Entomological Research at the USDA-ARS

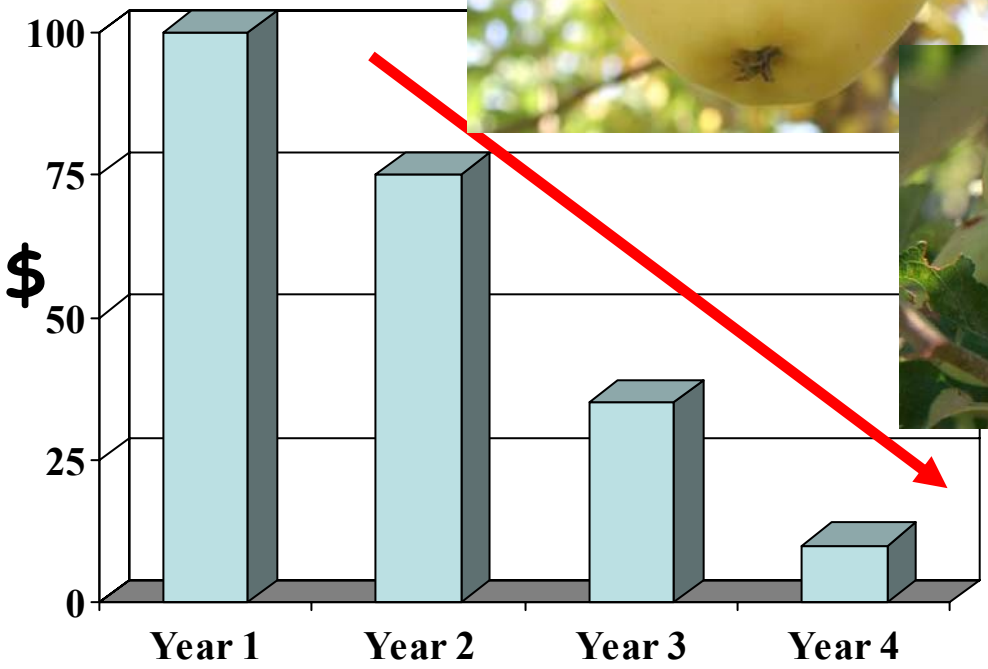
Yakima Agricultural Research Laboratory

USDA-ARS

Garczynski, Horton, Knight, Lacey, Landolt, Neven, Unruh, Yee

Codling Moth

Explosive Reproductive Potential
in the arid Western U.S.



OP To Be Phase Out in the U.S.

❖2007	10 lb ai /HA
❖2008-2009	7 lb ai/HA
❖2010	5 lb ai/HA
❖2011-2012	4 lb ai /HA
❖2013	Gone

Phosmet, chlorpyrifos, diazinon, and malathion face further regulatory action

So what, OP insecticide use is down 50% since FQPA in 1996

AND,

There are ***NOW*** more insecticides and miticides registered in tree fruits than ever before

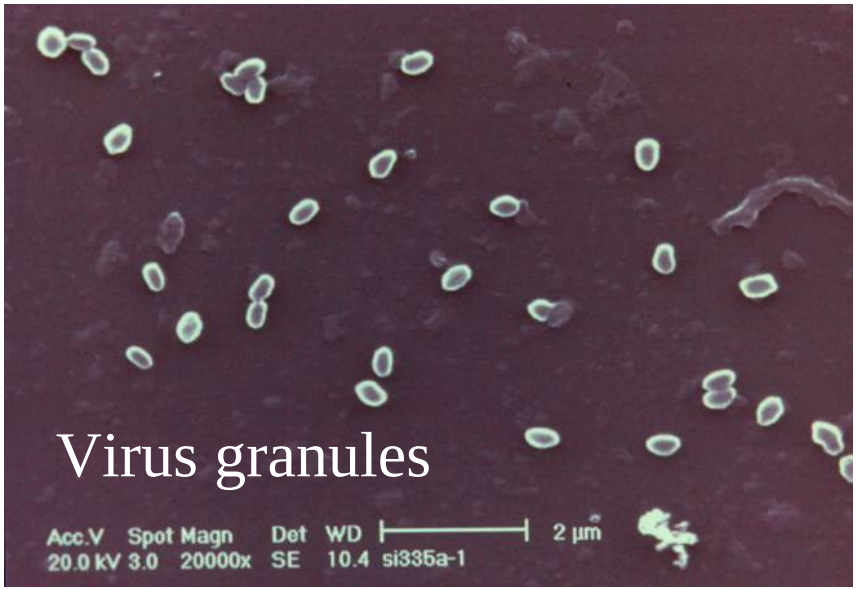
Issues with New Materials

- Low human toxicity, safer to the environment.
- More selective materials.
- More active than OP's against resistant targets
  - ✓ Good for pests
  - ✓ Bad for natural enemies
- Most require ingestion to be effective
  - ✓ Bad for CM control
  - ✓ Requires better timing
- Generally more expensive.
- Organic production.

OP-alternatives

Insecticides	Class	Activity
Assail	Neonicotinyl	Disrupt nerve transmission
Calypso		
Rimon	Insect growth regulator	Chitin inhibitor
Intrepid		Molt accelerator
Esteem		JH mimic
Delegate	Spinosyn	Disrupt nerve transmission
Success		
Proclaim	Avermectin	Disrupt nerve transmission
Altacor	Anthranilamide	Disrupt muscle action
HMO	Biologicals	Asphyxiant
Virus		Viral infection
BT		Bacterial infection

4.4% of Apple Industry has gone Organic
with 54% growth expected in next 2 years



Organic growers use:

MD, CM-GV, Spinosid

Finally,
Can Achieve Good CM Control!

Strategic IPM Plan

- Creating sustainable pest management
  - Targeting multiple pests
    - Optimize application timing and tank-mixing modes of action
  - Minimize insecticide resistance development
    - Use materials with different modes of action

MD, adulticides

Ovicides

Attack the Entire Life Cycle

Cultural, biological

Larvicides

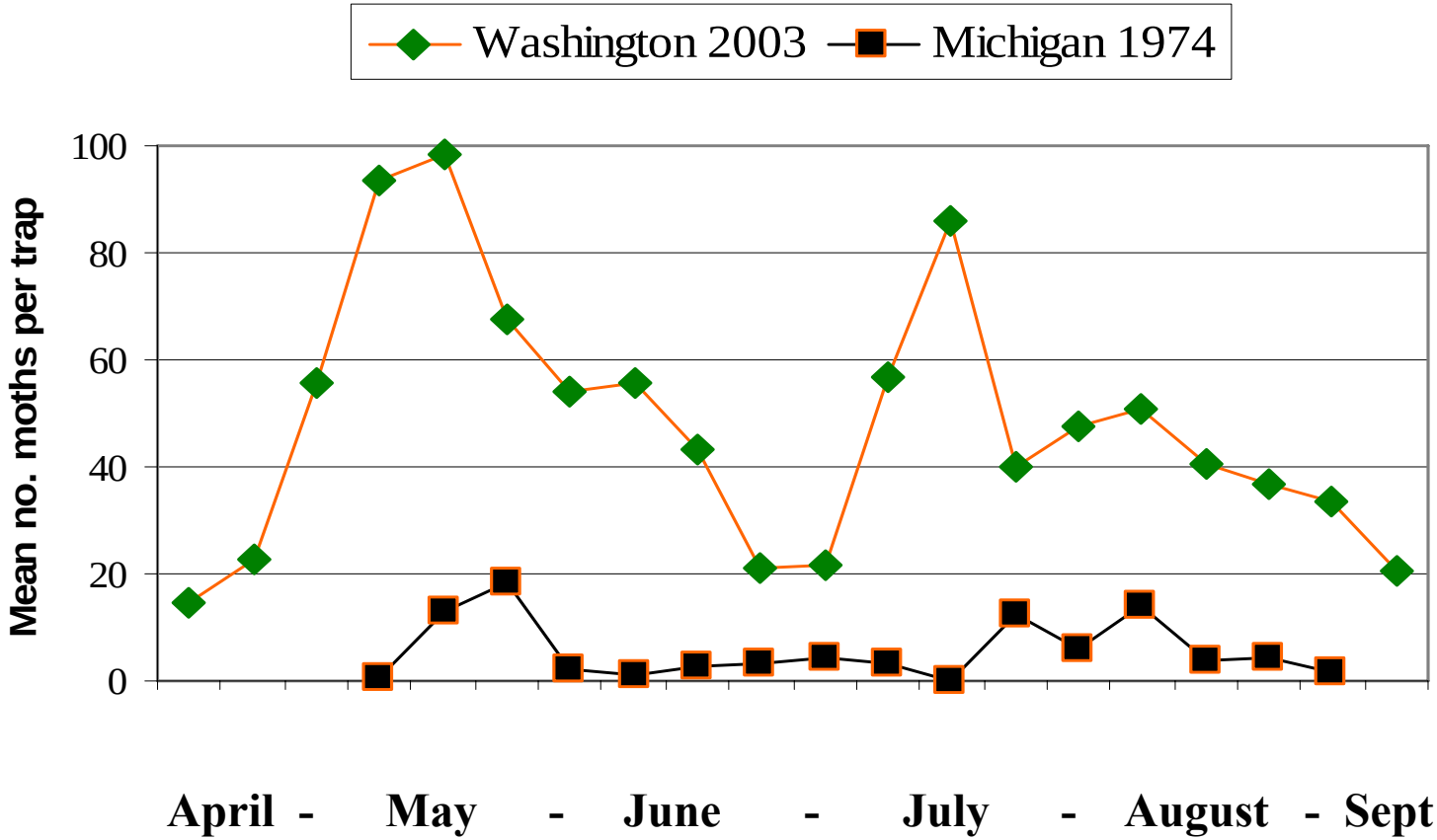
Strategic IPM Plans

- Pheromones are used on ***75%*** of apple acreage.
- Horticultural oil, neonicotinyls, IGRs can kill eggs when timed after petal fall.
  - Use of IGR's at 'petal fall' timing is also good for leafrollers.
- If using an ovicide early then delay 1st application of larvicide and tank-mix an ovicide and larvicide
- If needed, a second larvicide is applied 14 d later.
- 2nd Gen.: Use an IGR for leafrollers and a new class of larvicides for CM

But, the key is always proper timing

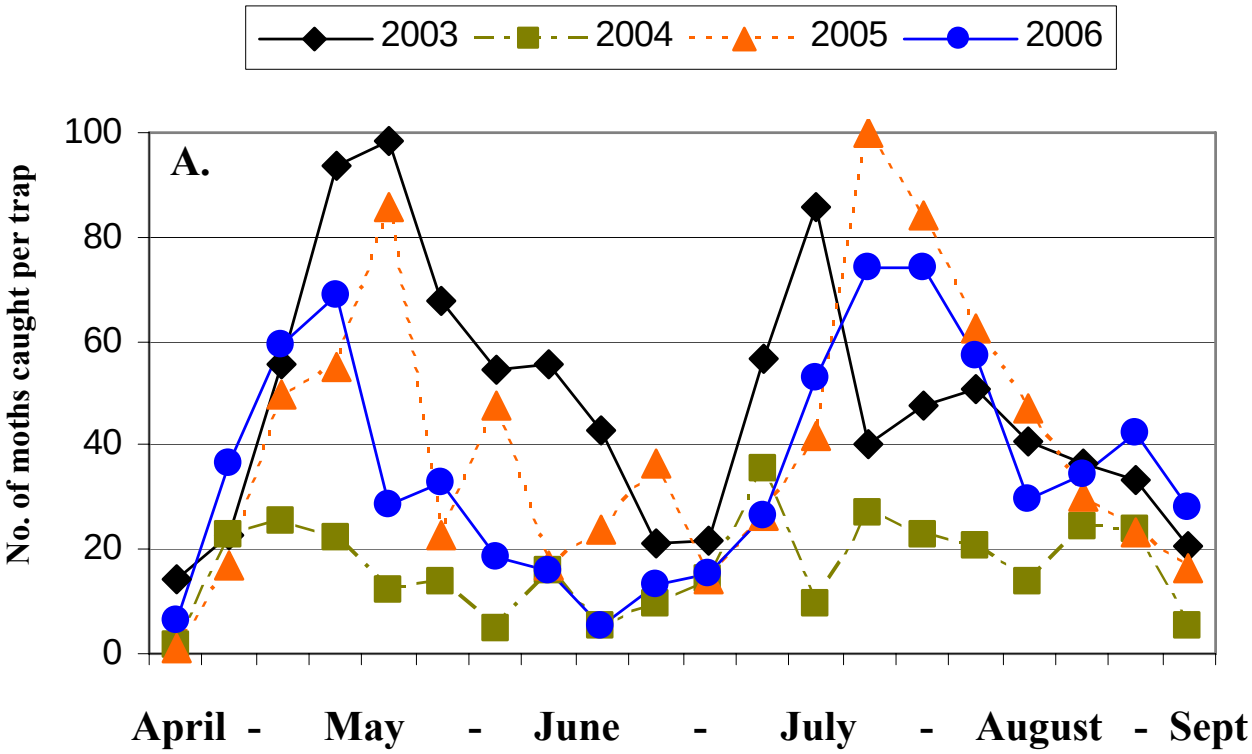
Has CM's Phenology Changed?

Phenology model was developed in Michigan

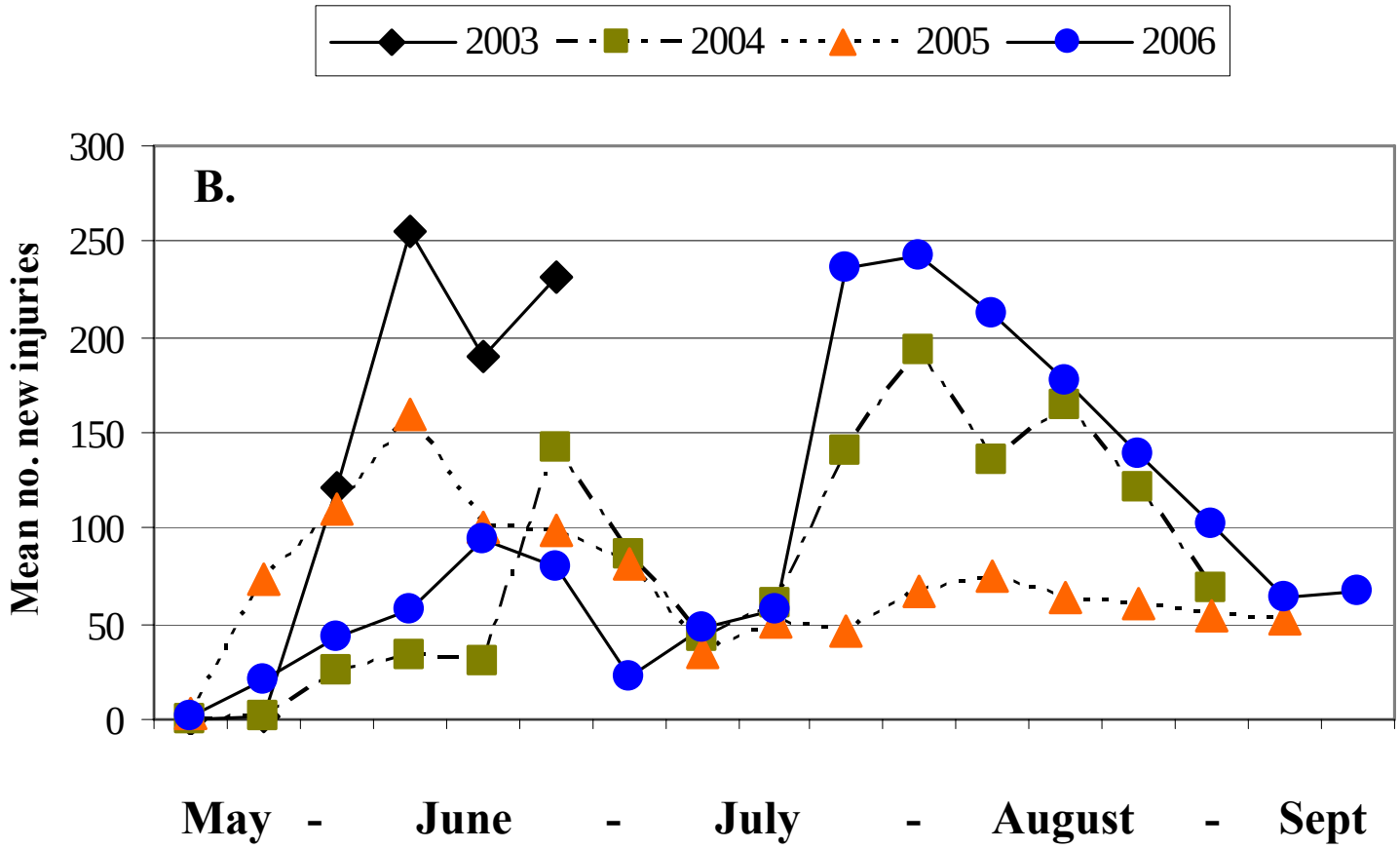


Michigan model was validated in WA with prediction of 1st egg hatch

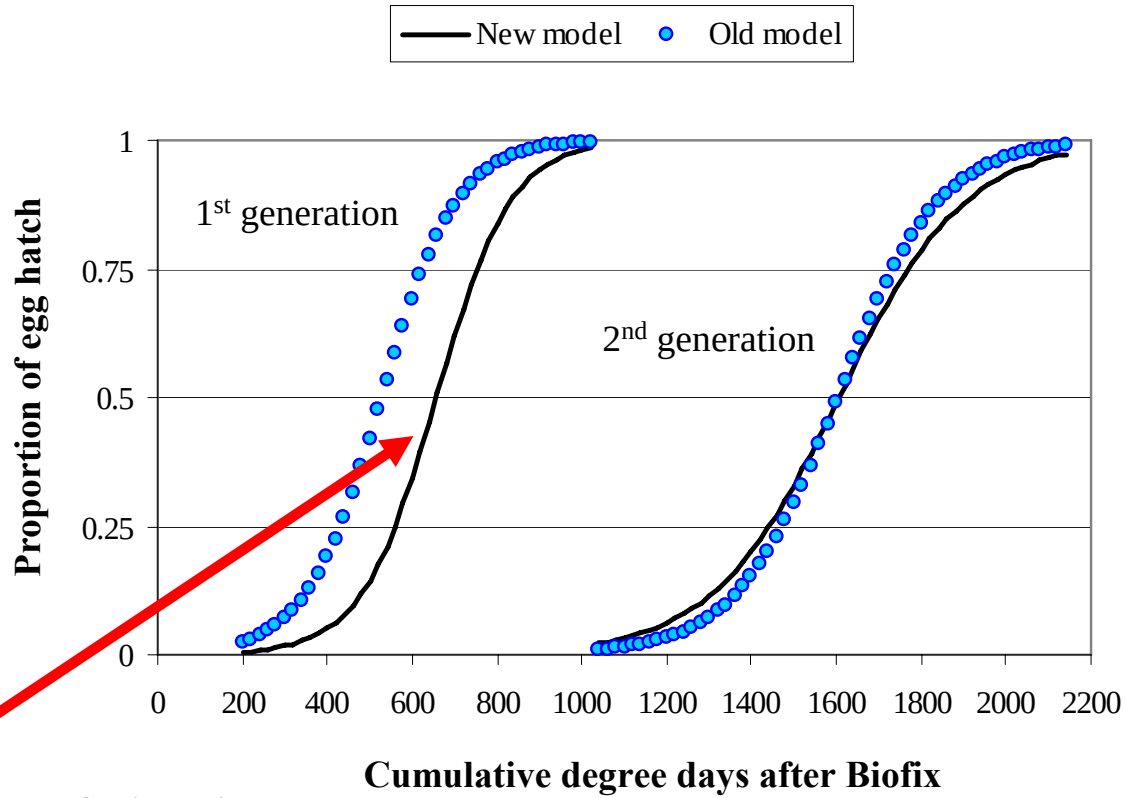
Broad Flight Periods in Unsprayed Sites in WA



Broad Periods of Egg Hatch in WA



Developed A New Model



A broader fit of the data

Impact of New Model:

- Timing of control tactics for CM, especially in the 1st generation, needs to be reconsidered and optimized.

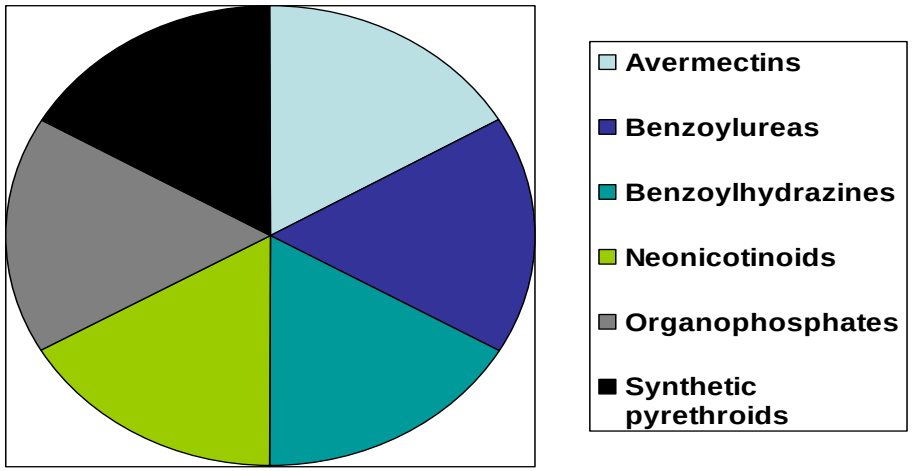
- ***Importance of each cover spray interval***
- ***Timing of ovicides***
- ***Covering the gap between overlapping generations***

CM Resistance – Important Factor

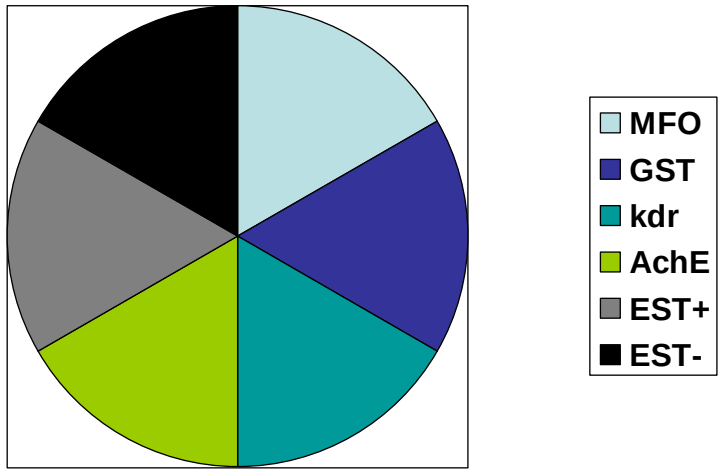
- Does resistance affect timing?
- Is there any evidence of cross resistance in CM to other insecticides?

Insecticide Resistance in CM is Diverse

Classes

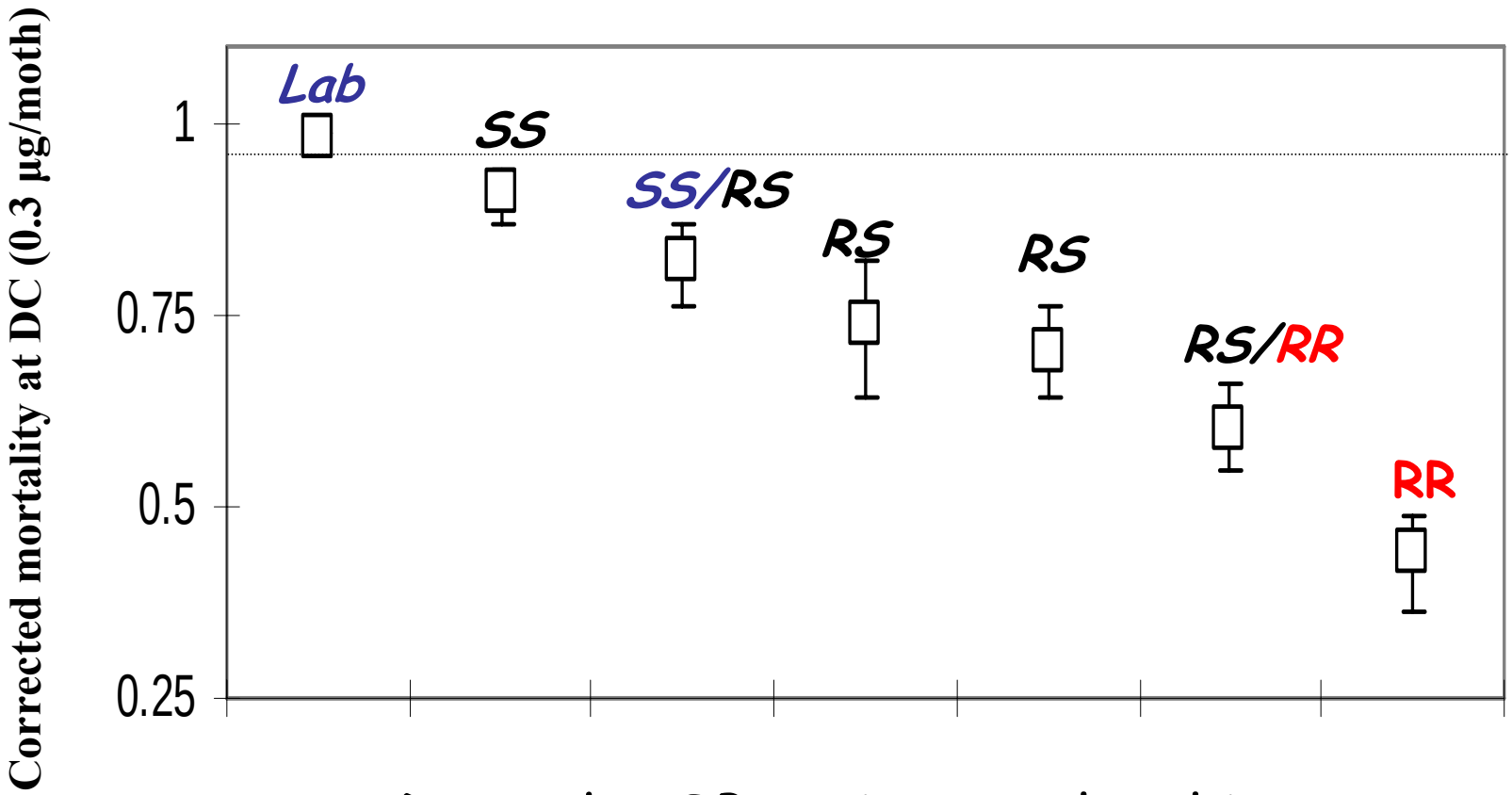


Mechanisms



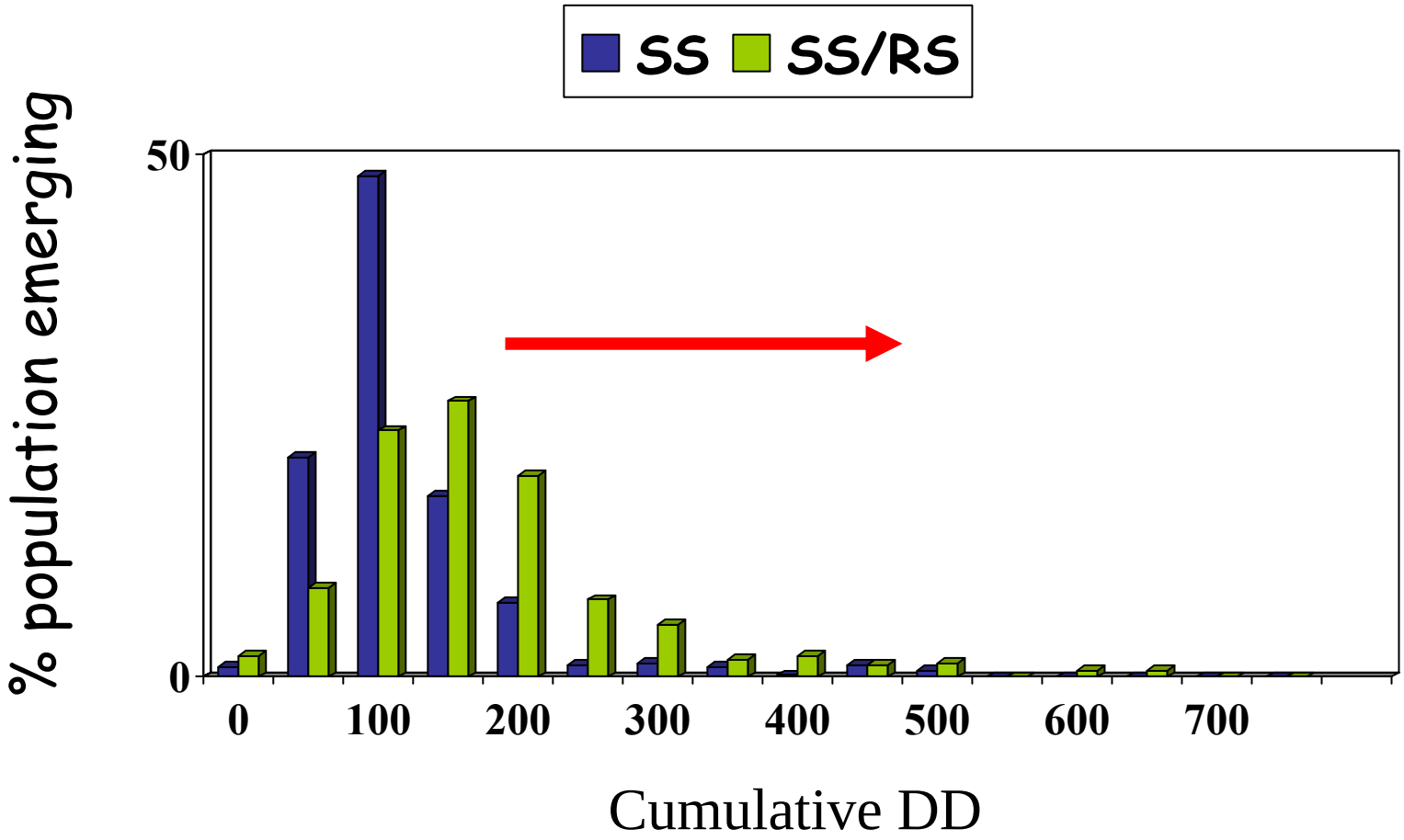
Is resistance management going to be possible?

Selected Populations - 2003



Does the OP resistance level impact the timing of the generations?

Shift in Emergence Curve



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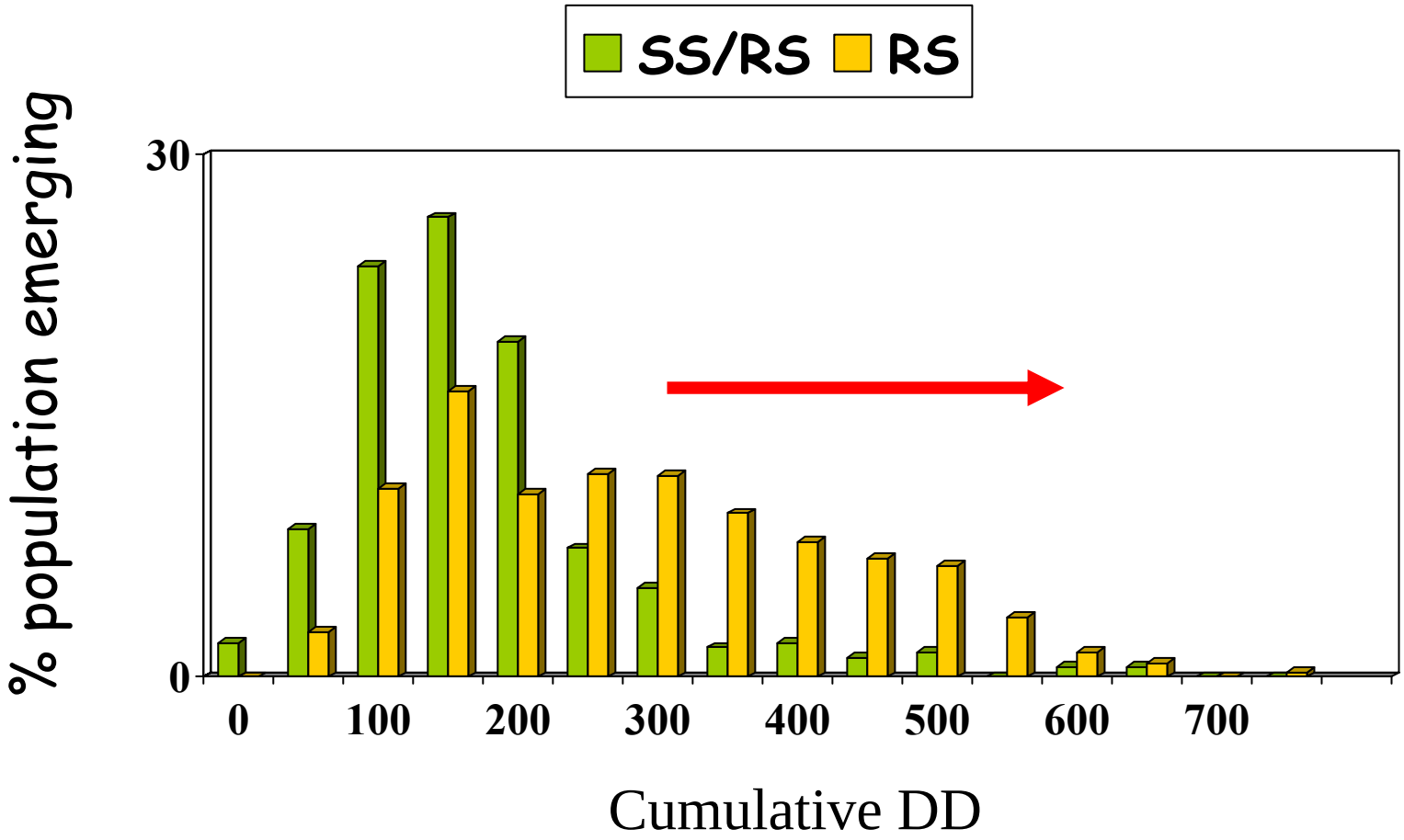

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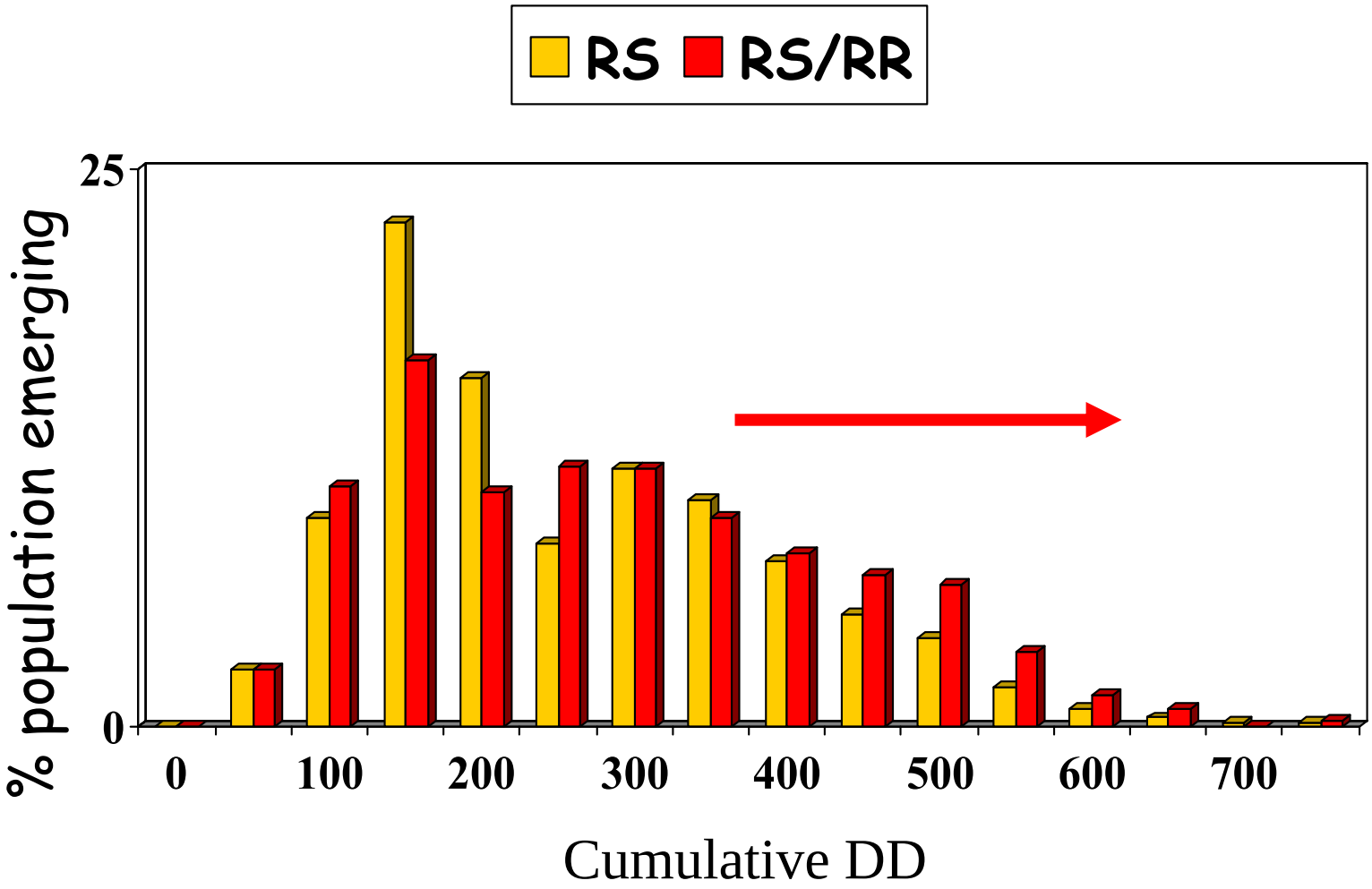
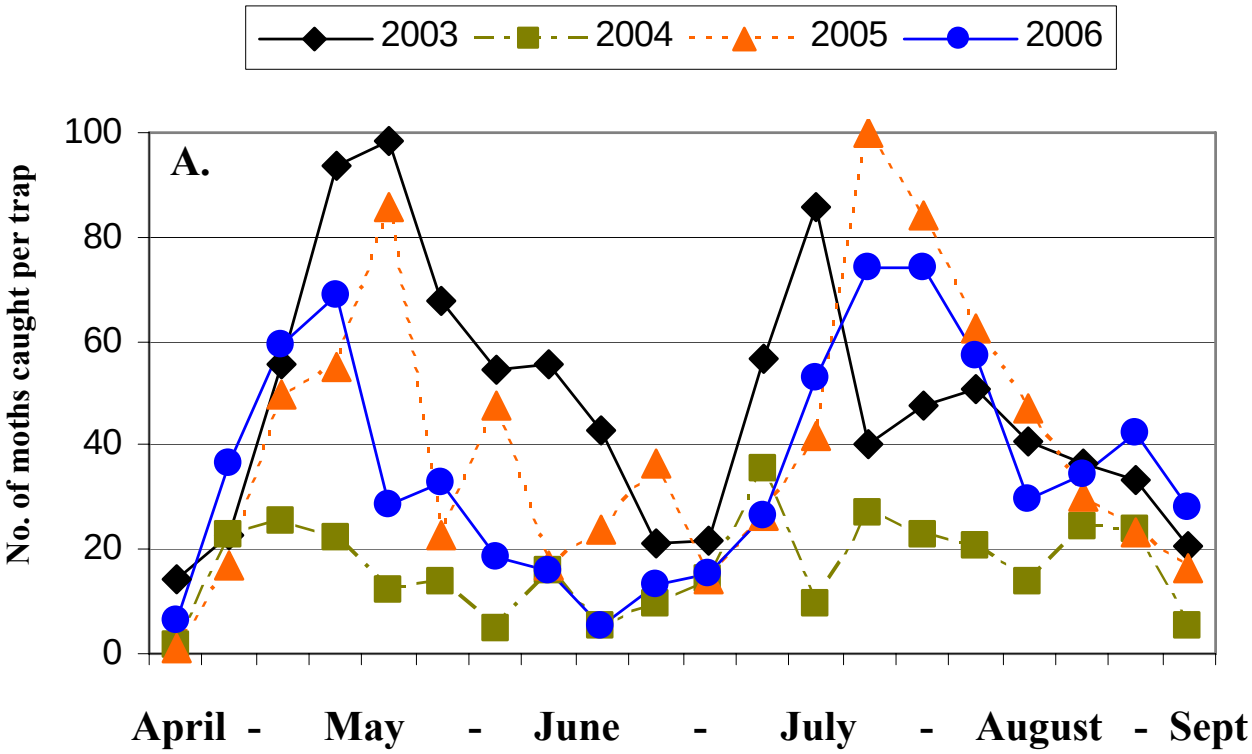
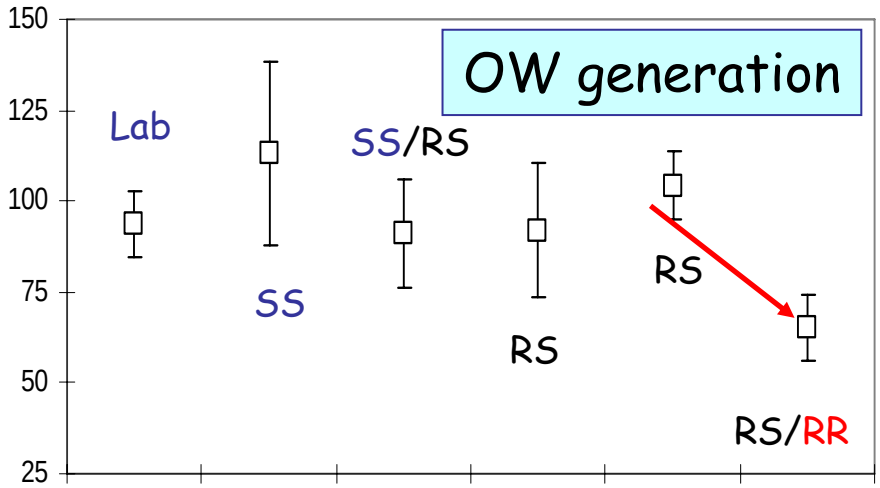
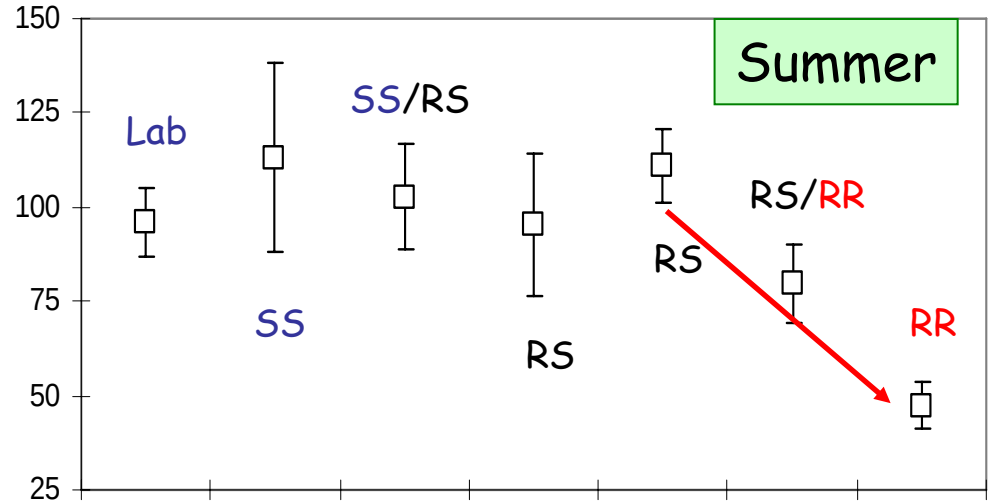


OP Resistant Populations Have Broader Periods of Flight



Resistance Reduces # of Eggs

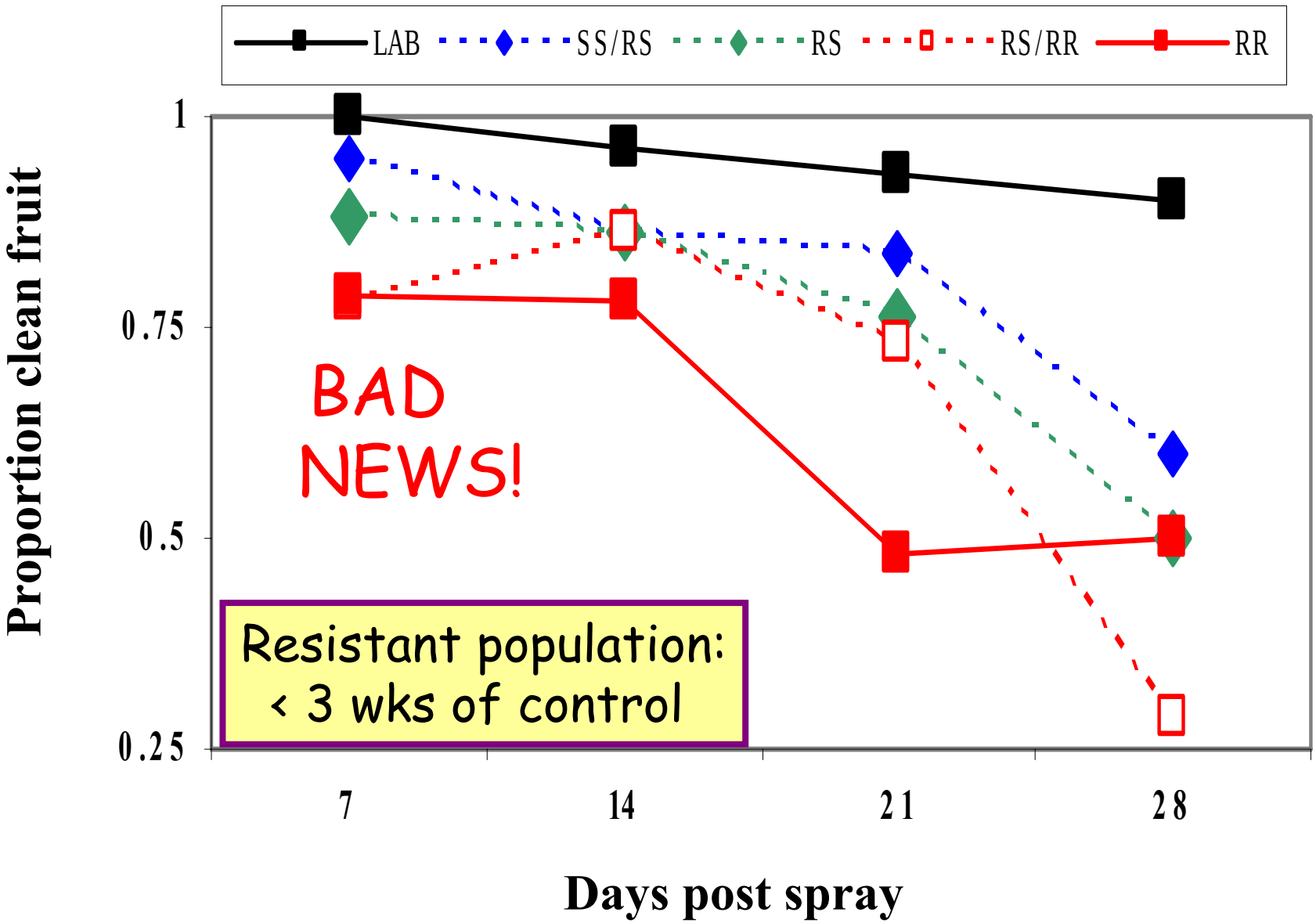




Mean (SE) # eggs laid/mated female

GOOD NEWS!

Guthion´s Effectiveness Drops



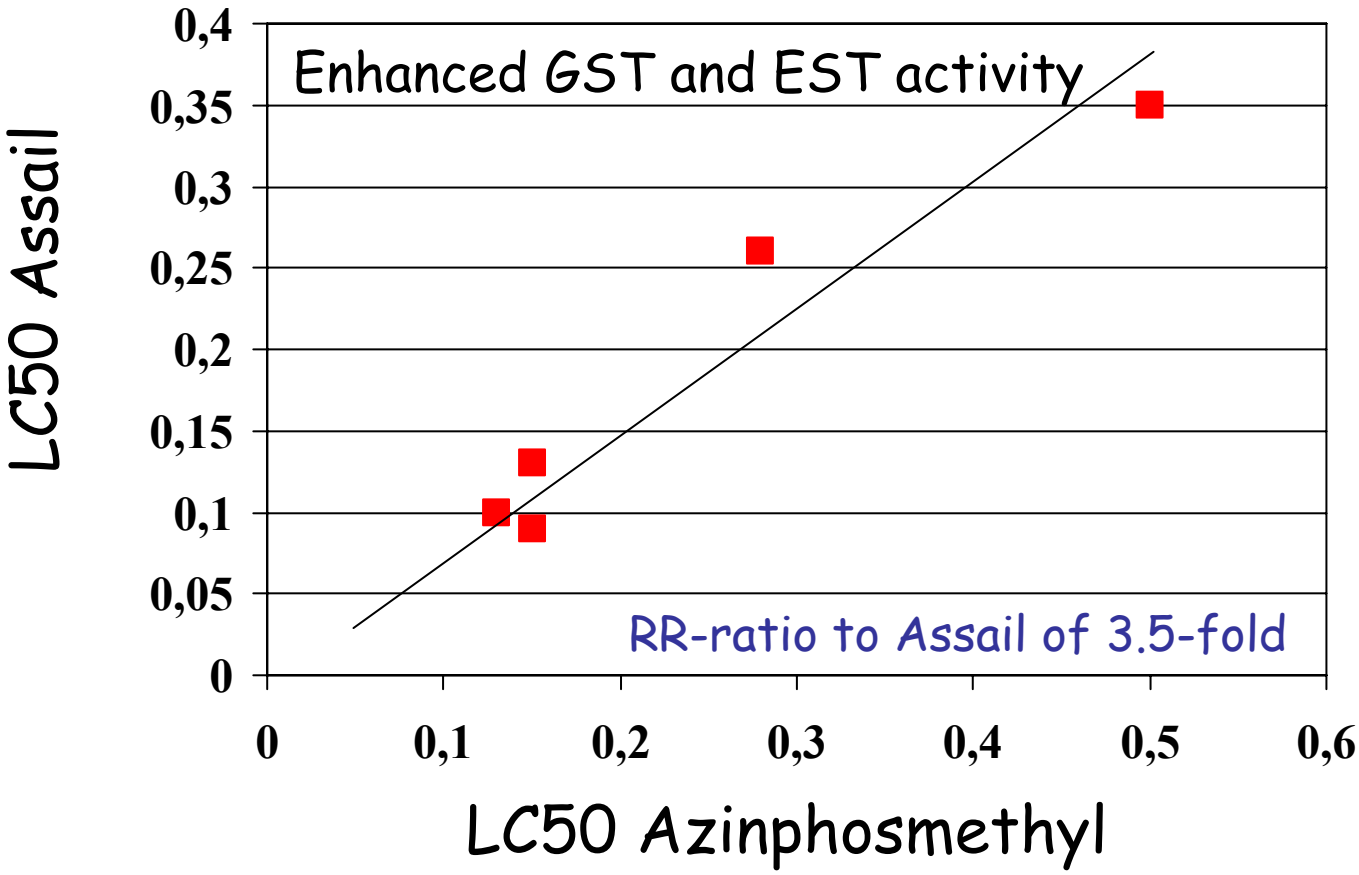
MORE BAD NEWS!

Cross Resistance

Population	Guthion	Asana	Intrepid	Assail	Success
Lab	A	A	A	A	AB
SS/RS	A	A	A	A	A
RS	A	A	AB	AB	**B**
RS/RR	**B**	A	**B**	**B**	**B**

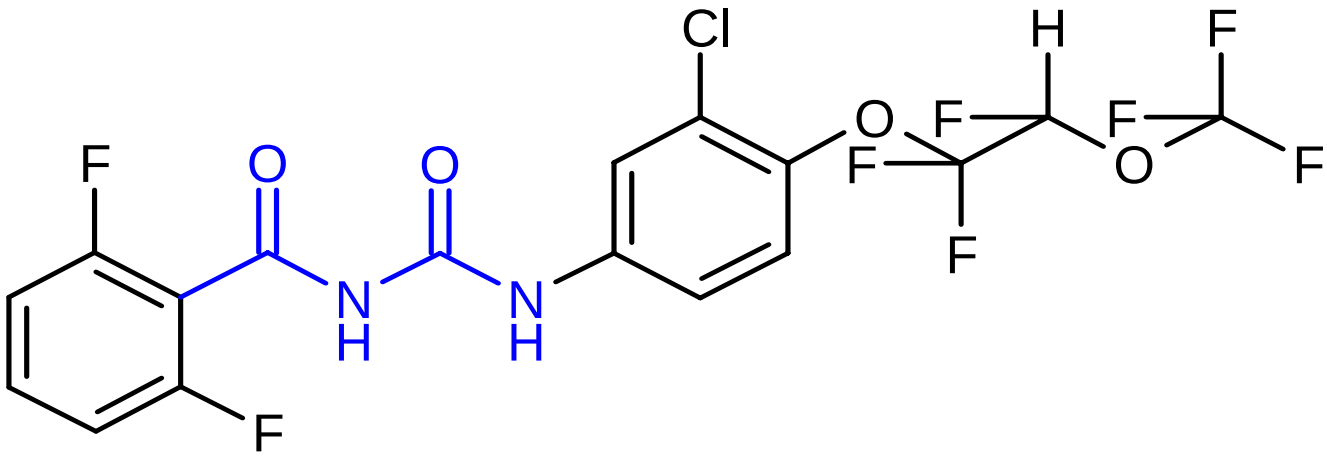
Neonate bioassay conducted at two rates per chemical. Three larvae per fruit. Means separated in sig. ANOVA's with LSD.

OP-Neonicotinyls
Positive Cross Resistance



Another Example of Resistance

Novaluron / Rimon



Benzoyl urea insect growth regulator

Mode of action:
Inhibition of chitin synthesis, causing abnormal endocuticular deposition and abortive moulting

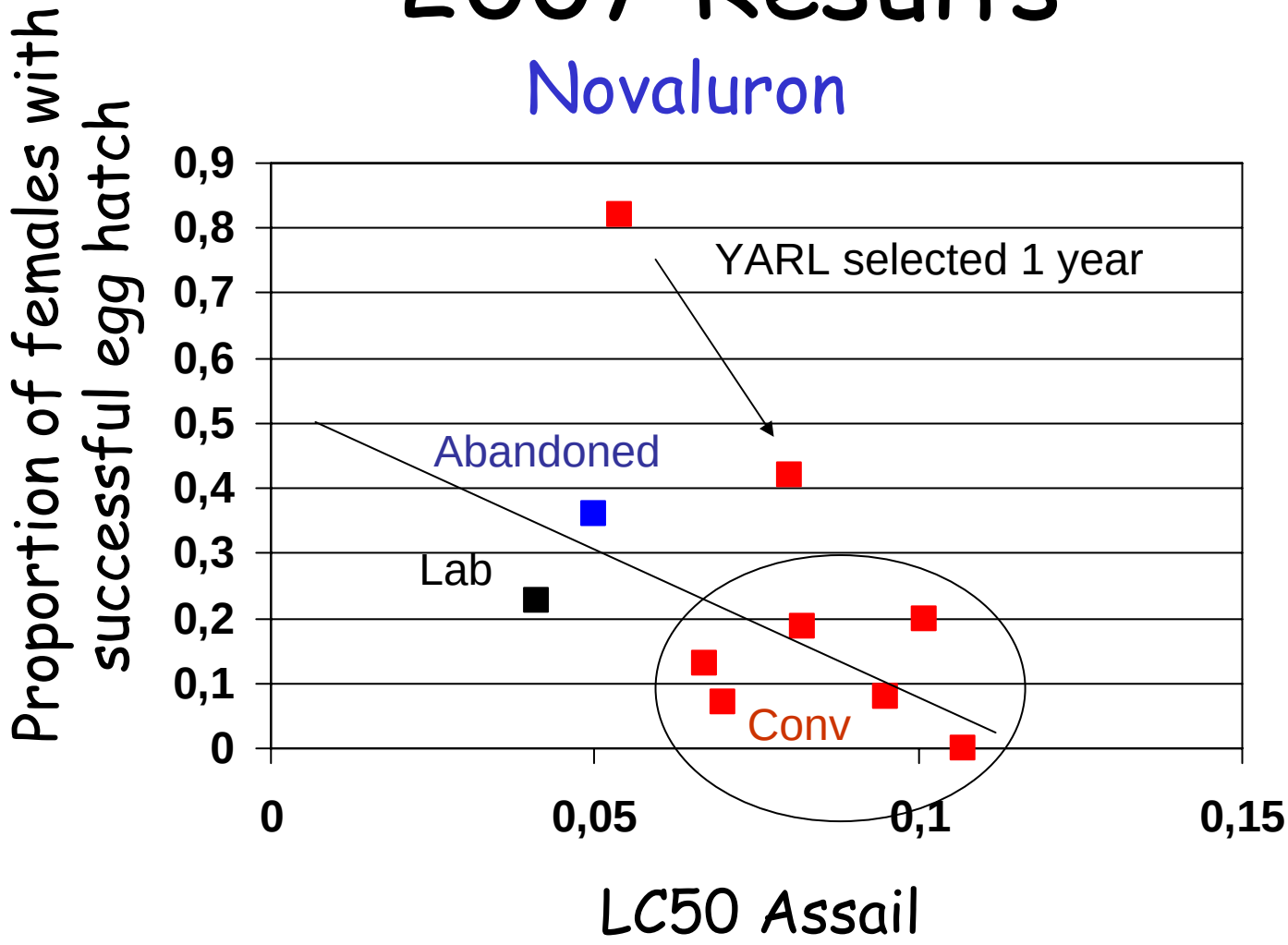
Significant Differences

Populations	Mean fecundity	% egg hatch
LAB	B	Highest
YARL Farm	Highest	A
Organic (3 yrs sprayed)	C	B
CONV (5 yrs unsprayed)	CD	B
CONV (1 yr unsprayed)	D	B
CONV	Lowest	Lowest

OP Susceptibility

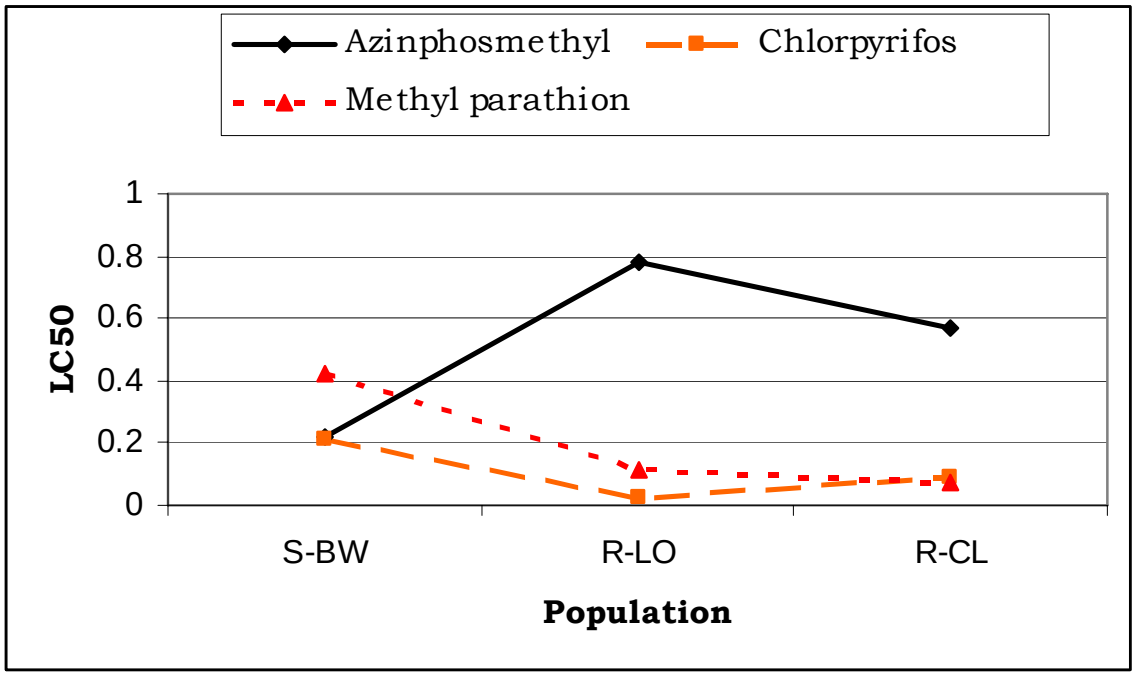
2007 Results

Novaluron



Negative Cross Resistance Can Occur

- Dunley and Welter (2000)
  - ❖2 – 10-fold levels between azinphosmethyl and chlorpyrifos and methyl parathion



Grower`s Actions Impact Everything

Ad from 1958

And, the complex evolution of insecticide resistance marches on

THANK YOU!