An Interactive Model to Predict Development of Codling Moth and Effectiveness of Insecticide Applications in Quebec Orchards

Roland Joannin[1], Daniel Cormier[2], Francine Pelletier[2], Franz Vanoosthuyse[2] and Gérald Chouinard[2]

[1]Agropomme [2] irda Institut de recherche et de développement en agroenvironnement

Decision making for CM control

Common tools :

- Pheromone traps
- Degree-days to predict key events

Phenology model included in CIPRA software (Quebec):
(Computerized Agricultural Pest Forecasting)

- Prediction of adult flight based on daily accumulation of DD
- Developed with data collected in 12 orchards (1977 -2006)

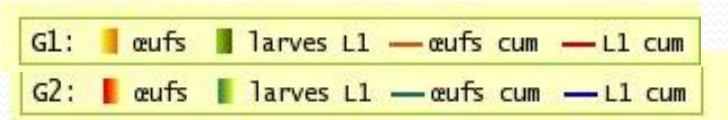
Chouinard *et al*. 2001; Bourgeois *et al*. 2008

Accurate information on biological stage of CM : essential

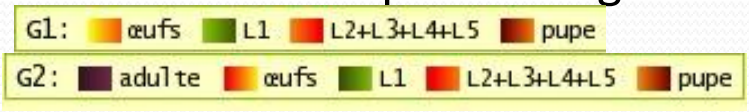
New interactive bio-climatic model

- Developped by Agropomme

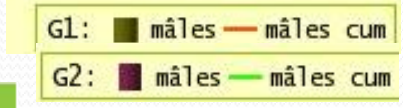
Egg laying and egg hatch

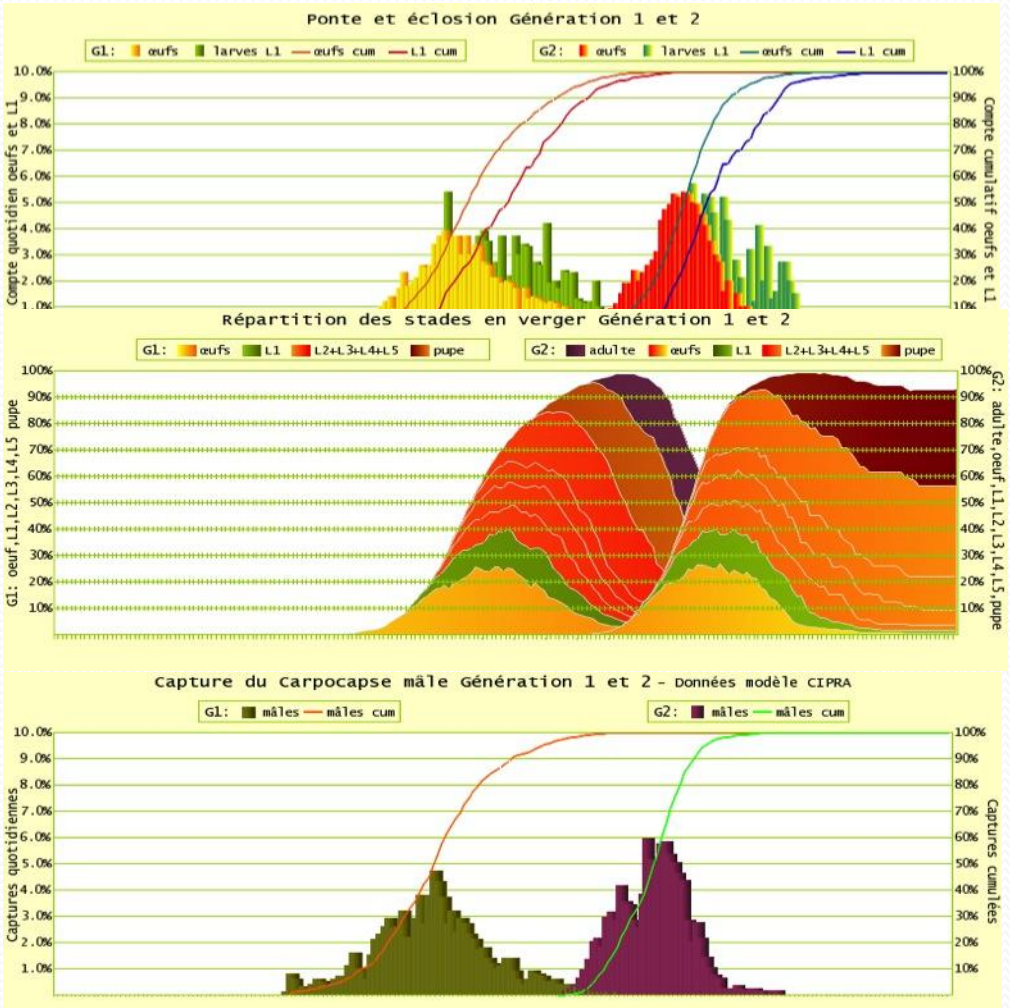


Distribution of specific stage



Adult flight activity





www.irda.qc.ca

Simulation parameters

Start: first male trap catch : DD-predicted or real

- Pre-oviposition period (DD)
- Flight and oviposition window
- Minimum temperature for development
- Minimum temperature for flight
- Minimum temperature for oviposition
- Daily oviposition pattern
- Development time (DD) for each instar
- Adult longevity (DD)

Validation in semi-natural conditions

- Diapausing larvae placed in hibernation cages



- New emerged adults then placed in oviposition cages

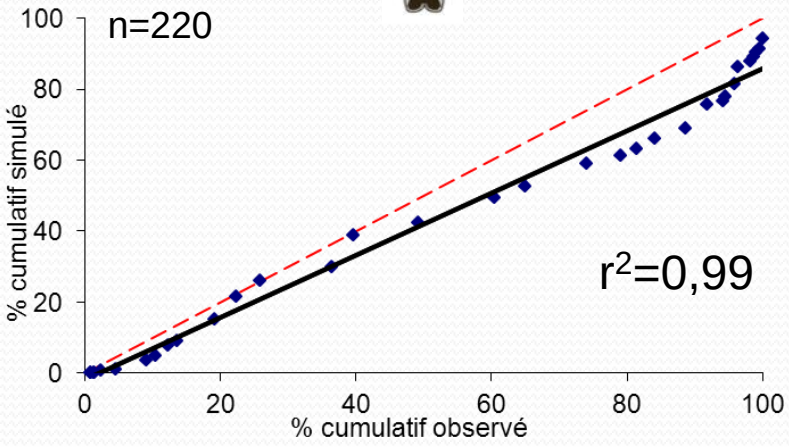

Male + female emergence


Egg-laying

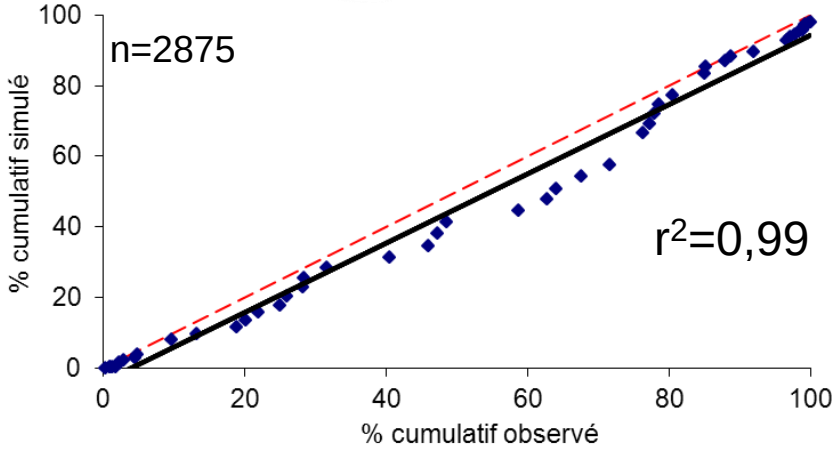

Hatching

Predicted vs observed data

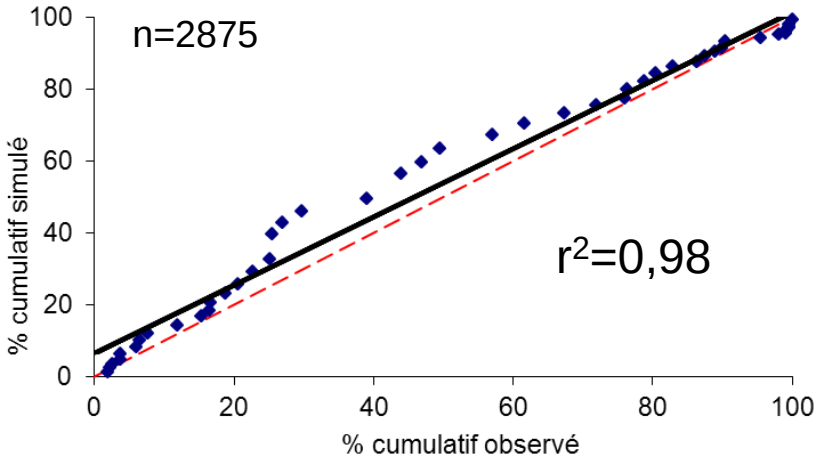
Male emergence

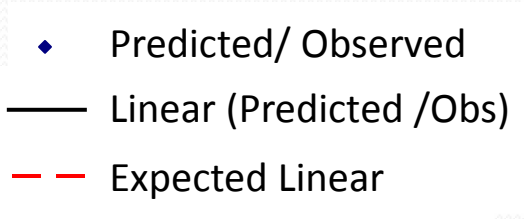


Egg laying



Egg hatch

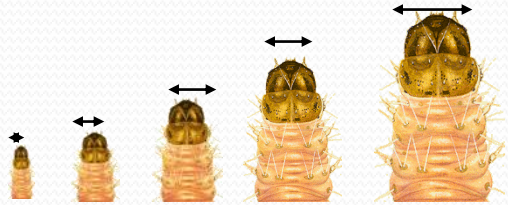


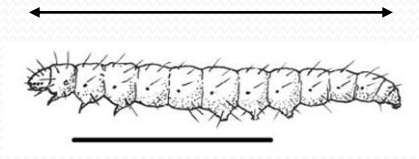


Validation of the model in 4 orchards

- Weekly sampling of CM larvae

- Determination of individual instar (L1-L5)





- Back calculation of approximative date of egg deposition

DD

DD

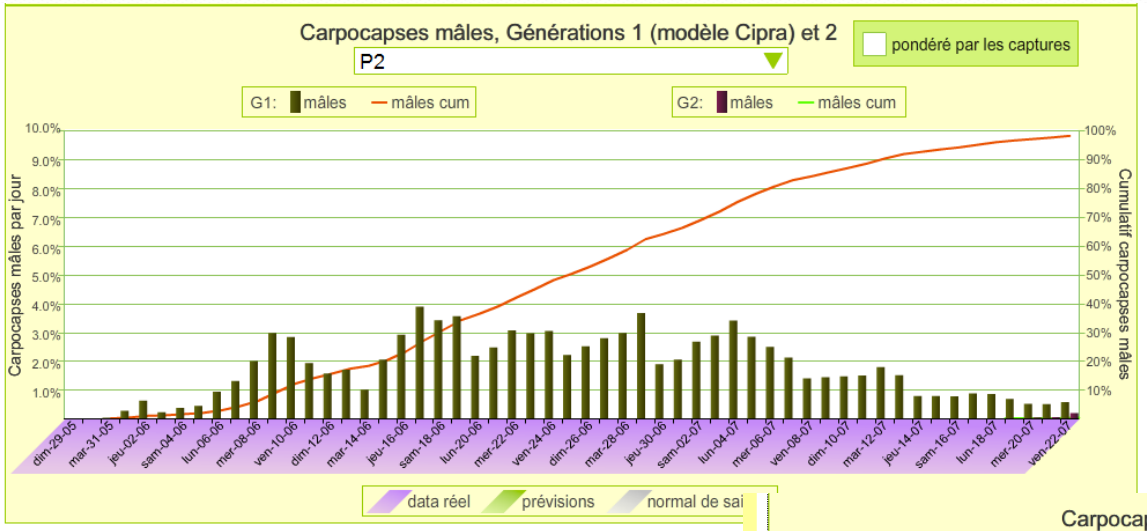
(Trapman et al. 2008; Weitzner et Whalon, 1987; Knight 2007; Pitcairn *et al*. 1992)

Predicted vs observed data (orchards)

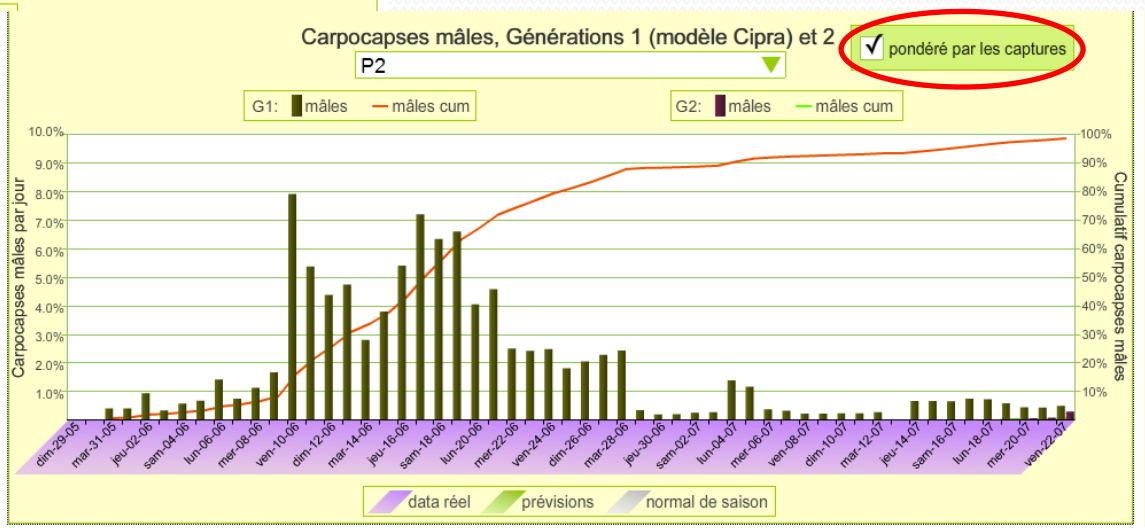
	Sites	2008 (r^2)	2009 (r^2)	2010 (r^2)	2011 (r^2)
Trap catch 	FRAN	0,98	-	-	-
	FRELIG	-	0,77	-	-
	ROUG	0,98	0,96	-	-
	STBR	0,94	0,98	0,95	0,98
Egg laying 	FRAN	0,80	-	-	-
	FRELIG	-	0,99	-	-
	ROUG	0,98	0,98	-	-
	STBR	0,88	0,98	0,97	0,97
Egg hatch 	FRAN	0,89	-	-	-
	FRELIG	-	0,98	-	-
	ROUG	0,99	0,95	-	-
	STBR	0,87	0,97	0,98	0,99

Interactive model

- Without entering trap catches



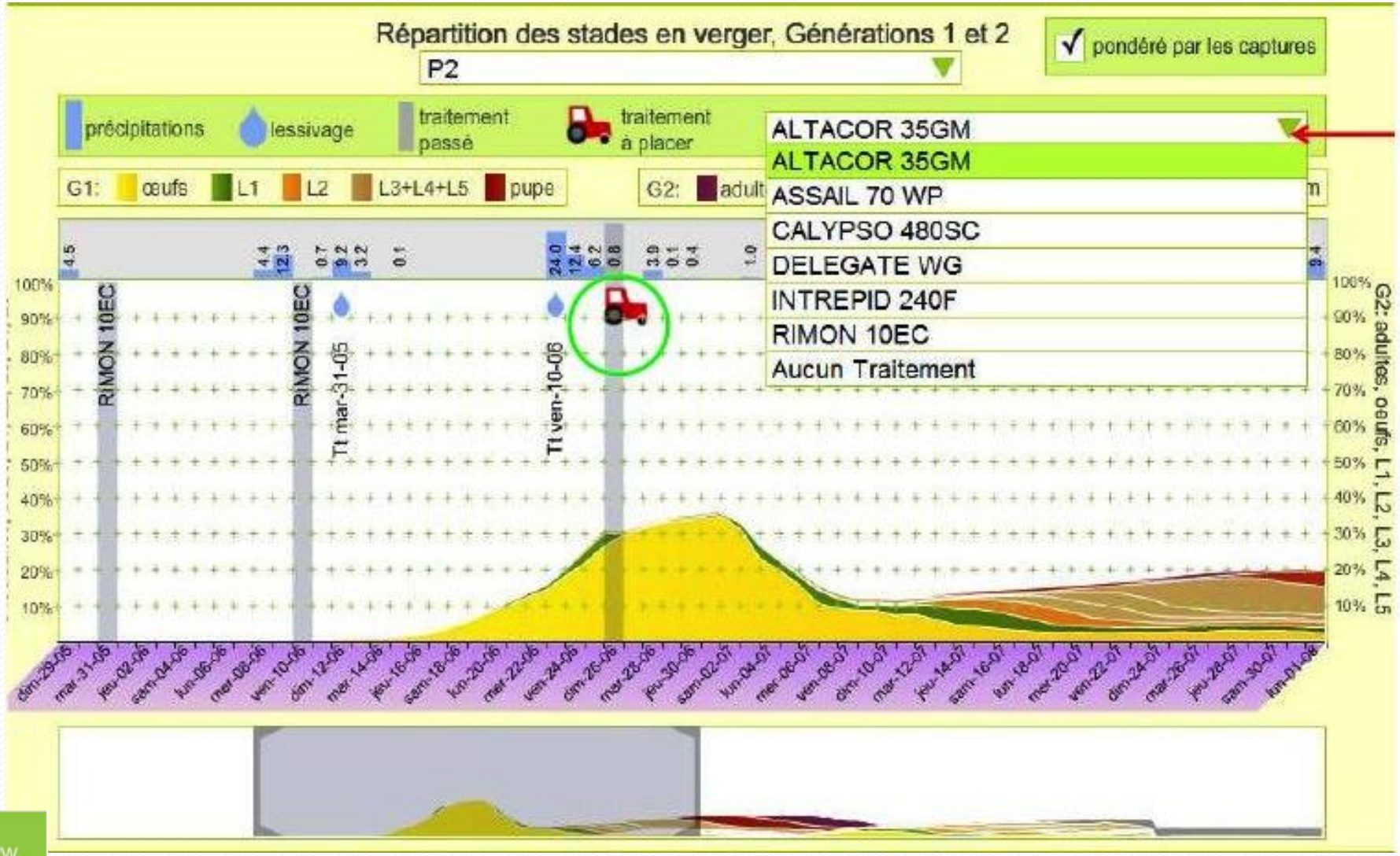
- Using actual trap catches



Agropomme website

www.irda.qc.ca

Interactive model – Insecticides



Relative toxicity to various life stages

- Experimental unit : 5 trees * 3 replicates
- Handgun applications to dripping point
- 6 insecticides tested + control (water only)
- Direct (topical) and residual toxicity assessed for:

Active ingredient	Trade name	Rate (/ha)
Novaluron	Rimon 10 EC	0,93 L
Methoxyfenozide	Intrepid™ 240F	1,0 L
Acetamiprid	Assail 70 WP	120 g
Thiacloprid	Calypso^MC 480 SC	290 ml
Spinetoram	Delegate WG	210 g (1/2dose)
Chlorantraniliprole	Altacor^MC	145 g

Residual toxicity




Eggs:

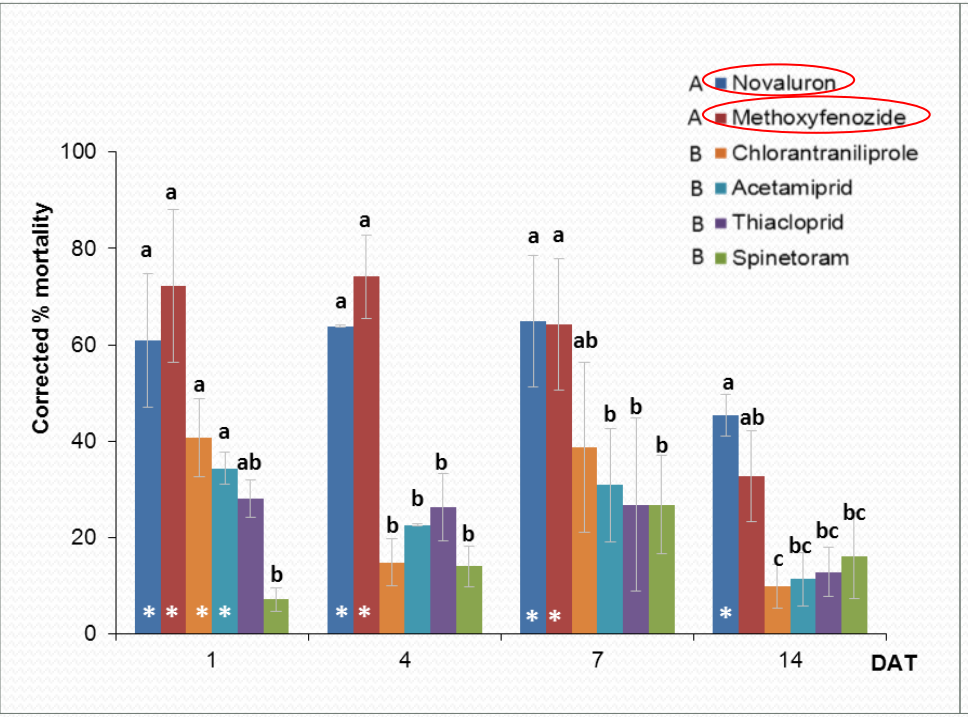
- Fruits or leaves collected 1, 4, 7, 14 DAT
- Placed in oviposition cages (18h)
- Egg hatch recorded daily for 10 d

Neonates:

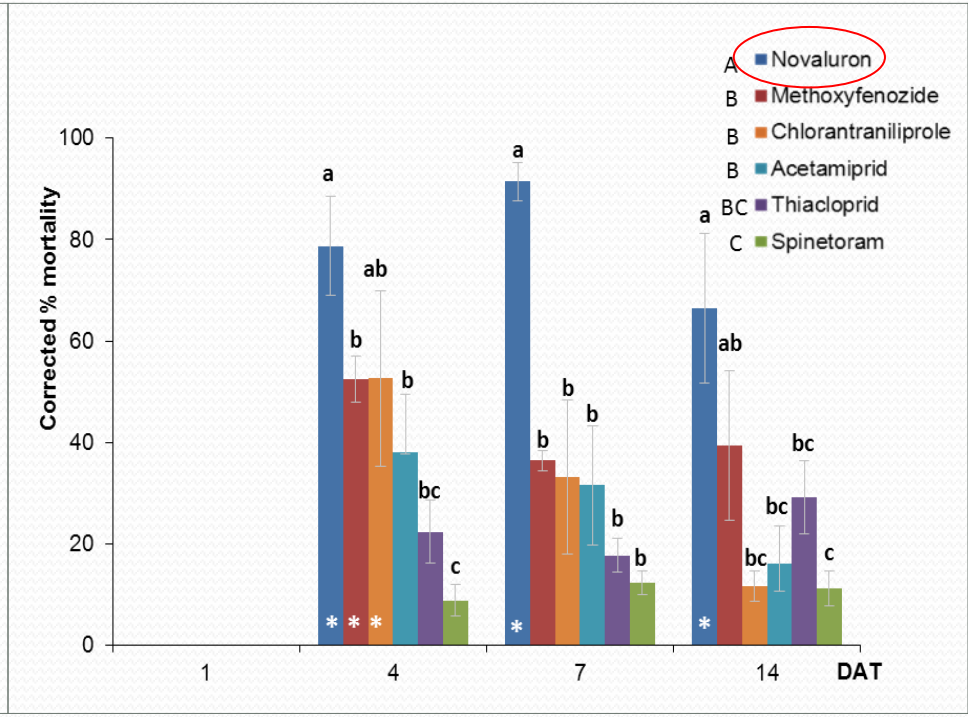
- Fruit collected 1, 4, 7, 14 DAT
- exposed to neonates
- Survival evaluated after 10 d


Results - Residual toxicity on eggs

Eggs laid on fruits



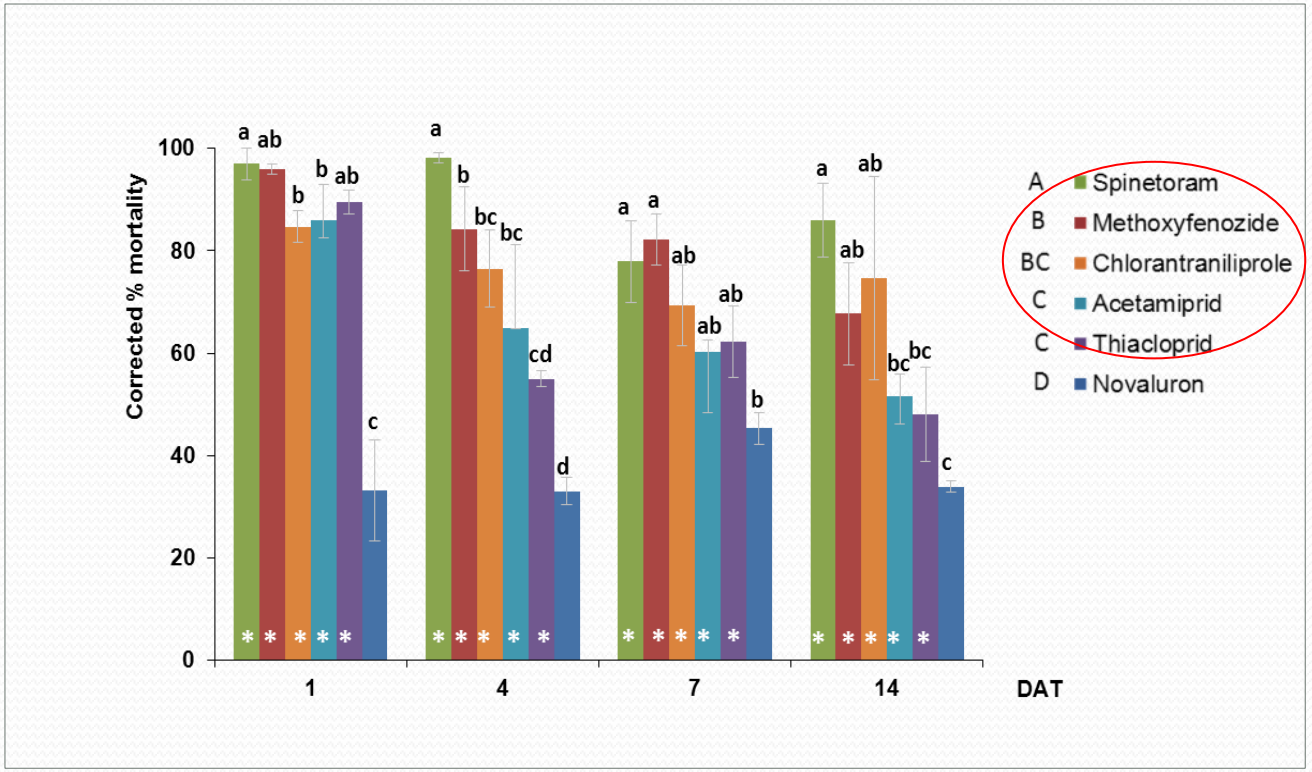
Eggs laid on leaves



Treatments with the same letter are not significantly different (ANOVA, α=0,05).
Insecticides with an asterisk (*) are significantly different from the control (ANOVA, Test de Dunnett's, α=0,05).

www.irda.qc.ca

Results -Residual toxicity on neonates



Treatments with the same letter are not significantly different (ANOVA, α=0,05).
Insecticides with an asterisk (*) are significantly different from the control (ANOVA, Test de Dunnett's, α=0,05).

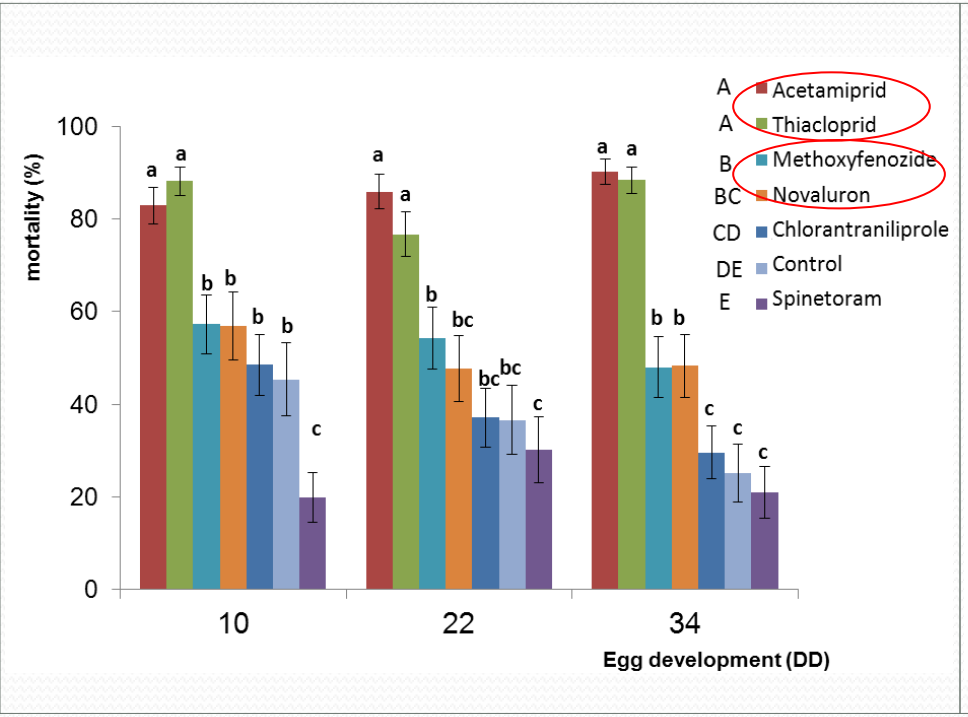
Topical toxicity on eggs

Topically-treated eggs :

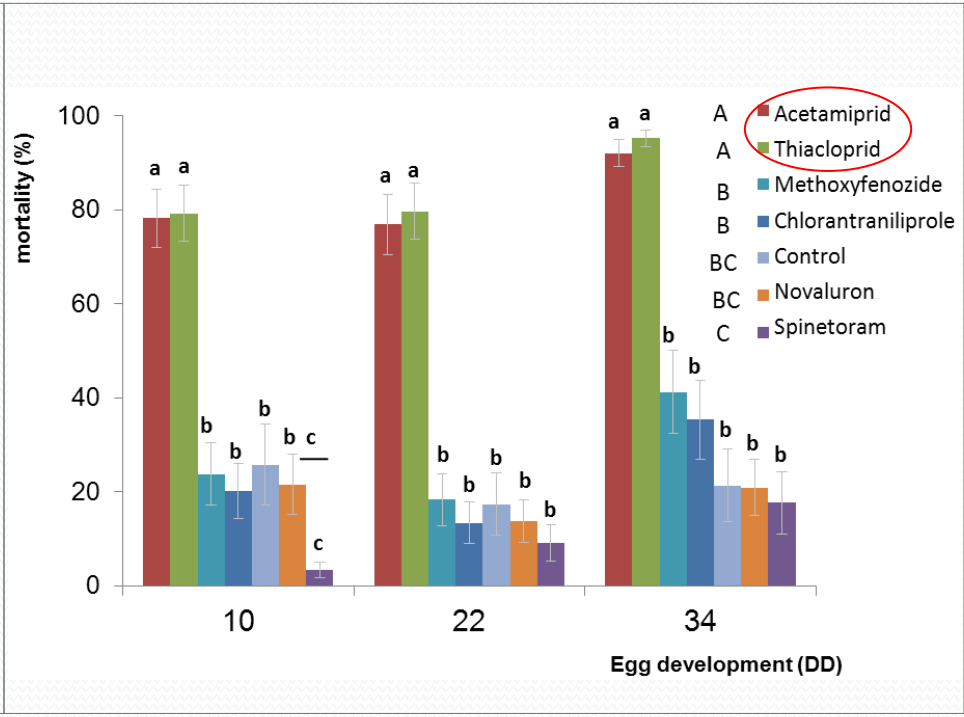
- 3 cohorts of eggs of different ages
- 1, 2 or 3 days before insecticide applications
- Egg hatch evaluated after 10 d

Results - Topical toxicity on eggs

Eggs laid on fruits



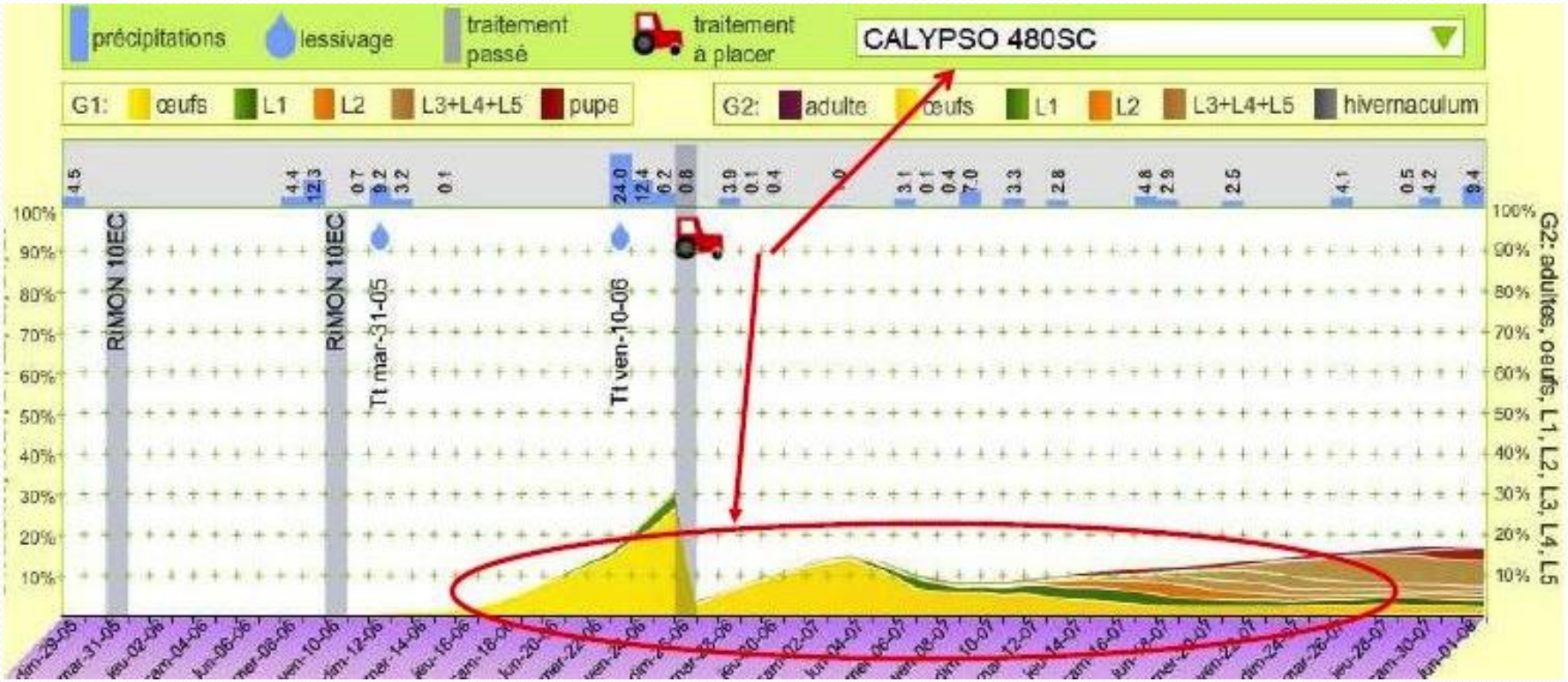
Eggs laid on leaves



Treatments with the same letter are not significantly different (ANOVA, α=0,05).

www.irda.qc.ca

Decision tool for CM management



Acknowledgement

- **Suggestion on experimental protocol :**
  Gaëlle Charpentier, Sylvie Bellerose, Steeve Lamothe (IRDA); Gaétan Bourgeois, Dominique Plouffe (CRDH/AAC); Marc Trapman (Bio Fruit Advies)
- **Agronomic expertise :** Yvon Morin, Nathalie Tanguay
- **Access to orchard plot :** Monique Audette, M. Leduc, Jocelyn Tardif
- **Statistical analysis** : Michèle Grenier
- **Design of the model** : Alain Rochia (Tranquilsoft)
- **Technical assistance** : Martin Duquette
- **Funding:** Programme Prime-Vert, Appui à la Stratégie phytosanitaire of the Ministère de l'agriculture, des Pêcheries et de l'Alimentation du Québec
  Programme de soutien à l'innovation horticole (PSIH) of the Ministère de l'agriculture, des Pêcheries et de l'Alimentation du Québec

www.irda.qc.ca

Ministère de l'Agriculture, des Pêcheries et de l'Alimentation Québec