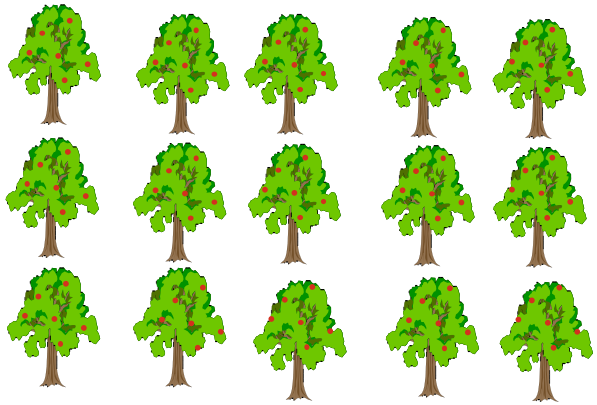
An In-depth Look at the Efficacy of New Insecticides on Tree Fruits



Dr. Larry A. Hull
Penn State University
Fruit Research and Extension Center
Biglerville, PA
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Old Tool - AZINPHOS-METHYL SITUATION:

- PEACHES - no further use after Sept 30, 2006
- APPLES: Driven by worker exposure and ecological concerns - EPA stated their final ruling - Nov '06

  - 2007: 8 lbs. maximum total formulated product per acre
  - 2008 and 2009: maximum 6 lbs. total formulated product per acre - **Present label**
  - 2010: 4 lbs. maximum total formulated product per acre
  - 2011 and 2012: 3 lbs. maximum total formulated product per acre

Relative Efficacy of Older Insecticides in PA

Common Name	Codling Moth	Oriental Fruit Moth	Leaf-rollers	Apple Maggot	Plum Curculio	
Guthion	E	E	F-E	E	E	Res.
Imidan	G-E	G-E	F-G	G	E	Res.
Sevin	F	F-G	P	F	P-F	
Lorsban	—	E	E	—	—	

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OP/SP- Alternative Insecticides – CM/OFM

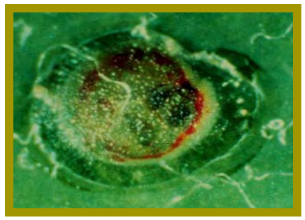
Insecticide	Class	Activity	Stage of Attack
Assail Calypso Clutch	Neonicotinyl	Disrupt nerve transmission	egg(topical)/larvae
Esteem Intrepid Rimon	Insect growth reg.	Juvenile hormone mimic Molt accelerator Chitin inhibitor	egg(topical/residual) larvae(Intrepid only)
Delegate Spintor	Spinosyn	Disrupt nerve transmission	larvae
Proclaim	avermectin		larvae
Altacor, Voliam flexi Belt	anthranilamide	Disrupt muscle action	larvae
Virus-Cyd-X -Carpovirusine BT	Biological	viral infection bacterial infection	larvae

A Management Program for CM/OFM:

should consider:

Adult

Larvae



Eggs

- ✓Targeting as many life stages as possible
- ✓Using products with different modes of action
- ✓Rotating insecticide chemistries to prevent resistance (i.e., between generations)
- ✓Supplementing insecticides with mating disruption

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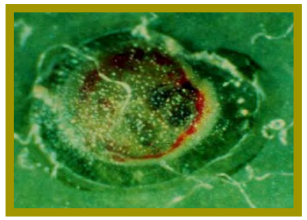
Ideal Management Program for CM/OFM:

GOAL: to interrupt CM and OFM life cycles in as many places as possible.

Adult

Larvae



Eggs

- ✓ Reduce oviposition with MD and adultacides
- ✓ Use ovicides to kill eggs
- ✓ Use larvacides to kill larvae
- ✓ Use viruses or insect growth regulators that affect this generation and next generation
- ✓ Biological control agents that attack all stages within and outside the fruit

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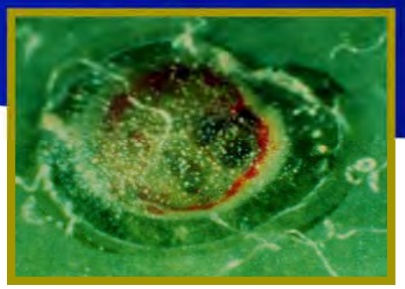
Reducing Oviposition of CM/OFM:

OFM

CM



Eggs

- ✓ Mating disruption products -- many on the market

- ✓ Adultacides -- best examples include:
  - Pyrethroids, Avaunt® (repellency?)
  - IGR's - Intrepid®

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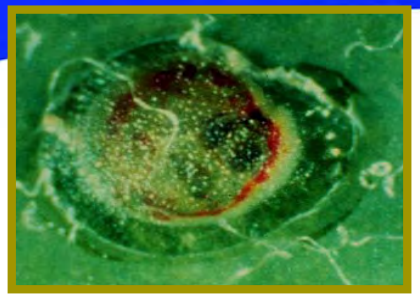
Ovicides for CM/OFM:



Eggs

- Most OFM eggs laid on the fruit 2-4th Br.
- CM eggs mostly on spur lvs next to fruit (1st Br)
  2nd Br - spur leaves & fruit

- ✓IGR's -- Esteem®, Intrepid®, and Rimon®
  - Product residue should be present before eggs deposited/residual control also
- ✓Altacor?
- ✓Neo-nicotinoids -- Assail®, Calypso®, Clutch®
  - Effective if applied topically to eggs
- ✓Horticultural oils (min. 1%)
  - Applied topically to eggs (e.g., 3x's per generation)

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Larvacides for CM/OFM:

Larvae

Larvacides (most common - apply @ start of egg hatch)

- ✓OP's, pyrethroids, Altacor®, Belt®, Delegate®
- ✓Neo-nicotinoids - Assail®, Calypso®, Clutch®
- ✓Intrepid® (some injury does occur, affects next generation)
- ✓Granulosis virus (Cyd-X®, Carpovirusine®) - limited fruit protection initially (i.e., "stings" occur), greatest effects occur in next generation

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WHAT & WHEN of Internal Worm Control

If using insecticides and/or MD for control - consider the following:

- Choice of products - efficacy and $$
- Rate of the products
- Optimum timing of the products
- Method of application
- Water volume and coverage
- Rotate insecticide chemistries between broods where possible
- Pheromone mating disruption

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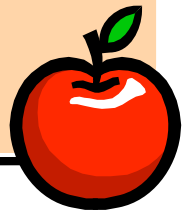
Relative Efficacy of Older Insecticides in PA

Common Name	Codling Moth	Oriental Fruit Moth	Leaf-rollers	Apple Maggot	Plum Curculio	
Guthion	E	E	F-E	E	E	Res.
Imidan	G-E	G-E	F-G	G	E	Res.
Sevin	F	F-G	P	F	P-F	
Lorsban	—	E	E	—	—	
Pyrethroids	G	G-E	G-E	G	F	
Calypso	G-E	E	F	G	G	
Assail	G-E	E	F	G	G	
Intrepid	G-E	G-E	E	P	P	
Rimon	E	E	E	P	P	
Proclaim	G	G	E	P	P	
Esteem	G	G	G-E	P	P	
SpinTor	F	F	G-E	G	P	



E=Excellent, G=Good, F=Fair, P=Poor

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Understanding OFM/CM Larval Behavior and Spray Coverage

Egg

Larva

Injured shoot

(OFM only)

Within 1 to 24 hours of hatch, the larva will enter a shoot or fruit

Injured fruit (CM / OFM)

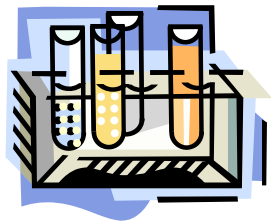
Key to control: The egg or the larva must contact the insecticide either via contact or ingestion before entry. Once inside, the larva cannot be killed unless it exits the shoot/fruit.

LAH-2003

New Insecticides - Internal Worm Control

- ✓**Altacor™** (Rynaxypyr, also DPX-E2Y)
  DuPont Co.

- ✓**Belt™** (Flubendiamide, also NNI-0001)
  Bayer CropScience



- ✓**Delegate™** (Spinetoram), also XDE-175)
  Dow AgroSciences

- ✓ **Voliam flexi™** (Chlorantraniliprole + Thiamethoxam)
  Syngenta

DELEGATE™ WG

Crops and pre-harvest intervals (PHI):

Pome fruit (7d PHI); bushberries (3d PHI); caneberries (1d PHI); tree nuts (14 d PHI), grape (7d PHI); stone fruit (1d PHI on nectarines, 7d PHI on cherries, plums and prunes, 14 d PHI on peaches).

Pests (control):

Codling moth, oriental fruit moth, obliquebanded leafroller, tufted apple bud moth, thrips, leafminers, grape berry moth, cherry fruitworm, loopers, pear psylla

Pests (suppression):

Apple maggot, plum curculio, blueberry maggot, currant fruit fly

Recommended rate(s):

From 4.5 to 7 oz per acre depending on pest and pest pressure.

- **REI requirements: 4 hours**

Altacor™

Mode of Action and Symptomology

- Ryanodine receptor agonist
- Regulates release of stored calcium
- Primary route of exposure is through ingestion
- IRAC Group 28 Insecticide

Crops - Apple, Pear, Stonefruits, Grapes
Targeted Pests (apple/peach) -- codling moth, OFM, leafrollers, STLM

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Belt™

Targeted Insect Pests in Fruit (Apple/Pear)

- Codling moth
- Obliquebanded leaf roller
- Tufted apple bud moth
- Green fruitworm
- Spotted tentiform leafminer

- 3-5 oz/acre
- 3 applic/season
- 15.0 oz/acre for the season
- 14 day PHI

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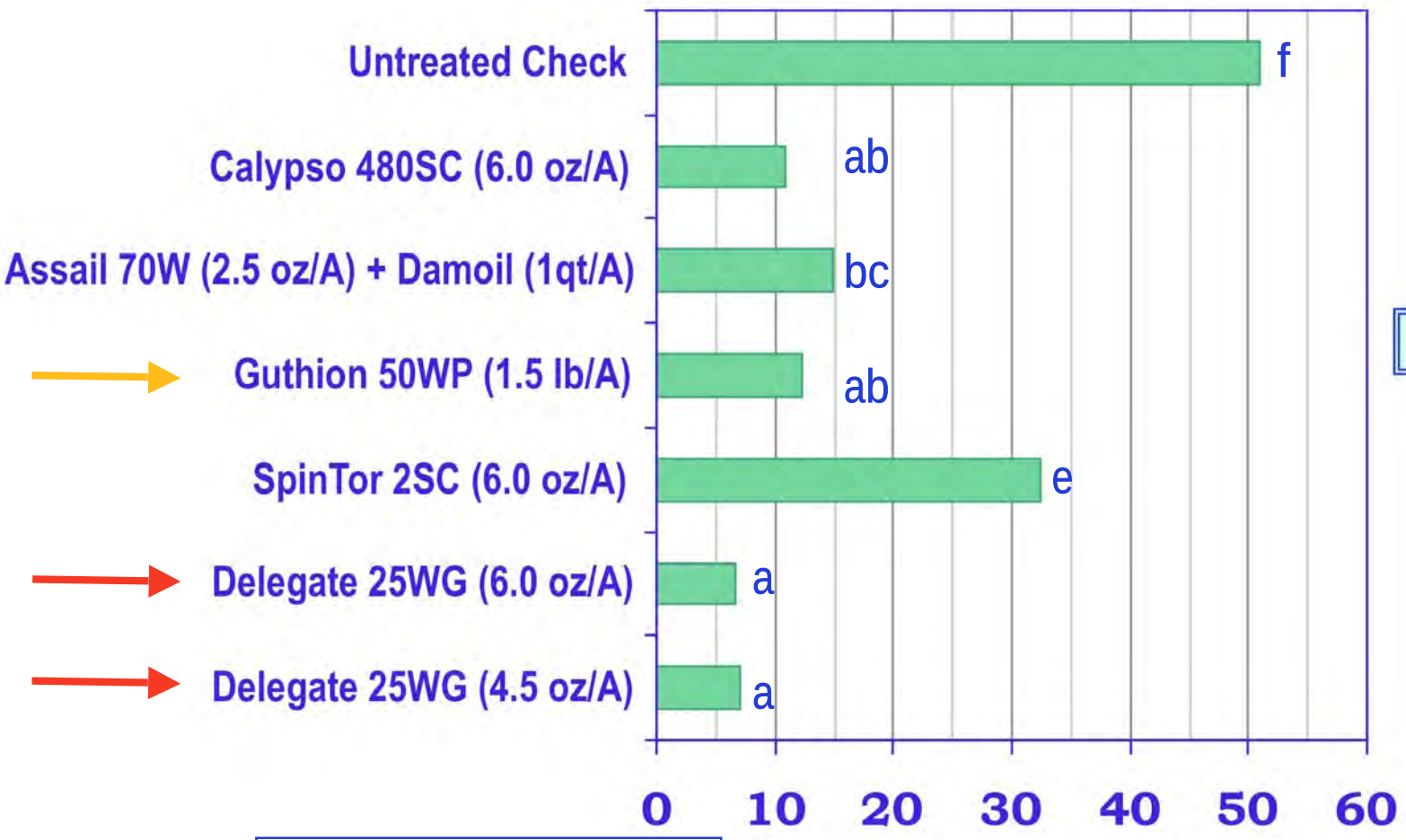
2005 CM/OFM Timing Study

CM/OFM Entries



100 GPA - Airblast,
(5 Reps) # applic. = 8

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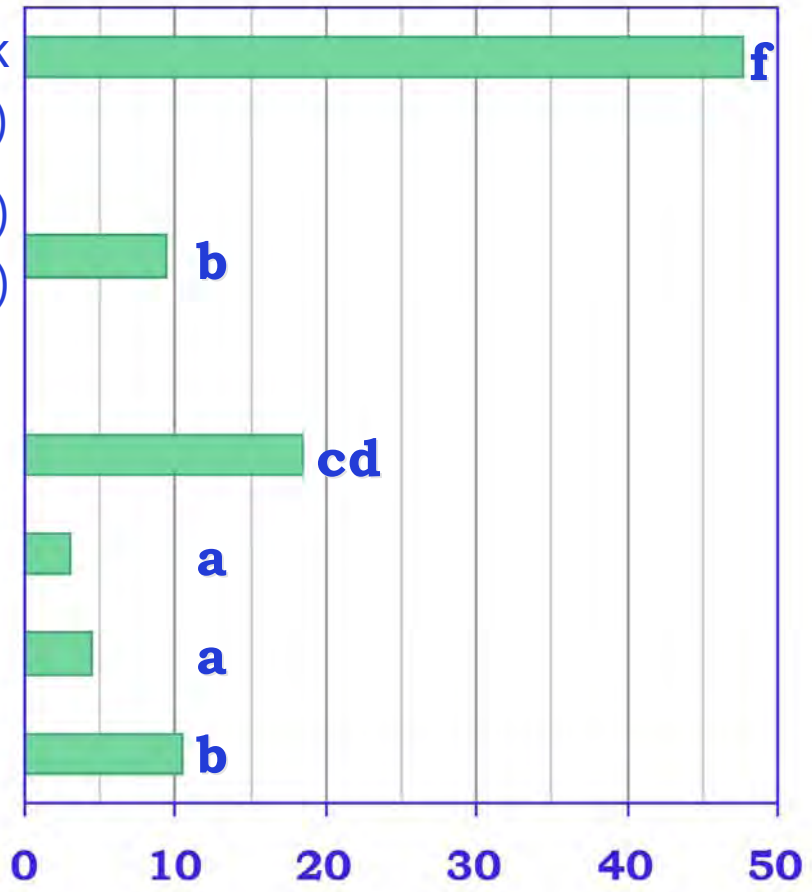
2006 Single Tree Plot - Internal Lep.

Live larvae

CM/OFM Entries



	CM	OFM
Untreated Check	91	52
Lorsban 75WG (2.0 lb/A) Guthion 50W (1.5 lb/A) Intrepid 2F (1.0 pt/A)		
Rimon 0.83EC (20.0 oz/A)	16	1
Guthion 50W (1.5lb/A)	31	28
Altacor 35WG* (4.0 oz/A)	3	1
Altacor 35WG* (3.0 oz/A)	7	1
Altacor 35WG* (2.0 oz/A)	15	8

6 applic. (21 day interval)
(5 Reps) 100 GPA

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*LI-700 (0.0625%)

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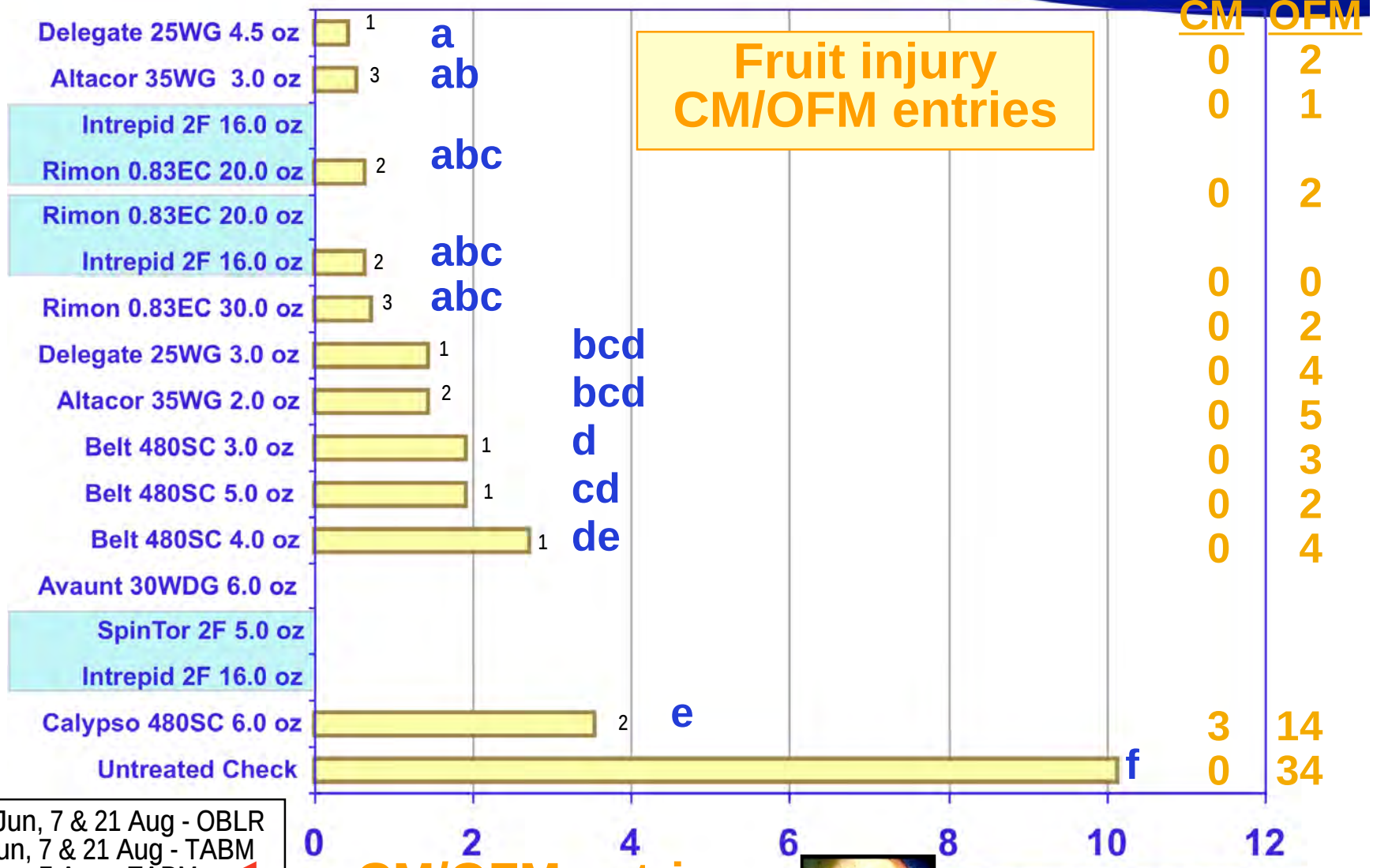
2006 Large Plot Study

'Yorking'

100 GPA



[1] 14 & 28 Jun, 7 & 21 Aug - OBLR
[2] 6 & 19 Jun, 7 & 21 Aug - TABM
[3] 6 & 19 Jun, 7 Aug - TABM

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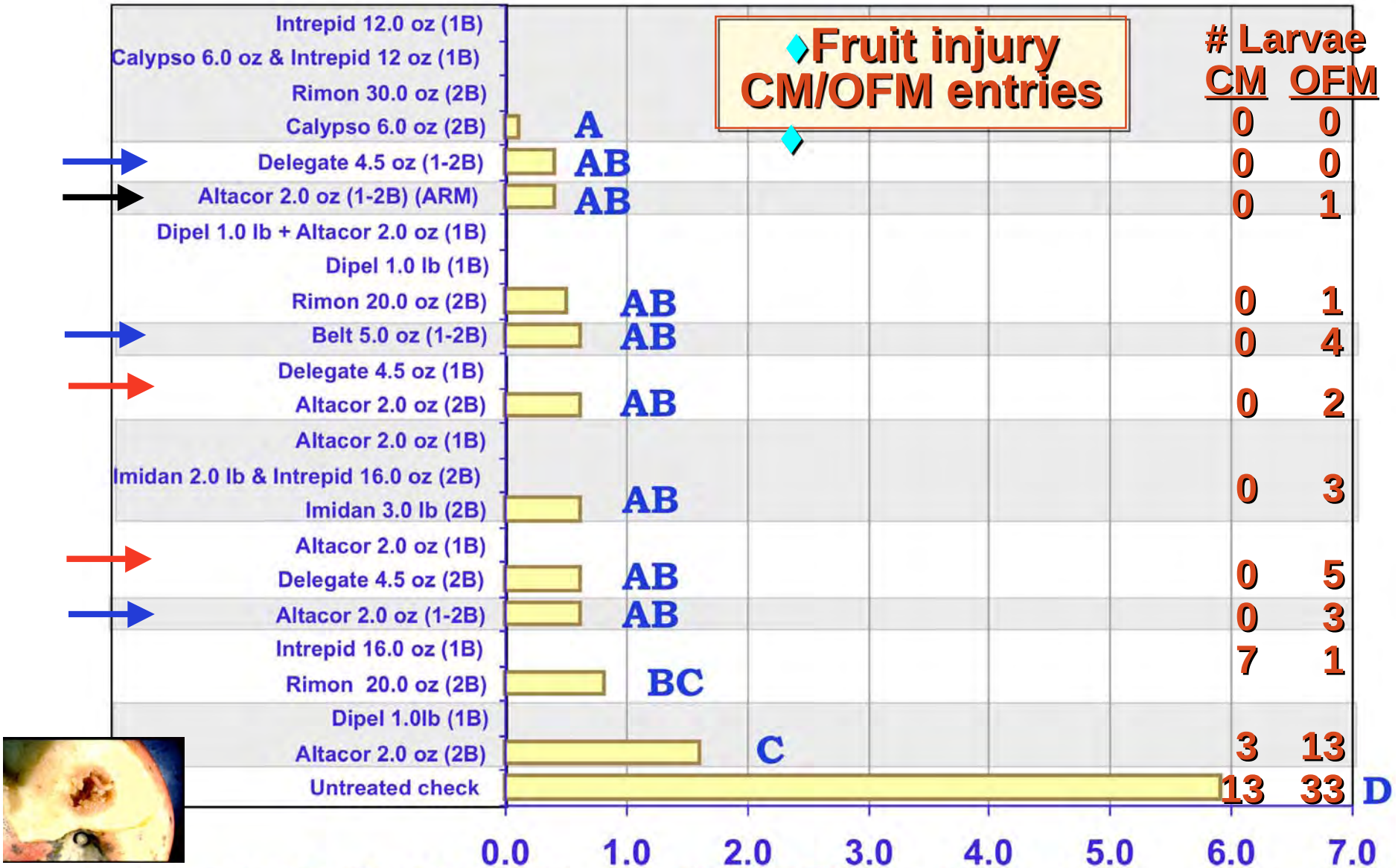
2007 Large Plot Study

'Golden Delicious' & 'York'



Applic.timings for LRs (TABM & OBLR)

2 sprays/gen all trmts but Altacor (8 ARM both sides) 100 GPA

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2008 Large Plot Study

Materials and Methods

- 11 insecticide treatments
- Untreated check
- Treatments timed for either CM/OFM or TABM/OBLR based on degree day accumulations
- Plot size - 12-15 tree plots (0.125 acre), 4 reps, 14' high trees

- All treatments applied at 100 GPA as a complete (both sides) or ARM (one side per application)
- Fruit injury on 2 cvs/treatment, "frass" apples for CM/OFM on 'G. Delicious', picked samples for leafroller and CM/OFM on 'Yorking' -- 1400 apples/trmt/CV

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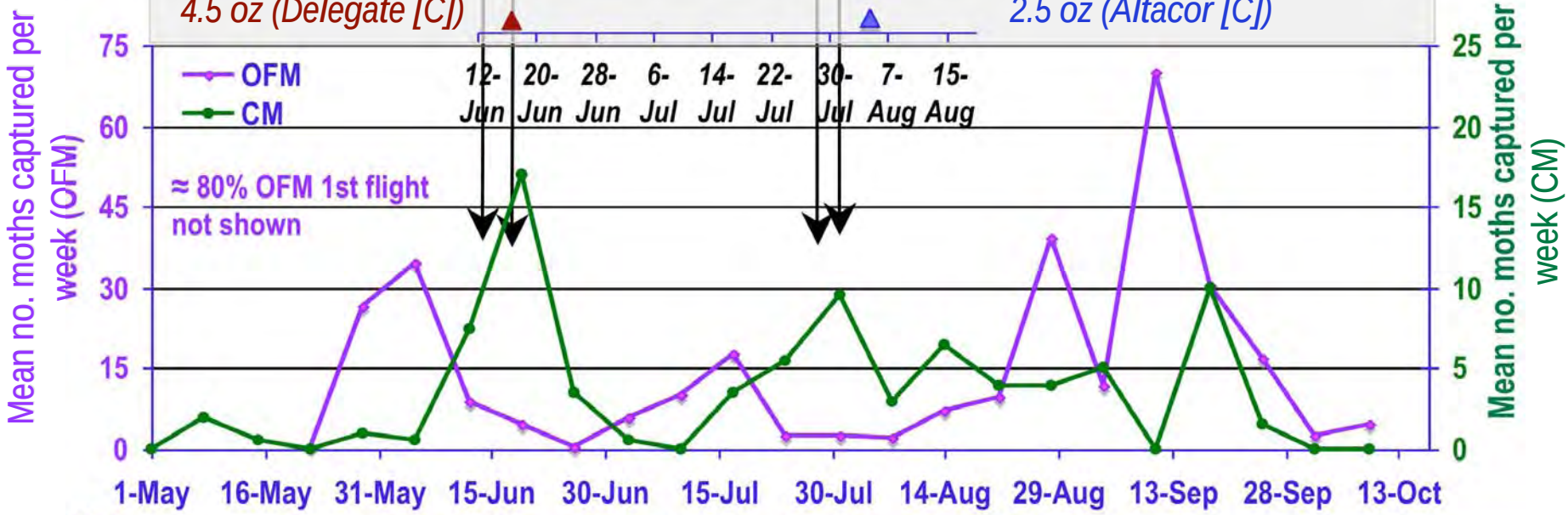
Large Plot Trial with Altacor/Delegate - 2008
Trap Captures and Spray Timings

Amt/A		Amt/A	
Std-8 fl oz(In), 6 fl oz(C+In)		20 fl oz(R), 6 fl oz(C)	
4.5 oz (Delegate [ARM])		2.5 oz (Altacor [ARM])	
2.5 oz (Altacor [ARM])		4.5 oz (Delegate [ARM])	
6 oz (Delegate [ARM])		3 oz (Altacor [ARM])	
3 oz (Altacor [ARM])		6 oz (Delegate [ARM])	
2.5 oz (Altacor [C]		4.5 oz (Delegate [C])	
4.5 oz (Delegate [C])		2.5 oz (Altacor [C])	

Treatment Timings and Application Methods



100GPA

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Entire block treated with 2 ARM applications of Imidan 70W (1lb/A/side) on 16 Jul and 27 Aug.

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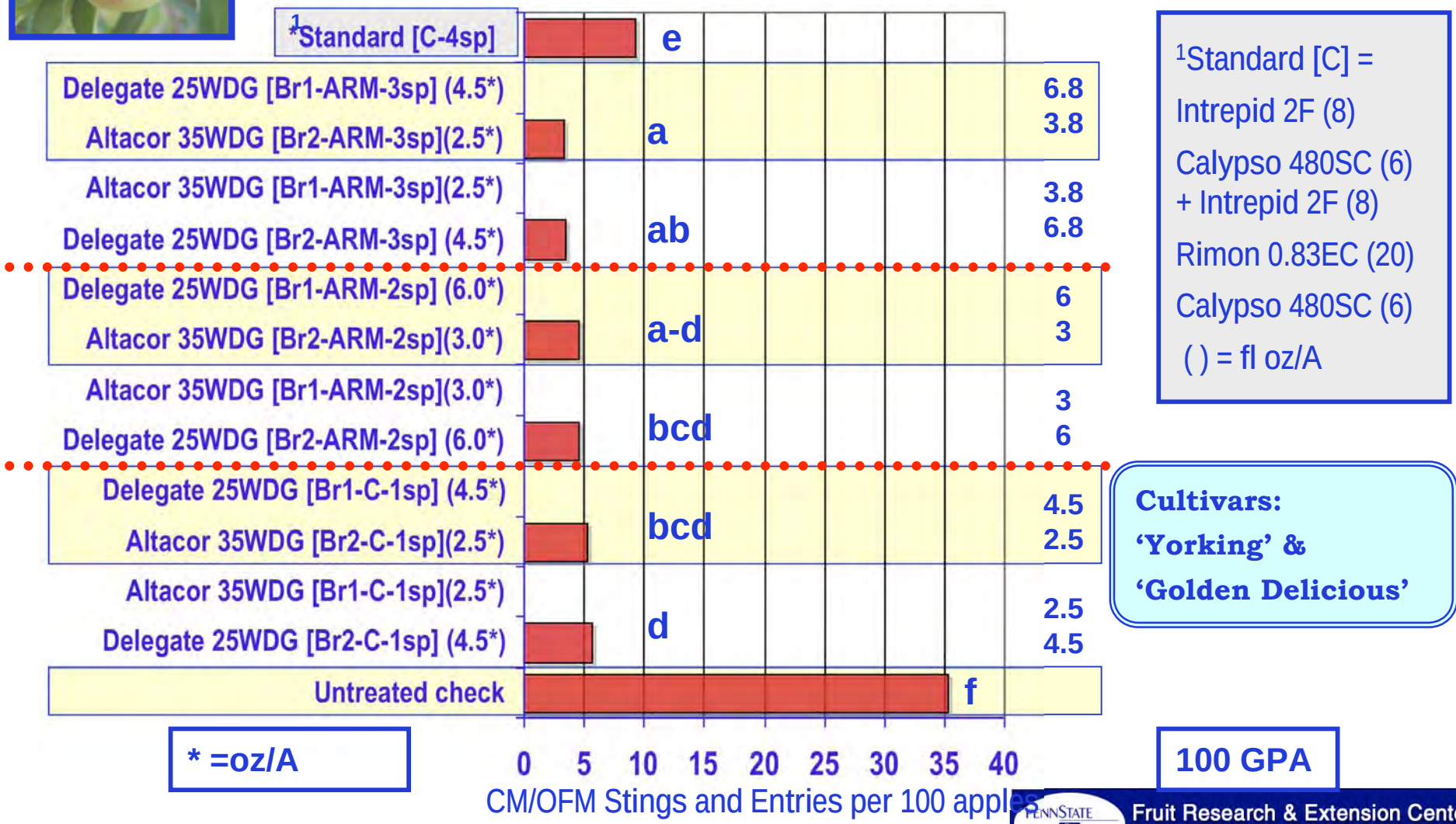
Large Plot Fruit Injury / Internal Larvae - 2008



[1]Standard [C] =
Intrepid 2F (8)
Calypso 480SC (6) + Intrepid 2F (8)
Rimon 0.83EC (20)
Calypso 480SC (6)
( ) = fl oz/A

Cultivars:
'Yorking' &
'Golden Delicious'

* =oz/A

100 GPA

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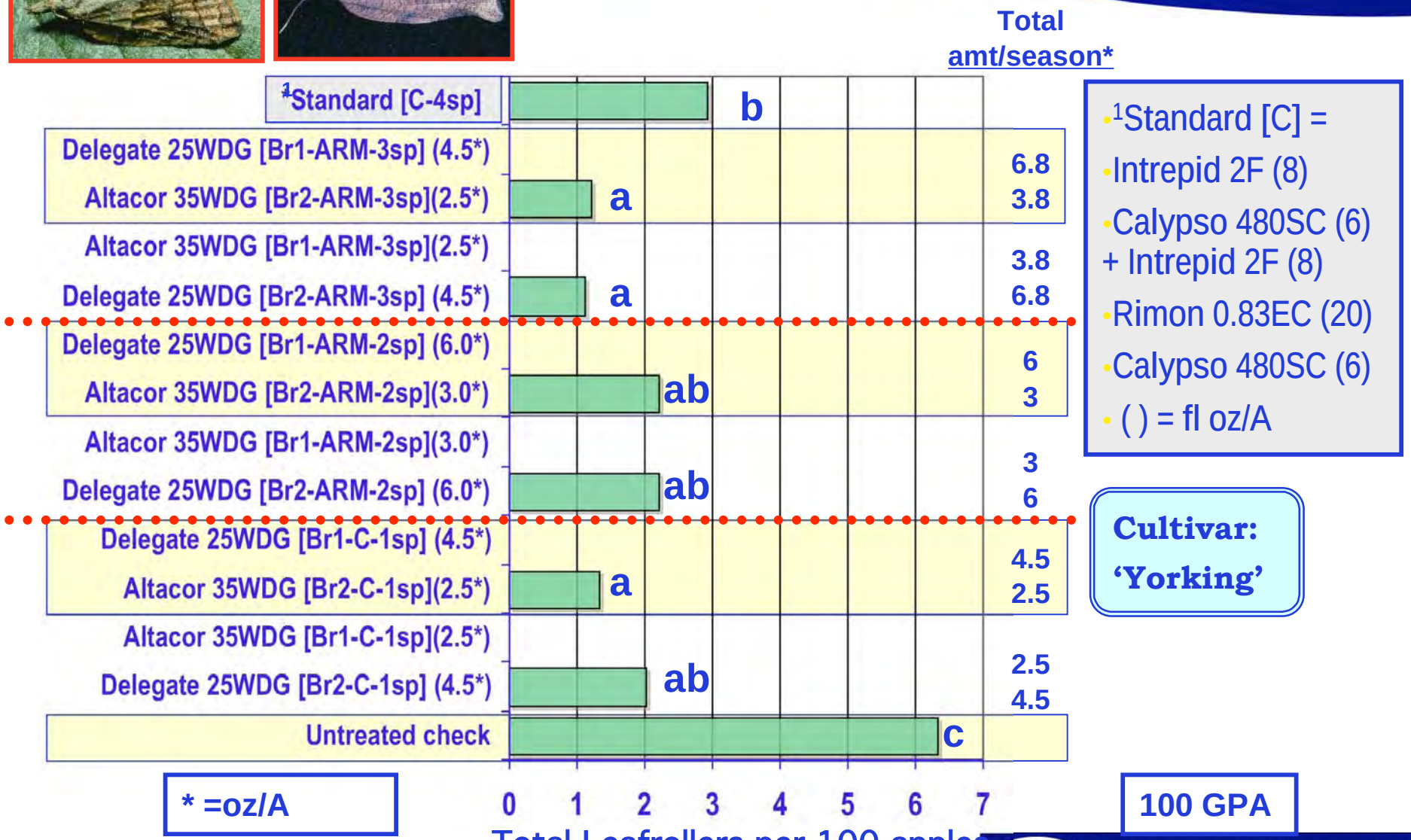
Large Plot Fruit Injury / Leafrollers- 2008



- [1]Standard [C] =
- Intrepid 2F (8)
- Calypso 480SC (6) + Intrepid 2F (8)
- Rimon 0.83EC (20)
- Calypso 480SC (6)
- ( ) = fl oz/A

Cultivar: 'Yorking'

*** =oz/A**

100 GPA

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Efficacy Ratings[1] – New Chemistries vs. Other Products – Apple

by L. A. Hull

Product	CM	OFM	TABM	OBLR	PC
Altacor	E	E	E	E	P
Belt	G-E	G-E	E	E	P
Delegate	E	E	E	E	F
Voliam flexi	E	E	E	E	G-E
Guthion	F-E	G-E	G	F	E
Assail	G	G	—	—	E
Calypso	G	G	—	—	G
Intrepid	F-G	F-G	E	E	—
Rimon	G-E	G-E	E	E	—
Warrior	F	E	E	G-E	F

1 Ratings may differ from PSU-TFPG — this is more of a comparison between compounds

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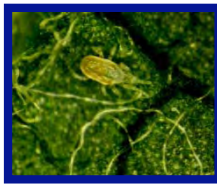
Phytoseiid Mite Predator Field Study - 2006 (Large Plot) - PA

Treatment	Amt/A	Phytoseiid mite predators / leaf 10 Jul	24 Jul	2 Aug	(% TP, NF)
Delegate 25WG	3.0 oz	0.8 d	1.8 ab	2.0 bc	(87, 13)
Delegate 25WG	4.5 oz	0.8 d	0.5 c	1.8 c	(100, 0)
Altacor 35WG	2.0 oz	1.2 a-d	2.4 ab	4.0 a	(97, 3)
Altacor 35WG	3.0 oz	1.0 a-d	1.8 ab	2.9 ab	(96, 4)
Belt 480SC	3.0 oz	1.0 bcd	2.1 ab	2.9 ab	(92, 8)
Belt 480SC	4.0 oz	0.8 cd	1.7 ab	4.0 a	(97, 3)
Belt 480SC	5.0 oz	1.3 a-d	1.6 b	2.8 abc	(96, 4)
Intrepid 2F	16.0 fl oz				
Rimon 0.83EC	20.0 fl oz	1.4 a-d	1.3 bc	3.1 ab	(100, 0)
Rimon 0.83EC	20.0 fl oz				
Intrepid 2F	16.0 fl oz	1.4 abc	1.4 bc	3.3 ab	(97, 3)
Rimon 0.83EC	30.0 fl oz	1.6 ab	3.4 a	3.8 a	(97, 3)
Avaunt 30WDG	6.0 oz				
SpinTor 2F	5.0 fl oz				
Intrepid 2F	16.0 fl oz				
Calypso 480SC	6.0 oz	1.8 a	1.6 b	3.3 ab	(87, 13)
Untreated Check	. .	1.8 ab	2.7 ab	3.0 ab	(100, 0)



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2 applic - 14 and 28 Jun -- 100 GPA

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Comparison of Natural Enemy Toxicity Under Field Conditions – L. Hull (Penn State)

Natural Enemy	AZM	Pyrethroid	Assail	Rimon	Delegate	Altacor
T. pyri/ N. fallacis	1	3	1	0	1-2	0
Zetzellia mali	1	2	1	0	1	0
Stethorus punctum Adults	1	3	2	2	1	1
Larvae	1	3	2	3	1	1
Aphidoletes	1	2	1	1	0	0
Coccinellids - aphids	1	3	2	2	1	1
Campylomma	1	2	2	0	1	0

0 = no toxicity, 1 = slight toxicity, 2 = moderate toxicity, 3 = high toxicity

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PSU recommendations for new tools

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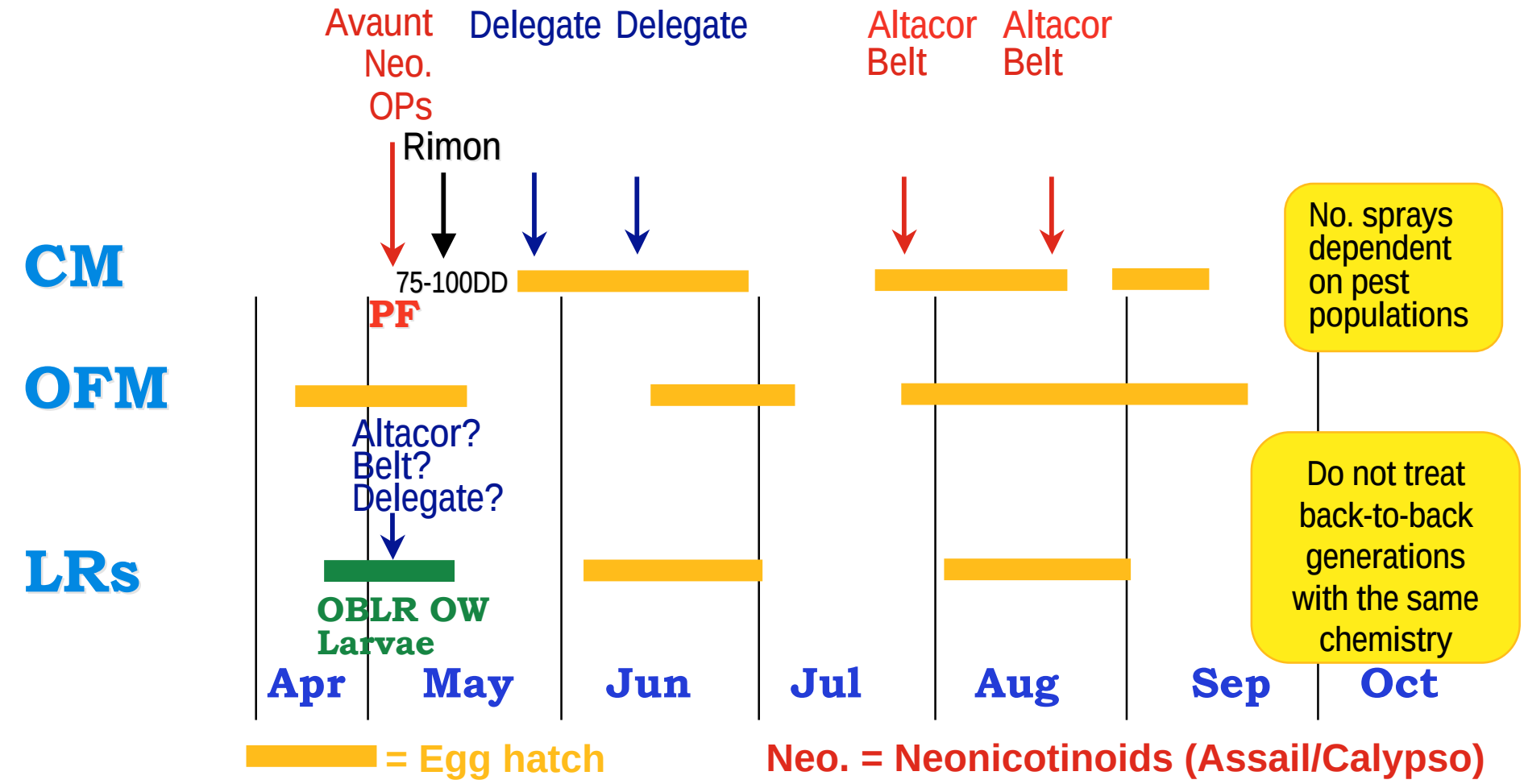
New Product Timing Options - #1 - 2009
Pennsylvania



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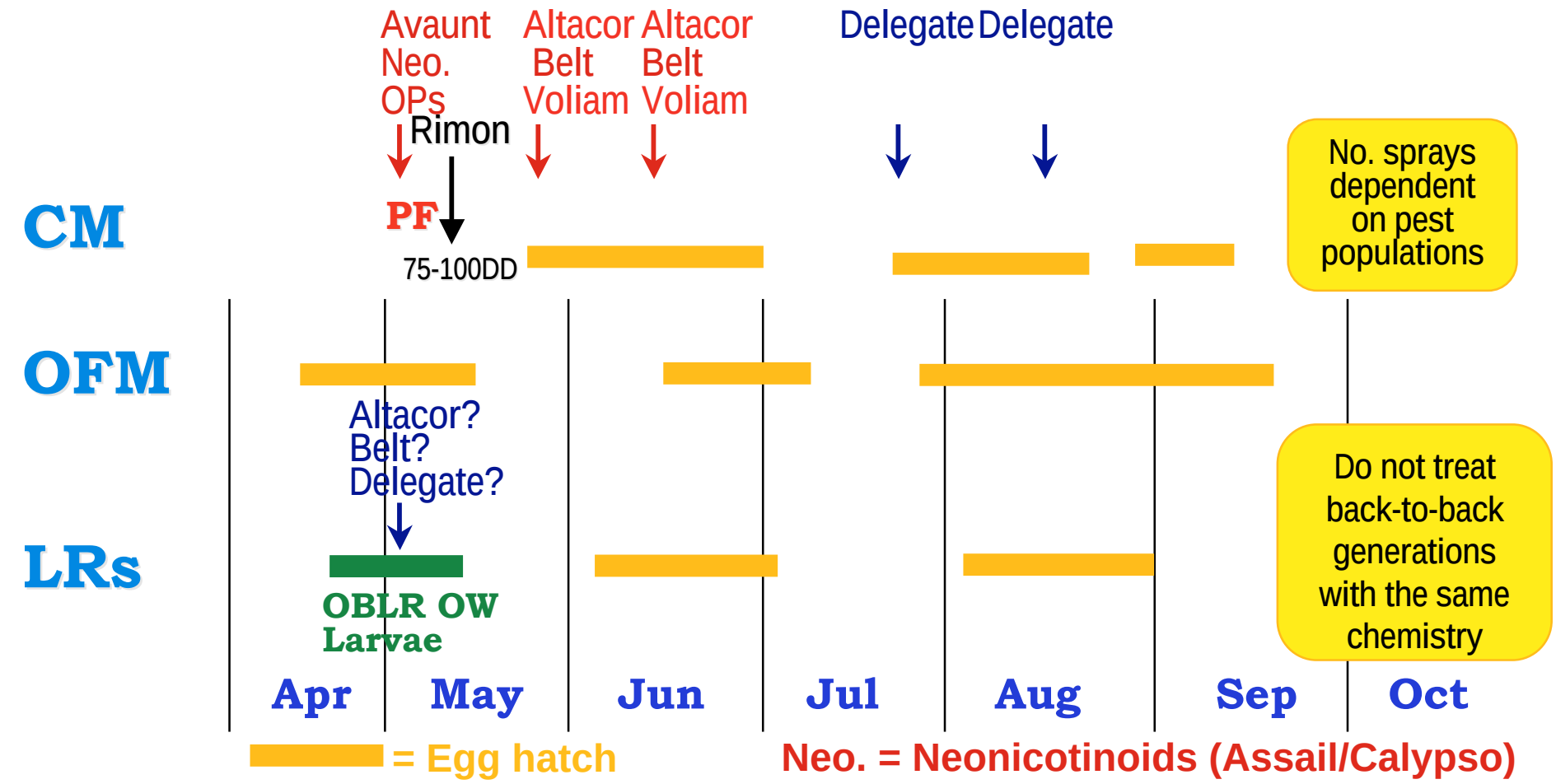
New Product Timing Options - #2 - 2009
Pennsylvania



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New Product Timing/MD Options - #3 - 2009
Pennsylvania

High CM Populations

Avaunt
Neo.
OPs
Rimon

Altacor
Belt
Delegate
Voliam

Altacor
Belt
Delegate
Voliam

Altacor
Belt
Delegate

PLUS

CM-MD Options

All sprays may not be necessary if MD used

CM

OFM

LRs

PF

Altacor?
Belt?
Delegate?

OBLR OW Larvae

Do not treat back-to-back generations with the same chemistry

Apr **May** **Jun** **Jul** **Aug** **Sep** **Oct**

= Egg hatch

Neo. = Neonicotinoids (Assail/Calypso)

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Final comments: Altacor, Belt, Delegate

- These new products are EXCELLENT against CM/OFM and leafrollers, but they are not the proverbial "silver bullet" and will not control all the pests in the orchard (i.e., plum curculio, stink bug, mites, borers).

- Lack of GOOD AND THOROUGH coverage or LONG intervals between applications will limit the efficacy of these compounds, especially under high pressure - WATCH ARM SPRAYS!

- If your current insecticide program works well, there may not be a need to change to new chemistries, although it may be very beneficial from the resistance management perspective to gradually incorporate Altacor/Belt and Delegate into the program.

- If using Altacor/Belt/Delegate, use only one group for 1st gen CM/OFM/LR control (Delegate), then switch to other group for 2nd gen control (Altacor/Belt - not both).

- Under high CM/OFM pressure, the combination of new products and mating disruption is the best approach.

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Lorsban

Proclaim

Calypso

Mating Disruption

SpinTor

Avaunt

Pyrethroids - 7+

Surround

Beleaf

Bts

Rimon

Assail

Actara

Esteem

Lannate

Provado

Clutch

The insecticide tool box is getting very different and far from empty!

Imidan

Virus

Intrepid

Delegate

Altacor

Belt

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Best wishes for a PEST "FREE" Crop in 2009

Thank you!

Any Questions!