



# **IPM, Thinning, and Rootstocks:** Apple research at Western Colorado Research Center – Rogers Mesa

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# A dire nuisance in the valley

## Codling Moth – *Cydia pomonella*

Crop: Apples

Order: Lepidoptera

Location: Earth



Codling moth adult

## How bad is it?

### Organic Grower Reports (Rogers Mesa) Apples with codling moth damage

2020

2021

2022

8%

11%

18%

33%

20%

27%

60%

60%

52%

50%

70%



Multiple CM larval entry points!

# Exclusion netting?

- First implemented in 2005 in France
- 2020 in the North Fork Valley
- Mesh size: 6mm x 1.8mm
- Hypothesis:
  - Physical separation
  - Mating/behavior disruption

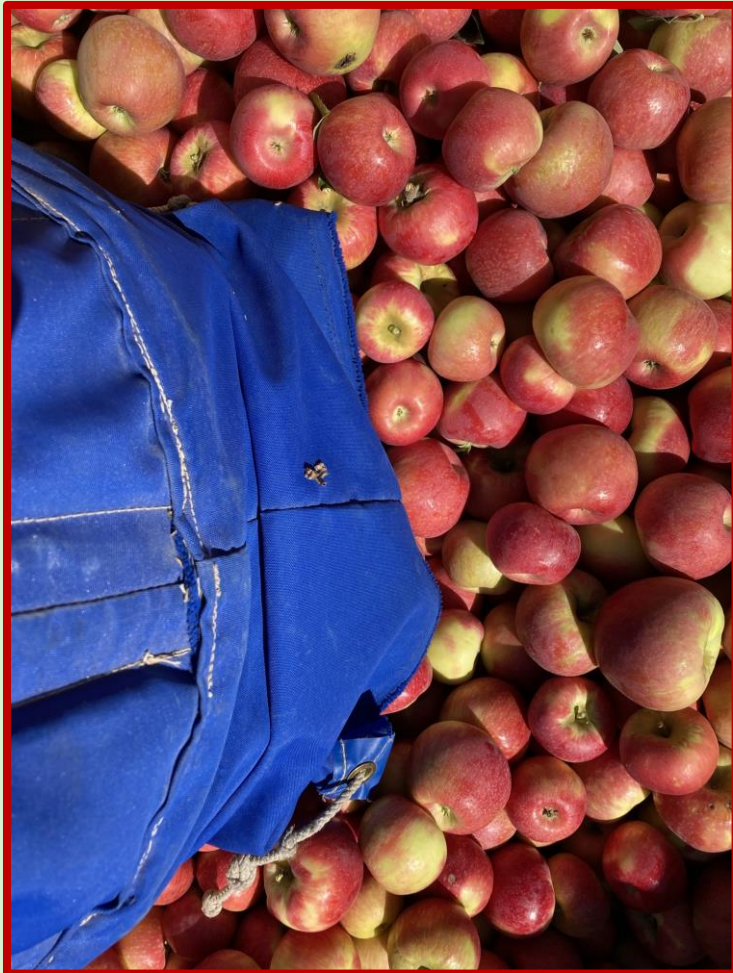


**Tractor implement for draping nets over tree rows**



**Young apple trees (4<sup>th</sup> leaf) with netting supported by scaffolding at WCRC-RM**

# Exclusion netting. *Greatly* reduces CM damage



Estimated percent of apples with Codling Moth damage

Year	“Honeycrisp”	“Cameo”	“Gala”
2020	70%	50%	NA
2021	8%	2%	NA
2022	3%	<1%	<1%

- Netted

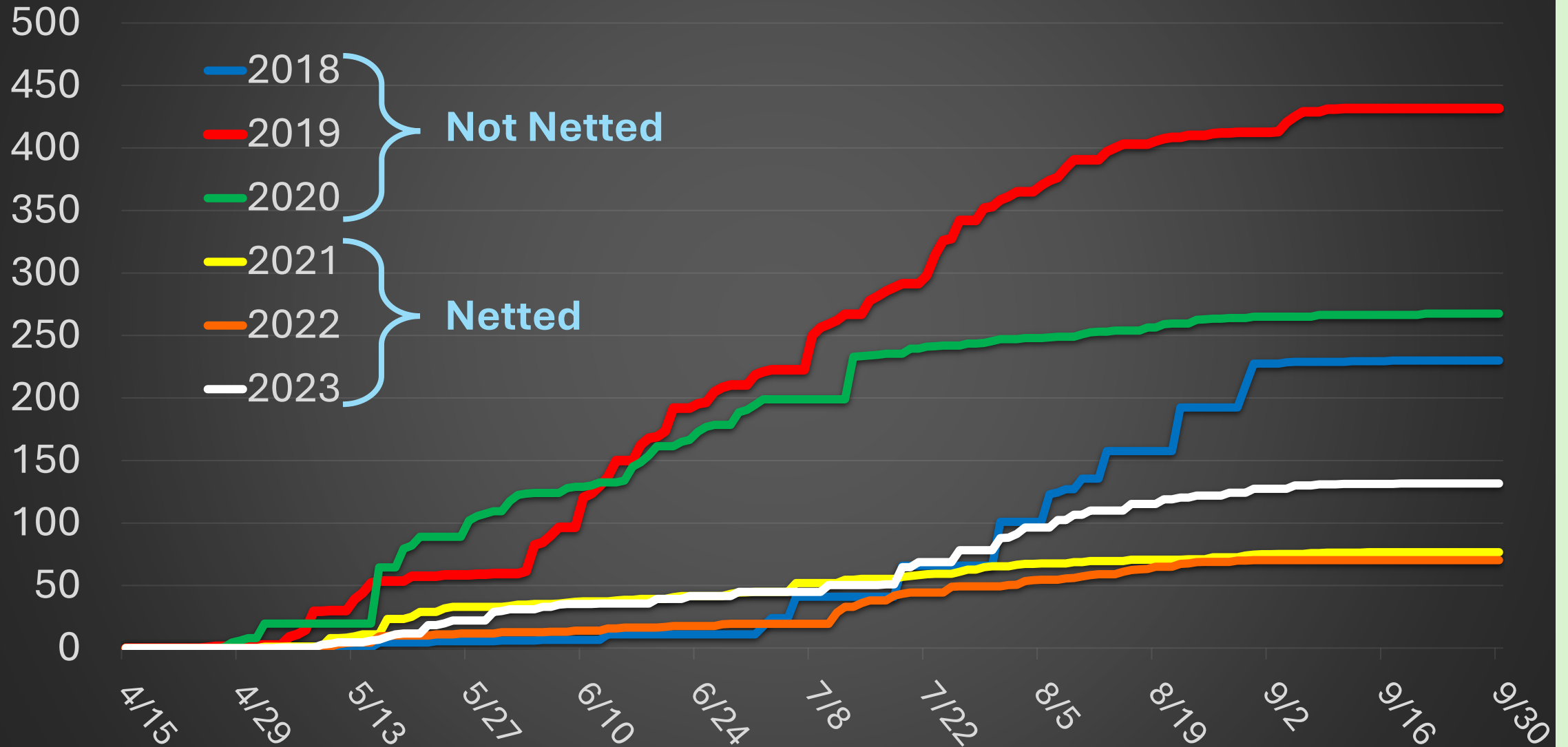
2023 adjacent comparison trial

“Honeycrisp”		“Cameo”		“Gala”	
No Net	Netted (6/21/23)	No Net	Netted (6/21/23)	No Net	Netted (6/8/23)
100%	43%*	99%	25%*	99%	1%*

2023 Percentage codling moth damaged apples per tree across three varieties (Netted vs. No Net). 7 trees per treatment. Later netting timing = greater damage.

# WCRC-RM Codling Moth Cumulative Trap Counts

Averaged across three orchards



***Netting the orchard reduces local populations of codling moth***

# Local growers also see positive outcomes with exclusion netting



Estimated percent of apples with Codling Moth damage

Year	Orchard 1		Orchard 2		Orchard 3			Orchard 4		Orchard 5
	Gala	Golden	Gala	Golden	Honeycrisp	Jonathan	Golden	Gala	Fuji	Honeycrisp
2020	6%	10%	70%	40%	5%	2%	4%	30%	35%	>50%
2021	9%	12%	60%	60%	20%	16%	17%	2%	<3%	<5%
2022	<1%	18%	<5%	52%	27%	3%	13%	1%	<5%	<5%

- Netted

- Conventionally managed

*Work by Ben Bentele,  
2020 - 2022*

# Assisted apple thinning for organic orchards

## 1. Utilizing codling moth exclusion netting

**Hypothesis:** Applying nets at different times during bloom will affect the number of developing fruits due to reduced pollination.

### Treatments (netting time):

Pink

25% king bloom (KB)

50% KB

75% KB

100% KB

After petal fall (not thinned)

After petal fall (hand-thinned)

### Method:

Counted total flowers and clusters per tree (7 per treatment). Counted and weighed fruit at harvest.

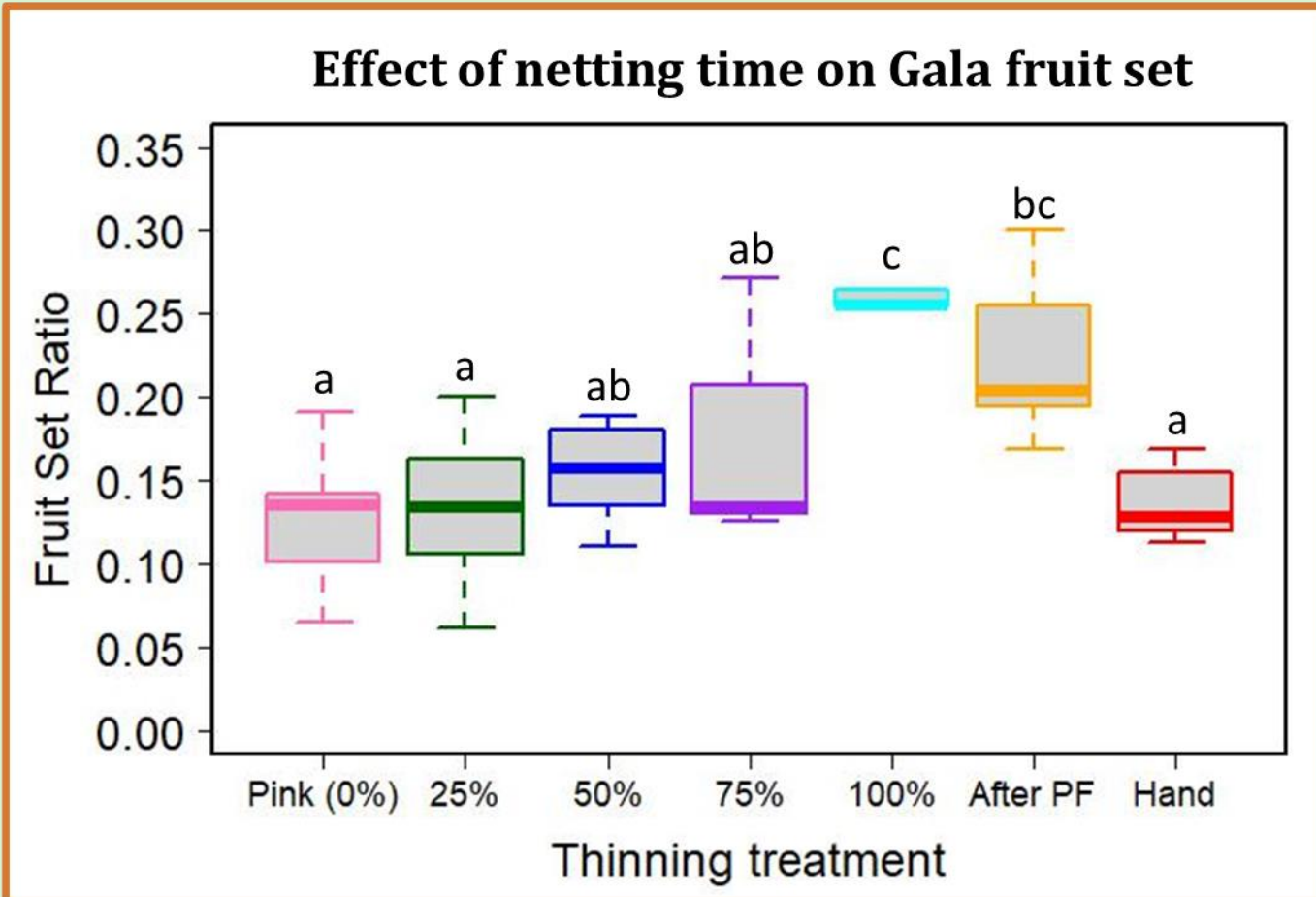


**An open king  
bloom within spur  
cluster**



**A Non-thinned  
cluster**

# Netting timing affects number of set fruit



## ***Conclusions***

- The industry standard (“Hand-thinned”) is most comparable to applying the nets at 0%, and 25% bloom.
- Fruiting occurs even with nets applied at 0% bloom, due to parthenocarp or insects within nets?



# Assisted apple thinning for organic orchards

## 2. Applying a plant hormone, Abscisic Acid

### Hypothesis:

Through photosynthetic inhibition due to stomatal closure, applying Abscisic Acid (ABA) early during fruit development will induce fruit drop throughout the tree and act as an organic chemical thinner.

### Treatments (Protone PPM):

125, 250, 300x2, 375, and 500

Non-thinned control

Hand-thinned control

**Method:** Fruitlets counted on each tree. When developing fruitlets reached ~10mm in diameter, seven random Gala trees were backpack sprayed with Protone. Counted and weighed at harvest.

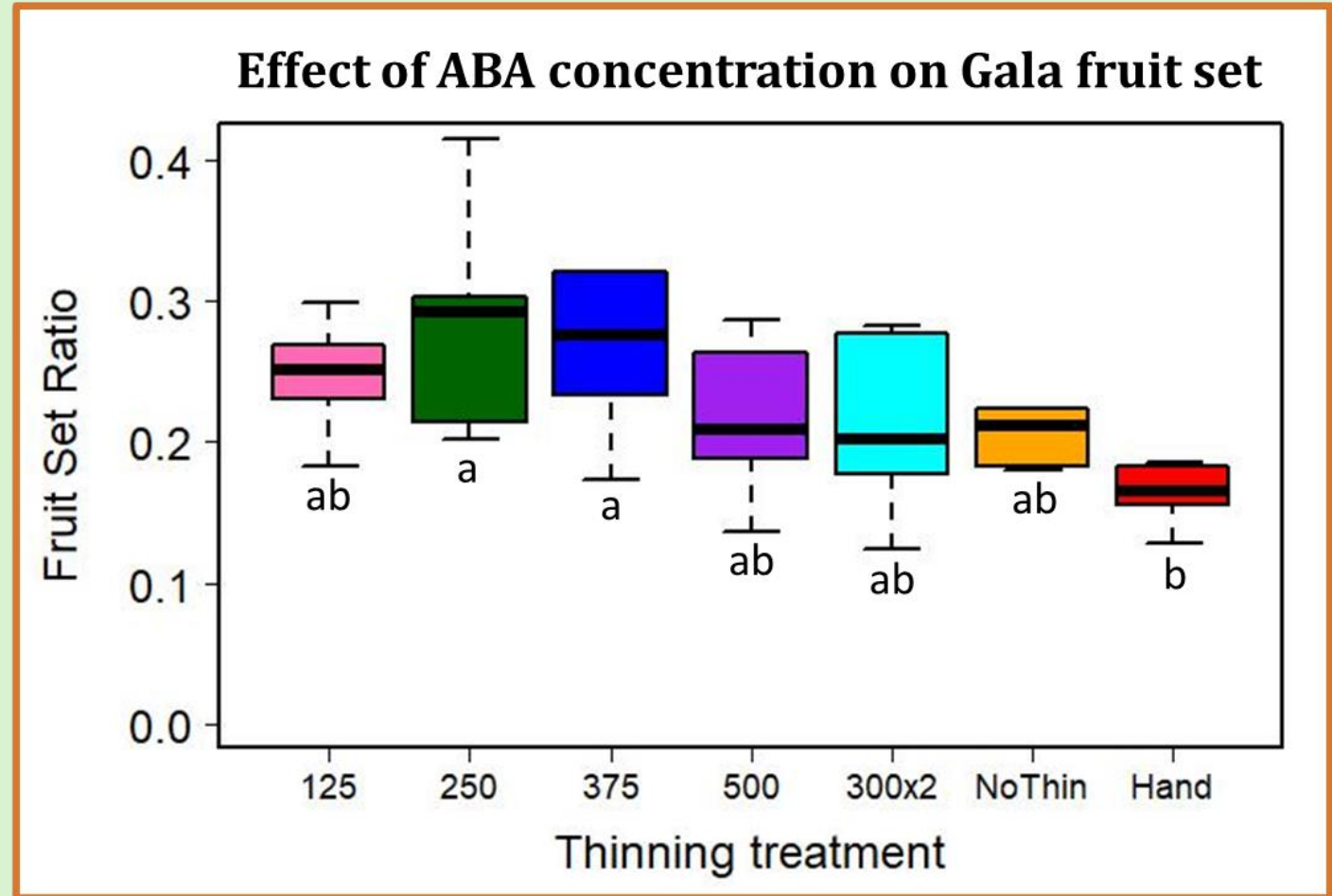


**Measuring fruitlet diameter**

# ABA-thinning...needs work.

## *Conclusions*

- Visible trend of less fruit set ratio with higher concentration.
- Inconclusive results due a lack of difference between positive and negative controls.

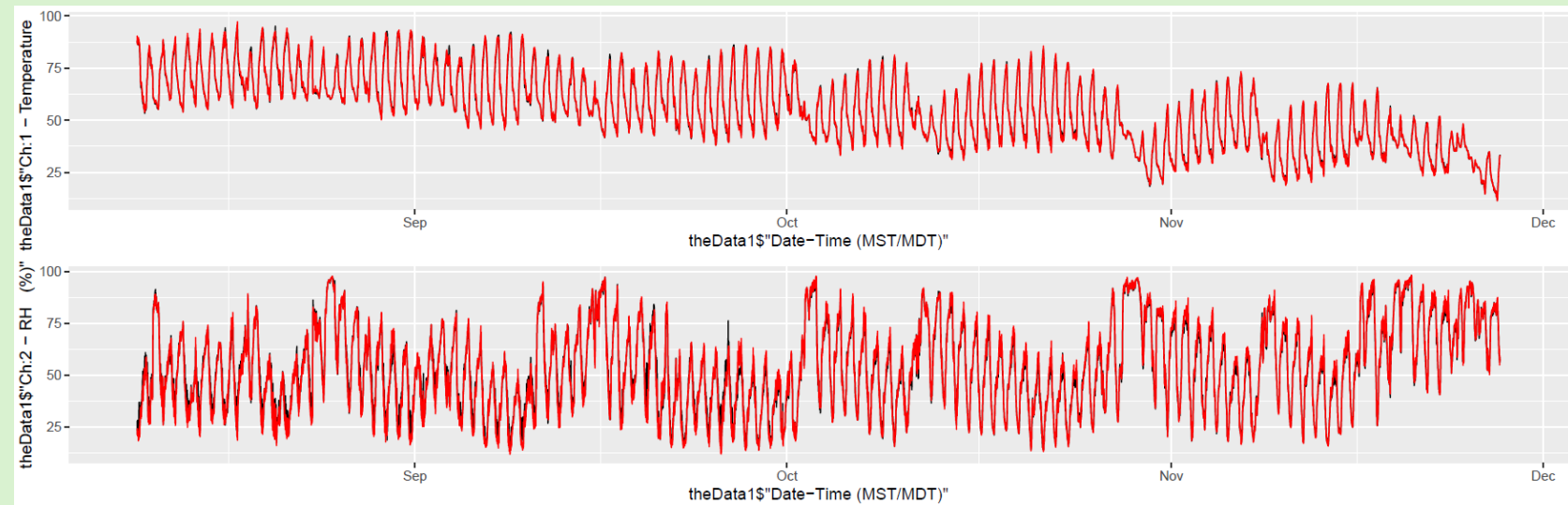
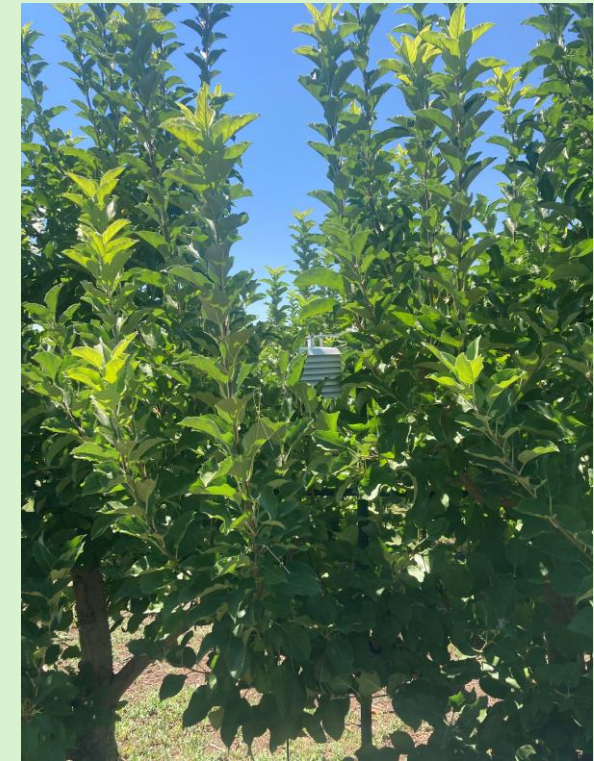


# What's more to learn about netting?

Which is more humid?

Which is hotter?

...Nets or No Nets??

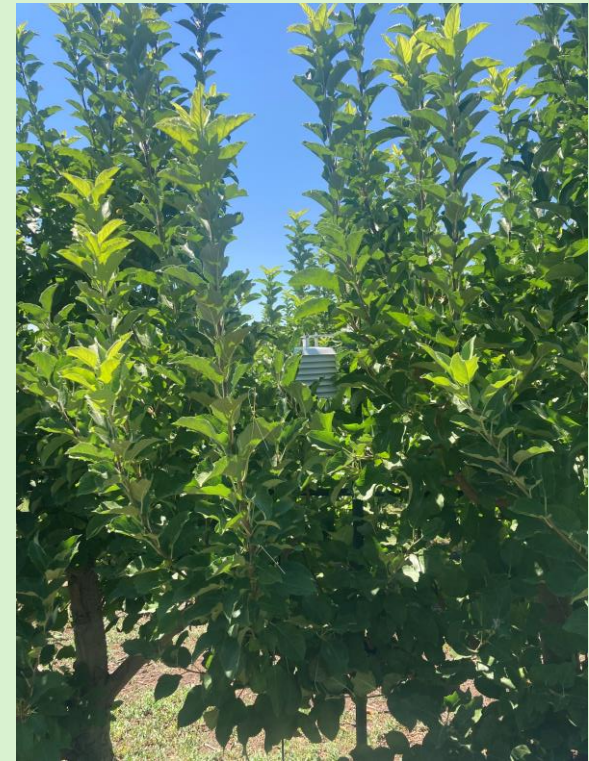


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**Daily *maximum* temperature:**

**The nets make it:**

# What's more to learn about netting?

Which is more humid?

Which is hotter?

...Nets or No Nets??



Daily *maximum* temperature:

The nets make it: *Hotter* by 0.11°F

# What's more to learn about netting?

Which is more humid?

Which is hotter?

...Nets or No Nets??



**Daily *minimum* temperature:**

**The nets make it:**

# What's more to learn about netting?

Which is more humid?

Which is hotter?

...Nets or No Nets??



**Daily *minimum* temperature:**

**The nets make it: *Colder* by  $-0.48^{\circ}\text{F}$**

# What's more to learn about netting?



Which is more humid?

Which is hotter?

...Nets or No Nets??

**Daily *maximum* Relative Humidity:**

**The nets make it:**



# What's more to learn about netting?

Which is more humid?

Which is hotter?

...Nets or No Nets??



Daily *maximum* Relative Humidity:

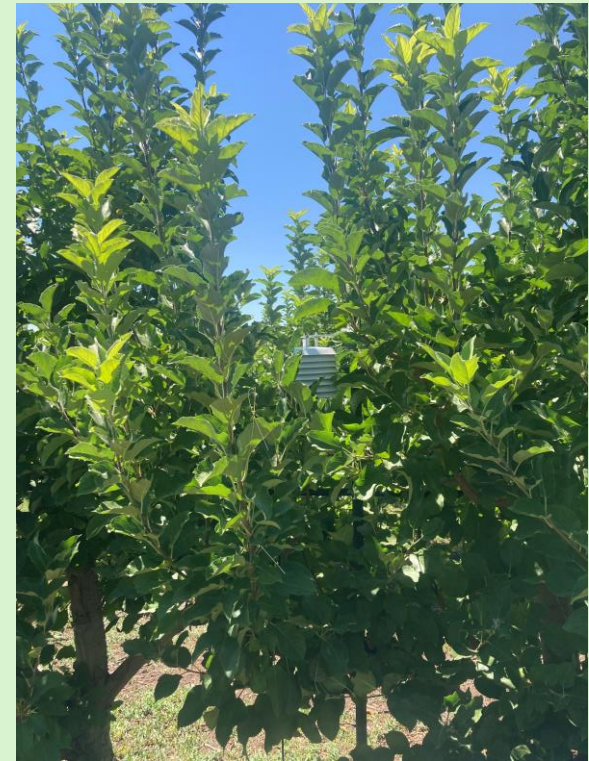
The nets make it: ***MORE*** humid by 2.78%

# What's more to learn about netting?

Which is more humid?

Which is hotter?

...Nets or No Nets??



**Daily *minimum* Relative Humidity:**

**The nets make it:**

# What's more to learn about netting?



Which is more humid?

Which is hotter?

...Nets or No Nets??

Daily *minimum* Relative Humidity:

The nets make it: ***MORE*** humid by 1.51%

*There's a slight change*



<b>Difference by Nets</b>	<b>Max Temp. (F)</b>	<b>Min Temp. (F)</b>	<b>Max RH %</b>	<b>Min RH%</b>
	+0.11	-0.48	+2.78	+1.51

**Granted, this is only from August through September!**

# Effect of exclusion netting on insect populations

A collaboration with Mel Schreiner – CSU Extension Entomologist



**Netted 'Cameo' apples**



**Non-Netted 'Cameo' apples**

# Effect of exclusion netting on insect populations

A collaboration with Mel Schreiner – CSU Extension Entomologist

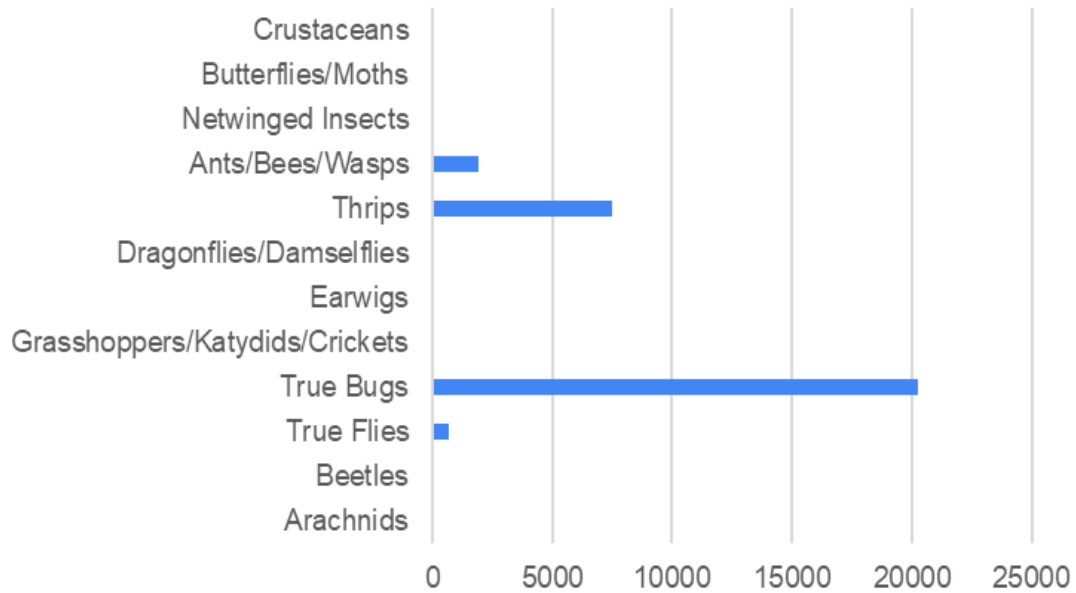


**Netted 'Cameo' apples**

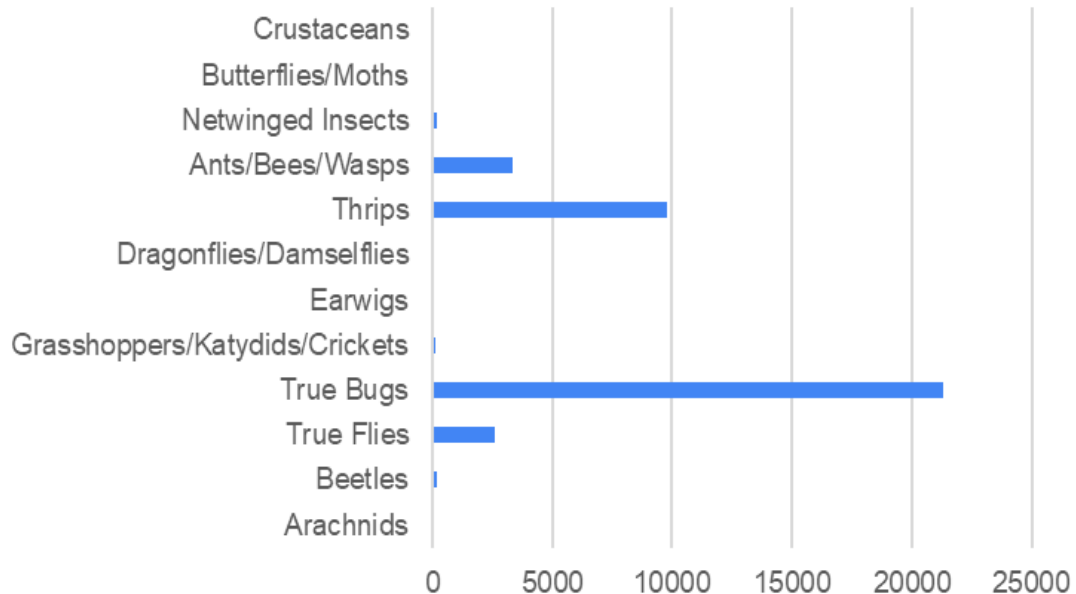


**Non-Netted 'Cameo' apples**

2023 total individuals found under apple nets



2023 total individuals found in apples without nets present



## Shannon-Weiner Diversity Indices

Date	Netted	Non-Netted (open)
June 26 2023	1.28	1.92
July 11 2023	1.77	1.87
July 24 2023	1.8	2.24
Aug 7 2023	1.72	2.15
Aug 21 2023	1.32	1.63

**Insects are present and abundant underneath the nets.**

**They are just MORE abundant without the nets**

**Also depends on size and insect type...**



An antlion adult, an aerial predator in the family Myrmeleontidae which was stuck inside the codling moth netting



Western Lynx , *Oxyopes scalaris*

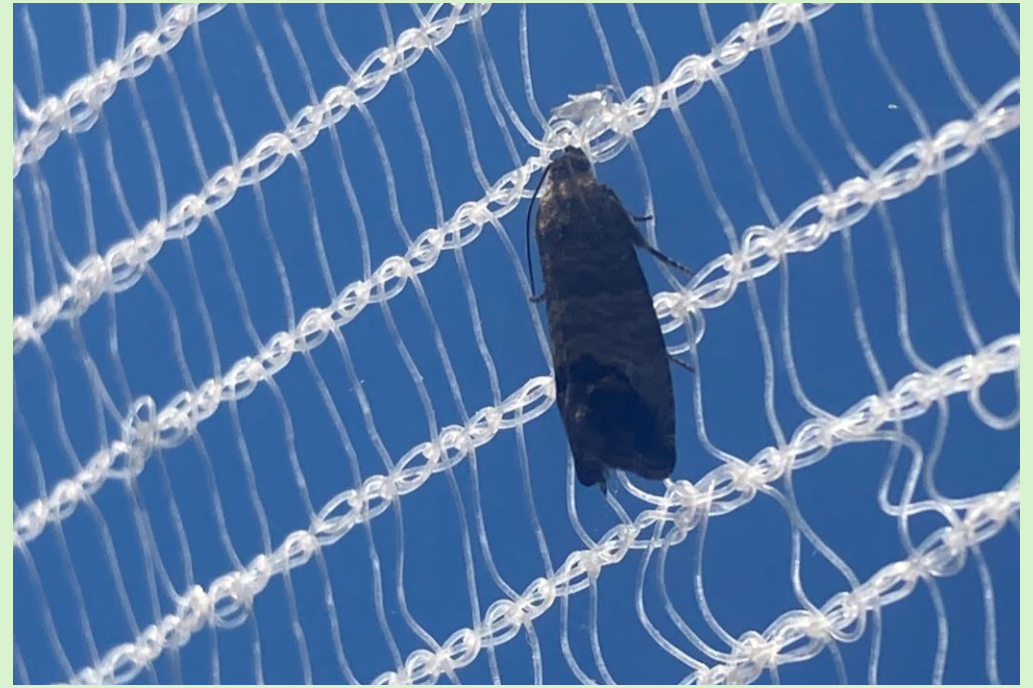


Utah Crab Spider,  
*Bassaniana utahensis*





A little beetle



A Codling Moth



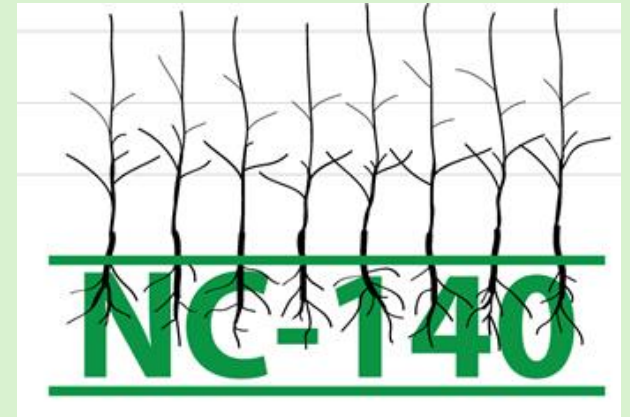
Plenty of predators!



# Rootstock Trials: Finding what works in organically-managed orchards

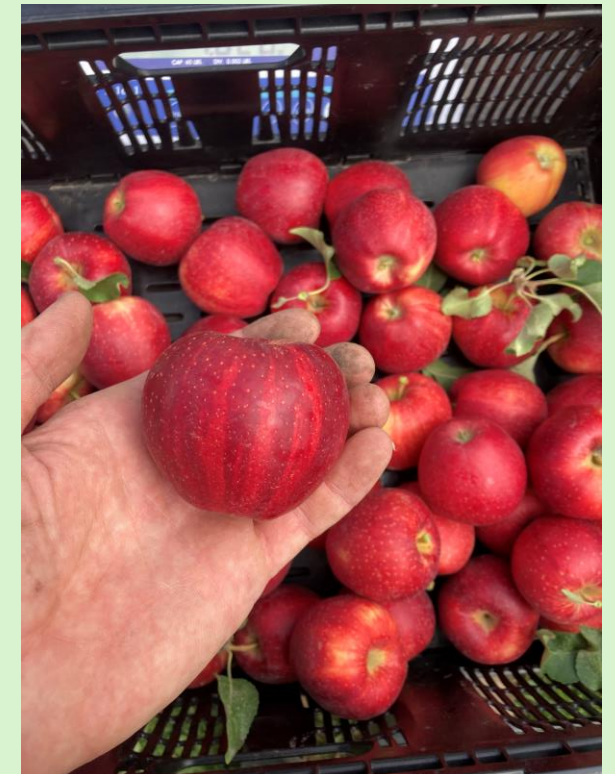
## ***NC-140 Multi-state program***

"Improving economic and environmental sustainability in tree fruit production through changes in rootstock use."



### Two plantings at WCRC-Rogers Mesa

- Buckeye Gala (2019)
  - 8 Rootstocks, 3' x 11', tall spindle pruning
- Porter's Perfection (Cider) (2023)
  - 7 rootstocks, 4.5' x 15', tall spindle pruning



# 2019 NC-140 'Buckeye Gala' Apple Rootstock Trial

**Sites:** CO-WCRC-OM, CO-WCRC-RM

**Coordinator(s):** Todd Einhorn (Michigan State University, MSU); Stefano Musacchi (Washington State University, WSU)

**Cultivar:** 'Buckeye Gala'

**8 Rootstocks:** G.41, G.11, G.969, G.4814, Bud 10, M.9 T337, M.26, IFO#2

**Year planted:** 2019

**Training system:** TSA

**Spacing:** 3 x 11 feet (0.9 x 3.4 m)

**Trees/acre:** 1320



# The impact of rootstock on 'Buckeye Gala' apple tree survival and TCSA, WCRC-Rogers Mesa (Organic) site

5<sup>th</sup> leaf – 2023

Rootstock	Survival (%) 2023	TCSA (cm <sup>2</sup> ) Fall 2023	Suckers 2023
B.10	93	17.9 ab	0.0 b
G.11	60	17.1 ab	0.3 b
G.41	47	17.9 ab	1.7 b
G.4814	60	14.6 b	10.9 a
G.969	87	19.9 a	1.9 b
IFO#2	53	16.9 ab	1.9 b
M26	67	19.3 ab	2.5 b
M9-T337	100	15.7 b	0.3 b
Estimated LSD		4.3	8.5

**Note!**  
Survival affected greatly by October 2020 freeze event prior to dormancy.

\*Mean separation in columns by Tukey's HSD ( $P \leq 0.05$ ). LSD was calculated based on the number of observations per mean.

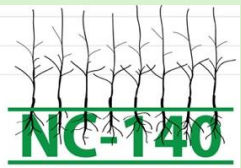


# The impact of rootstock on 'Buckeye Gala' productivity, WCRC-Rogers Mesa (Organic) site

5<sup>th</sup> leaf – 2023

Rootstock	No. of Fruit	Yield (kg/tree)	Average Fruit Weight (g)	Yield Eff. (kg/cm <sup>2</sup> of TCSA)	Crop load (no. of fruit/cm <sup>2</sup> of TCSA)
<b>B.10</b>	43.6	6.5 a	149	0.37	2.5
<b>G.11</b>	32.2	4.6 ab	144	0.27	1.9
<b>G.41</b>	36.7	5.4 ab	148	0.30	2.0
<b>G.4814</b>	26.0	3.4 b	137	0.26	2.0
<b>G.969</b>	32.3	4.5 ab	143	0.23	1.6
<b>IFO#2</b>	32.3	5.0 ab	157	0.30	2.0
<b>M26</b>	47.3	7.0 a	148	0.36	2.5
<b>M9-T337</b>	34.5	5.4 ab	154	0.34	2.2
Estimated LSD	ns	3.1	ns	ns	ns

\*Mean separation in columns by Tukey's HSD ( $P \leq 0.05$ ). LSD was calculated based on the number of observations per mean.



# 2023 NC-140 'Porter's Perfection' Cider Apple Rootstock Trial

**Sites:** CO-WCRC-RM

**Coordinator:** Gregory Peck, Cornell University

**Planting locations:** Colorado, Idaho, Kentucky, Massachusetts, Michigan, Montana, North Carolina, New Jersey, Nova Scotia, New York-Lansing, New York-Walden, Ohio, Pennsylvania, Vermont, Washington, Wisconsin

**Rootstocks:** G.11, G.202, G.210, G.21,3 G.41, G.4004, G.890, G.969

**Spacing:** 4.5 x 15 feet (645 trees/acre)

**Training and support:** Tall spindle



## **What to be measured:**

Tree health/growth rate

Fruit quality

Yield

Juice quality & cider quality

# October 24<sup>th</sup>!

## Apple and Peach Rootstock trial annual update at WCRC-Rogers Mesa



WESTERN COLORADO RESEARCH CENTER – ROGERS MESA  
COLORADO STATE UNIVERSITY

## 2024 WORKSHOP SERIES

**FEB 15** **CROP PLANNING & RECORD KEEPING FOR VEGETABLE FARMS**  
Max Kirks, Research Associate, WCRC-Rogers Mesa

**FEB 29** **APPLE PRUNING AND MANAGEMENT**  
Bryan Braddy, Research Associate, WCRC-Rogers Mesa

**MAR 21** **PEACH PRUNING AND MANAGEMENT**  
Bryan Braddy, Research Associate, WCRC-Rogers Mesa

**APR 11** **WINE GRAPE RESEARCH AT ROGERS MESA- PAST, PRESENT, FUTURE**  
Dr. Horst Caspari, State Viticulturist

**MAY 16** **TWO YEARS OF REGIONALLY-ADAPTED SEED VARIETY TRIALS**  
Dr. Brad Tonnessen, Scientist, WCRC-Rogers Mesa

**JUN 27** **WEED MANAGEMENT ON THE VEGETABLE FARM**  
Dr. Brad Tonnessen & Max Kirks, WCRC-Rogers Mesa w/ Delta Conservation District

**JUL 11** **VEGETABLE PREDATORS AND POLLINATORS**  
Melissa Schreiner, Entomology Specialist, CSU Extension

**AUG 22** **3RD ANNUAL WCRC-ROGERS MESA FIELD DAY**  
Community event featuring information booths, food, games, and more!

**OCT 24** **APPLE AND PEACH ROOTSTOCK TRIAL ANNUAL UPDATE**  
Dr. Brad Tonnessen, WCRC-Rogers Mesa



We are excited to host seven unique workshops in 2024 that help inform and empower organic growers in Western Colorado. **All events are free and open to the public!** We will be sharing additional information for each workshop a few weeks before the date listed. While walk-ins are welcome, we request that you register via our Eventbrite (QR code below).



### Questions or concerns?

Max Kirks, Research Associate  
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Hotchkiss, CO 81419

# Thank you

Do you practice integrating livestock  
in your specialty crop operation??

We need to hear from you!

Go to the CSU table and sign up!



People at WCRC-RM

Brad Tonnessen (Me)

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CSU Extension Regional  
Specialist, Food & Ag