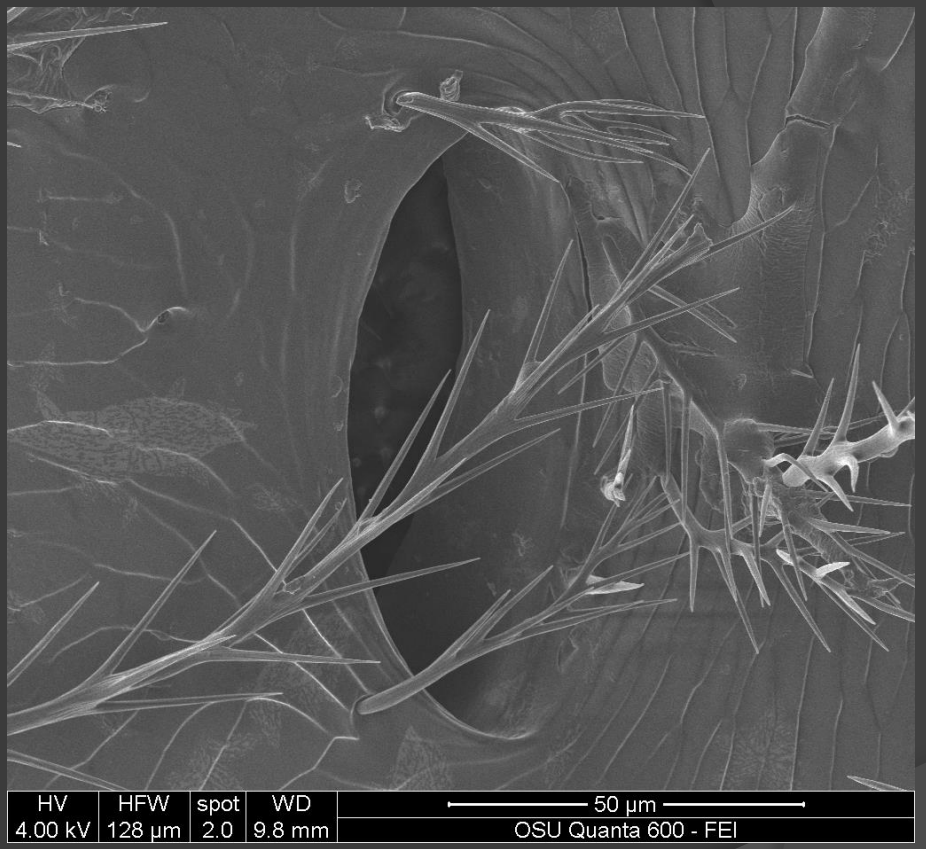


Sample scanning electron micrographs showing pollen grains on antenna and spiracular opening

SEM OF HONEY BEE WORKER SPIRACLES

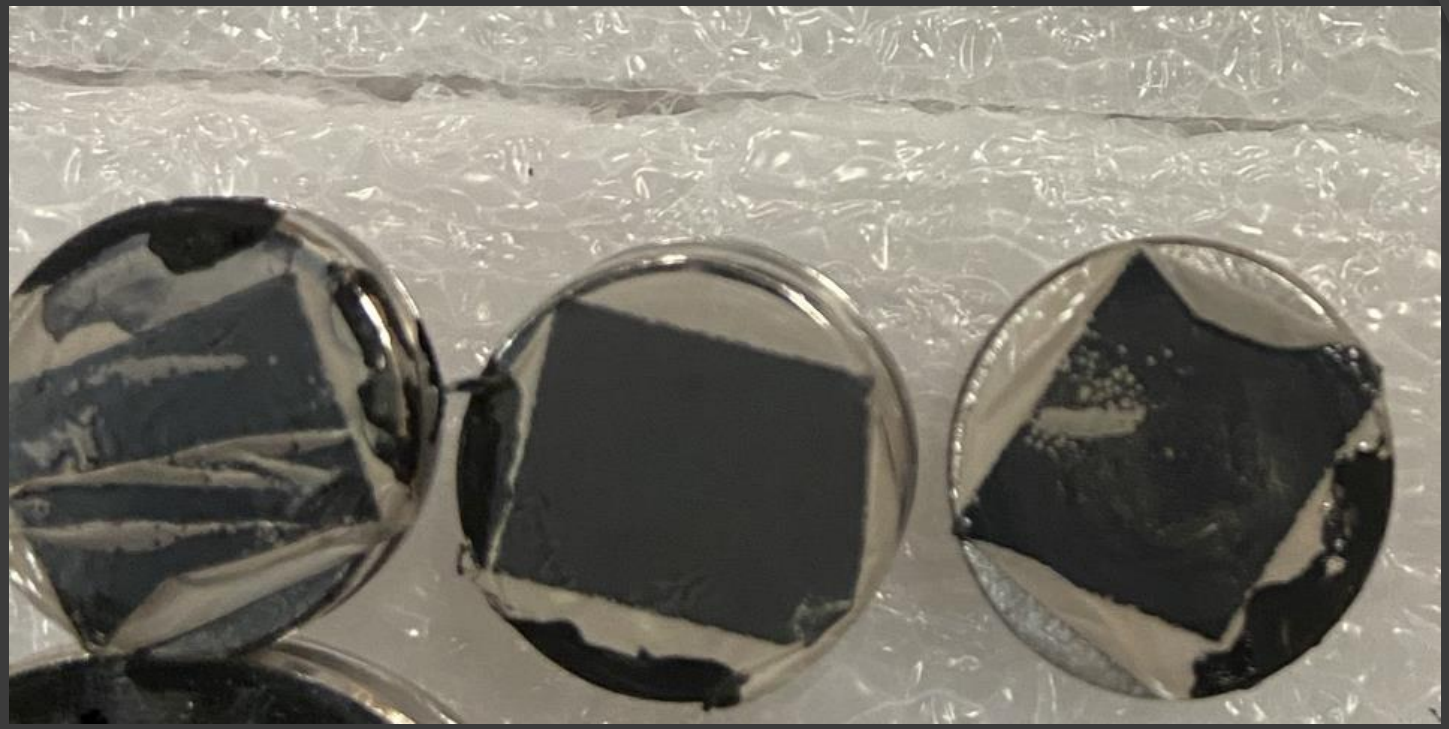


Forager honey bee during wildfire smoke



Nurse honey bee during wildfire smoke

ELEMENTAL ANALYSIS
(EDS OF HONEY BEE WORKERS)



Energy dispersive X-ray spectroscopy (EDS) allows for targeted analysis of sample surfaces to identify the elements on honey bee body parts.

Three honey bees from each hive (nurses and foragers, during and after wildfire smoke) washed and the solution filtered through a filter paper, capturing the particles.

Elemental analysis was then done after coating the particles with Au/Pd.

Effects of fire / smoke on honey bee queens

Courtesy: Project Apis m / George Hansen

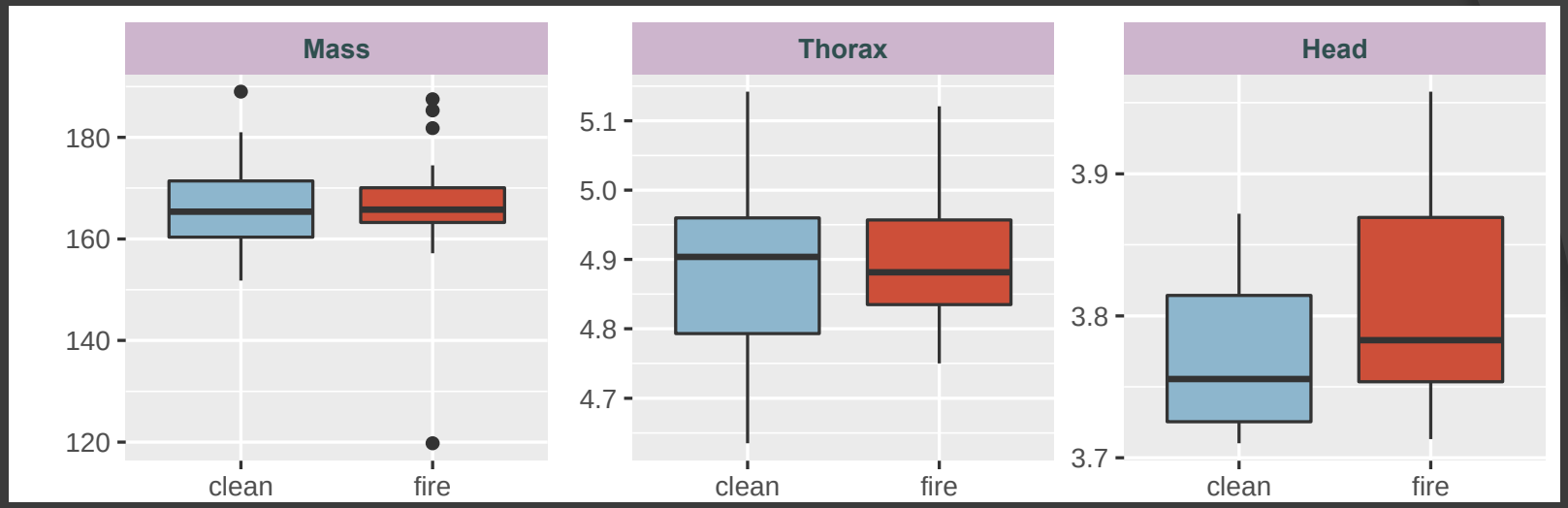
Queens from fire exposed hives (n=20)

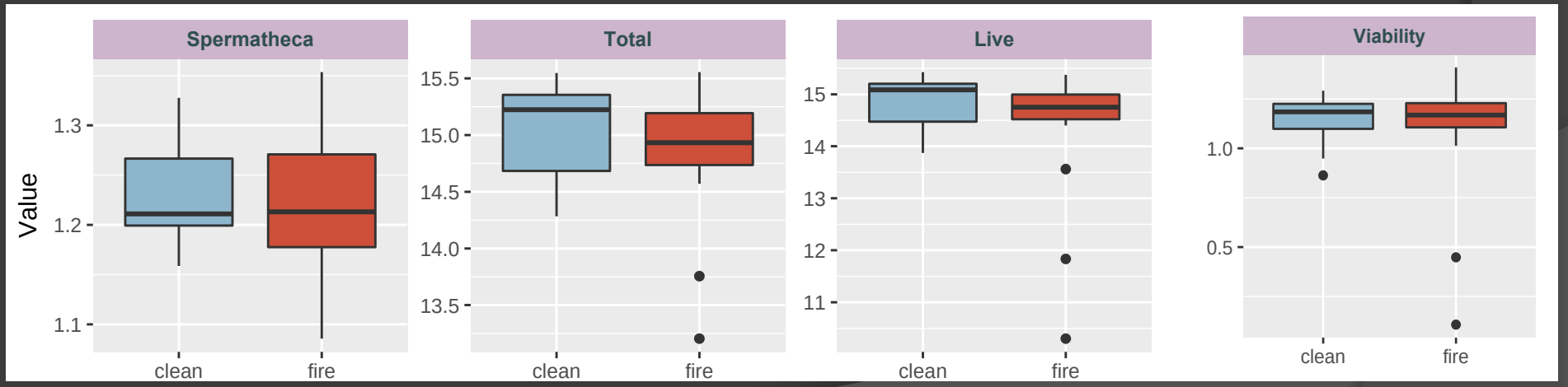
Queens from hives not exposed to fire (n=20)

Queen Quality Parameters Measured

- **Physical Quality:** **Morphometric Parameters such as weight, thorax width, head width (NCSU)**
- **Reproductive Quality:** **sperm count and sperm viability (NCSU).**
- **The spermathecal content were shipped back to OSU for proteomic analysis.**

Queen Health Indices





Proteomic analysis is pending

QUESTIONS ???