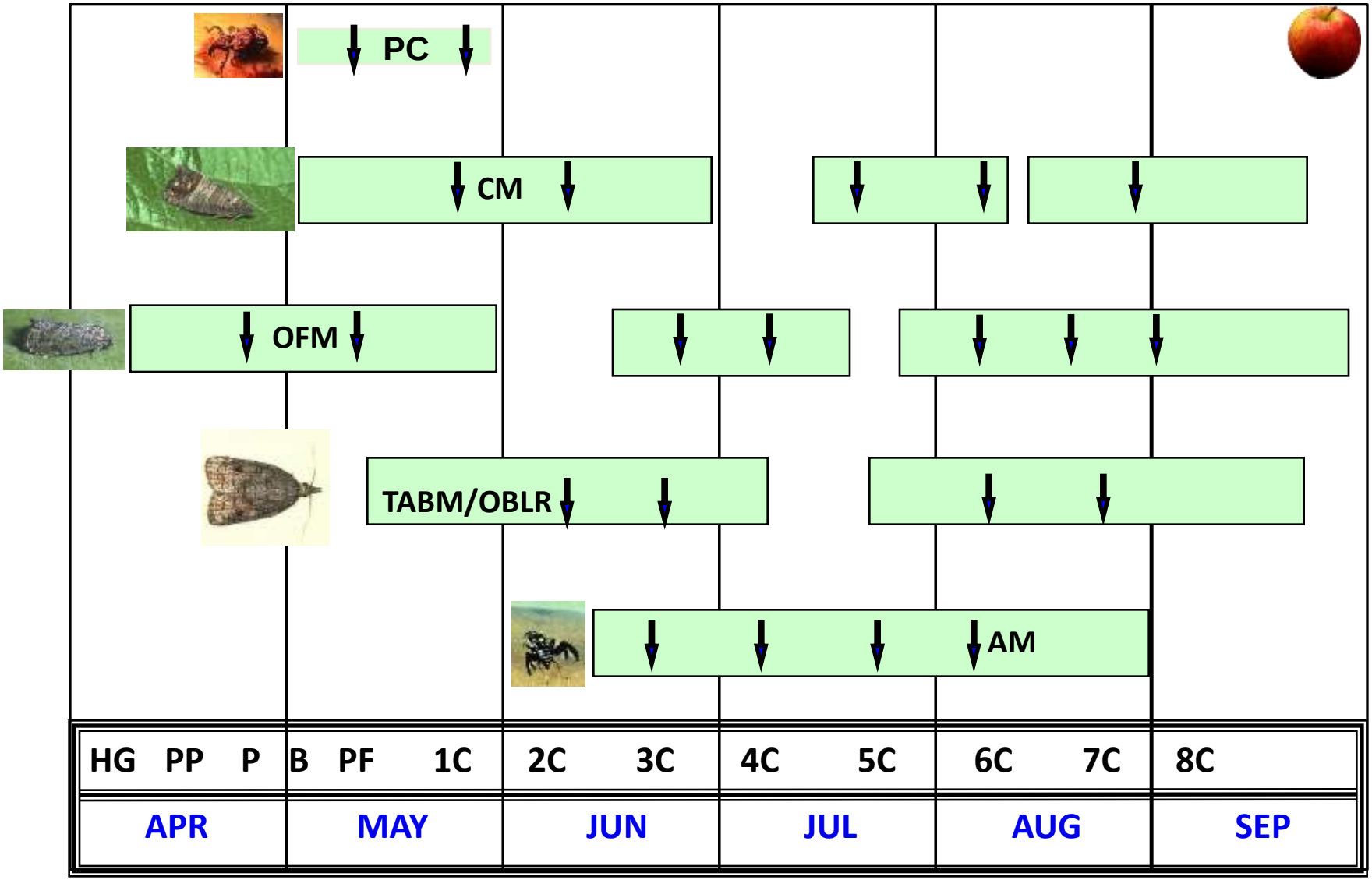
Revisiting management options for codling moth and Oriental fruit moth

(with plenty of BMSB around)

Greg Krawczyk, Ph. D

Pennsylvania State University, Department of Entomology,
Fruit Research and Extension Center, Biglerville, PA
gxk13@psu.edu

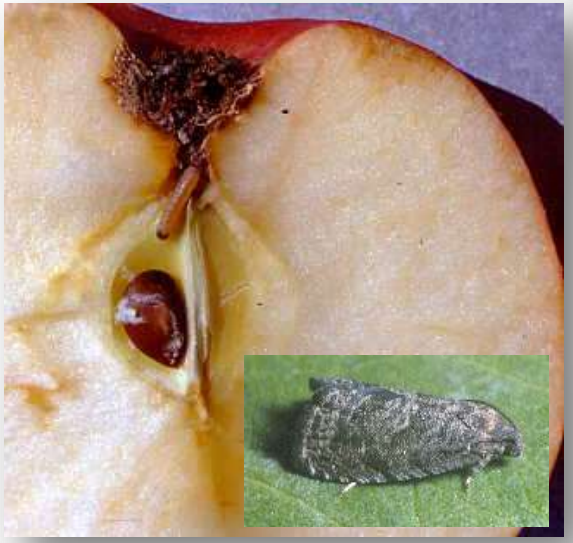
Flight periods and major control periods for various major pests of apple in PA* **(2002)**



* Approximate dates

Fruit Injuries by Various Internal Lepidopteran Larvae

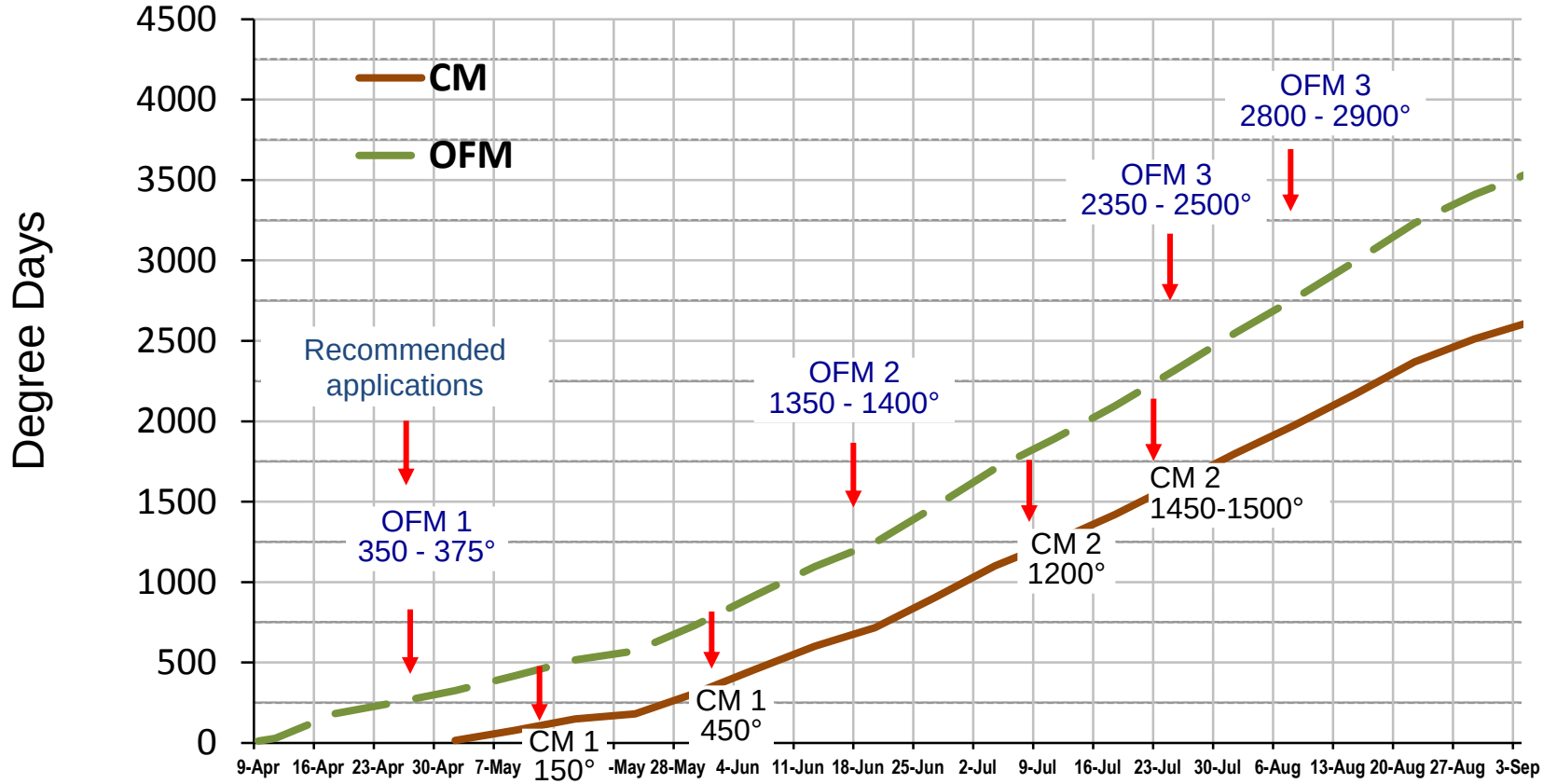
CM



OFM

LAW

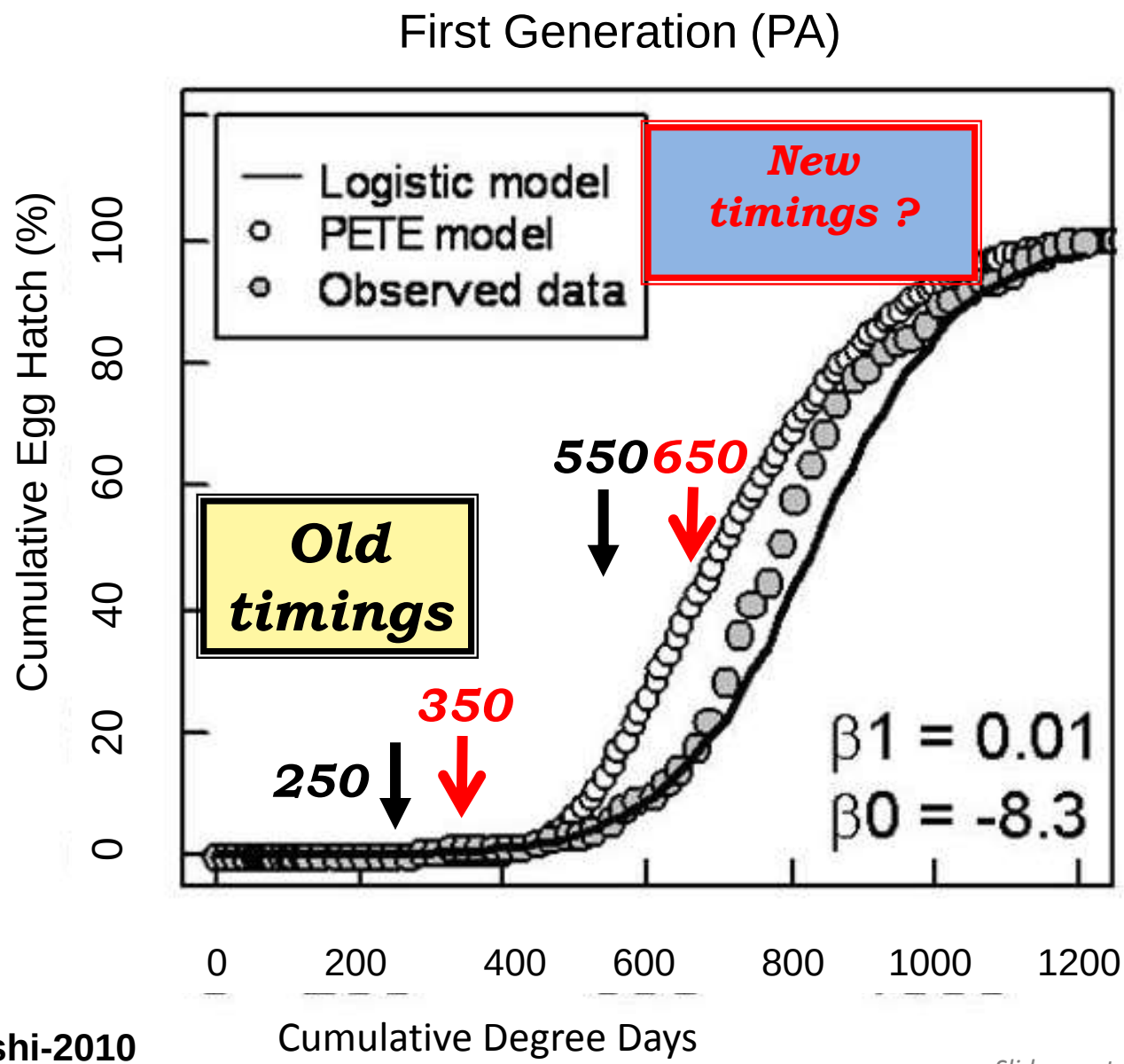
Recommended insecticide applications based on CM/OFM Degree Day Timings and Monitoring - **APPLE 2002**



OFM - (45-90°)
CM - (50-88)

PF	1C	2C	3C	4C	5C	6C	7C

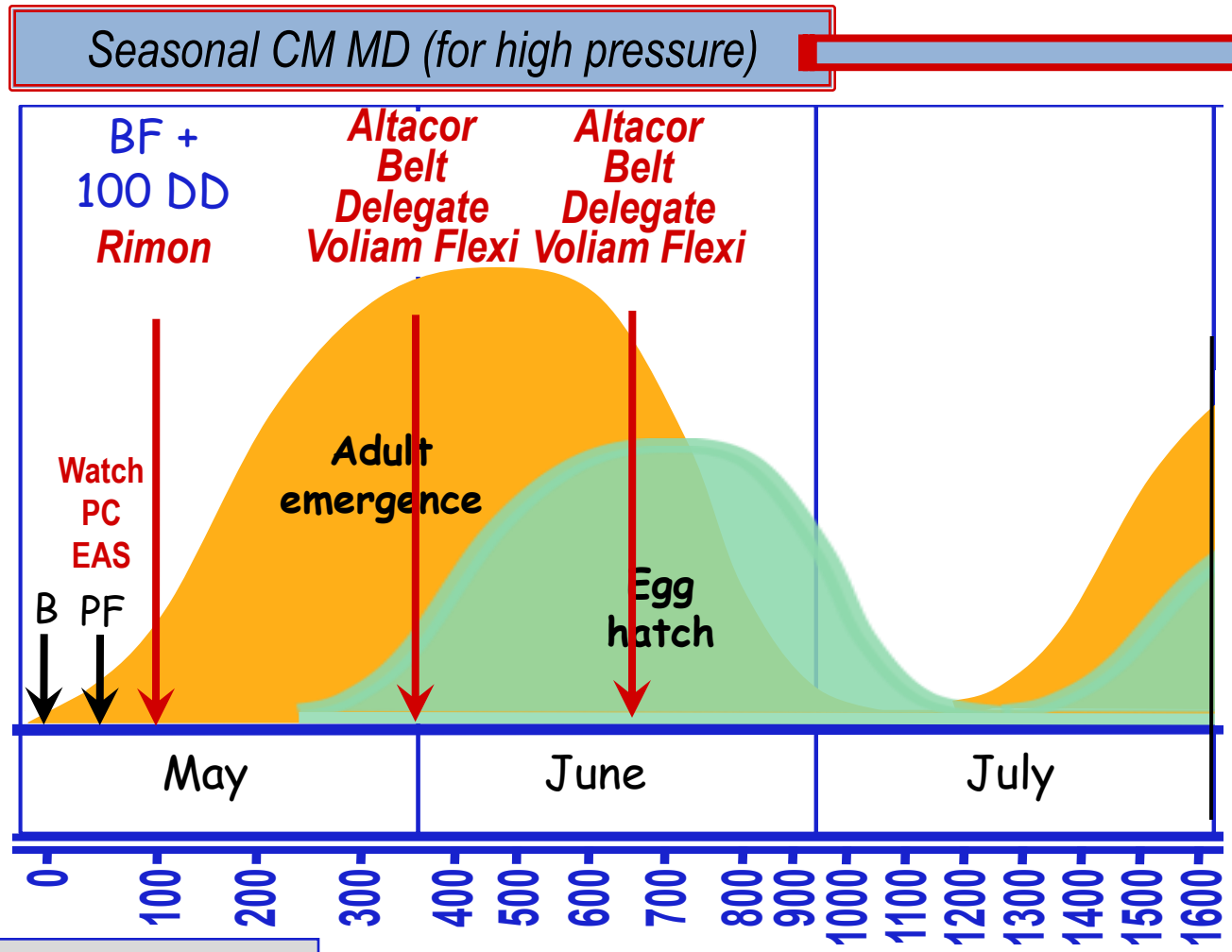
Proposed New CM Egg Hatch Model for PA



Nelendra K Joshi-2010

Slide courtesy of Dr. Larry Hull

Option – Management of 1st Gen. CM with Delayed Emergence



If use Altacor, Belt, Voliam for 1st Gen., use Delegate or other Chem. for 2nd Gen.

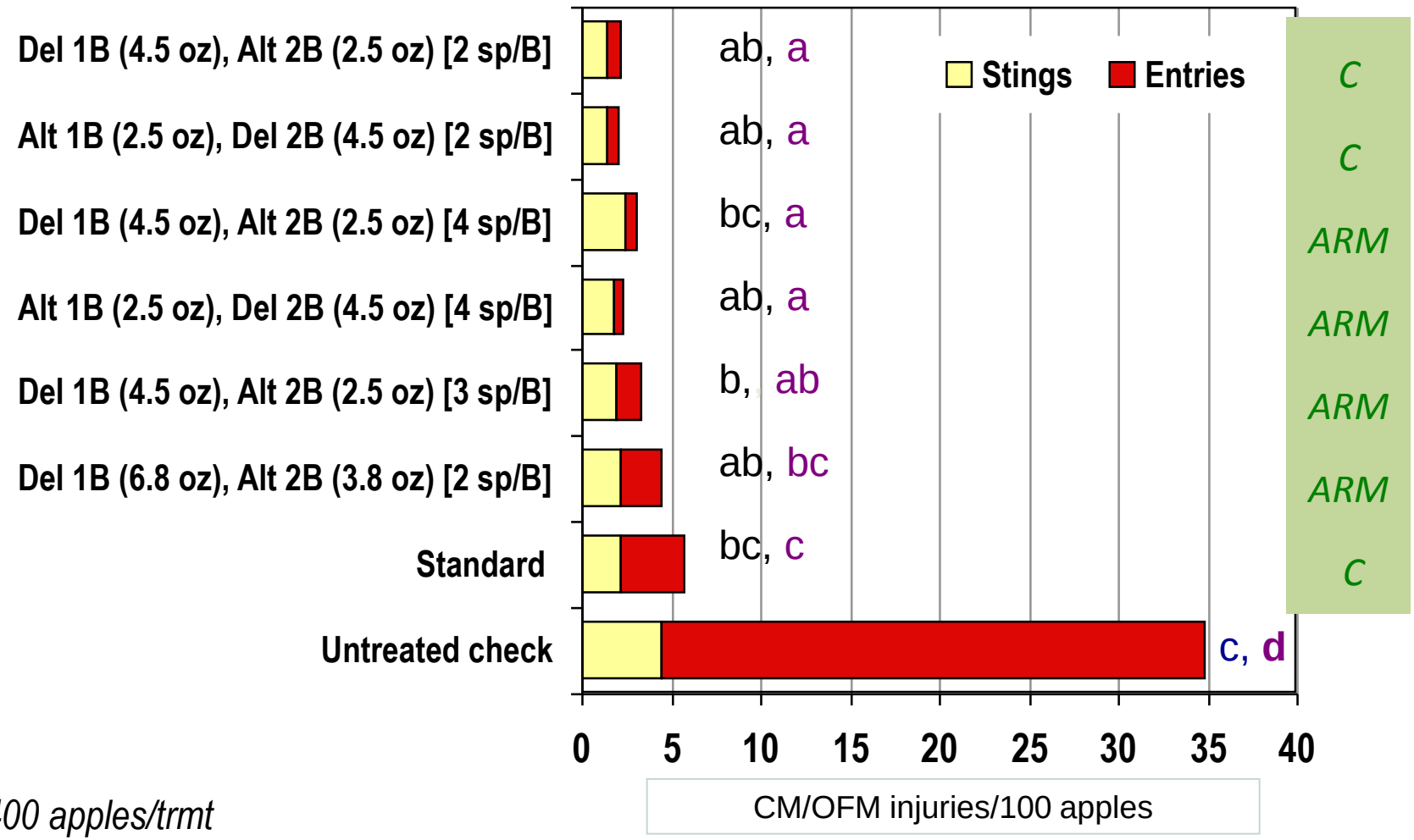
If use Delegate for 1st Gen., use Altacor, Belt, Voliam for 2nd Gen.

B = Bloom
PF = Petal fall
BF = Biofix (1st moth)

Slide courtesy of Dr. Larry Hull

Large Plot Study with Altacor/Delegate - 2009

CM/OFM Stings and Entries, *Yorking* - 6 Oct



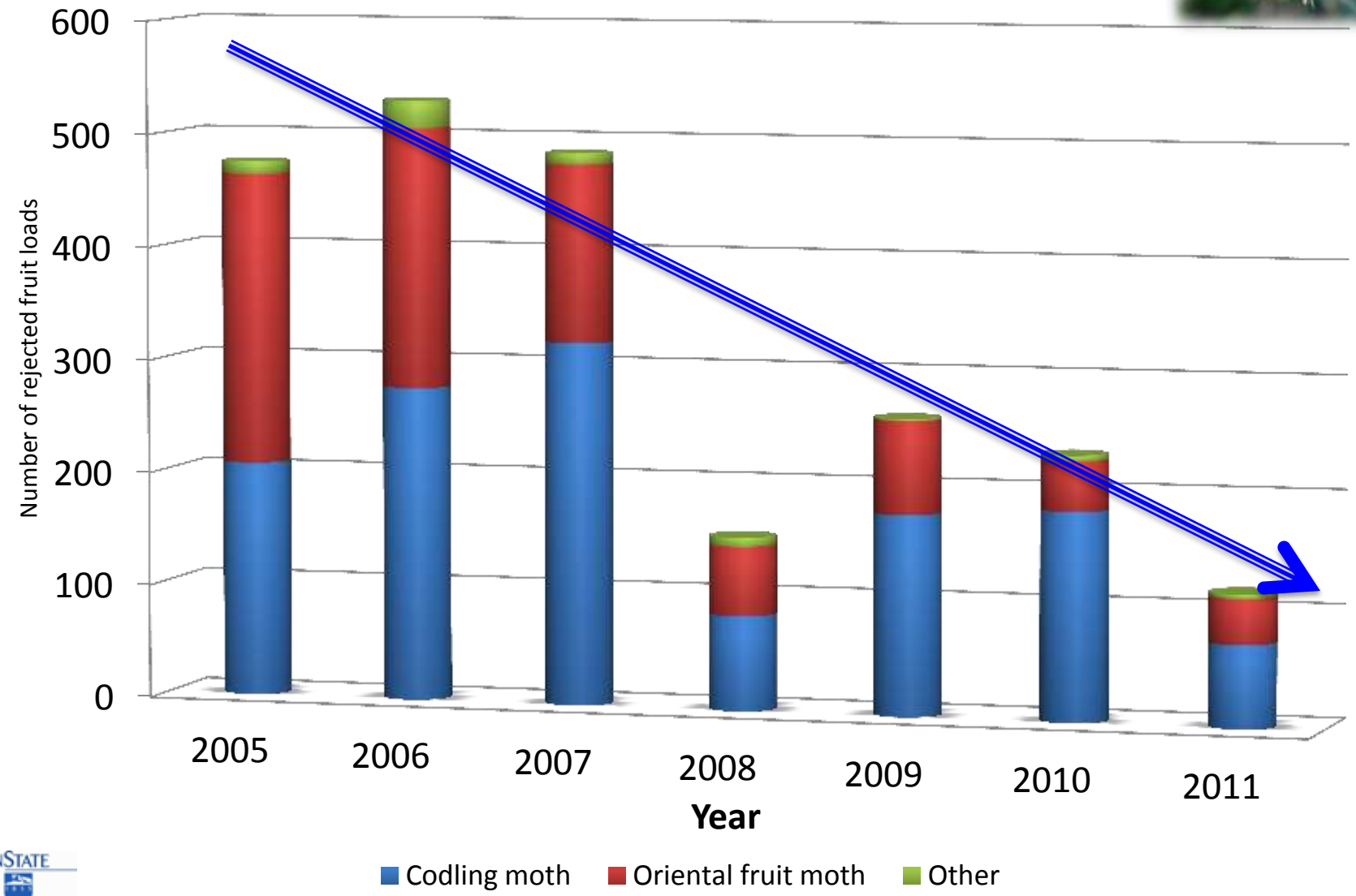
≈ 1400 apples/trmt

Standard: Assail 30SG (6 oz) [5/11, 8/11], Calypso 480SC (6 oz) [5/28], Calypso 480SC (4 oz) + Intrepid 2F (16 oz) [6/15], Rimon 0.83EC (20 oz) [7/20]

Slide courtesy of Dr. Larry Hull

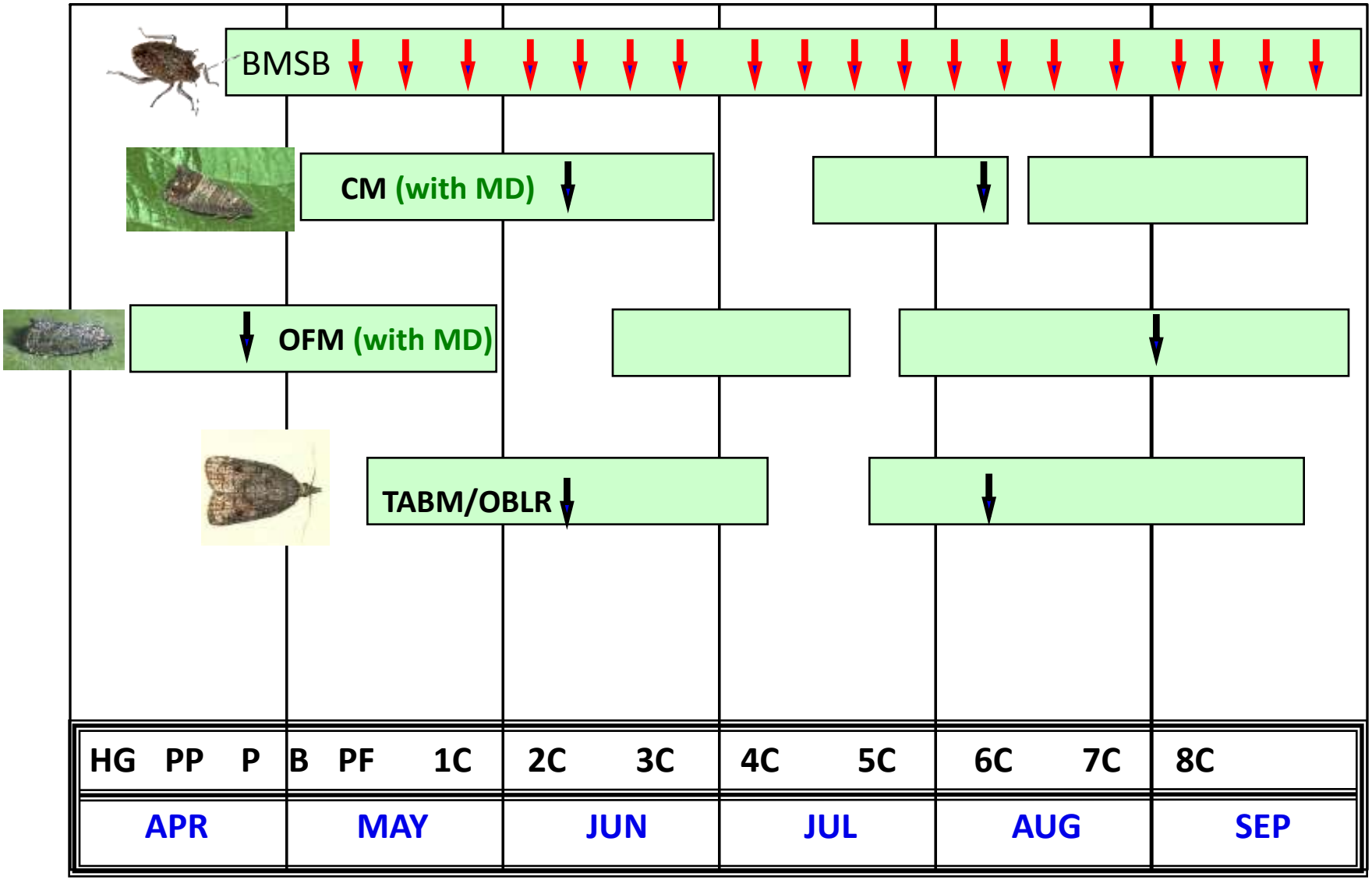
Fruit loads rejected by PA fruit processors

2005-2011 seasons



PENNSTATE

Flight periods and optimal management periods for various major pests of apple in PA* **(2011)**



* Approximate dates

Modified from Dr. Larry Hull

BMSB challenge

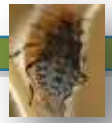
Fruit injury risk period

Diapause in dwellings

Diapause in dwellings

Adult stink bugs *(2 generations)*

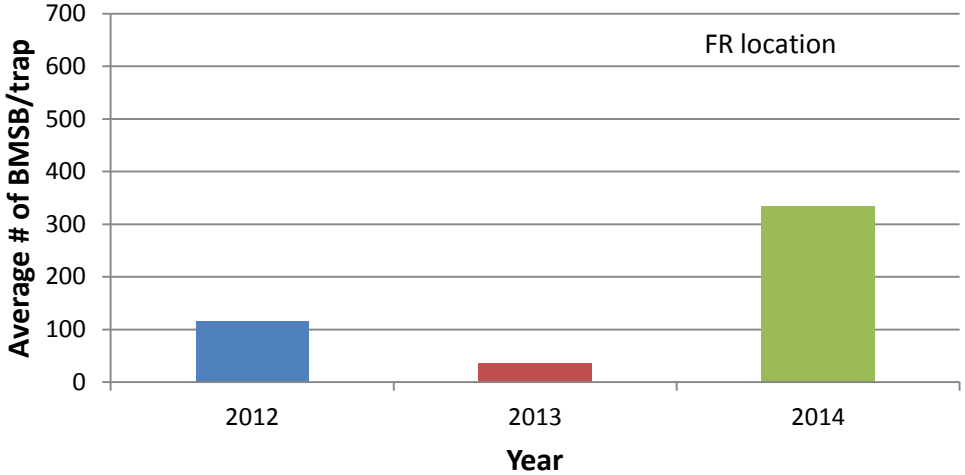
Nymphs



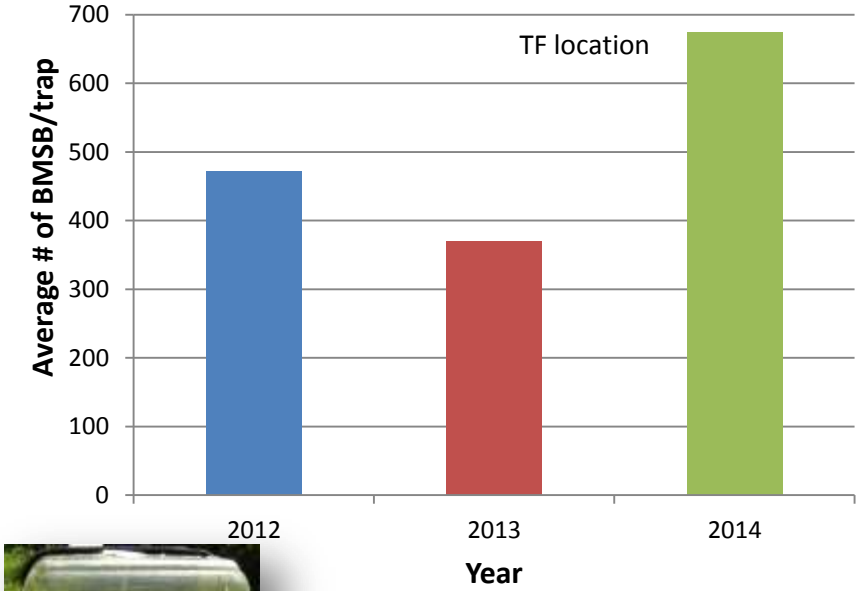
April | May | June | July | Aug | Sep | Oct

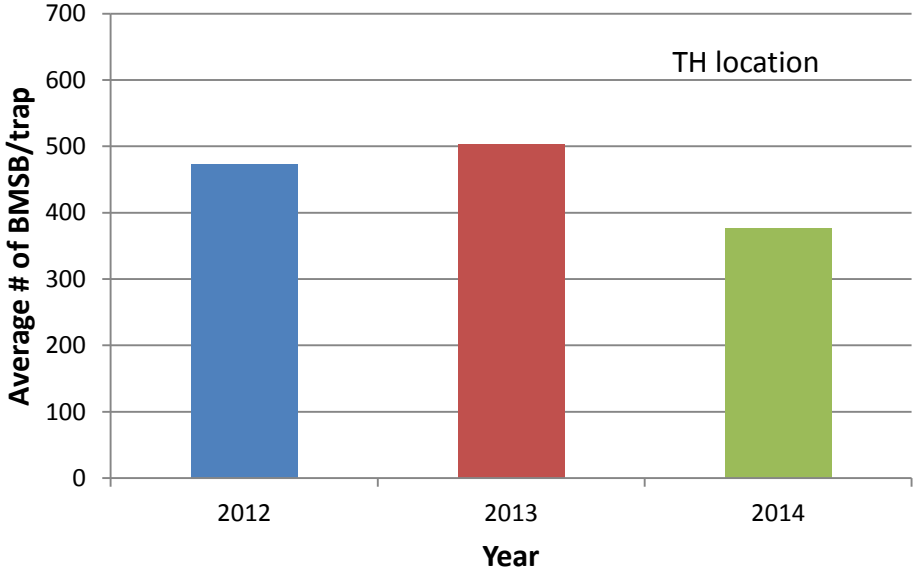
2 generations per season

Comparison of BMSB captures during the 2012 - 2014 seasons



BMSB adults and nymphs combined, average number per trap/season
(the same lure/trap combination each year)





BMSB capture data for traps with Rescue lure /AgBio trap combination

Most effective insecticides against BMSB

(based on combined data from T. Leskey, T. Kuchar and G. Krawczyk)

PYRETHROIDS

IRAC Group 3A

- bifenthrin **(Brigade)**
- fenpropathrin **(Danitol)**
- cyfluthrin **(Baythroid)**
- λ-cyhalothrin **(Warrior)**

NEONICOTINOIDS

IRAC Group 4A

- dinotefuran **(Venom, Scorpion)**
- thiametoxam **(Actara)**
- clothianidin **(Belay)**
- imidacloprid **(Provado, Admire Pro)**
- acetamiprid **(Assail)**

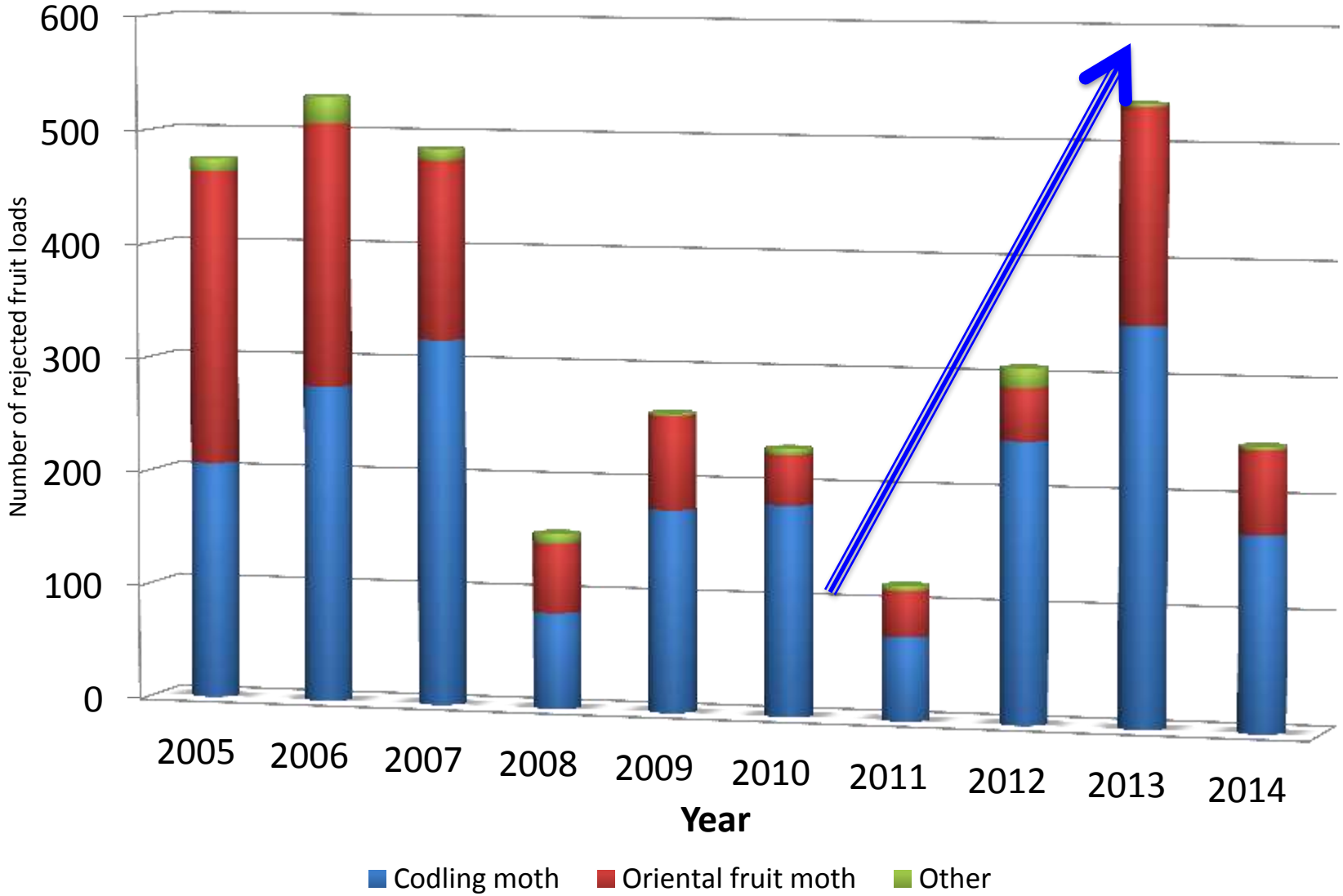
OTHER

(IRAC Groups 1A, 1B, 2A

- methomyl (carbamate) **(Lannate LV and SP)**
- endosulfan (organochlorine) **(Thionex)**
- acephate (organophosphate) **(Acephate)**

Fruit loads rejected by PA fruit processors

2005-2014 seasons



Most effective insecticides against BMSB

(based on combined bioassays data from T. Leskey, T. Kuchar and G. Krawczyk

Efficacy against CM and OFM

Effective | Moderate | Poor

Good CM/OFM activity

Moderate CM/OFM activity

- methomyl **(Lannate)**
- clothianidin **(Belay)**
- acetamiprid **(Assail)**

Poor CM/OFM activity

- bifenthrin **(Brigade)**
- fenpropathrin **(Danitol)**
- cyfluthrin **(Baythroid)**
- λ-cyhalothrin **(Warrior)**
  (PYRETHROIDS)
-
- dinotefuran **(Venom, Scorpion)**
- thiametoxam **(Actara)**
- imidacloprid **(Provado)**
  (NEONICOTINOIDS)

- endosulfan **(Thionex)**
- acephate **(Acephate)**
  (OTHER)

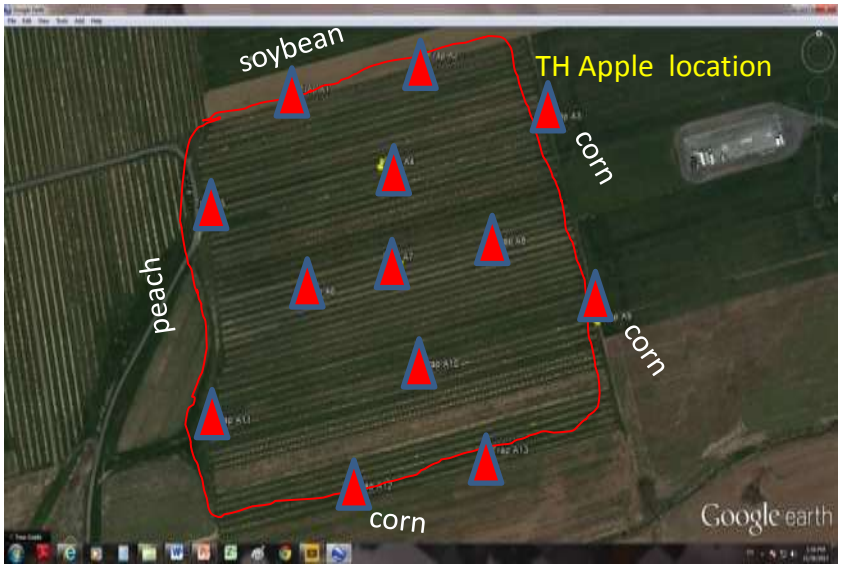
2013 and 2014 BMSB Trap Placement Grid evaluations

Commercial apple orchard location

(2013 started July 01; 2014 started May 05):

1. Ag-Bio lure in Ag-Bio tall Black trap,
2. Edge traps (4x2) and interior trap (4 + 1); total 13 traps,
3. Weekly trap and 12 min visual observations,
4. Fruit evaluations at 1, 3 and 5 tree from trap and 1 and 2 rows from trap.

1. **Full insecticide program**



2013-14 BMSB Trap Placement Grid evaluations

BMSB pressure distribution (apples)

BMSB ADULTS & NYMPHS PER TRAP/WEEK

July 8

51
BMSB

Size proportional to the number of collected BMSB

2013 Adults ●Nymphs

Number of BMSB per trap/week

2014 Adults ●Nymphs

TH Apple location

2013-14 BMSB Trap Placement Grid evaluations

BMSB pressure distribution (apples)

BMSB ADULTS & NYMPHS PER TRAP/WEEK

July 15

51
BMSB

Size proportional to the number of collected BMSB

2013 Adults ●Nymphs

Number of BMSB per trap/week

2014 Adults ●Nymphs

TH Apple location

2013-14 BMSB Trap Placement Grid evaluations

BMSB pressure distribution (apples)

BMSB ADULTS & NYMPHS PER TRAP/WEEK

July 22

51
BMSB

Size proportional to the number of collected BMSB

2013 Adults ●Nymphs

Number of BMSB per trap/week

2014 Adults ●Nymphs

TH Apple location

2013-14 BMSB Trap Placement Grid evaluations

BMSB pressure distribution (apples)

BMSB ADULTS & NYMPHS PER TRAP/WEEK

July 30

51
BMSB

Size proportional to the number of collected BMSB

2013 Adults ●Nymphs

Number of BMSB per trap/week

2014 Adults ●Nymphs

TH Apple location

2013-14 BMSB Trap Placement Grid evaluations

BMSB pressure distribution (apples)

BMSB ADULTS & NYMPHS PER TRAP/WEEK

August 5

51
BMSB

Size proportional to the number of collected BMSB

2013 Adults ●Nymphs

Number of BMSB per trap/week

2014 Adults ●Nymphs

TH Apple location

2013-14 BMSB Trap Placement Grid evaluations

BMSB pressure distribution (apples)

BMSB ADULTS & NYMPHS PER TRAP/WEEK

August 12

51
BMSB

Size proportional to the number of collected BMSB

2013 Adults ●Nymphs

Number of BMSB per trap/week

2014 Adults ●Nymphs

TH Apple location

2013-14 BMSB Trap Placement Grid evaluations

BMSB pressure distribution (apples)

BMSB ADULTS & NYMPHS PER TRAP/WEEK

August 19

51
BMSB

Size proportional to the number of collected BMSB

2013 Adults ●Nymphs

Number of BMSB per trap/week

2014 Adults ●Nymphs

TH Apple location

2013-14 BMSB Trap Placement Grid evaluations

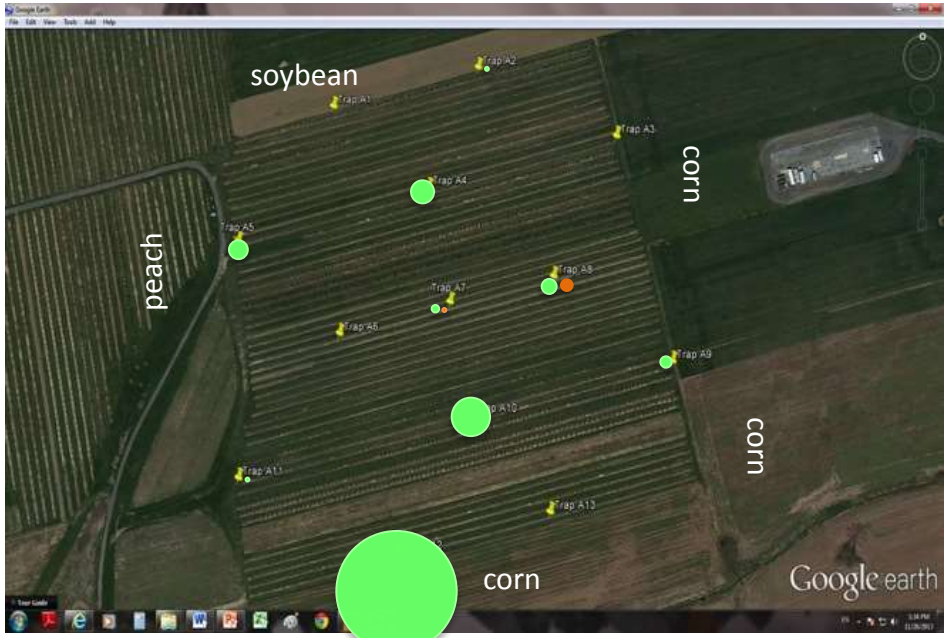
BMSB pressure distribution (apples)

BMSB ADULTS & NYMPHS PER TRAP/WEEK

August 26

51
BMSB

Size proportional to the number of collected BMSB



2013 Adults ●Nymphs

Number of BMSB per trap/week

2014 Adults ●Nymphs

TH Apple location

2013-14 BMSB Trap Placement Grid evaluations

BMSB pressure distribution (apples)

BMSB ADULTS & NYMPHS PER TRAP/WEEK

September 3

51
BMSB

Size proportional to the number of collected BMSB

2013 Adults ●Nymphs

Number of BMSB per trap/week

2014 Adults ●Nymphs

TH Apple location

2013-14 BMSB Trap Placement Grid evaluations

BMSB pressure distribution (apples)

BMSB ADULTS & NYMPHS PER TRAP/WEEK

September 9

51
BMSB

Size proportional to the number of collected BMSB

2013 Adults ●Nymphs

Number of BMSB per trap/week

2014 Adults ●Nymphs

TH Apple location

2013-14 BMSB Trap Placement Grid evaluations

BMSB pressure distribution (apples)

BMSB ADULTS & NYMPHS PER TRAP/WEEK

September 16

51
BMSB

Size proportional to the number of collected BMSB

2013 Adults ●Nymphs

Number of BMSB per trap/week

2014 Adults ●Nymphs

TH Apple location

2013-14 BMSB Trap Placement Grid evaluations

BMSB pressure distribution (apples)

BMSB ADULTS & NYMPHS PER TRAP/WEEK

September 24

51
BMSB

Size proportional to the number of collected BMSB

2013 Adults ●Nymphs

Number of BMSB per trap/week

2014 Adults ●Nymphs

TH Apple location

2013-14 BMSB Trap Placement Grid evaluations

BMSB pressure distribution (apples)

BMSB ADULTS & NYMPHS PER TRAP/WEEK

October 1

51
BMSB

Size proportional to the number of collected BMSB

2013 Adults ●Nymphs

Number of BMSB per trap/week

2014 Adults ●Nymphs

TH Apple location

2013-14 BMSB Trap Placement Grid evaluations

BMSB pressure distribution (apples)

BMSB ADULTS & NYMPHS PER TRAP/WEEK

October 8

51
BMSB

Size proportional to the number of collected BMSB

2013 Adults ●Nymphs

Number of BMSB per trap/week

2014 Adults ●Nymphs

TH Apple location

2013-14 BMSB Trap Placement Grid evaluations

BMSB pressure distribution (apples)

BMSB ADULTS & NYMPHS PER TRAP/WEEK

October 15

51
BMSB

Size proportional to the number of collected BMSB

2013 Adults ●Nymphs

Number of BMSB per trap/week

2014 Adults ●Nymphs

TH Apple location

2013-14 BMSB Trap Placement Grid evaluations

BMSB pressure distribution (apples)

BMSB ADULTS & NYMPHS PER TRAP/WEEK

October 22

51
BMSB

Size proportional to the number of collected BMSB

2013 Adults ●Nymphs

Number of BMSB per trap/week

2014 Adults ●Nymphs

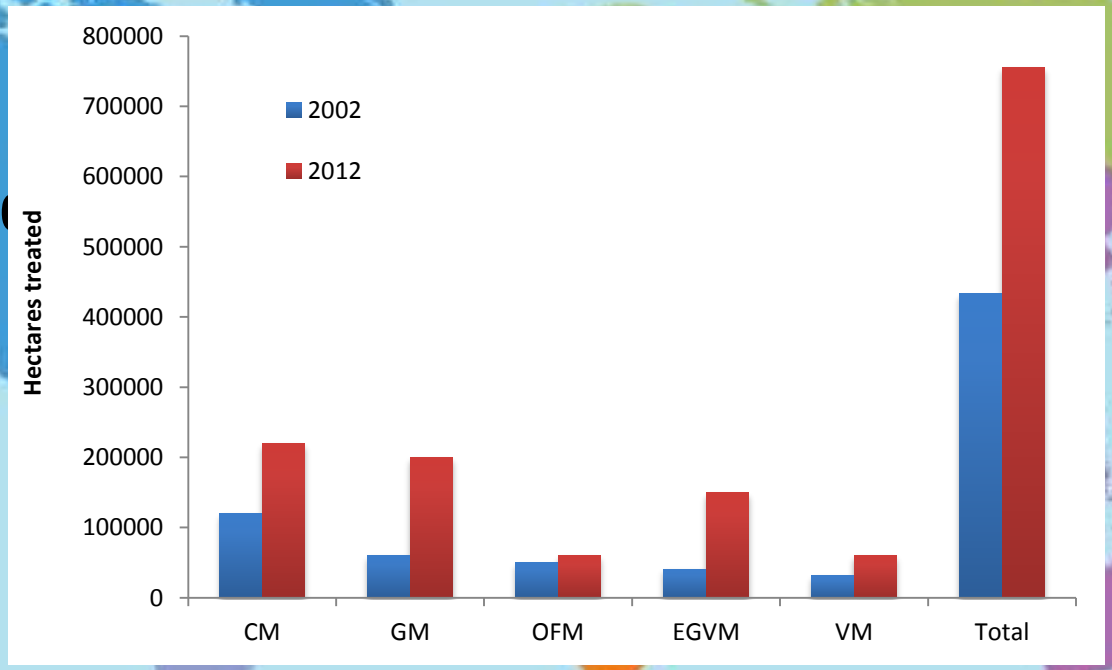
TH Apple location

Insect pests monitoring and mating disruption

Worldwide use of MD

756,000 ha

CM– 220,000



OFM– 60,000 ha

Larry Gut. MSU 2014

Mating disruption trials

2014 CM/OFM mating disruption trials

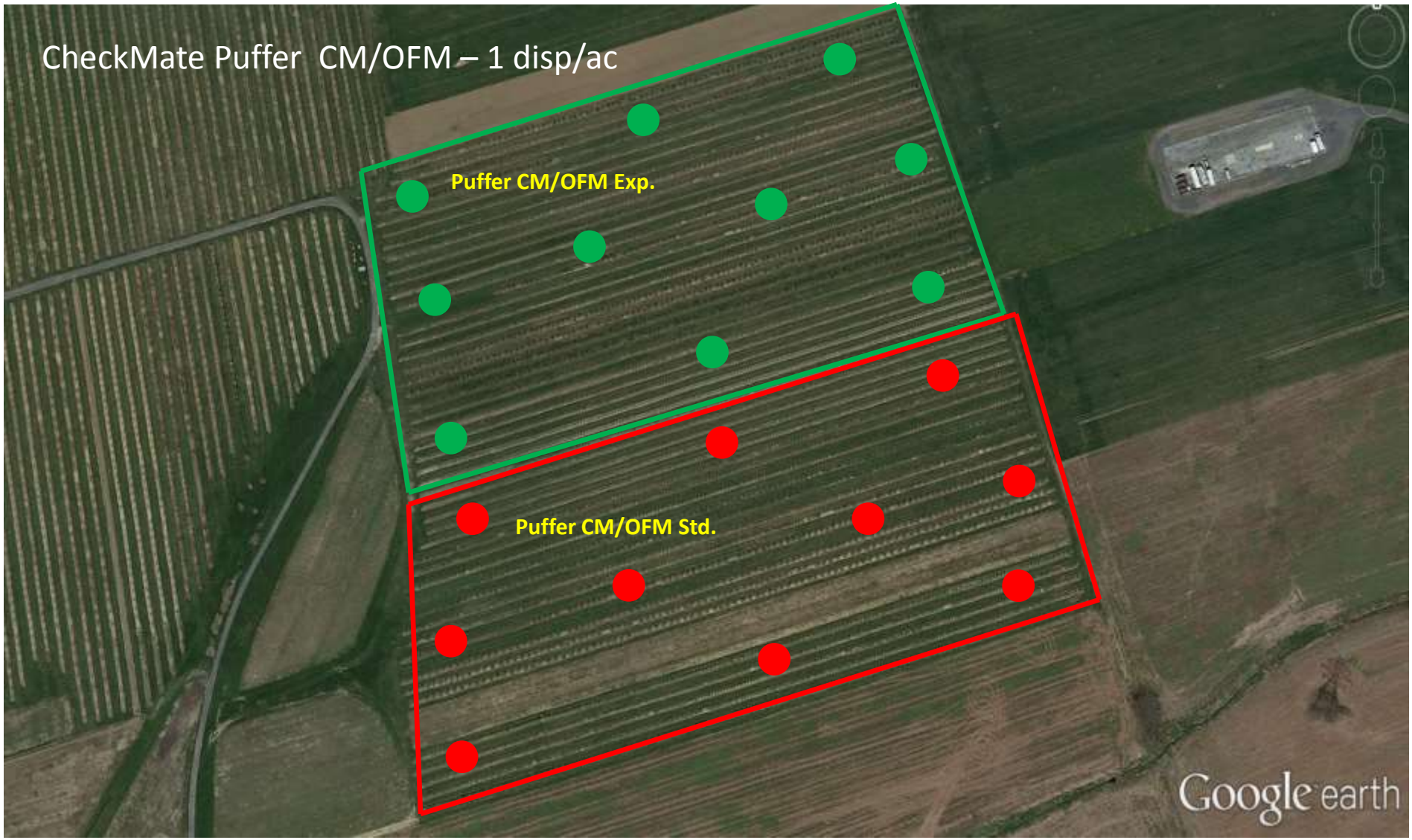
Sites and activities:
Three commercial orchards plus PSU FREC
Pheromone traps monitored weekly
In season and harvest fruit evaluations

Suterra LLC MD products:
CheckMate Puffer CM-OFM – standard, 1 dispenser/acre
CheckMate Puffer SPX-PM1 - experimental (0.5x pheromone load rate)

TRECE Inc. MD products:
CIDETRAK CM/OFM Meso, 32 dispensers/acre, apples (experimental)
CIDETRAK CM/OFM – 150 dispensers/acre, apples
CIDETRAK OFM Meso, 30 dispensers/acre, peach (experimental)
CIDETRAK OFM only, 150 dispensers/acre, peach

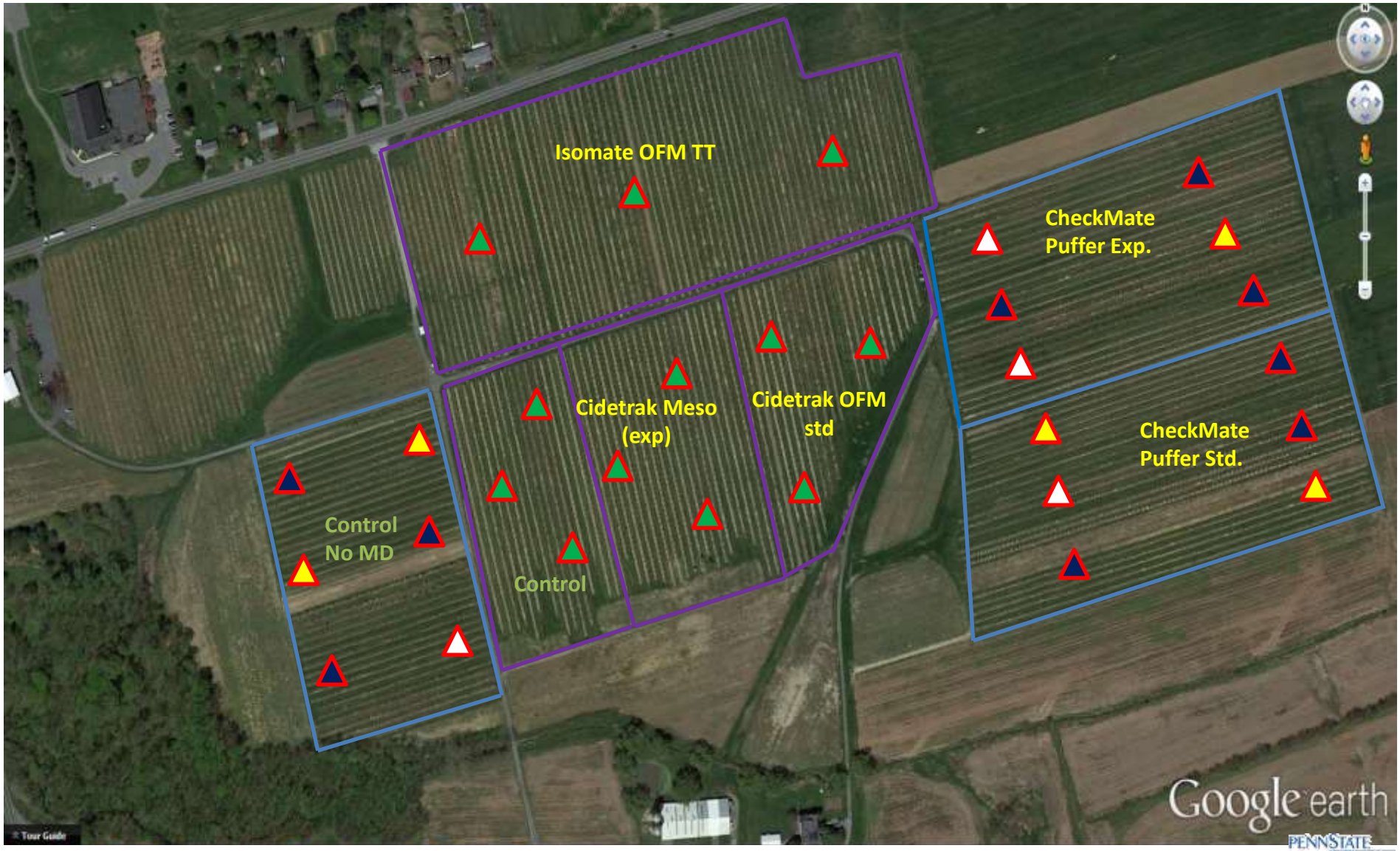
CH Puffer Locations 2014

Experimental Puffer Location
Standard Puffer Location
Experimental Block
Standard Block



CH Mating Disruption 2014 Trapping

OFM, CM, TABM, OBLR
OFM, CM (BioLure)
OFM, CM
OFM
Apple Block
Peach Block



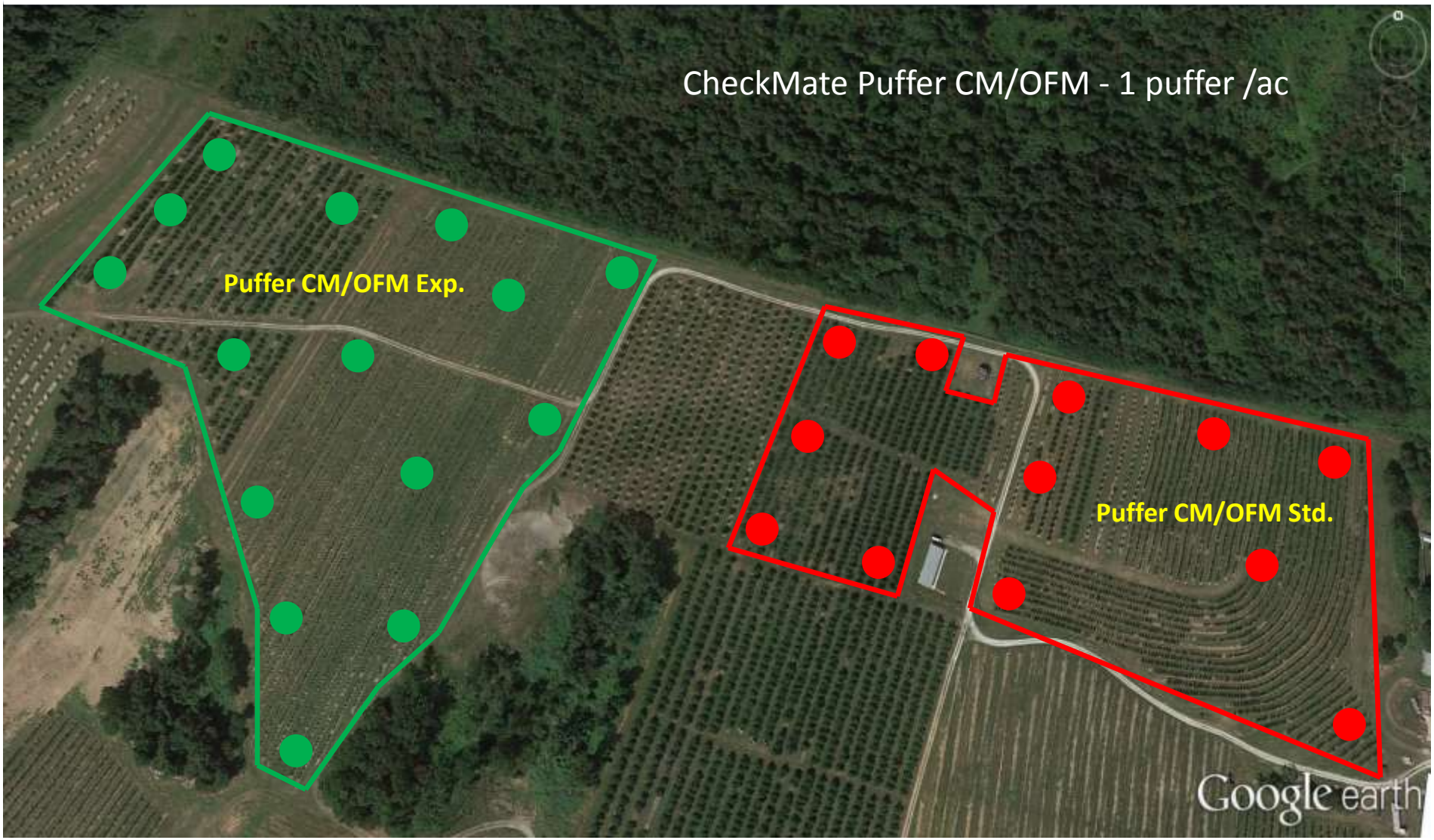
EV Puffer Locations 2014

Experimental Puffer Locations

Experimental Block

Standard Puffer Locations

Standard Block



EV Mating Disruption 2014

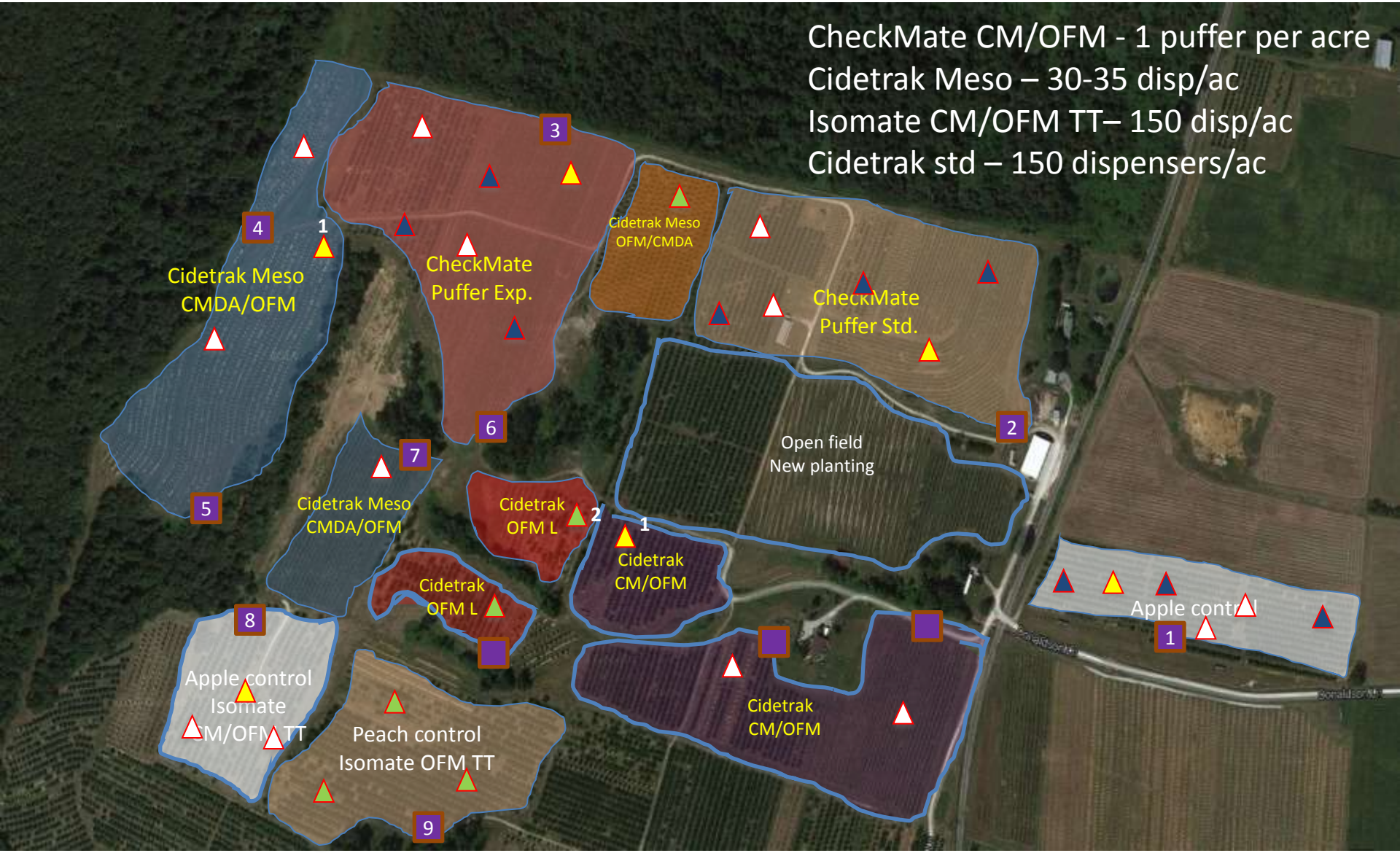
OFM, CM, TABM, OBLR (Standard)

OFM, CM (Standard)

OFM, CM (BioLure)

OFM Only (In Peaches)

Stink Bug Traps (Ag Bio Traps with Rescue Lures)

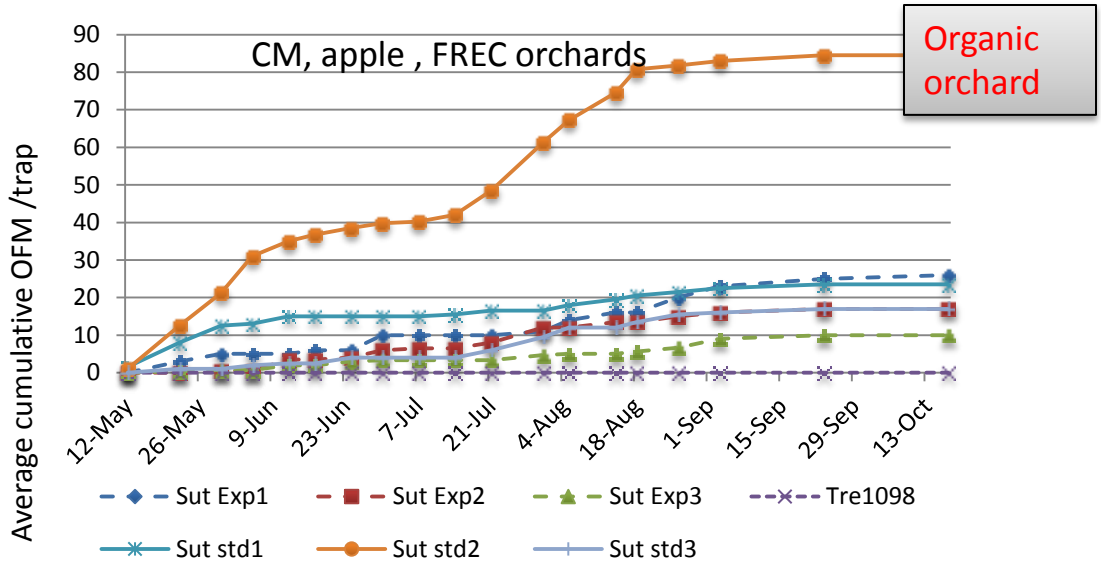


2014 Mating disruption trials apples

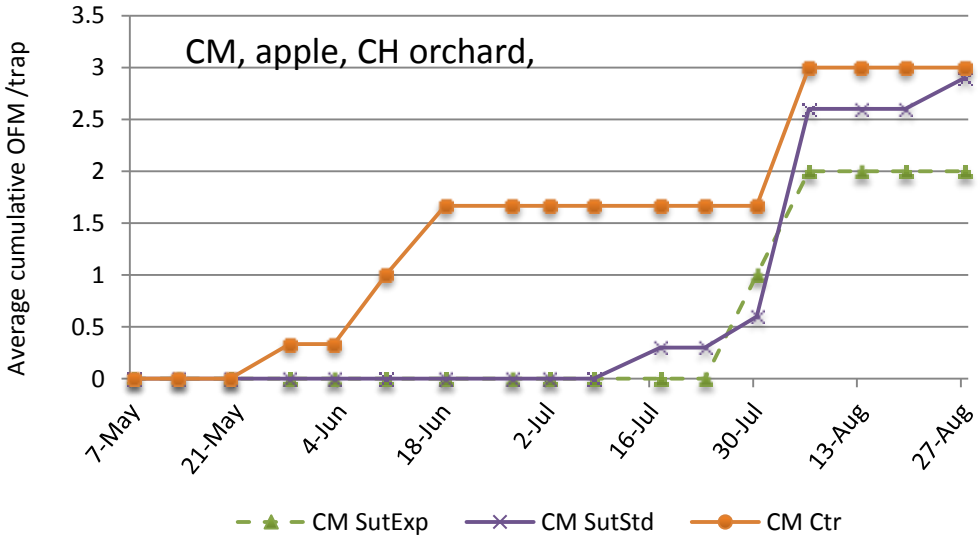
Treatment	Percent injured fruit at harvest (apples only)	
	CM	OFM
Puffer CM/OFM (exp)	0.0 a	0.0 a
Puffer CM/OFM	0.0 a	0.0 a
Cidetrak Meso (exp)	0.0 a	0.0 a
Cidetrak CM/OFM	0.0 a	0.0 a
Isomate CM/OFM TT	**0.0 a**	**0.0 a**

Harvest fruit evaluations, averages from 3 commercial orchards

2014 Mating disruption trials: results



Treatment	CM (%)
CheckMate Puffer Exp.1	0.1 a
CheckMate Puffer Exp.2	0.0 a
CheckMate Puffer Exp.3	0.0 a
CheckMate Puffer Std.1	0.0 a
CheckMate Puffer Std.2	3.9 b
CheckMate Puffer Std.3	0.0 a
Cidetrak CM/OFM Meso	0.0 a
Cidetrak CM/OFM	0.0 a



Harvest fruit evaluations

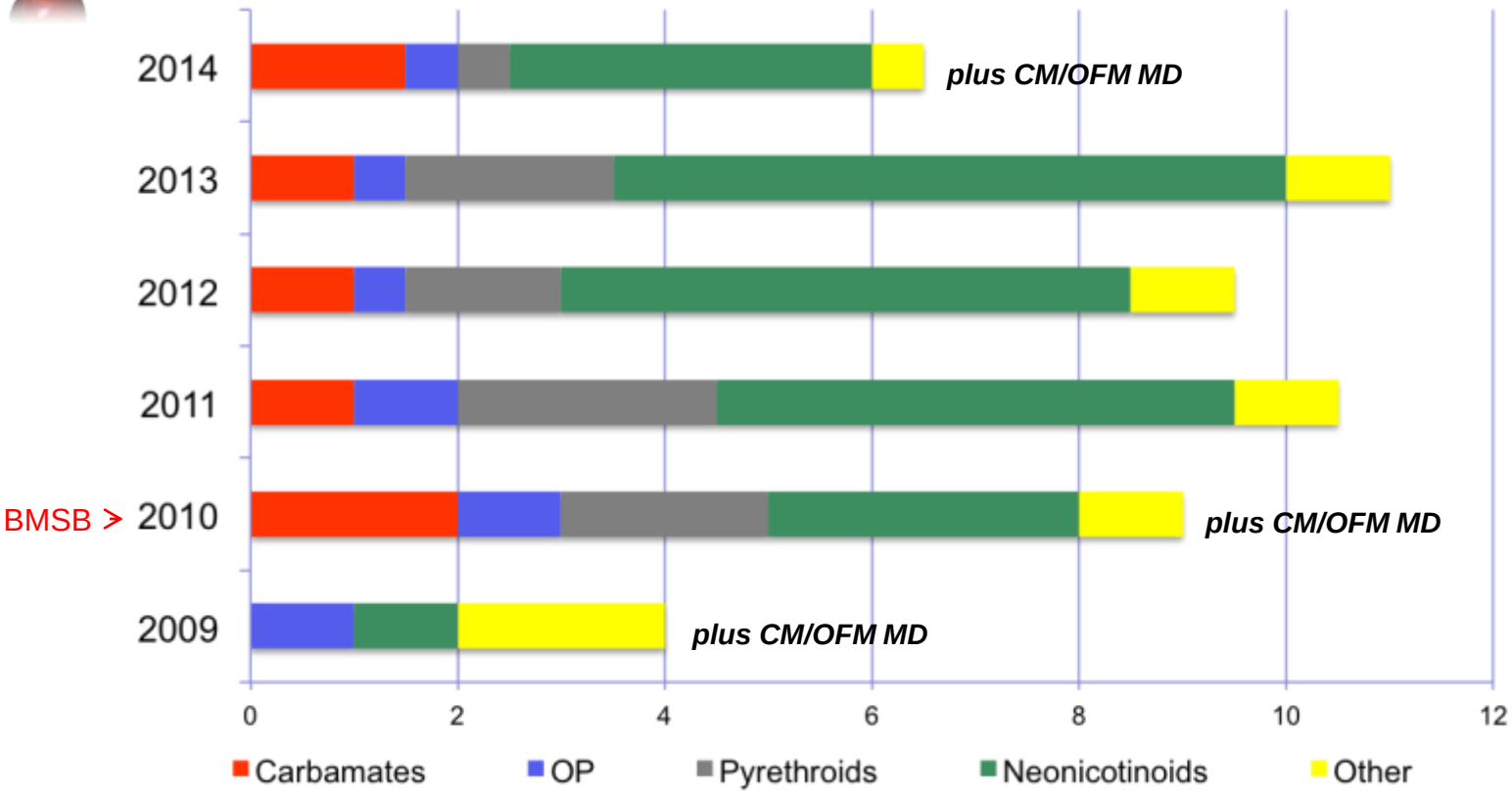
Treatment	CM (%)
CheckMate Puffer Exp	0.0
CheckMate Puffer Std	0.0
No MD Control	0.0

ANOVA, Fisher's Protected LSD, $p \leq 0.05$

Changes in seasonal insecticide applications - apples

2009-2014 seasons

(Commercial orchard, PA)



Number of insecticide applications per season

Insecticides:
Carbamates (IRAC Group 1A) – methomyl,
Organophosphates (IRAC Group 1B) – phosmet,
Pyrethroids (IRAC Group 3A) – fenpropathrin, lambda cyhalothrin, bifenthrin,
Neonicotinoids (IRAC Group 4A) – acetamiprid, clothianidin, thiametoxam, dinotefuran, thiacloprid,
Other (IRAC Groups 5, 18, 28) – methoxyfenozide, spinetoram, rynaxypyr.

Changes in seasonal insecticide applications - apple

2013 - 2014 seasons
(Commercial apple orchard, PA)

Month	2013 program	2014 program
May	Calypso (ARM) Assail (C) Imidan (ARM)	**CM/OFM MD** Assail (C) Assail (ARM) Imidan (ARM)
June	Lannate (C) Assail (C) Intrepid (ARM)	Altacor (ARM) Lannate (ARM)
July	Bifenture (C) Assail (ARM)	Lannate (C)
August	Belay (C) Scorpion(ARM) Bifenture (C) Delegate (C)	Belay (C) Bifenture (ARM)
September	Belay (C) Scorpion (C)	Scorpion (C)

PENNSTATE

G. Krawczyk, 2014

CM and OFM available mating disruption products

2015 season (based on information provided by manufacturers)

Codling moth

- CheckMate® CM-XL 1000
- Cidetrak® CM
- Cidetrak® CMDA Combo PP
- Cidetrak ® CMDA Combo Meso-A
- Cidetrak® DA MEC
- CheckMate® CM-F
- CheckMate® Puffer CM

Oriental fruit moth

- CheckMate® OFM
- Cidetrak® OFM-L
- Isomate® OFM TT
- CheckMate® OFM-F
- CheckMate® Puffer OFM

CM and OFM

- Cidetrak® CM-OFM Combo
- Isomate® CM/OFM TT
- CheckMate® Puffer CM/OFM
- Isomate® CM/OFM Mist

Hand applied dispensers;
30-200 dispensers/acre;

Aerosol dispensers;
1-3 dispensers/ac;

Sprayable;
aiblast applications.

Summary

Hand applied high rate MD products and newly registered low labor MD products (e.g., CheckMate puffers or Cidetrak Meso) provided good control of internal fruit feeders;

Targeted BMSB management activities based on effective pest monitoring reduced the number of necessary insecticide treatments;

Combinations of BMSB targeted treatments with available soft and selective CM and OFM management tools will help to revive practical long term benefits from effective integrated pest management (IPM)

Lab technicians:
Travis Enyeart and Brian Lehman

Summer Field/Lab Assistants:
Luke Bailey, Nettie Baugher, Tyler Lieberum, Olivia Moore, Martha Schupp

Project supported by the State Horticultural Association of Pennsylvania