Using Insect Growth Regulators and Biopesticides in Your Orchards

2009 Orchard and Vineyard Show

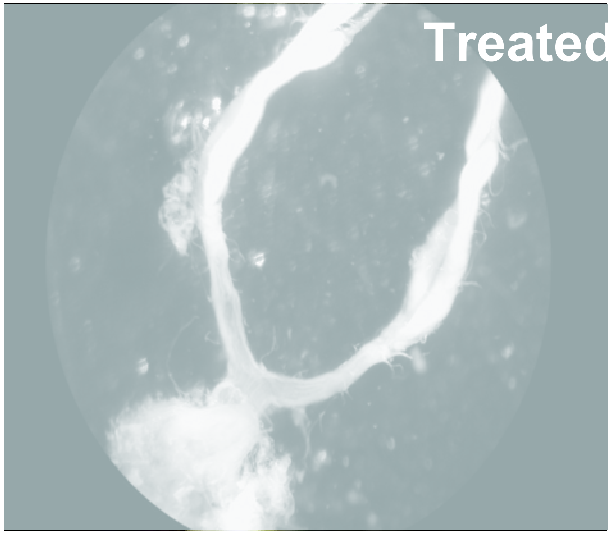
Renee Pereault
Mark Whalon

Michigan State University Department of Entomology

Insect Growth Regulators:
Esteem and Novaluron

Esteem

- Target 2nd generation
- Post-harvest cherry border-row spray
- Females commit fat body to producing eggs out of their normal life cycle
- Low cost, no residue issues



“Biopesticides”

- Def: pesticides derived from such natural materials as animals, plants, fungi, bacteria, viruses, and certain minerals
  - Microbial
    - Bacterium, fungus, virus, protozoan
  - Biochemical
    - Naturally occurring substances that control pests by non-toxic means
      - eg. Insect sex pheromones, kaolin clay

PEST	BIOPESTICIDE
Plum Curculio	Entomopathogenic nematodes and fungi
Borers	Entomopathogenic nematodes
Codling Moth	Entomopathogenic nematodes and granulosis virus

Entomopathogens

Nematodes

-Steinernema

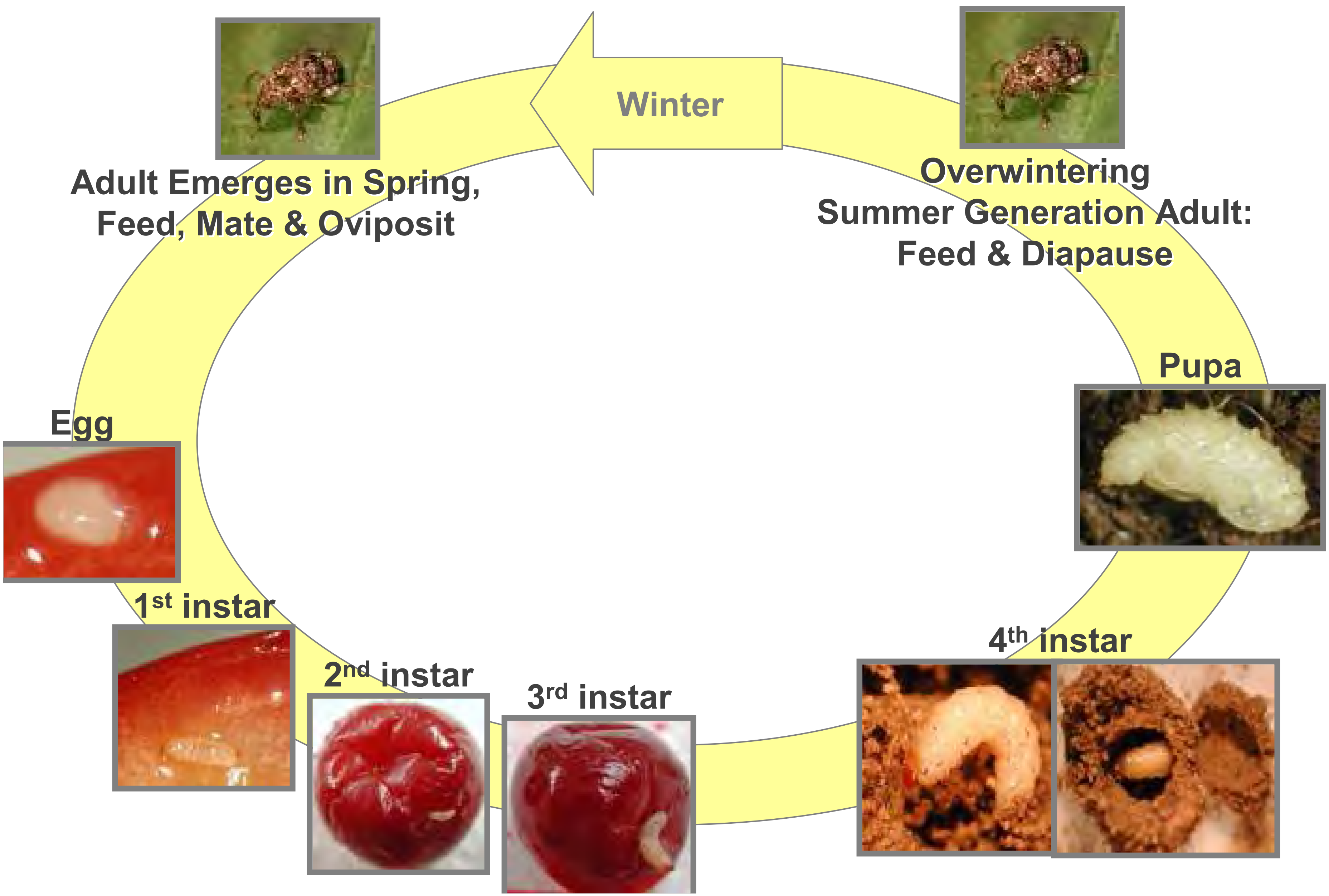
-Heterorhabditis

Fungi

-Beauveria bassiana

-Metarhizium anisopliae

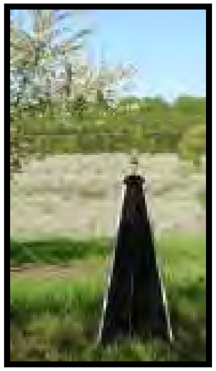
Plum Curculio Life History



Plum Curculio Background

- **Damage:**
  - Feeding & oviposition scars
  - Zero tolerance for larvae in processed fruit

- **Few Organic Management Tactics:**
  - Repeated kaolin clay coverage
  - Pyganic
  - Livestock



Plum Curculio Pathogen Experiment Design

-Larvae placed on surface of enclosed pots installed in 5 orchards

-Soil surface of each pot treated with a pathogen on day 0

-Counted number of adults emerging from pots

Plum Curculio Pathogen Experiment Design

Pathogens:	Rates:
-B. bassiana GHA (Mycotrol-O®)	(1) $5x10^{13}$ conidia/ha
-H. bacteriophora (Utah, unformulated)	(2) $1x10^{9}$ or $4x10^{9}$ IJ/ha
-S. riobrave (355 strain, Biovector®)	(2) $1x10^{9}$ or $4x10^{9}$ IJ/ha
-Control (water)	

Timings:

-Introduce larvae to soil -10, -5, 0, 5, 10, 15, or 20 d from pathogen application

-Hb was not tested for -10, 10, or 20 d

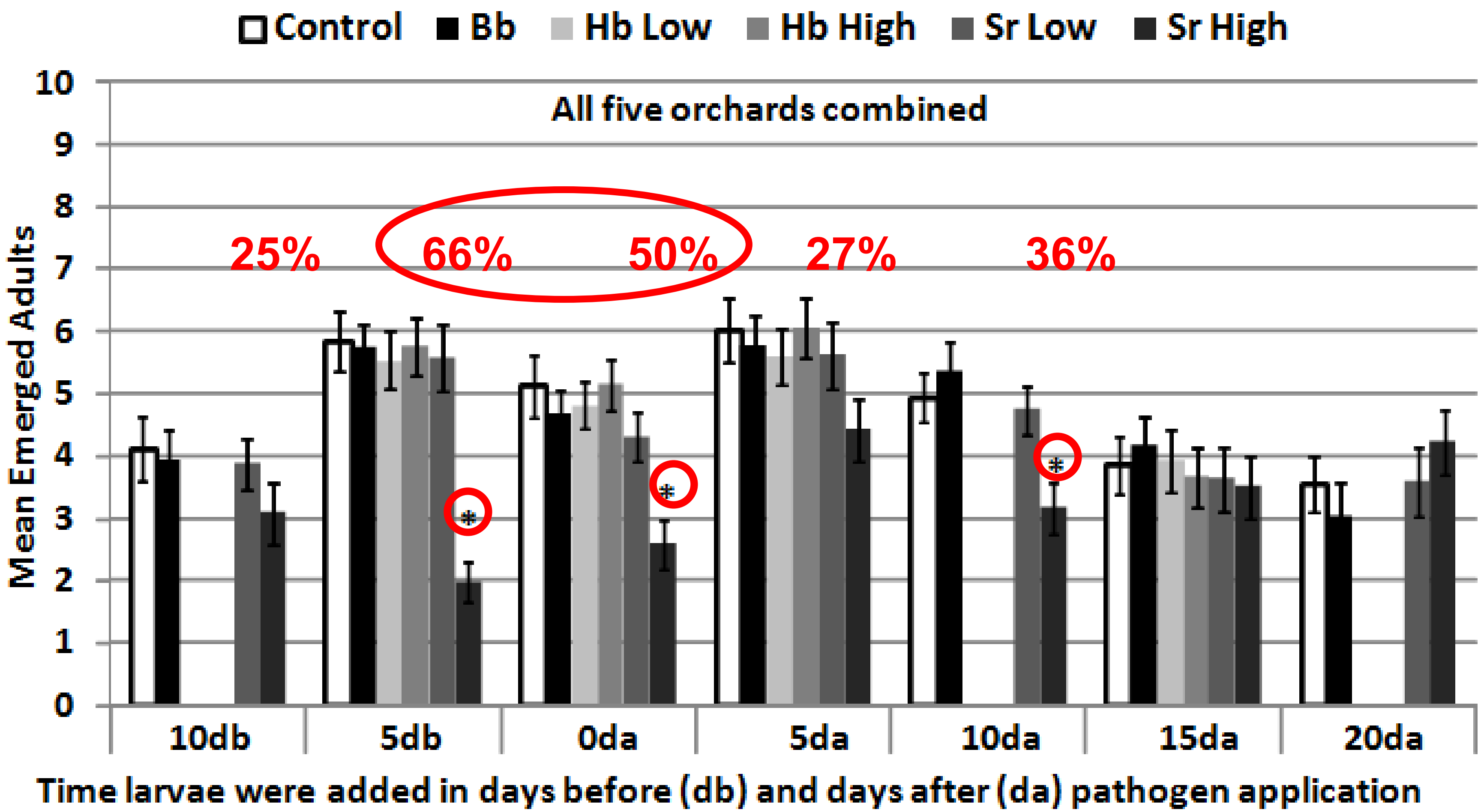
Design:

-36 treatments total

-Means comparisons made within each timing (α=0.5)

-8 reps per orchard, under two tree rows

Plum Curculio Pathogen Experiment Results



Average number of adult plum curculios emerging from pathogen-treated soil. Soils were treated with the fungus *Beauveria bassiana* (Bb) or the nematodes *Heterorhabditis bacteriophora* or *Steinernema riobrave* at a low or high rate (Hb Low, Hb High, Sr Low, Sr High). Larvae were placed on soil either -10, -5, 0, 5,10, 15, or 20 days from pathogen application. Bars with an asterisk (*) denote significantly lower means within a day-timing. Note: Hb Low and High were not included for the -10, 10, or 20 day treatments.

Plum Curculio Pathogen Experiment Results: Orchards

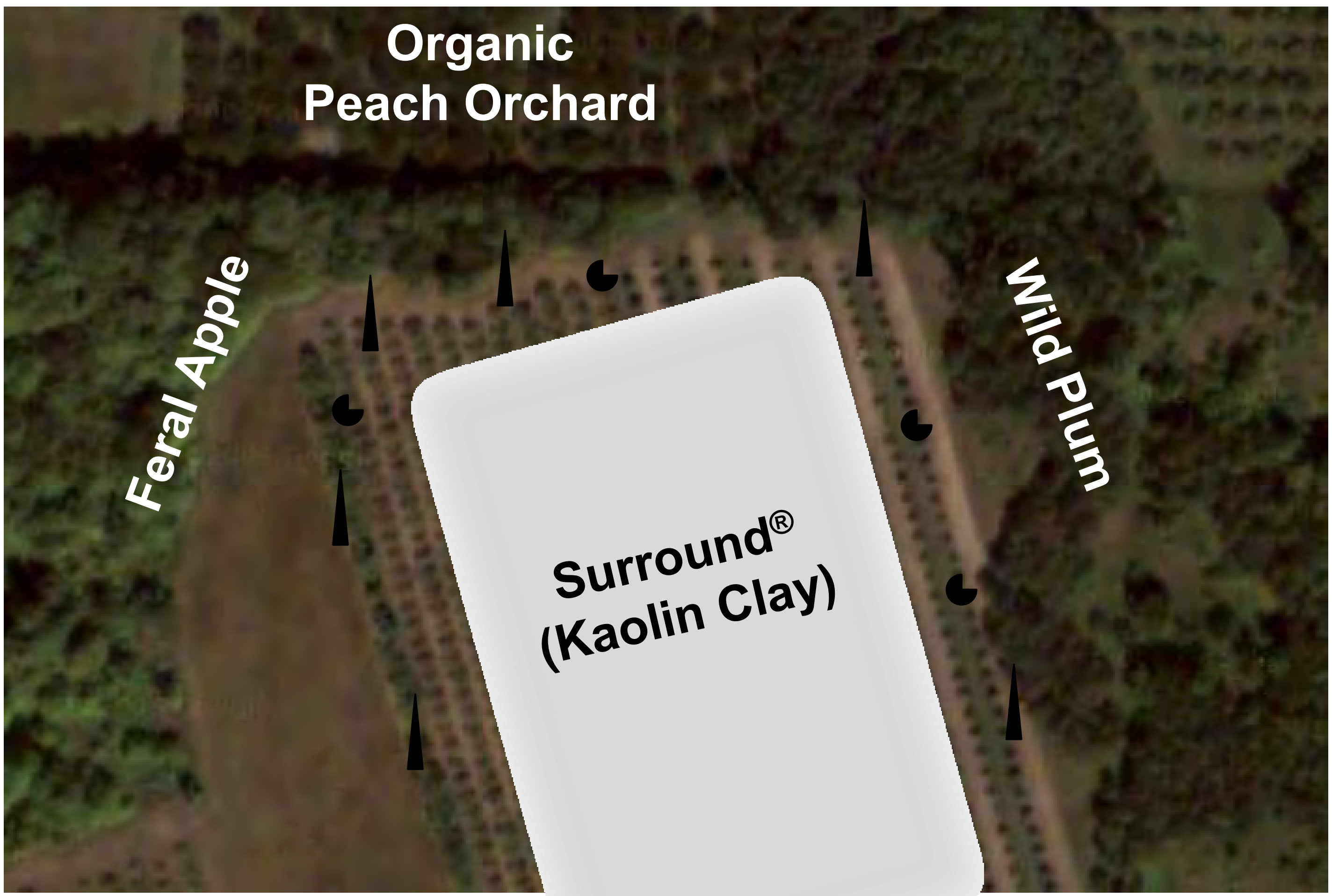
	Percent Reduction from Control Treatment for *S. riobrave* high rate treatments						
	-10 d	-5 d	0 d	5 d	10 d	15 d	20 d
All Orchards	25	66	50	27	36	8	-18
Loamy Sand	48	89	56	-22	25	-26	12
Sandy Loam	45	69	70	70	41	55	43
Loam	14	65	82	44	36	15	-24
Clay Loam	33	50	4	16	56	4	-79
Loam, High Org.	34	17	21	-10	50	-18	10

Plum Curculio Pathogen Experiment Discussion

- *B. bassiana* significantly suppressed adult emergence by 48-77% in low sand sites 1/3 yr
- *S. riobrave* most effective in high sand; larvae introduced -5, 0, or 10 d from pathogen; pupae susceptible
- Physical properties of soils – top 5 cm
- Foraging strategies: "sit-and-wait"$_{carp}$ vs. active $_{bac}$
- Optimal soil temp ranges: within ranges MI summer
- Formulation: gel vs. vermiculite, UV
- Fungicides
- Water activity: micro-jet sprinkler irrigation in citrus

Plum Curculio Pathogen Experiment

- Will targeting larvae reduce next summer's damage?
  - Spring immigration of adults surviving in refuges: wild hosts, nearby fruit trees, nearby organic orchards
  - Reduce cost by concentrating oviposition – combine "push-pull" with oviposition monitoring

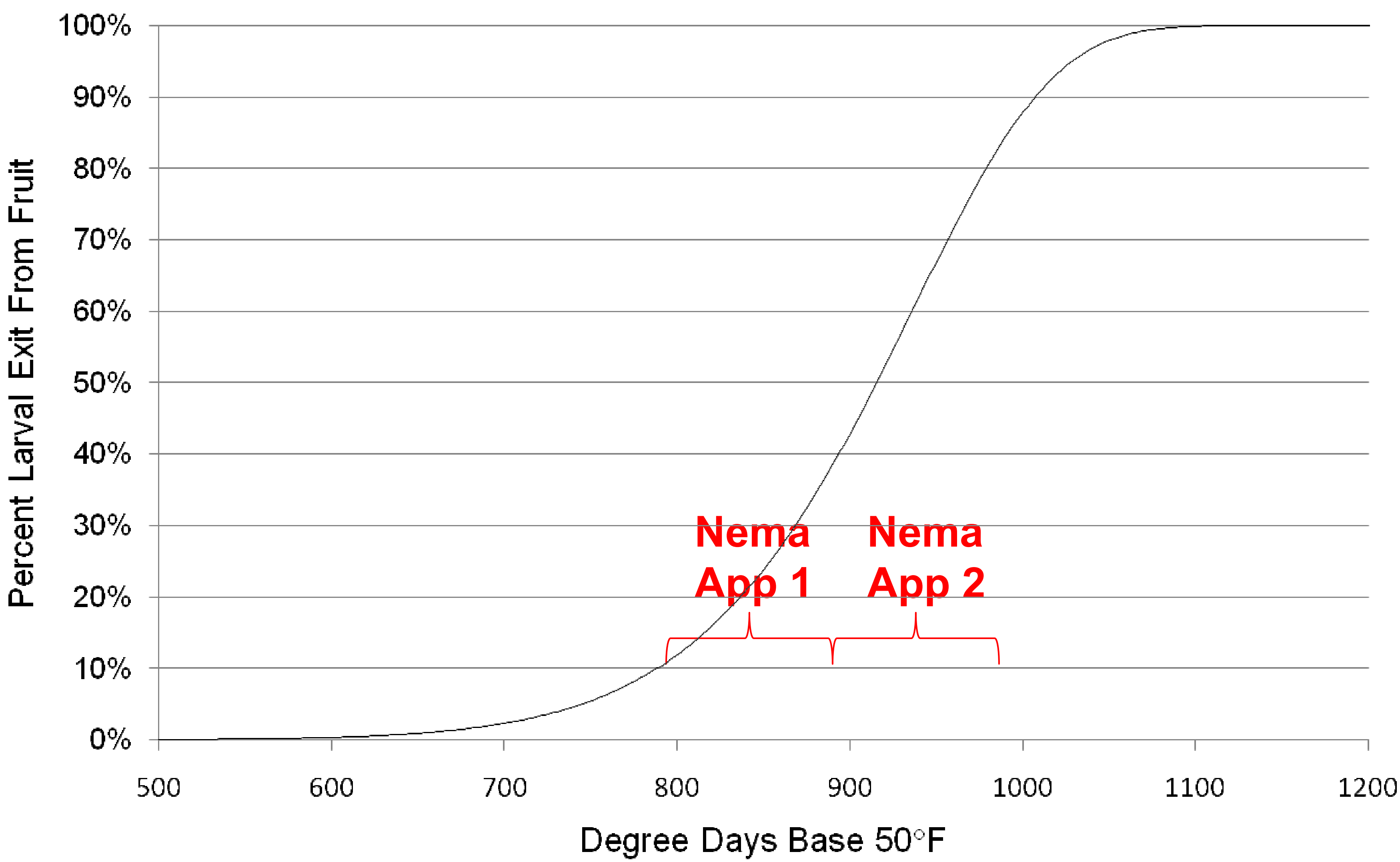


Plum Curculio Phenology Experiment Design

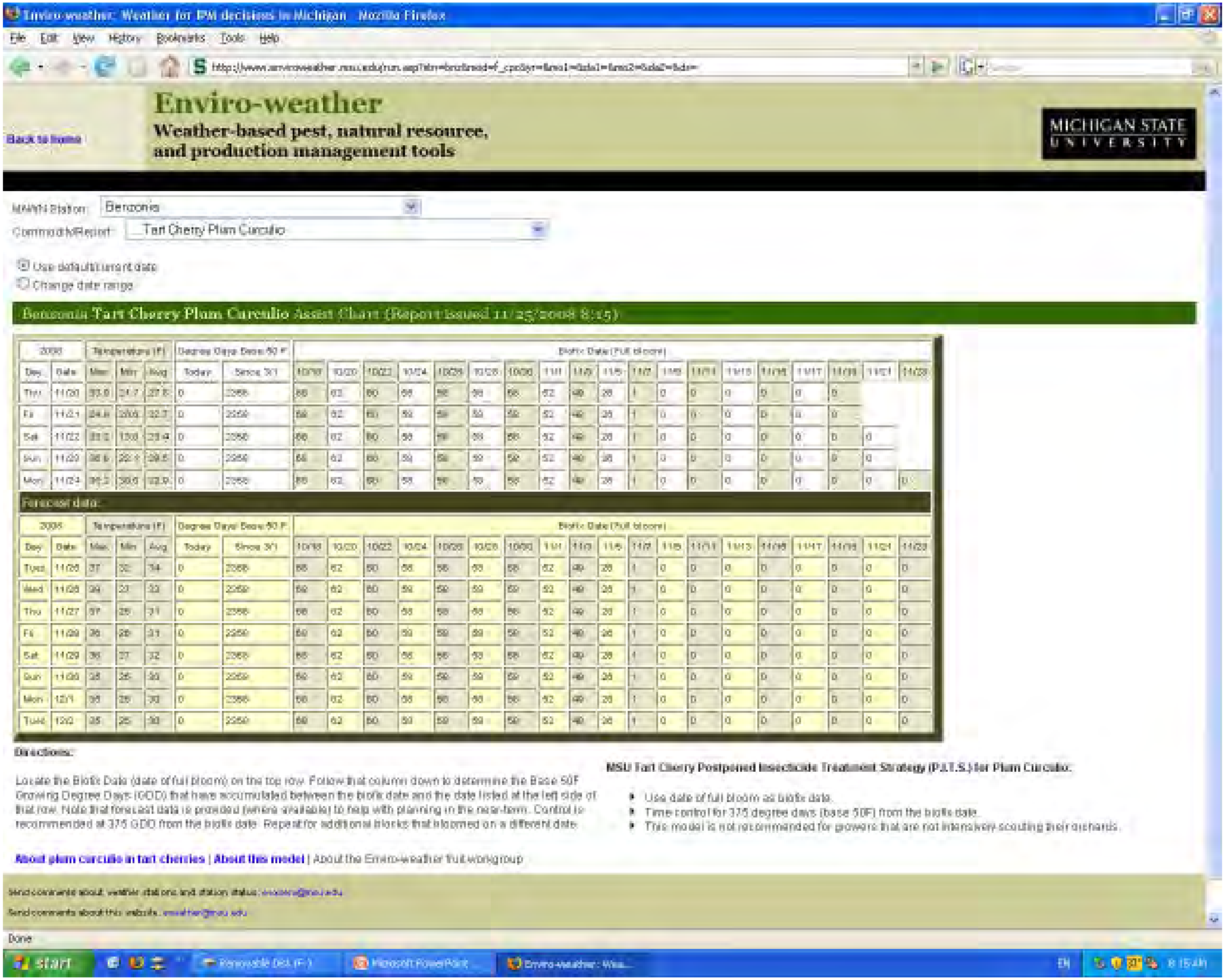
100 fruits held for larva emergence

100 fruits immediately dissected

Plum Curculio Phenology Experiment Results



www.enviroweather.msu.edu



Enviro-weather: Weather for IPM decisions in Michigan - Mozilla Firefox

File Edit View History Bookmarks Tools Help

Back to home

Enviro-weather

Weather-based pest, natural resource, and production management tools

MICHIGAN STATE UNIVERSITY

MAWN Station: Benzonia

Commodity/Report: Tart Cherry Plum Curculio

Use default/current date

Change date range

Benzonia Tart Cherry Plum Curculio Assist Chart (Report issued 11/25/2008 8:15)

2008		Temperature (F)			Degree Days Base 50 F		Biofix Date (Full bloom)																		
Day	Date	Max	Min	Avg	Today	Since 3/1	10/18	10/20	10/22	10/24	10/26	10/28	10/30	11/1	11/3	11/5	11/7	11/9	11/11	11/13	11/15	11/17	11/19	11/21	11/23
Thu	11/20	33.8	21.7	27.8	0	2358	58	62	60	58	58	58	58	52	49	28	1	0	0	0	0	0	0		
Fri	11/21	24.8	20.6	22.7	0	2359	59	62	60	59	59	59	59	52	49	28	1	0	0	0	0	0	0		
Sat	11/22	33.2	13.6	23.4	0	2358	58	62	60	58	58	58	58	52	49	28	1	0	0	0	0	0	0	0	
Sun	11/23	36.6	22.4	29.5	0	2359	59	62	60	59	59	59	59	52	49	28	1	0	0	0	0	0	0	0	
Mon	11/24	36.2	30.6	32.9	0	2358	58	62	60	58	58	58	58	52	49	28	1	0	0	0	0	0	0	0	0

Forecast data:

2008		Temperature (F)			Degree Days Base 50 F		Biofix Date (Full bloom)																		
Day	Date	Max	Min	Avg	Today	Since 3/1	10/18	10/20	10/22	10/24	10/26	10/28	10/30	11/1	11/3	11/5	11/7	11/9	11/11	11/13	11/15	11/17	11/19	11/21	11/23
Tues	11/25	37	32	34	0	2358	58	62	60	58	58	58	58	52	49	28	1	0	0	0	0	0	0	0	0
Wed	11/26	39	27	33	0	2359	59	62	60	59	59	59	59	52	49	28	1	0	0	0	0	0	0	0	0
Thu	11/27	37	25	31	0	2358	58	62	60	58	58	58	58	52	49	28	1	0	0	0	0	0	0	0	0
Fri	11/28	36	26	31	0	2359	59	62	60	59	59	59	59	52	49	28	1	0	0	0	0	0	0	0	0
Sat	11/29	36	27	32	0	2358	58	62	60	58	58	58	58	52	49	28	1	0	0	0	0	0	0	0	0
Sun	11/30	35	25	30	0	2359	59	62	60	59	59	59	59	52	49	28	1	0	0	0	0	0	0	0	0
Mon	12/1	35	25	30	0	2358	58	62	60	58	58	58	58	52	49	28	1	0	0	0	0	0	0	0	0
Tues	12/2	35	25	30	0	2359	59	62	60	59	59	59	59	52	49	28	1	0	0	0	0	0	0	0	0

Directions:

Locate the Biofix Date (date of full bloom) on the top row. Follow that column down to determine the Base 50F Growing Degree Days (GDD) that have accumulated between the biofix date and the date listed at the left side of that row. Note that forecast data is provided (where available) to help with planning in the near-term. Control is recommended at 375 GDD from the biofix date. Repeat for additional blocks that bloomed on a different date.

MSU Tart Cherry Postponed Insecticide Treatment Strategy (P.I.T.S.) for Plum Curculio:

- Use date of full bloom as biofix date.
- Time control for 375 degree days (base 50F) from the biofix date.
- This model is not recommended for growers that are not intensively scouting their orchards.

About plum curculio in tart cherries | About this model | About the Enviro-weather fruit workgroup

Send comments about weather stations and station status: mawn@msu.edu

Send comments about this website: enviroweather@msu.edu

Done

start | Removable Disk (F:) | Microsoft PowerPoint ... | Enviro-weather: Wea...

Ongoing Research:
Targeting Adult Plum Curculio with Fungi

Borers

Greater Peachtree Borer
Lesser Peachtree Borer
American Plum Borer
Dogwood Borer



Borers: Sites

			# Trees		Evaluation	
Site	Crop	Location	Treated	Control	Destructive	Non-Destructive
1	Peach	SW	32	32	2-Oct	
2	Tart cherry	SW	28	28	4-Nov	
3	Tart cherry	NW	32	32		summer 2009
4	Tart cherry	NW	32	32	16-Oct	
5	Sweet cherry	NW	32	32	16-Oct	summer 2009
6	Apple	CENTRAL	32	32		summer 2009
7	Apple	CENTRAL	32	32	15-Oct	

Borers: Applications

Backpack sprayer application of nematode
S. carpocapsae (BionemC, organic formulation)

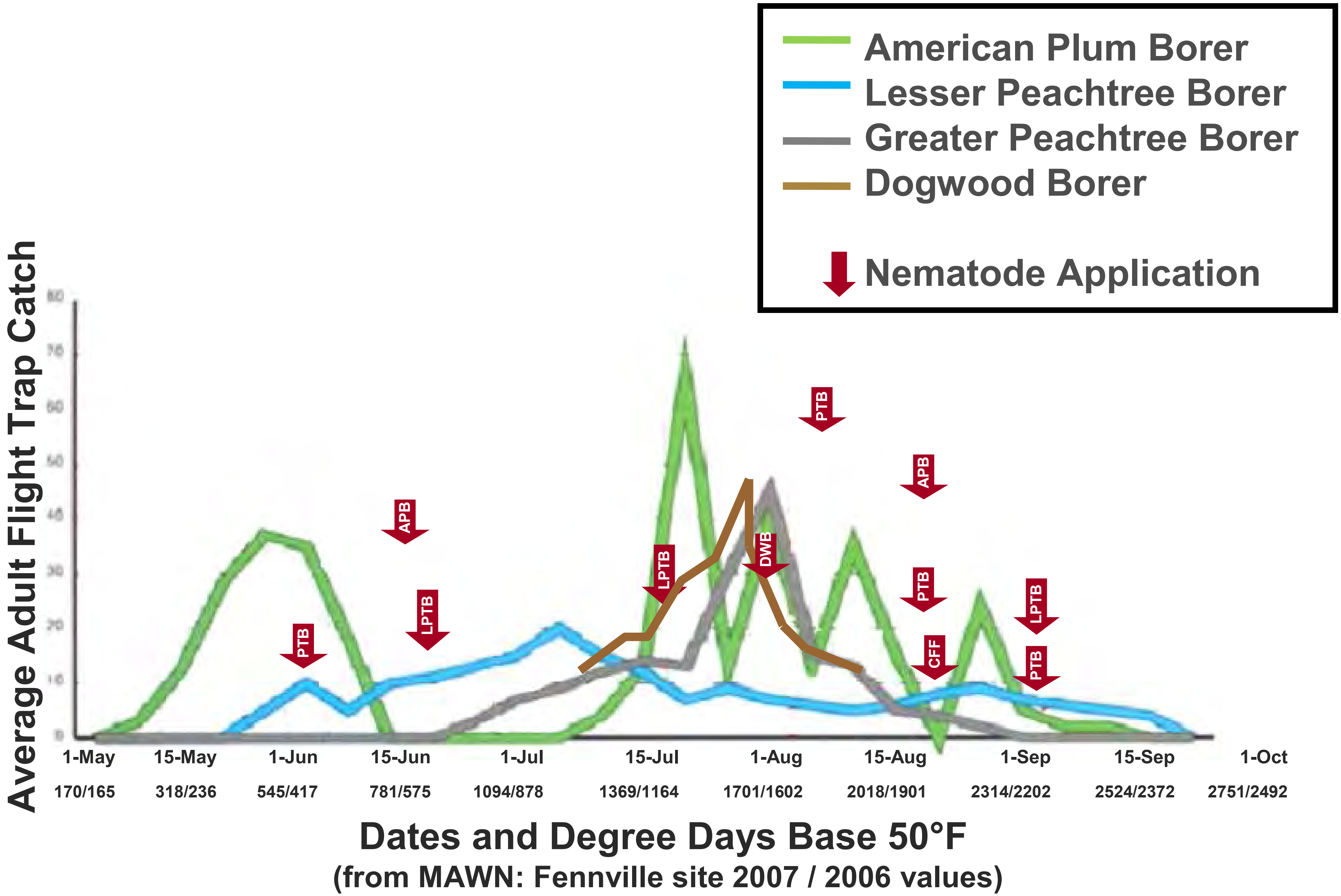
Rate: 300,000 Infective Juveniles (IJ's) in 2 cups water applied to tree trunks and 300,000 IJ's in 2 cups water applied under trees to a radius of 0.5 m from the trunk

At one site:

Wet 1 hr (30 gallons/acre/hr) with microjet sprinklers before nematode application

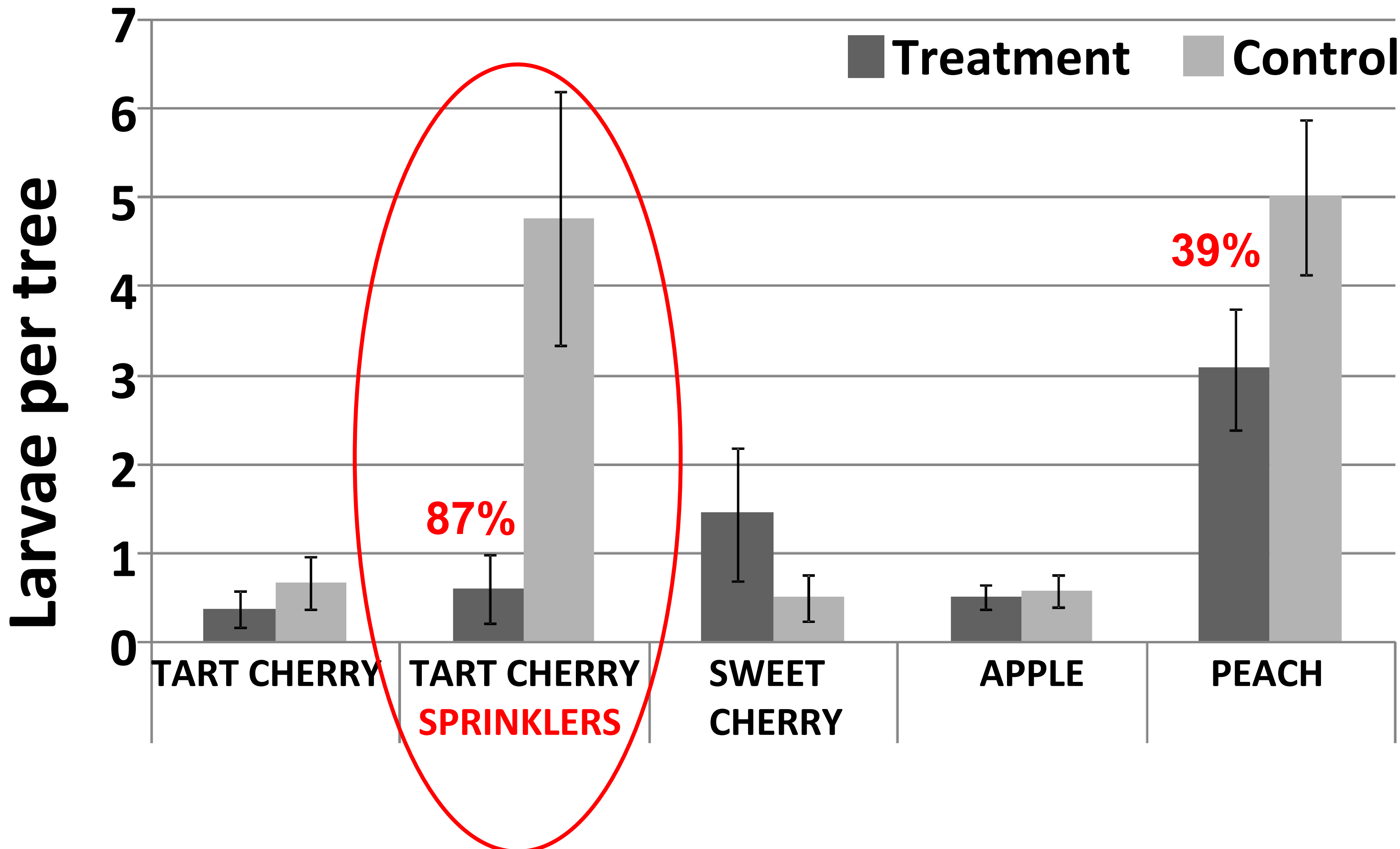
Wet 1 hr/day three days post-treatment

Borers: Timing



Borers: Evaluations

Borers: Early Results



Modifying Environment Key to Performance

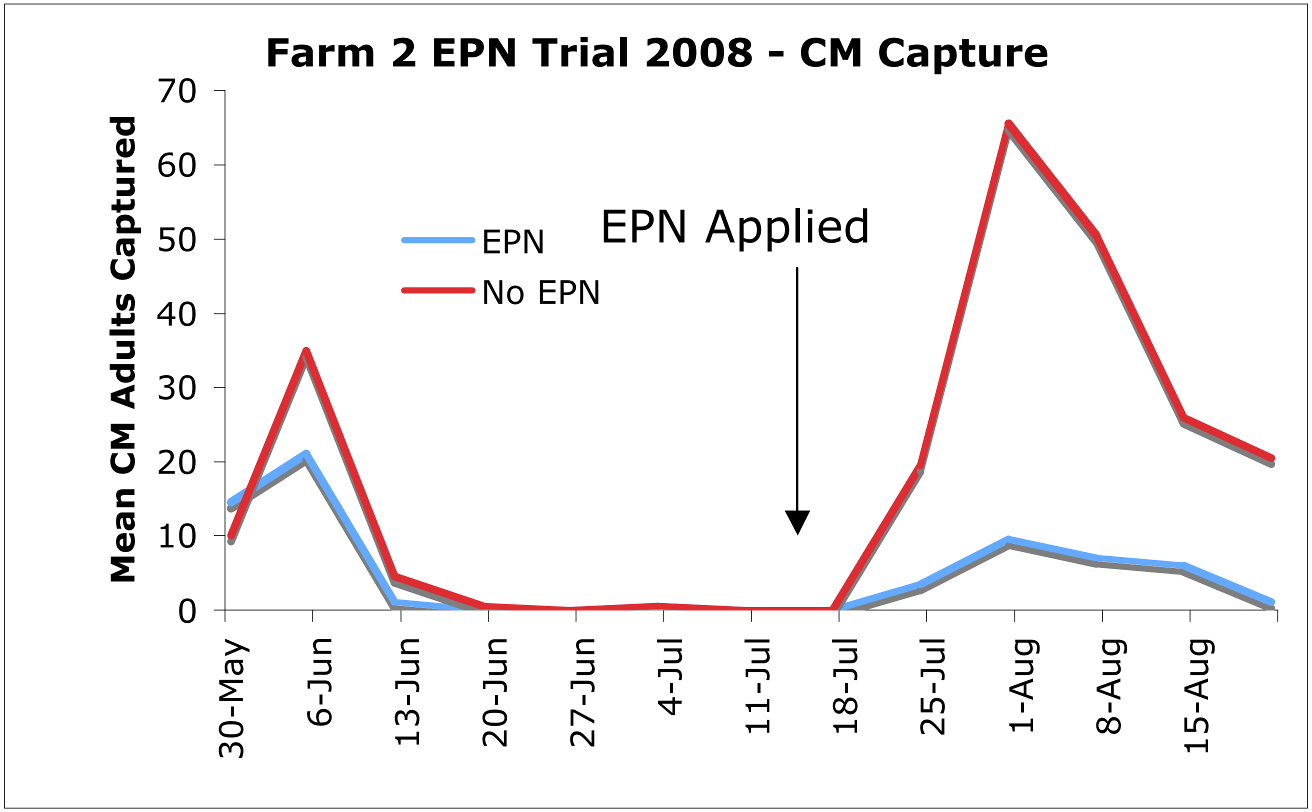
Solid State Delivery System

Codling Moth

Larry Gut & Dave Epstein

Same organic formulation of *S. carpocapsae* (BionemC)

-70% reduction of live larvae



Adult CM captures in pheromone-baited traps for organic farm two showed significant declines following the mid-season EPN application.

Codling Moth *Granulosis* Virus

- First collected in Mexico and tested in 1960's (Tanada, 1964)
- Highly lethal baculovirus protected by protein coat
- Must be ingested by neonate larvae for mortality to occur (Lacey and Shapiro-Ilan)
- Effectiveness in the field has been inconsistent (Charmillot 1993, Huber and Dickler 1977) - High incidence of stings

Slow acting

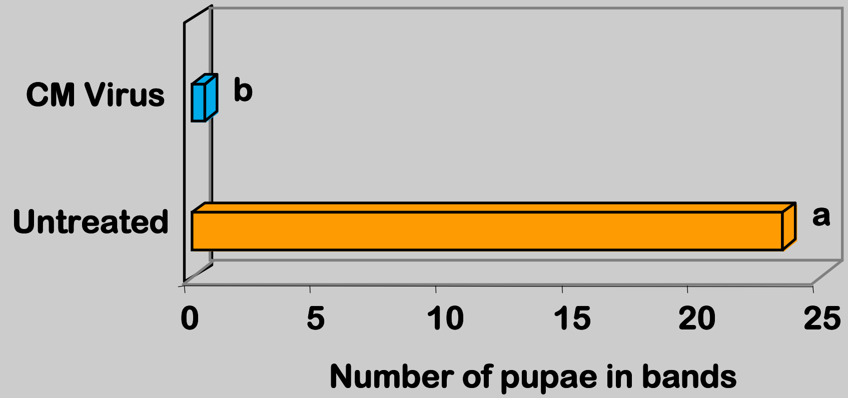
Disease progresses over 5 - 10 days

Short residual activity

Determine the efficacy and optimum patterns of use of CpGV

Summary of results:

- Targeting 1st generation protects fruit, lowers CM population density



- Use CpGV frequently at low rates

	Mean entries (%)		Proportion attributed to	
Treatment	Shallow	Deep	CM	OFM
Untreated	4.0	53.6a	25	75
Virus (4.4 oz)	8.0	8.6b	0	100
Virus (8.8 oz)	8.0	13.0bc	10	90
Virus (13.2 oz)	10.0	20.6c	40	60

Mean followed by the same letter are not significantly different at p = 0.05.

Codling Moth Summary

- **Multiple Targets:**
  - **Egg with oil**
  - **Larva with granulosis virus* & nematodes**

    ***granulosis virus Low Rate Frequent Applications**
  - **Adult with mating disruption**

Acknowledgements

Thanks to Dan Nortman, Pete Nelson, Karlyn Page, and Zach Koan for technical assistance.

Thanks to Larry Gut Lab and Dave Epstein for Codling Moth trials