

CYD-X[®]

BIOLOGICAL INSECTICIDE

Insecticidal Virus for Control of Codling Moth Larvae



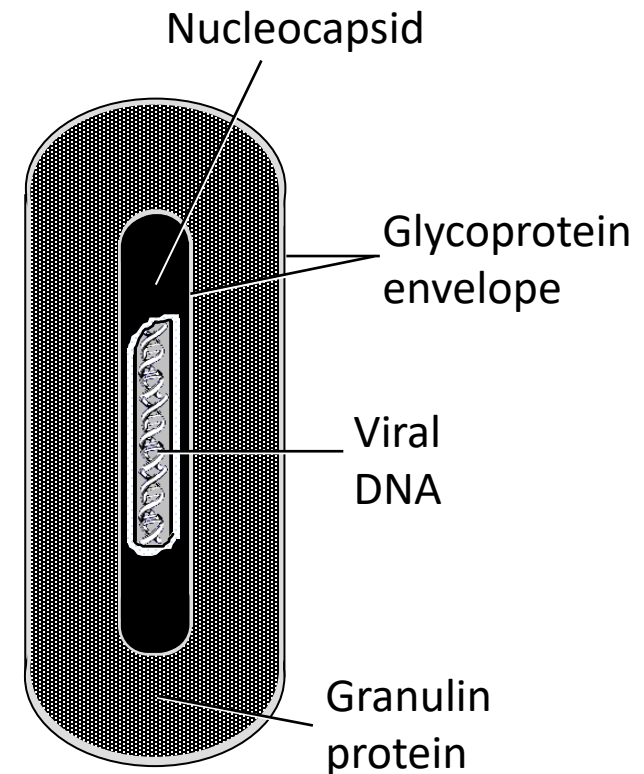
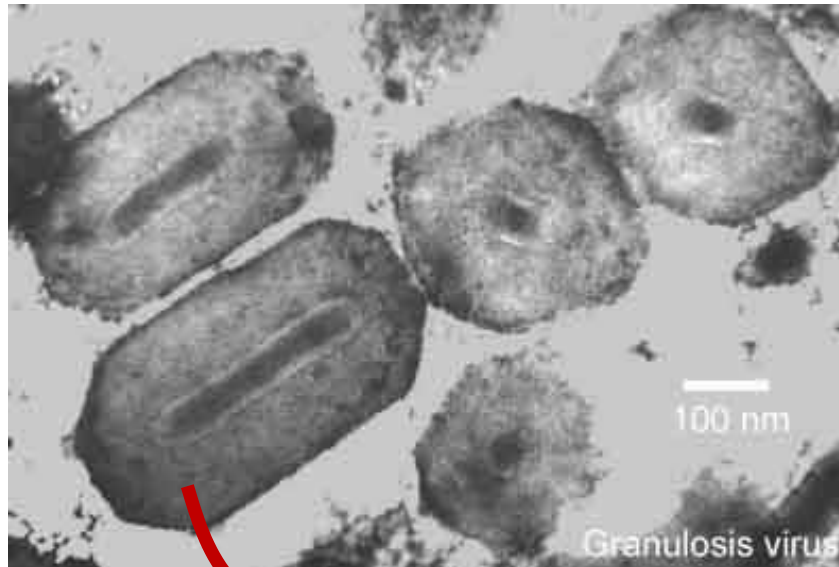
Andermatt

• • • • • Canada

Active ingredient:

Codling moth granulovirus

Electron
photo-
micrograph
of CpGV



**Occlusion
body (OB)**

- *Cydia pomonella* granulovirus (CpGV)
- Natural pathogen of codling moth
- “Mexican” isolate CpGV-M (1963)
- Commercial use since 1988 (Europe)

CYD-X®

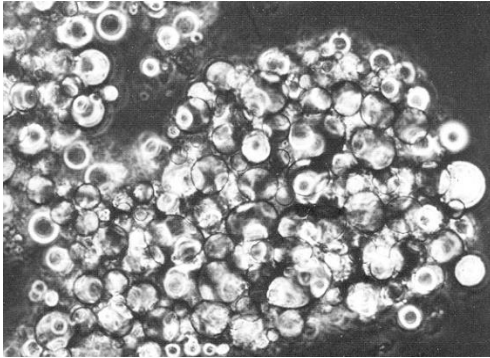
BIOLOGICAL INSECTICIDE



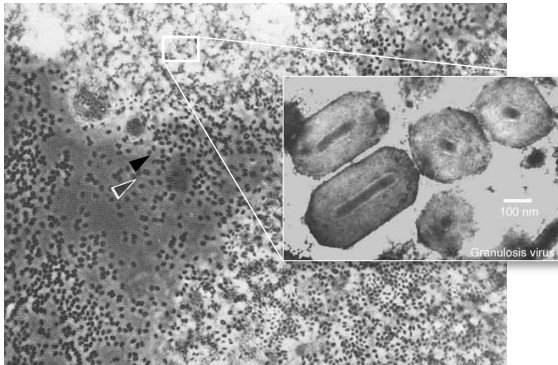
- Virus is produced in mass-reared codling moth larvae
- Formulated as aqueous suspension concentrate (3×10^{13} OB/L)
- Highly specific to codling moth larvae
- No effect on beneficials, wildlife, livestock, or users
- Can be used in organic production (OMRI/EcoCert)



Biology & Mode of Action of CpGV



Fat body of healthy larva



Fat body infected with CpGV



CpGV
infected
larva

- Virus must be ingested to infect larvae.
- Once in gut, OB dissolves & releases infectious virus particles (nucleocapsids)
- Virus penetrates midgut cells & replicates
- Replicated virus spreads to other tissues & continues to replicate exponentially
- Larva stops feeding in 1-3d, dies in 3 -7d (depends on temperature, dose & larval age)
- LD₅₀ is 1 or 2 virus particles per larva (1 ml of Cyd-X contains at least 30 trillion OBs!)

Symptoms of CpGV Infection (Laboratory)



Healthy CM larva



Larva killed by CpGV

Symptoms of CpGV Infection (Field)



Failed entry
("sting")

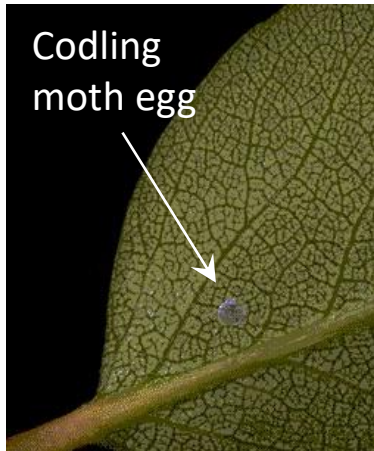


Larva infected as
early instar, died
before entering
fruit



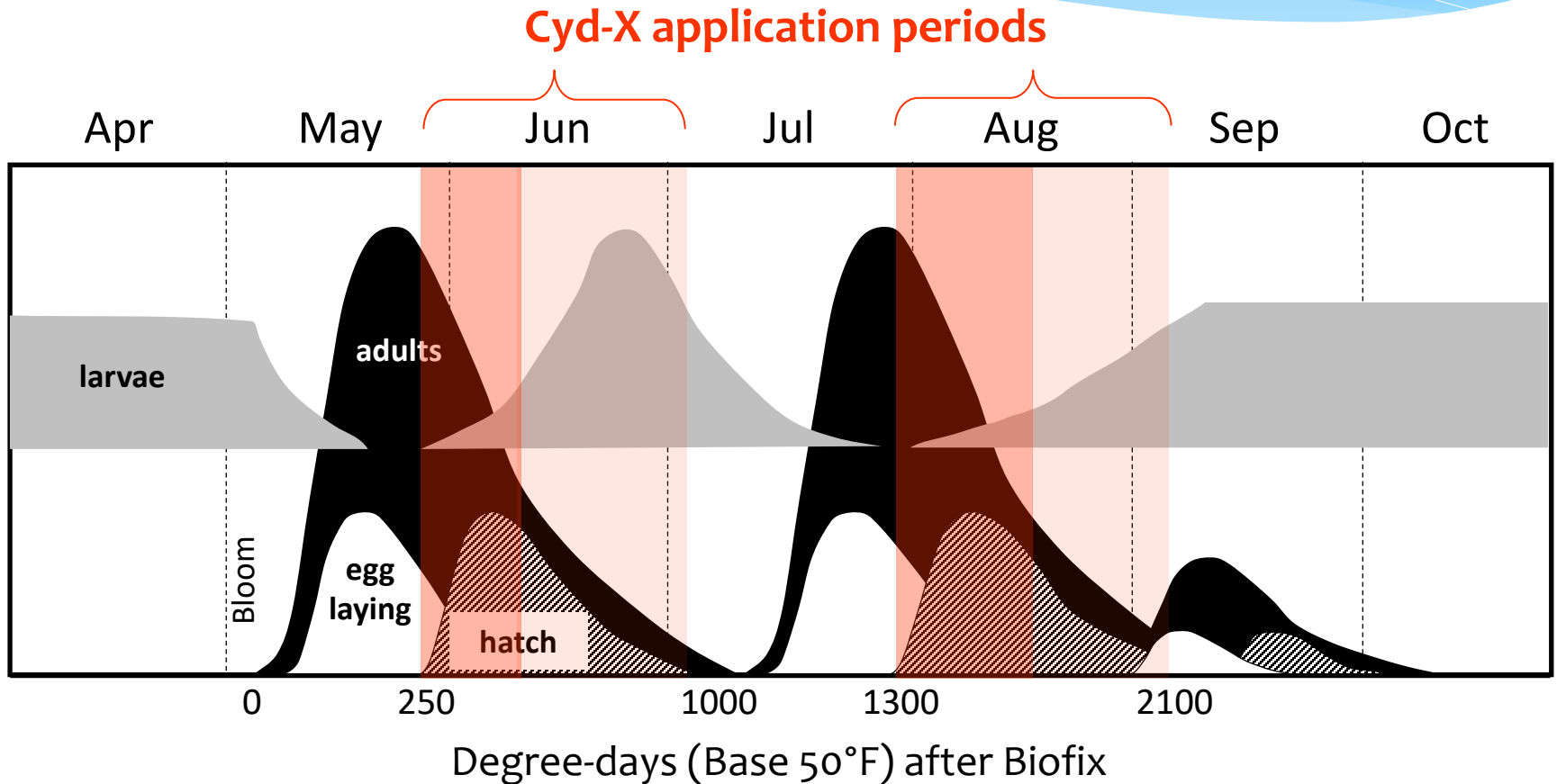
Larva probably infected as late
instar or with low dose, died
inside apple

Infection route & application timing



- Virus must be ingested by larva to initiate infection.
- Larva continues to feed until virus replicates enough to kill it (can require several days).
- Neonate larvae wander after hatching to seek fruit (usually within 1-2 days).
- Most don't eat until they enter fruit (may drink water droplets and sample foliage).
- Larvae don't ingest skin when making entry hole.
- Virus picked up on body & mouthparts will contaminate feeding site & infect larva when it starts to feed.
- **Target hatching eggs and wandering larvae**

Codling moth phenology



Source: L. Gut & J. Wise

Michigan State University Extension Bulletin E-154

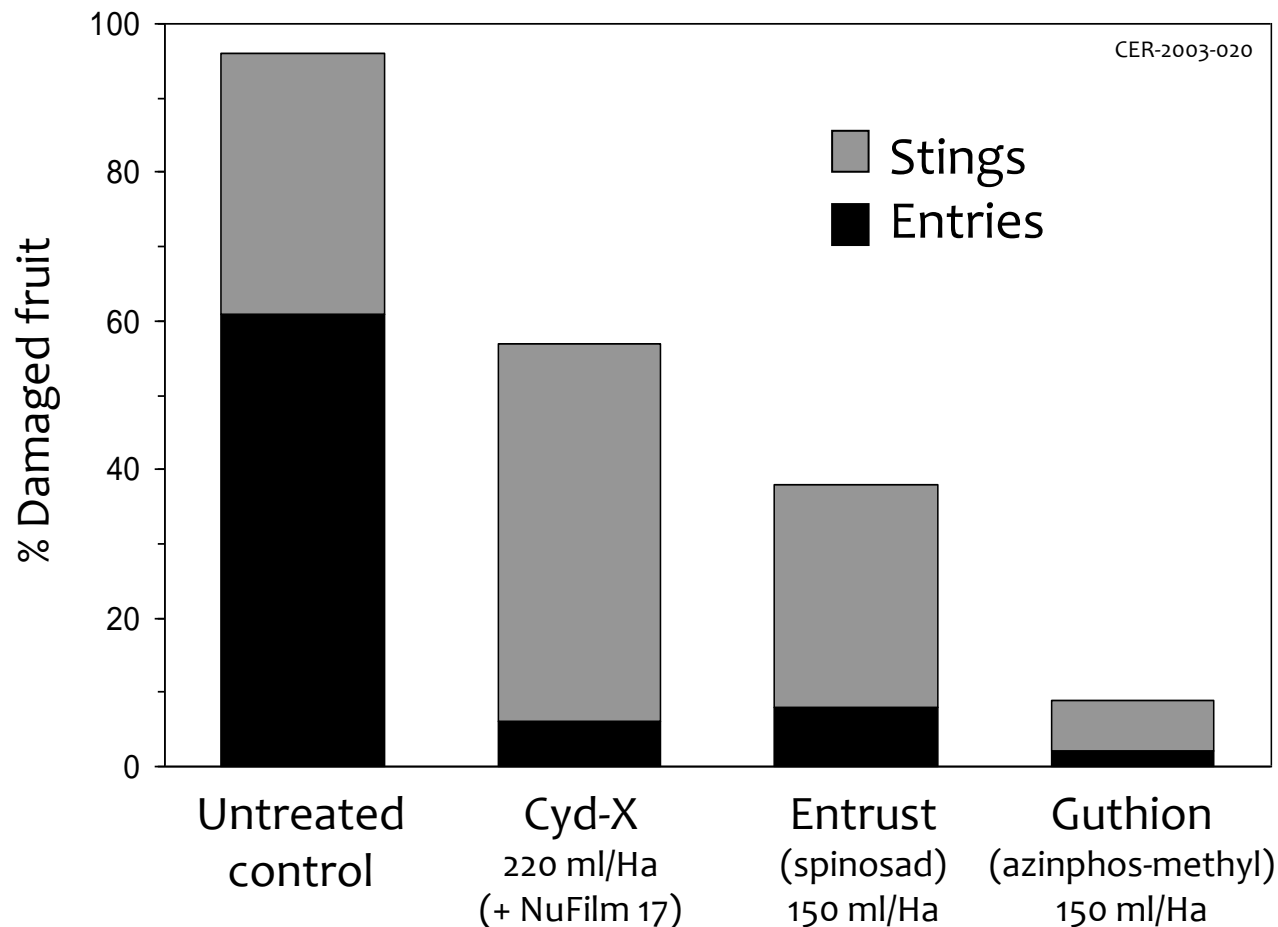
<http://www.msue.msu.edu/epubs/pestpubs/E154/18-CodlingMoth.pdf>

Short-term (single season) effects of CpGV application

Crop: Red Delicious apples

Investigator: Dr. Helmut Riedl, Oregon State Univ.

Location: Hood River, Oregon



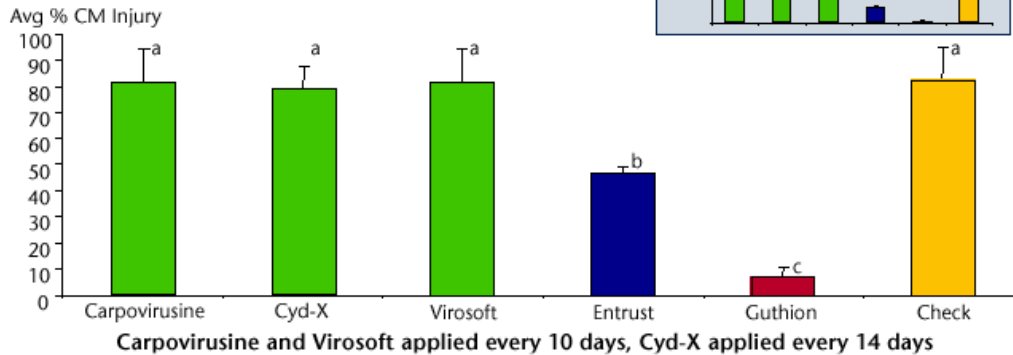
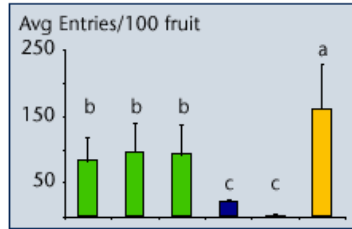
- Cyd-X applied weekly in 1,000 L water/Ha.
- Each spray included NuFilm 17 (0.0625%)
- Entrust & Guthion applied 4 times in 4,000 L/Ha.
- Four single tree replicates

CpGV Use Strategy: Damage prevention vs. Population reduction

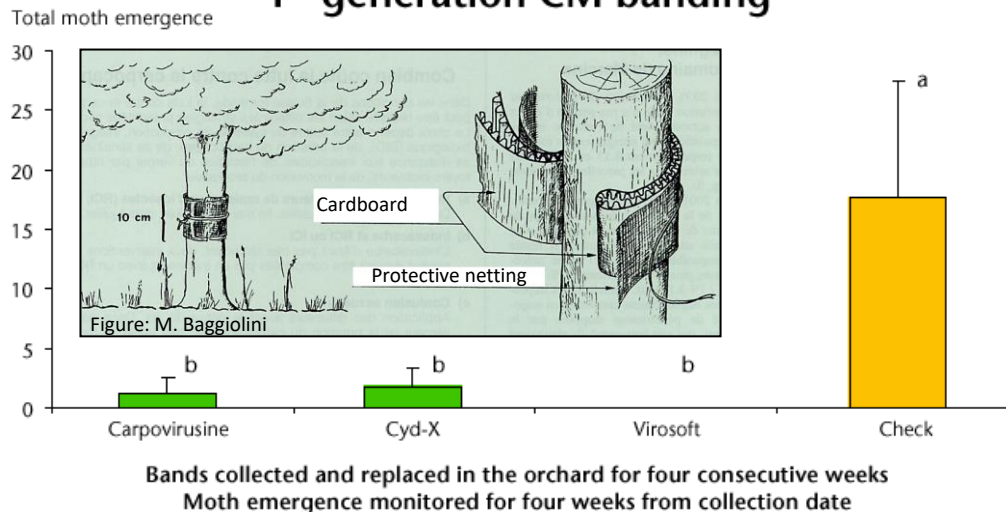
Small-plot handgun trial, 2003

Formulation	Field Rate*	OB x 10 ¹³
Carpovirusine	13.50	0.40
Cyd-X	3.04	0.27
Virosoft	3.24	0.38

*fl oz/100 gal



1st generation CM banding



- CpGV applied against 1st generation larvae.
- Virus did not eliminate damage but resulted in fewer entries than UTC.
- High level of delayed mortality (reduction in subsequent generation)

Source: "Managing Codling Moth with Granulovirus and Spinosad" by K. Granger, J. Brunner, & M. Doerr (Washington State Univ.)

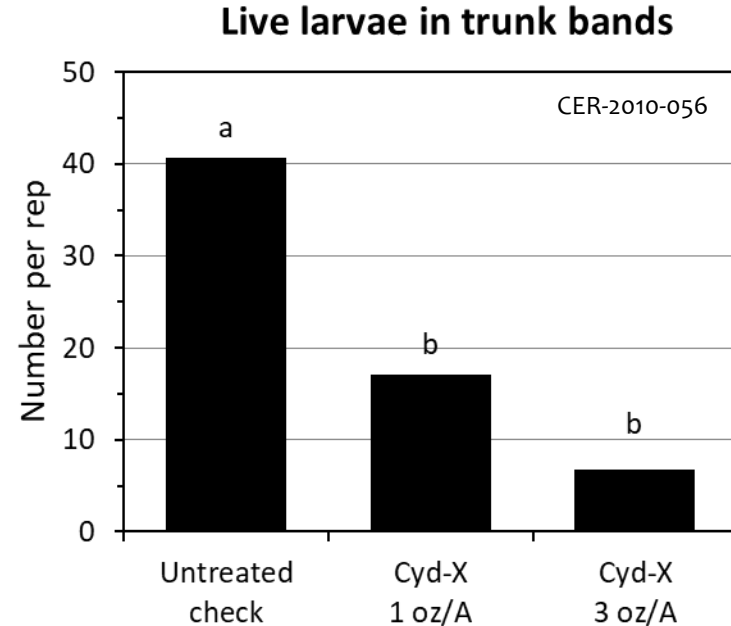
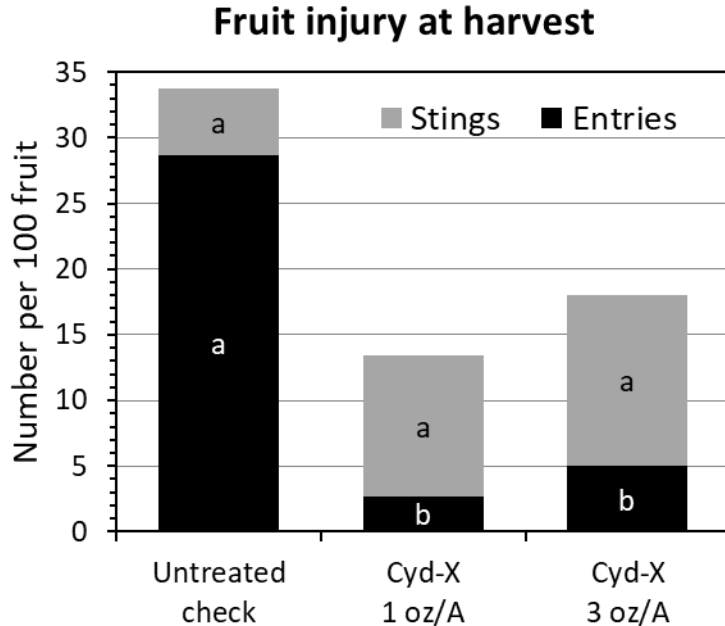
Poster presentation, 2003 Wash. State Hort. Assoc. meeting, Wenatchee, WA

Short-term (single season) effects of Cyd-X application

Effect of Cyd-X on Codling Moth Damage & Larval Survival

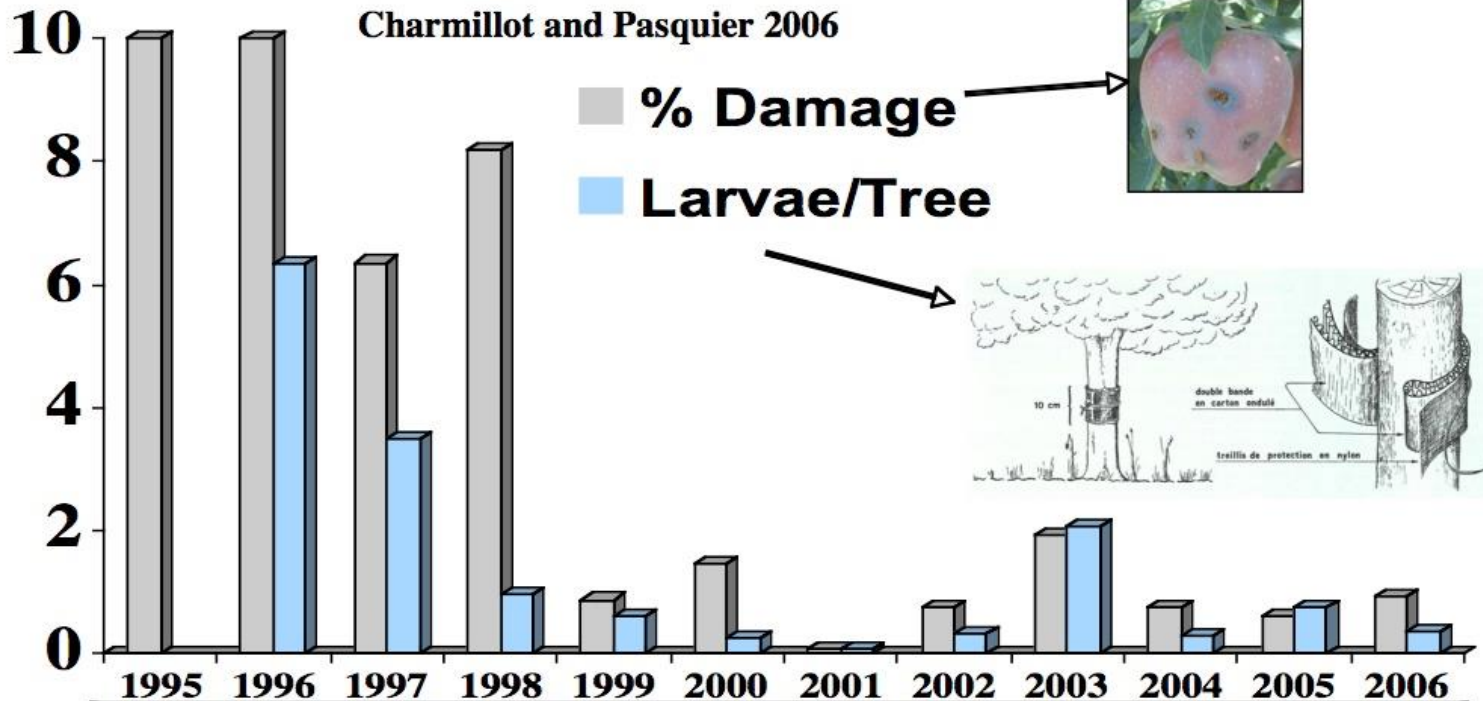
Investigators: J. Brunner & M. Doerr (Washington State Univ.)

Location: Wenatchee, Washington



- 3 – 4 applications per larval generation.
- Rear's Pak-Blast Airblast sprayer delivering 200 GPA at 200 psi.

Cumulative effects of CpGV applications



No Controls	4 x Insecticides	4 x Insecticides	Isomate C Plus							
			CM Virus						CM Virus	
			8 x Full	3 x Full	1 x Full	1 x Full			5 x Half	3 x Half
				4 x Half	6 x Half	5 x Half				

Longer-term (population) effects of CpGV



Horizontal transmission:

Infected larva dies, releasing new virus that can infect other larvae on the same crop

Vertical transmission:

Female that survives a sublethal infection as a larva can pass virus on to her offspring via egg contamination.

Latent infection:

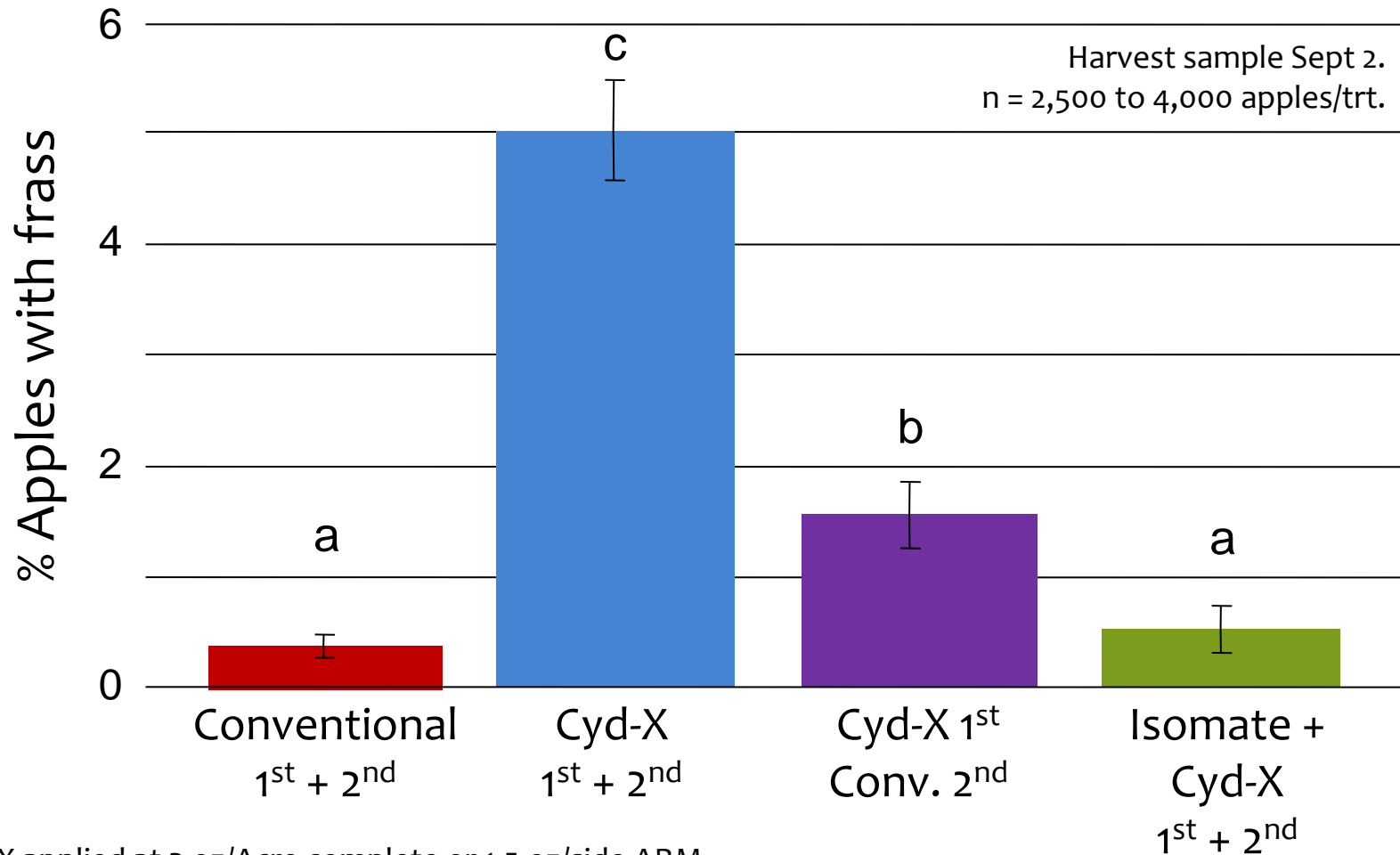
Virus lies “dormant” in host, until stress causes outbreak (e.g. overwintering, heat/cold stress, insecticides)



Granulovirus and Mating Disruption vs. Codling Moth

Investigators: Larry Hull & Greg Krawczyk, Penn State Univ.

Location: Peach Glen, PA (2004)



Cyd-X applied at 3 oz/Acre complete or 1.5 oz/side ARM
Isomate CM/OFM TT applied at 200 dispensers/Acre

- Application rate: 75 - 250 ml/Ha (75 ml pending PMRA approval)
- 2 - 4 applications per larval generation
- Time 1st application at 0-5% egg hatch
 - USA: 200 – 250 DD after biofix if using heat units
- 2nd application 7-14 days later or at peak egg hatch
- Subsequent applications at 7-14d intervals if needed
- Use sufficient water to attain thorough coverage
- Avoid high pH (≥ 9) in spray tank



- Virus persists for years in soil, leaf litter, etc.
- Half-life is 2-3 days in direct sunlight
- Longer persistence (7+ days) on shaded foliage
- Common recommendation: Reapply after 7-8 sunny days
- High temperature is not an issue in the field
- Moderately rainfast once spray has dried

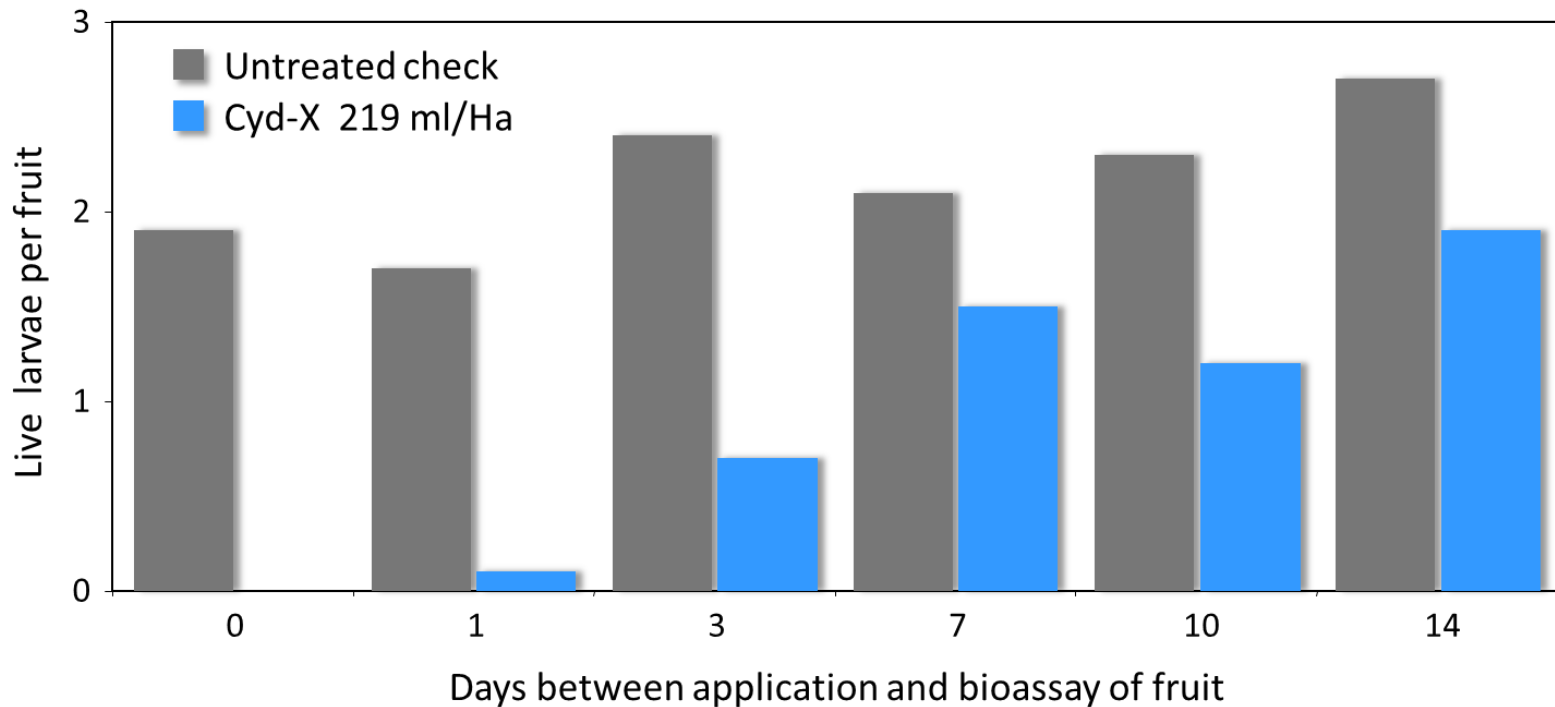
Test of residual activity on apples

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USDA-ARS, Wapato, WA (2003)

Five larvae confined in the laboratory on apples picked immediately before and 1 to 14 days after application.



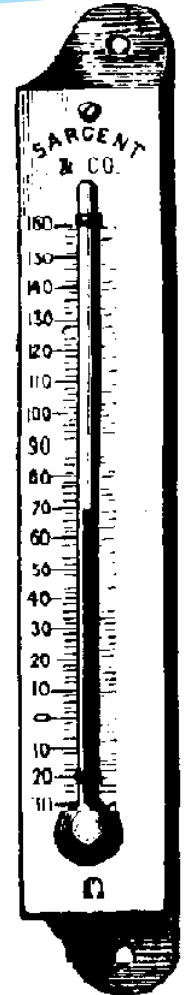
- Natural UV protection
 - “Whole” virus product, not artificially “purified”
 - No chemical additives or residues
 - Can enhanced to some extent by pinolene (NuFilm), humic acid, powdered milk, molasses
- Feeding stimulant may help more than UV screen
 - Sugar or molasses (5 -7 lb/A), brewer’s yeast
- Avoid silicone spreaders
 - Use oil-based or similar “spreader/stickers” (NuFilm, MSO, etc.)
- Compatible with other orchard pest management tactics
 - Excellent fit with pheromone-based mating disruption
 - Tank mix with most insecticides/fungicides/acaricides
 - Do not mix with copper fungicides if using low rates

USA:

- “90 days at 90 degrees (F)”
- Refrigeration not required if used within 3 months.
- Refrigerate (4°C) any unused Cyd-X and use it first next season.
- Cyd-X can be frozen for longer term storage.
- Certis keeps Cyd-X cold until shipped to distributor.

Canada:

“Store refrigerated at 4°C for up to one year from the date of manufacture.”



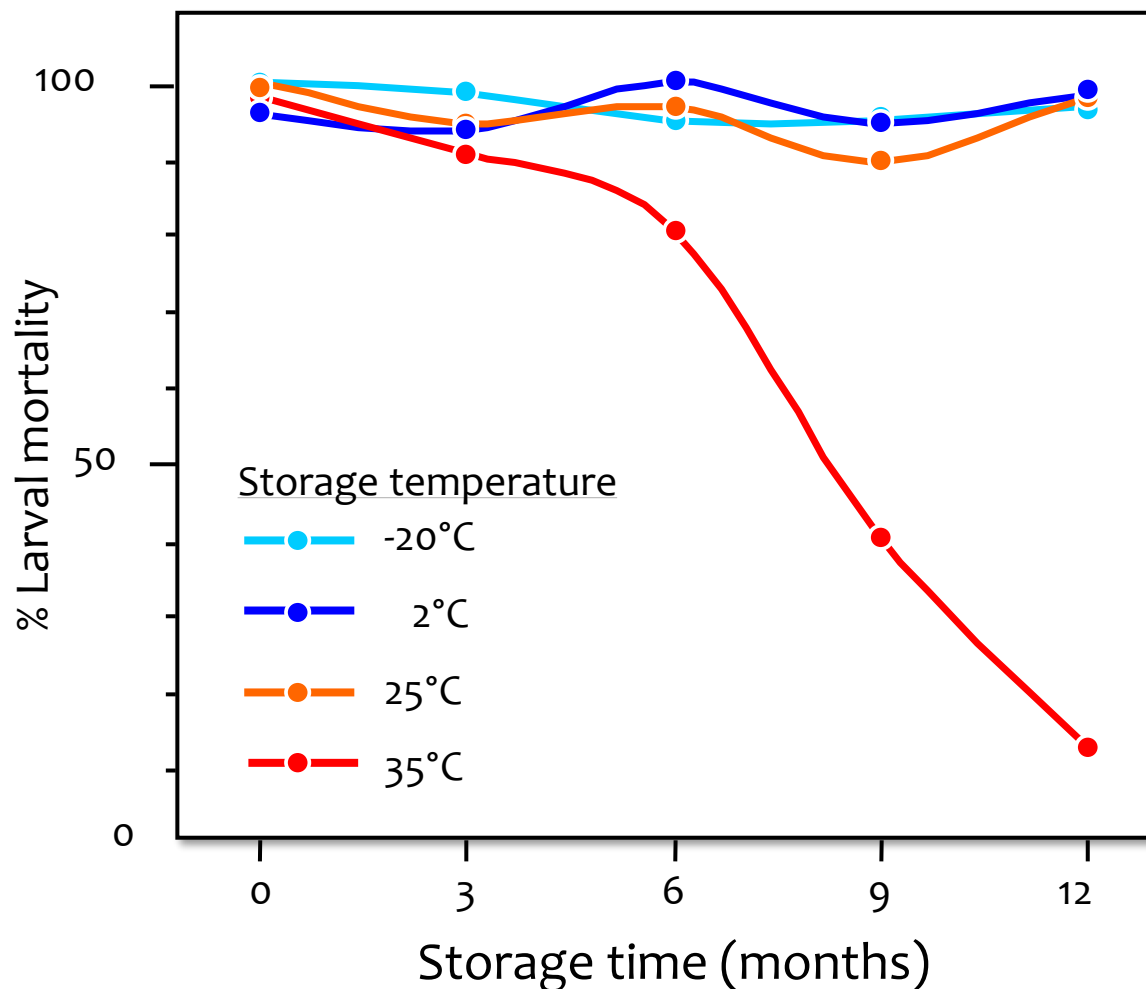
Storage stability

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Results of storage stability study
conducted by USDA-ARS, Wapato, WA

Lacey *et al.* 2008. *J. Econ. Entomol.* 101(2): 288 – 294.

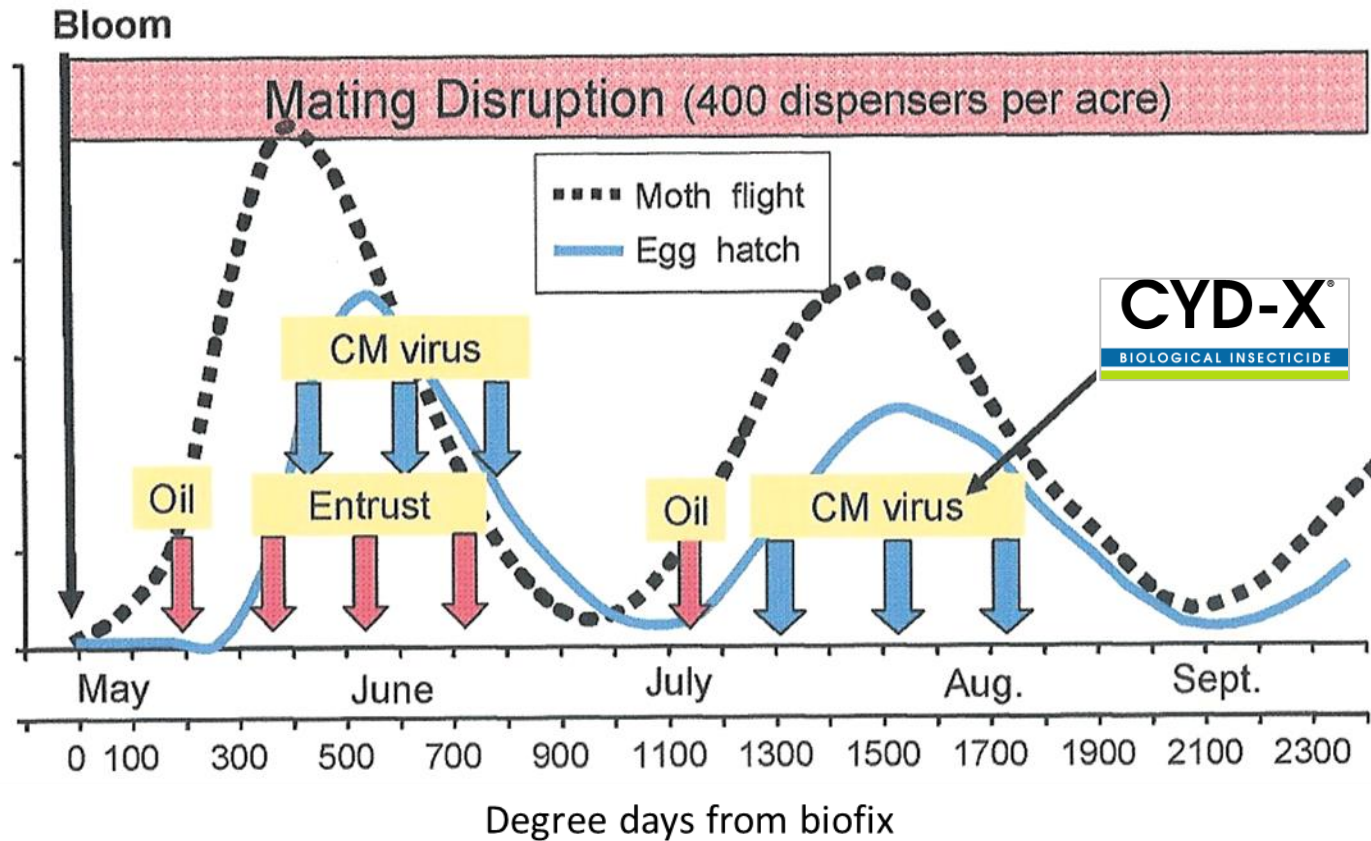


- Product stored at constant temperature.
- Sampled every 3 months.
- Diluted to 2 ppm for bioassay against 1st instar CM larvae (40X below field rate)
- No significant loss in potency if stored at room temperature (25°C) or lower.

Conventional Orchards

- 2 to 4 applications against 1st larval generation
- Rotate/mix with insecticide for rapid knock-down if desired
- Switch to chemical insecticides for 2nd larval generation
- Tank-mix or rotate with Cyd-X for resistance management
- Population management strategy:
 - Virus will reduce number of 2nd flight moths produced by 1st brood
 - Control of 2nd generation larvae will be easier
 - Virus will shift injury from deep entries to stings
 - Sting injury from 1st generation larvae is of lower economic impact
 - Rely on chemical insecticides to prevent direct damage by 2nd gen.
 - Virus can reduce overwintering larval population
 - Vertical transmission (carry-over of virus infection to next season)

Cyd-X Program in Organic Apples (WSU - 2003)



Cyd-X Program in Organic Apples

Washington State University (2003)



1st Cyd-X application

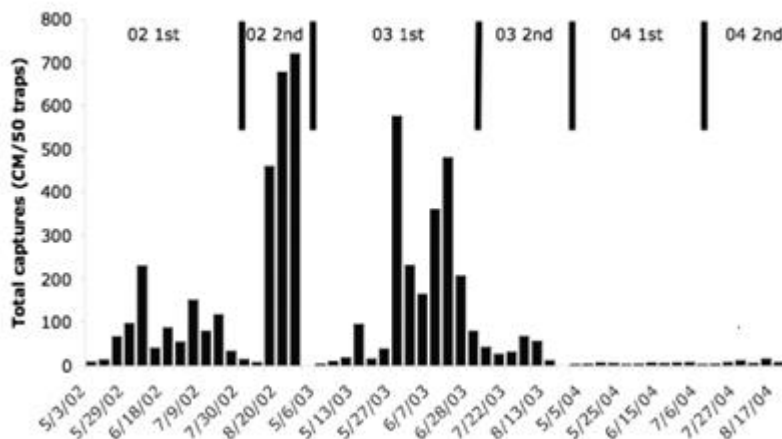


Organic Control in Royal Slope

- 270 acres using full rate of MD
- 2002
 - CM / trap - 67.0 (3 weeks in Aug.)
 - Hand removal - 158 bins, 989 man hours
 - % injury - 5% at harvest
 - Packout - 16 of 25 boxes/bin
- 2003
 - CM / trap - 45.6 (1st gen.)
 - CM / trap - 3.6 (2nd gen.)
 - % injury - < 1% **no hand culling**
 - Packout - 21 of 25 boxes/bin

Year	\$ controls	losses
2002	407	368 bins
2003	487	38 bins

Carson Frenchman CM Captures (02-04)



Toxicity of different active substances on beneficial organisms in fruit production

Interaction of different active substances against *Cydia pomonella* to population of Pear Psylla (*Cacopsylla pyri*)



Fruit damage caused by Cp [%]



Fruit damage caused by Psylla

Efficacy [%]

	Fruit damage caused by Cp [%]	Efficacy [%]	Fruit damage caused by Psylla
Pyrethroid (3 treatments)	5.2	81.7	100
Neonicotinoid (3 treatments)	4.7	83.5	85
Organophosphate (4 treatments)	5.5	80.7	0
CpGv (4 treatments)	0.5	98.2	0
Control	28.5		0

Servicio Fitosanitario, Regione Emilia-Romagna, M. Boselli, 2009

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Lethal Infection

Introducing CYD-X insecticidal virus, the worst medical disaster to befall codling moth larvae. When ingested by codling moth, this powerful biological insecticide replicates inside the larval gut.

Prognosis: Death by massive viral infection. Specific only to codling moth, CYD-X cannot harm non-target species. Ideal for resistance management programs. Perfect partner with mating disruption programs.

It's flu season for Codling Moth

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• • • • • Canada

