

# Counting Bad Apples:

## A 3-year Study of Codling Moth in North Fork Organic Apple Production

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on Rogers Mesa



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# Grant Background

As part of a CDA specialty crop block grant, I've spent the last 3 years studying codling moth dynamics in Organic Orchards on Rogers Mesa & the broader North Fork valley.



# Our Areas of Inquiry:

- Weak links in current IPM -
- Biocontrol -
- Sterile Insect Release -
- Exclusion Netting -





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*1st Culprit:*

Abandoned / Neglected Orchards

Research Bulletin 202

# Are We Developing Strains of Codling Moths Resistant to Arsenic?

LEONARD HASEMAN and R. L. MEFFERT

(Publication Authorized July 24, 1933)



COLUMBIA, MISSOURI  
AUGUST, 1933

# Cycles of Resistance

## 1920s Colorado

- Codling Moth from the Grand Valley were the most Arsenic Resistant population in the US
- Our region was among the first to use Lead Arsenate
- & we had some of the highest dosage recommendations

# Current Methods - *Cydia pomonella granulovirus*

- CpGV is most effective at controlling small populations.
- Very UV light sensitive
  - Nearly 100% effective against CM larva in a laboratory setting
  - Drops to 2%-30% when exposed to sunlight
- It's not practical for larger orchards to only spray only at night
  - *Potential for resistance*

## *Weak link?*

- CM acquired resistance to CpGV after just 2 decades of use in Europe
- *We sent samples to Purdue for analysis, but they lost the larvae*
- *CM is a genetically plastic species – resistance is inevitable*





BioControl





COMMENTS ON BIRDS AND CODLING MOTH  
CONTROL IN THE OZARKS

BY JOHNSON A. NEFF

FOR nearly fifty years my parents have engaged in the growing of fruit, largely apples, in the southwest Missouri Ozarks. Thirty years

# Natural Predators

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- This quaint bulletin relates the decrease in woodlots to an increase in CM
  - Woodpeckers kept CM in check
  - Logging destroyed bird habitat
- Bird Predation of CM is also important in wooded Ohio, Ontario & British Studies
  - In Bristol apple orchard, only 2-11% of fruit were infested in an unsprayed orchard.

# Natural Predators

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A molecular analysis to assess codling moth *Cydia pomonella* L. (Lepidoptera: Tortricidae) predation by orchard birds

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- In 2018, a CSU study checked the diets of North Fork orchard birds
  - (via DNA fecal analysis)
- Found only .5% of samples contained CM
  - Only sequenced in Brown-headed cowbird (*Molothrus ater*)
- *Codling moth has minimal predation in our environment*

## *Side note*

*Neff:*

*“The dense construction of the Robin's nest made it a good home for the adaptable apple worm, and on one occasion more than 100 hibernating larvae were taken from a single nest”*

Other overlooked infestation vectors:

- Orchard Wood Piles
- Wooden Apple Bins





## Entomopathogenic Nematodes

- Naturally occur in most soils
  - Seek out CM hibernaculum & prey upon them - even through cocoons

# Entomopathogenic Nematodes

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Entomopathogenic nematodes for control of codling moth  
(Lepidoptera: Tortricidae) in apple and pear orchards:  
Effect of nematode species and seasonal temperatures,  
adjuvants, application equipment, and post-application irrigation  
Lawrence A. Lacey<sup>a,\*</sup>, Steven P. Arthurs<sup>a</sup>, Thomas R. Unruh<sup>a</sup>, Heather Headrick<sup>a</sup>,  
Robert Fritts Jr.<sup>b</sup>

- They can be applied with a normal pesticide sprayer.
  - Cold hardy strains available for use in apple orchards
- Humidity is necessary to nematode survival
  - Lack of irrigation water after fall harvest makes this method difficult
- Most effective if applied to wetted banded trunks :
  - 70% mortality of larvae in the band after hand-sprayer application of nematodes. *Mortality approached 100% if both pre- and post-wetting was used.*

# Other Bio-Control:

## *Trichogramma Wasps*

- German study: 53–84% reduction of CM population
- But not economically feasible



Review

## Pest Management Challenges and Control Practices in Codling Moth: A Review

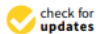
Martina Kadoić Balaško <sup>1,\*</sup>, Renata Bažok <sup>1</sup>, Katarina M. Mikac <sup>2</sup>, Darija Lemic <sup>1</sup> and Ivana Pajač Živković <sup>1</sup>

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# Sterile Insect Release (SIR)





# Sterile Insect Release

- Radiation sterilized insects are raised & released in quantities sufficient to overwhelm the native moth population.
- Mating still occurs, but the chance of fertile moths finding each other is diminished.
- This technology eradicated screw-worm pests from the cattle industry.
  - But flies are not moths.
  - SIT succeeded with screw-worm because they mate just once per season



# Sterile Insect Release

- The orchard area here is too small & heterogenous
- An economic study of SIR states the break-even point is above 6000 acres, (Cartier, 2015)
- After 30 years of operation in British Columbia, CM still has not been eradicated
  - The funding model is based on the whole region's taxbase paying into the program.
  - *“Shipping is easier to New Zealand than Michigan”* - due to customs protocols.



# Exclusion Netting







2020:

Only 1 netted orchard

2021:

3 orchards



2022:

6 Orchards

~100 acres

2023:

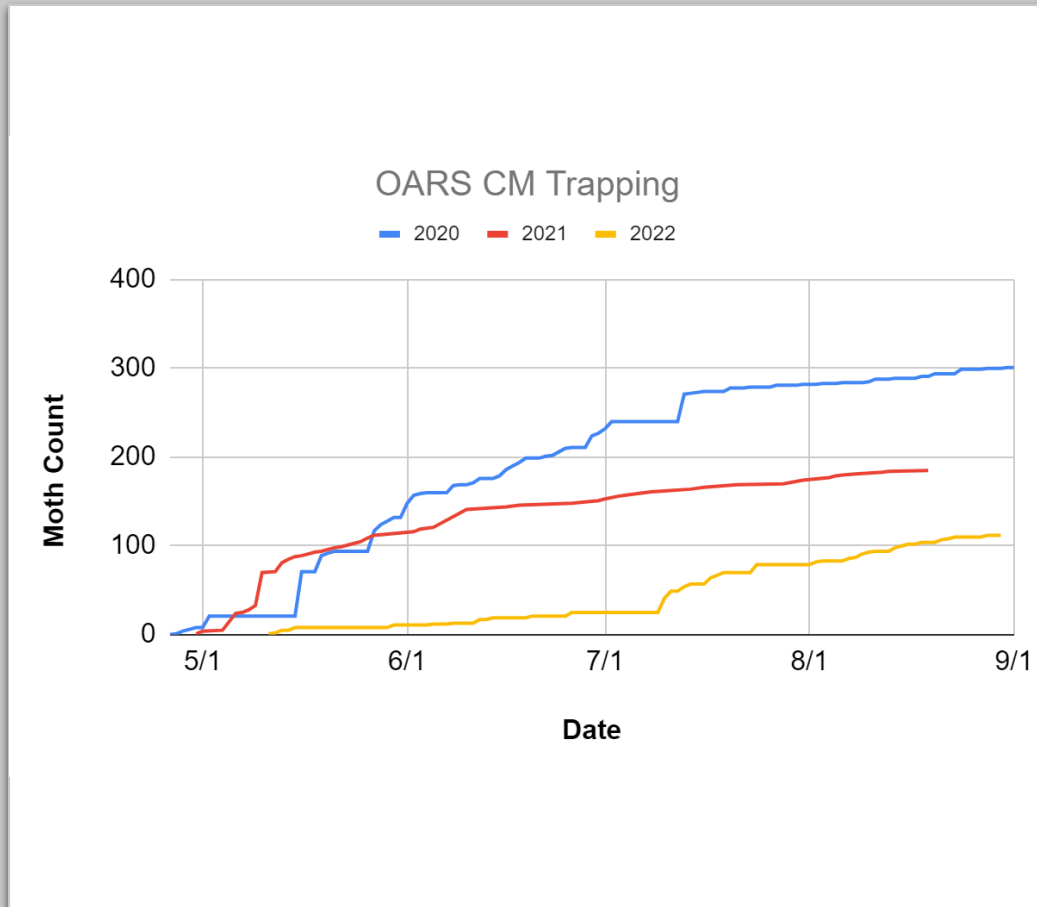
6 Net Wizz  
Machines in the  
Valley

# 3 Years of Trapping Data

- Moth counts at a trap in the Honeycrisp orchard at OARS is shown for 2020-2022:

- 2020: Unnetted
- 2021 & 2022: Netted

Nets disrupt the ability of moths to mate & result in the long-term decline of their population.



## 3 Years of cull data

OARS				
	Year			
Block		Honeycrisp	Cameo	Gala
	2020	70%	50%	N/A
	2021	8%	2%	N/A
	2022	3%	<1%	<1%

- 2 treatments in 2020 – one sprayed with CYD-X & the other sprayed with only mineral oil. Damage exceeded 70% in the oil treatment, while the CYD-X protocol had 50% damage.
- Even where damage had exceeded 70% in 2020, under netting in 2021 we observed 8% CM damage & 3% in 2022.
- 2022 was the first year of fruit in our Gala orchard, which we netted & observed less than 1% damage.

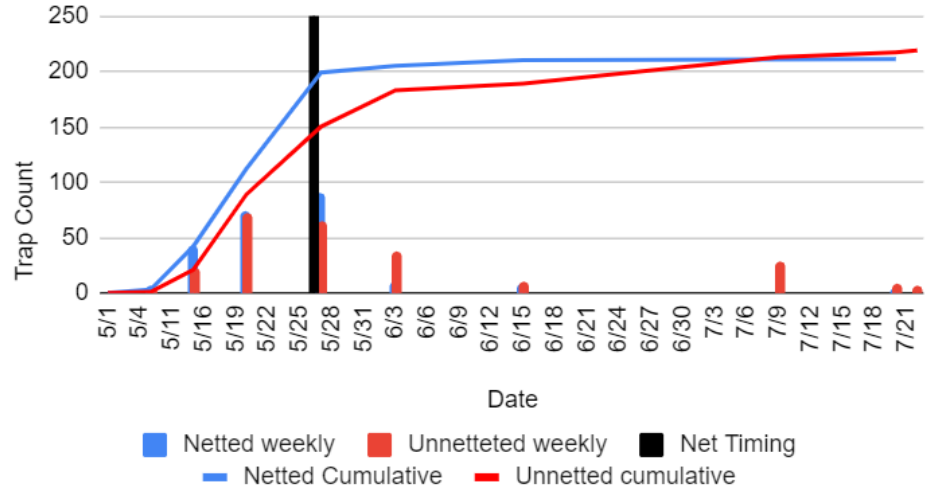


- Comparing 2 nearby apple blocks within the same survey orchard
- One netted 5/27
  - 8% CM damage
- Other unnetted all season
  - 52% CM damage
- No second generation in netted block

(both sprayed all season)

## Survey Data - First Time User

### Moth Trap Count Netting Comparison



*<5% damage for most netted  
orchards*

Except where nearby untended  
apples increase CM populations  
(new grafts with unthinned fruit)

Observed 30% of fruits damaged in  
hot spots



# Further Research





# Sails?

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- T posts couldn't handle this past spring's windstorms



We tried netting early for  
pollination exclusion

Shoots grow through the nets –  
makes removal more difficult



## Woolly Aphids

Researchers from WSU observed 100x the incidence of woolly aphids under netting compared to outside control

No woolly aphids observed on Honeycrisp or Swiss Gourmet

Woolly Aphids were a problem for Fujis, Gala, Goldens

Potential for both  
tree & apple  
damage

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# Synthesis







Thanks!

Questions?

