

Impacts of pesticides used in Quebec (Canada) corn fields on honeybee colonies

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Economic value of pollinators in Quebec

Culture	Taux de dépendance aux pollinisateurs Références					Valeur de la culture				Valeur attribuable aux pollinisateurs
	Pouveau ¹	Morse et Caldrone ²	Agri. Agro. Canada ³	deOliveira ⁴	Moyenne	Superficie Qc/Ha	Produit brut/ha	Références	Valeur brute	
Bleuets		1	1	0,89	0,96	12 400	1 995	5 et 6	24 738 000 \$	23 830 940 \$
Canneberge		1	1	0,80	0,93	1 619	24816	9	40 177 104 \$	37 498 630 \$
Canola/Colza	0,10		0,20	0,46	0,25	21 000	982	5 et 6	20 622 000 \$	5 224 240 \$
Citrouille		0,90	1	1,00	0,97	647	12 150	5 et 8	7 861 050 \$	7 599 015 \$
Concombre		0,90	1	0,60	0,83	809	10 636	5 et 7	8 604 524 \$	7 170 437 \$
Courge Zucchini		0,90	1		0,95	647	20 930	5 et 6	13 541 710 \$	12 864 625 \$
Fraise	0,80	0,20	0,30	0,36	0,42	1 477	30 627	5 et 6	45 236 079 \$	18 772 973 \$
Framboise			0,90	0,38	0,64	526	24 206	5 et 6	12 732 356 \$	8 148 708 \$
Poivrons		0,20		0,65	0,43	587	25 200		14 792 400 \$	6 286 770 \$
Pomme	0,70	1	1	1	0,93	4 961	8 361	5 et 6	41 478 921 \$	38 368 882 \$
Raisins		0,1			0,10	301	12 600	1 et 2	3 792 600 \$	379 260 \$
Total									233 576 744 \$	166 142 599 \$

¹ Pouveau, A. 2004. Les insectes pollinisateurs. Eds. Delachaux et Niestlé, Paris 189 p.

² Morse, R. et Calderone, N., 2000. The Value of Honey Bees as Pollinators of U.S. Crops in 2000. <http://www.bee-culture.com/bee-culture/pollination2000/pg1.html>

³ Agriculture et Agroalimentaire Canada - 2001. The Value of Honeybee Pollination in Canada. <http://www.honeycouncil.ca/users/folder.asp?FolderID=5174>

⁴ deOliveira, D. 2005. Évaluation économique de l'abeille domestique, en 2005, au Québec. Congrès SEQ 2005

⁵ Évolution des superficies cultivées en fruits et légumes au Québec de 2002 à 2008 nouveauté

⁶ Références économiques du CRAAQ

⁷ La Financière agricole :

⁸ Adgex 1987* prix marché MTL oct 2008

⁹ Jacques Painchaud MAPAQ Centre du Québec



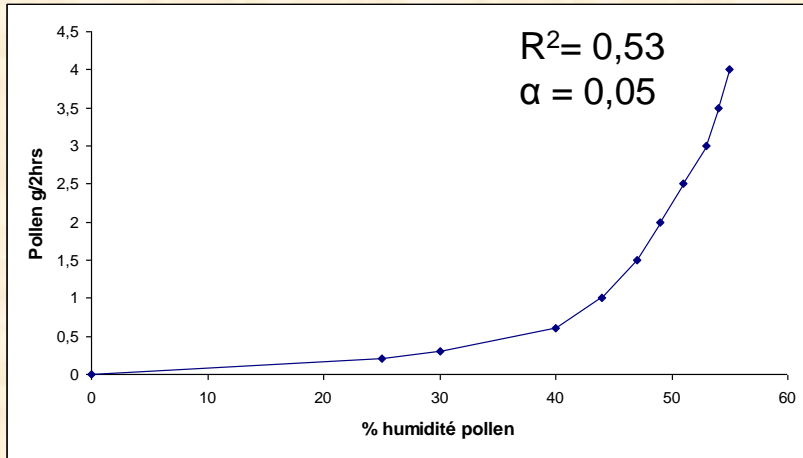
Corn, especially sweet corn is a source of pollen, but also a risk of poisoning by pesticides



By pollen analysis, It is possible to quantify presence of honeybees in a crop



Honeybees forage on corn



When pollen reaches 30% to 40% humidity (required to form pellets ?)

When other pollen resources are poor



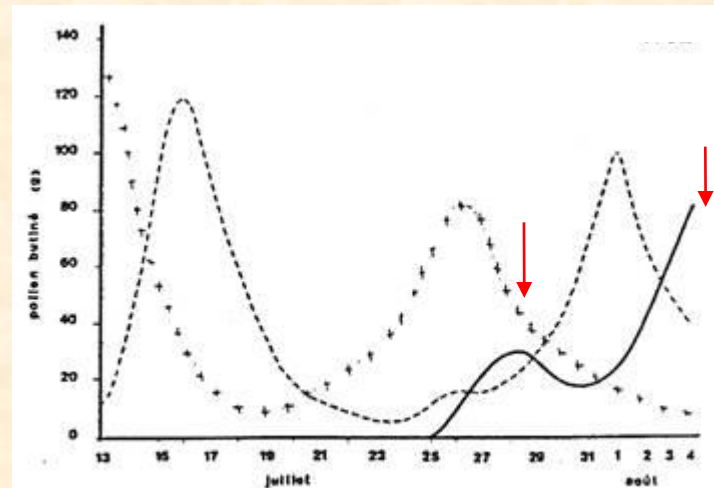
----- MUSTARD



..... CLOVER

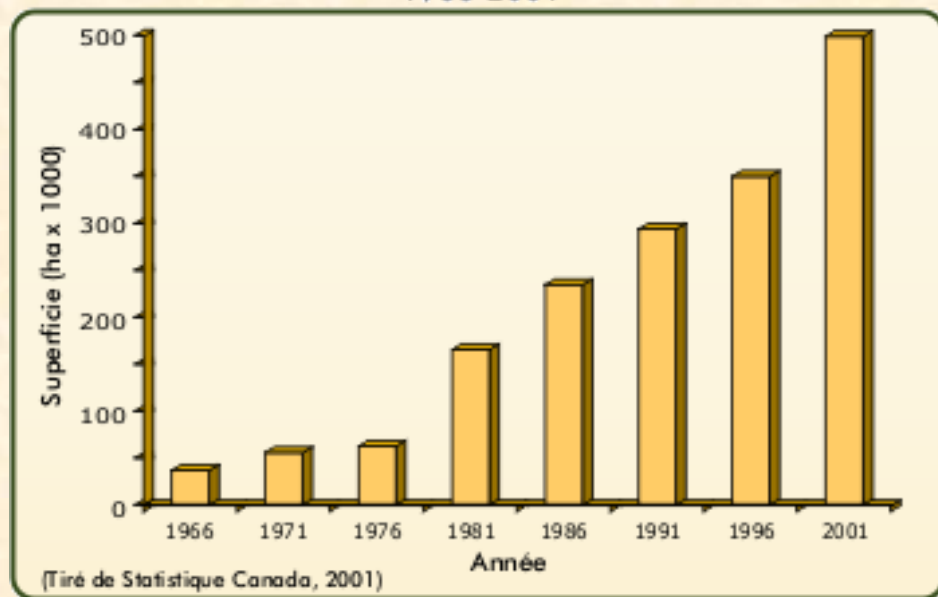


———— CORN

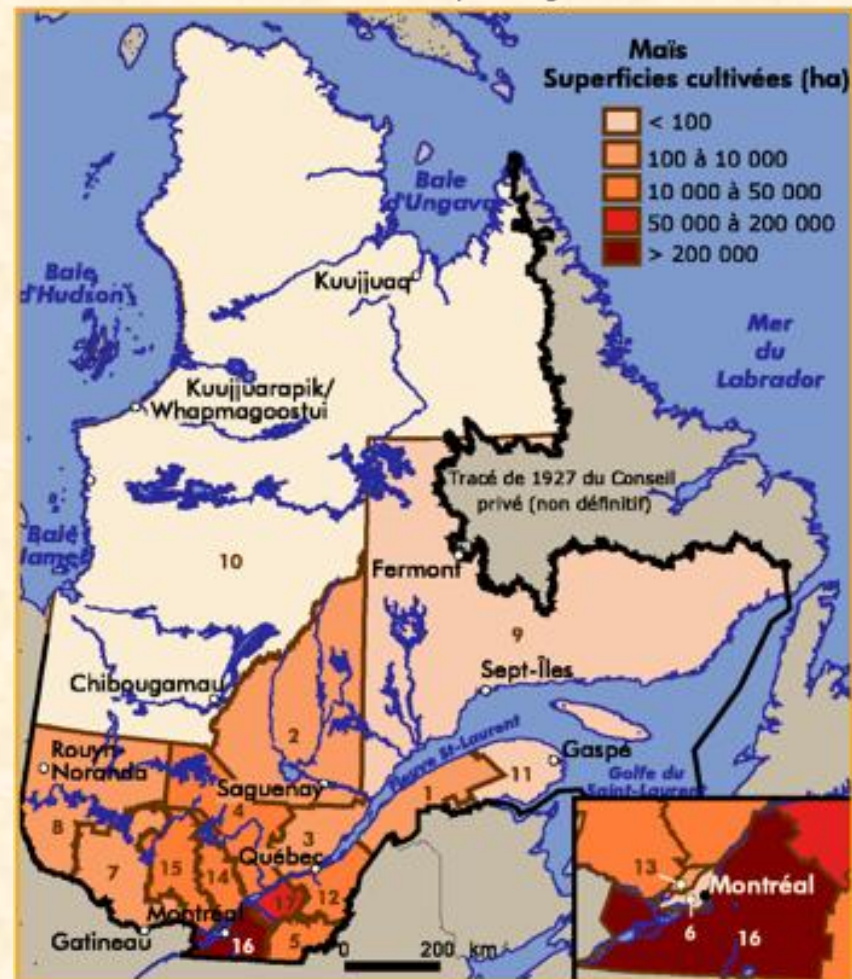


Increasing land use for corn crops in Quebec

Superficie des terres agricoles utilisées à des fins de culture du maïs
1966-2001



Culture du maïs au Québec par région administrative



Données : Statistique Canada, 2001
Ministère de l'Environnement, 2004

TWO ways for Honeybees of getting poisoned



1: The bees are directly spayed

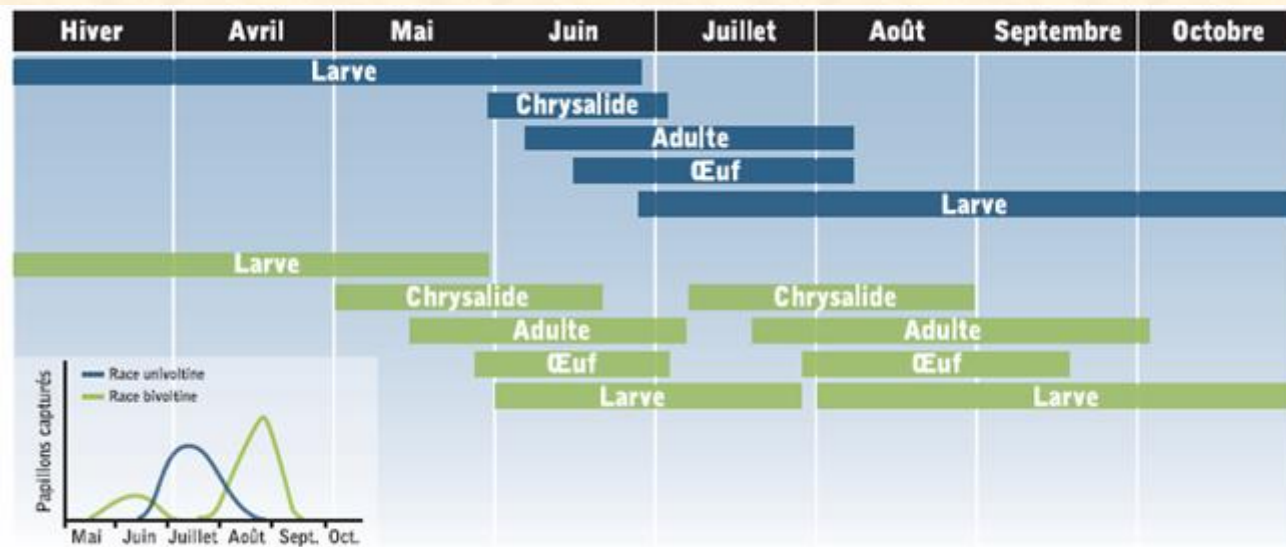


2: Insectides drift in the border plants

Carbamates Crabaryl (Sevin XLR)
Carborufan (Furanda 480F)

Insecticides that are highly toxic to bees and may have a residual hazard longer than 8 hours

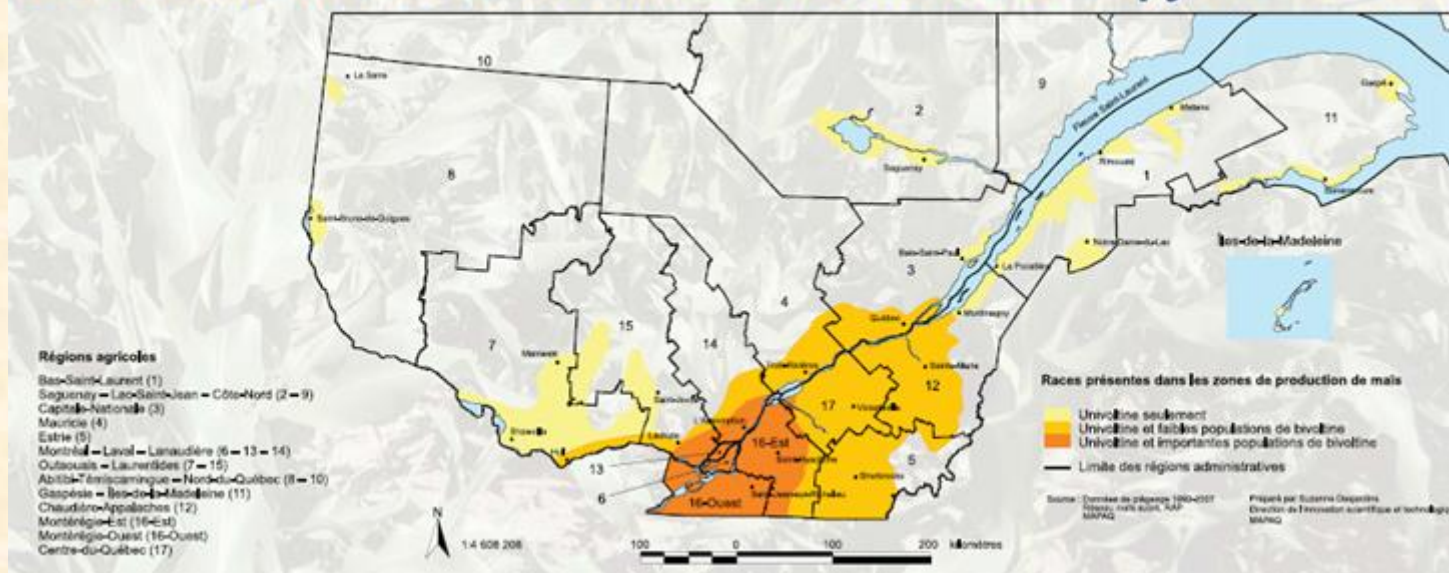
European corn borer



Les périodes d'apparition des stades de la pyrale du maïs peuvent varier selon la situation géographique et les conditions climatiques.



Distribution des races univoltine et bivoltine de la pyrale du maïs



Éni infesté

échantillon	Volume d'eau	Q injectée $\mu\text{g}/\text{ml}$ pour 10 ml	Carbofurane ($\mu\text{g}/\text{ml}$)	Carbofurane absorbé/abeille (μg) **	XDL ₅₀ a b. ***
	3,3	48,2	146	7,3	912
2	1,0	11,1	111	5,5	693
3	1,3	7,7	59	2,9	368
4	1,3	14,2	109	5,5	681
5	2,8	41,9	149	7,5	931
6	1,6	14,5	91	4,5	568

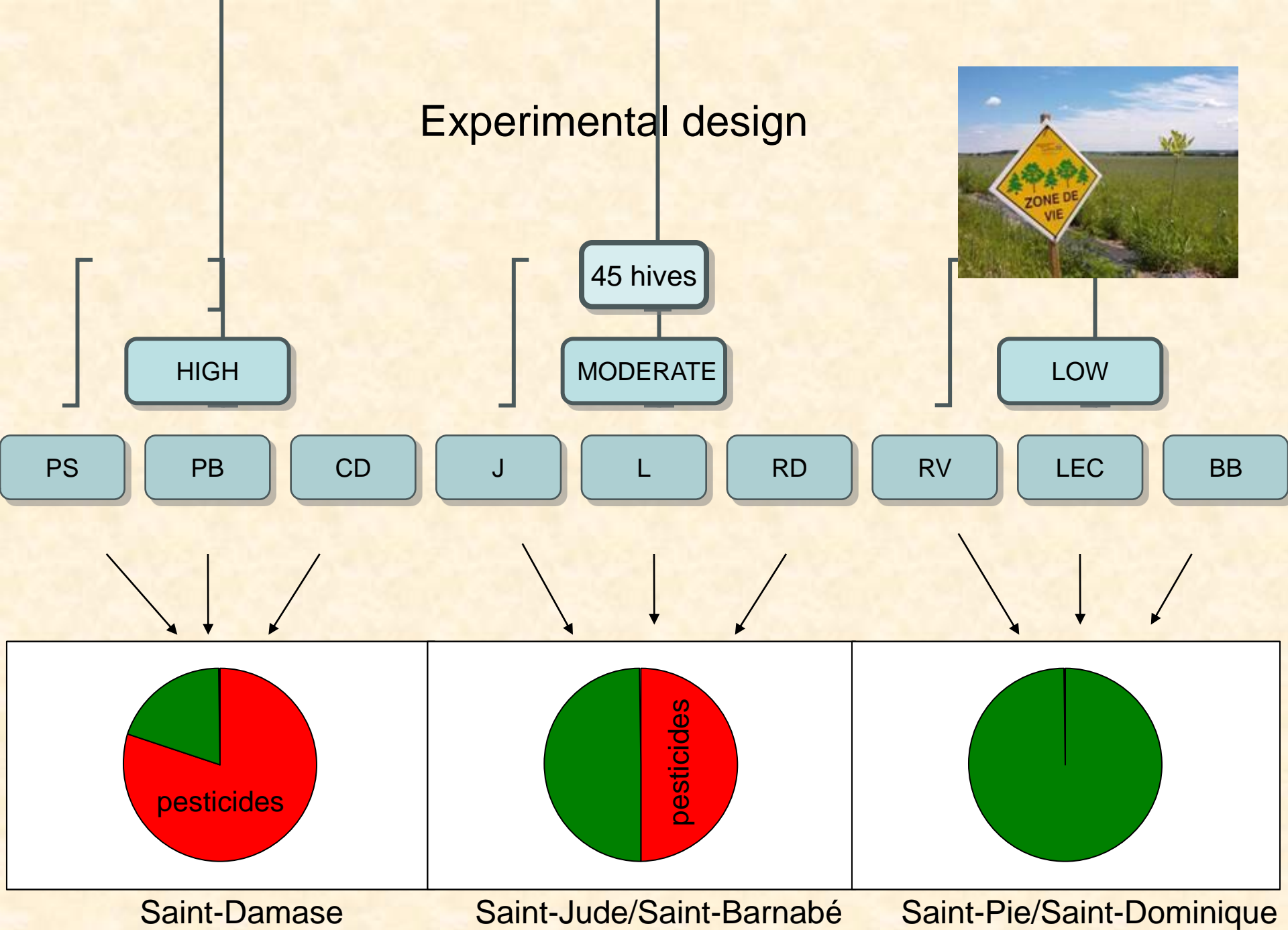
** si une abeille s'y abreuverait , charge moyenne (jabot= 50 μg)

*** DL₅₀ = 0,16 μg /abeille

Accumulation and concentration of insecticide in little pools formed in the leaves nodes (ramification) of the maize plant



Experimental design



Variables measured

1. Weight of hives



2. Dead honeybee count



3. Problems with queens

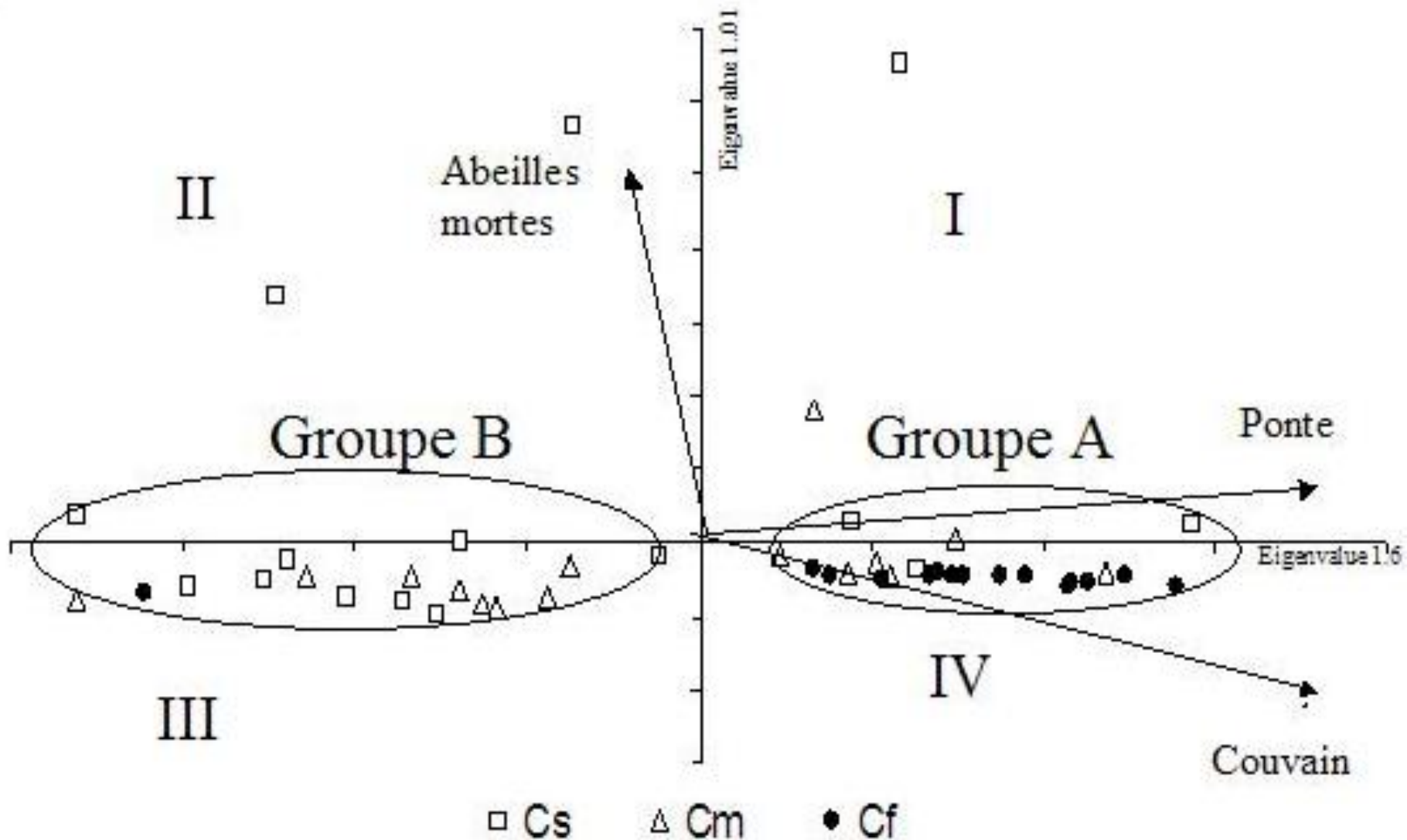
- Loss
- Interruption of egg laying



4. Brood development



MULTIVARIATE ANALYSIS

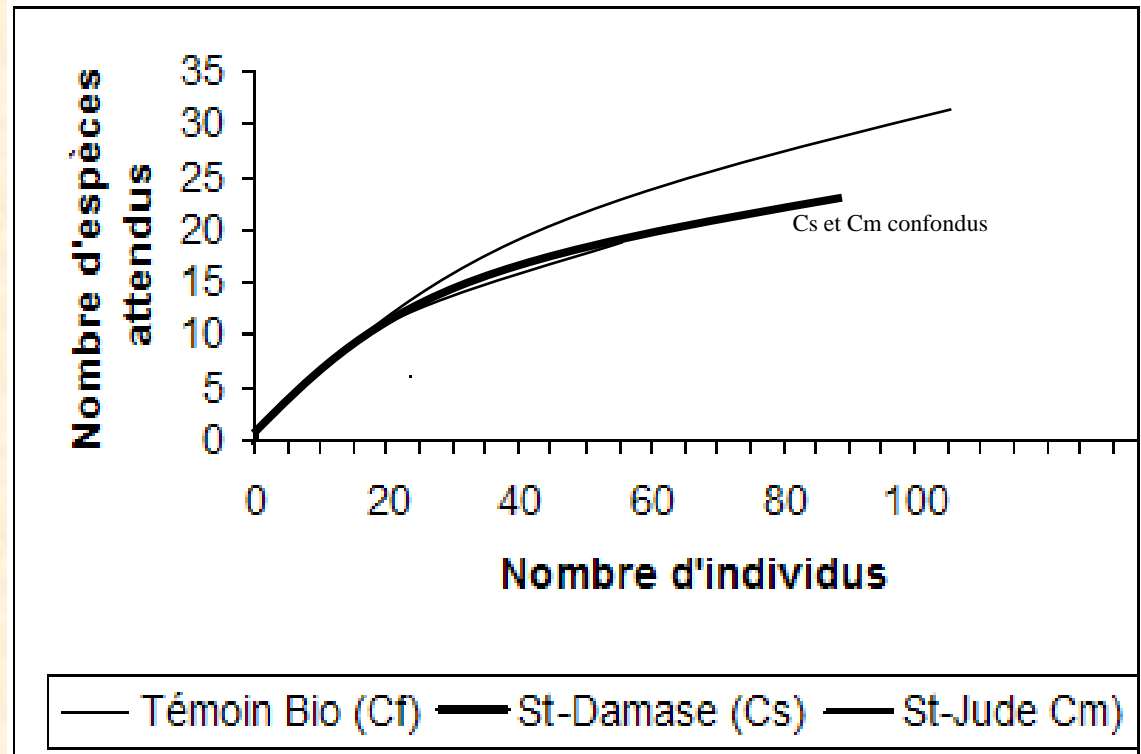


RESULTS

GLOBAL HIVE PERFORMANCE vs PESTICIDE USE IN THE ENVIRONNEMENT

	High	Moderate	Low
Queenless hive Queen stops laying eggs	9 hives on 15*	7 hives on 15	1 hive on 15**
Percent of dead honeybees collected during the study	68 %	27 %	5 %
Number of time more than 100 dead honeybees were found	11	2	0
Hive weight gain(kg)	+ 32.09	+ 48.91	+ 44.55
Gain in brood cells	-6967	-4232	+ 8075

Follow up on native wild bees wild bees : species accumulation curves



Wild bee are also prolific pollinators.

2003

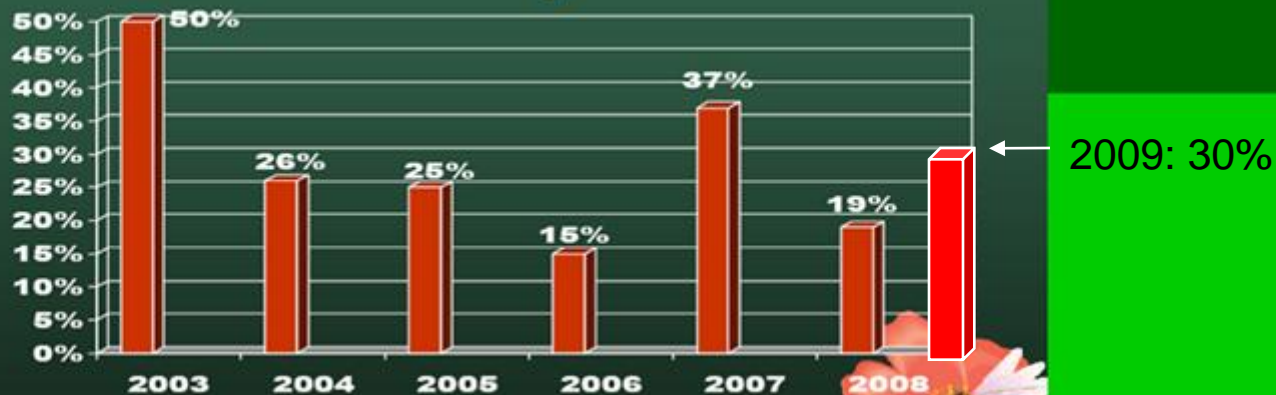
Rises in colony losses in Québec

Arrival of the varroa mite

Qu'en est-il au Québec....

- Taux de mortalité à l'hivernage anormalement élevé
 - Dans le passé (pré-varroa) = moyenne de 10-15%
 - Depuis l'arrivée du varroa = moyenne ††† (avec des extrêmes de 0-100%)
 - Cause: VARROA et?

Mortalité hivernale de colonies au Québec depuis 2003



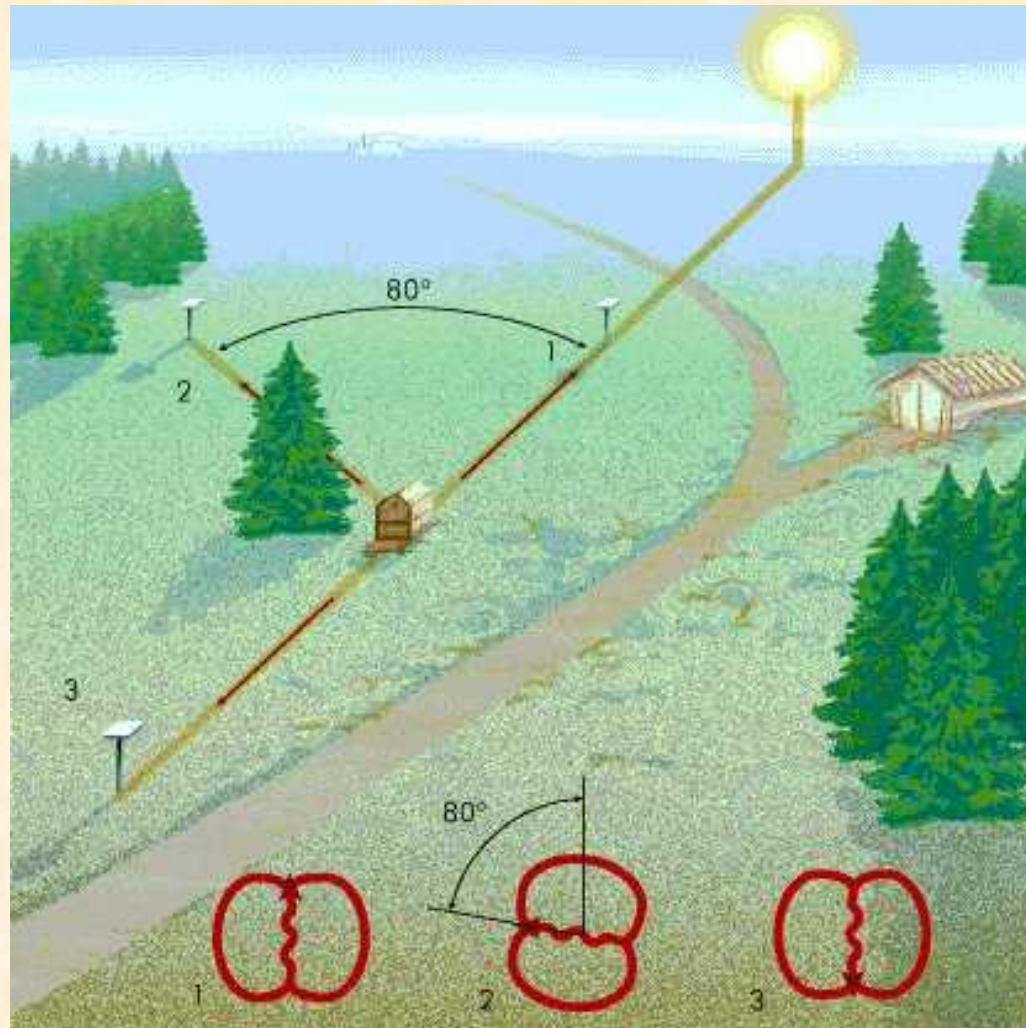
Tiré d'une présentation de Claude Boucher mv MAPAQ

Chemical communication

organe odorant



glande Nasonov



Disruption of temperature regulation

Affectation wing muscles

Systemic Insecticides

Seed coating (néonicotinoïde)

DL₅₀ contact

Clothianidine (PONCHO®)

0,003 µg/bee (3 ng)

Thiaméthoxame (CRUISER®)

0,005 µg/bee (5 ng)

Imidaclopride (GAUCHO®)

0,004 µg/bee (4 ng)

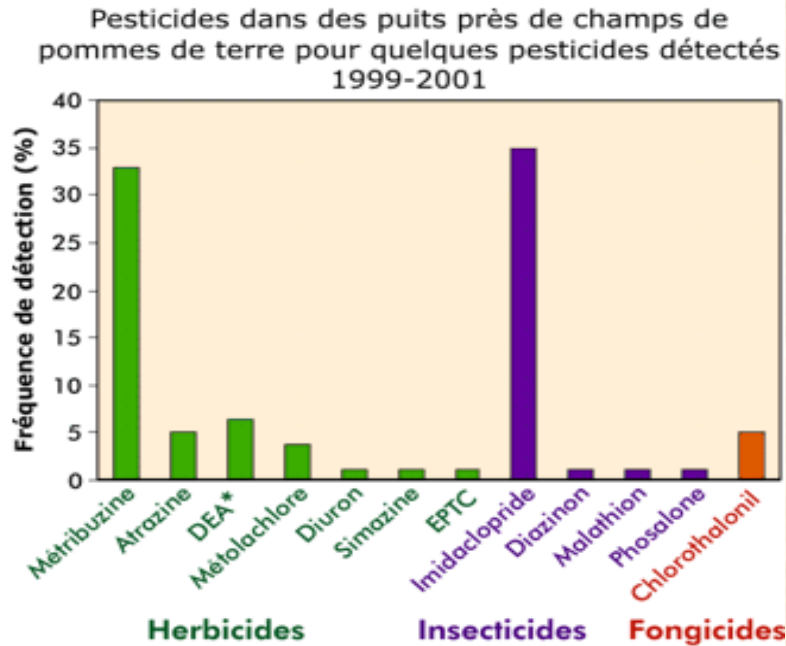
(SAgE pesticide)

Acétylcholine Inhibitor (neurotransmission)

Half-life in soils : between 1 and 4 years

SOIL

Canadian studies have shown that the half-life of this insecticide in bare soil can go from 282 to 366 days, in soil covered with grass from 224 to 257 days and in soil planted with potatoes, from 266 à 457 days (PMRA, 1997).



* DEA : produits de dégradation de l'atrazine

Ministère de l'Environnement, 2004

WATER

The ministry of environment detected Imidaclopride in 35 % of the wells sampled near potato crops (up to 6,4 µg/l)

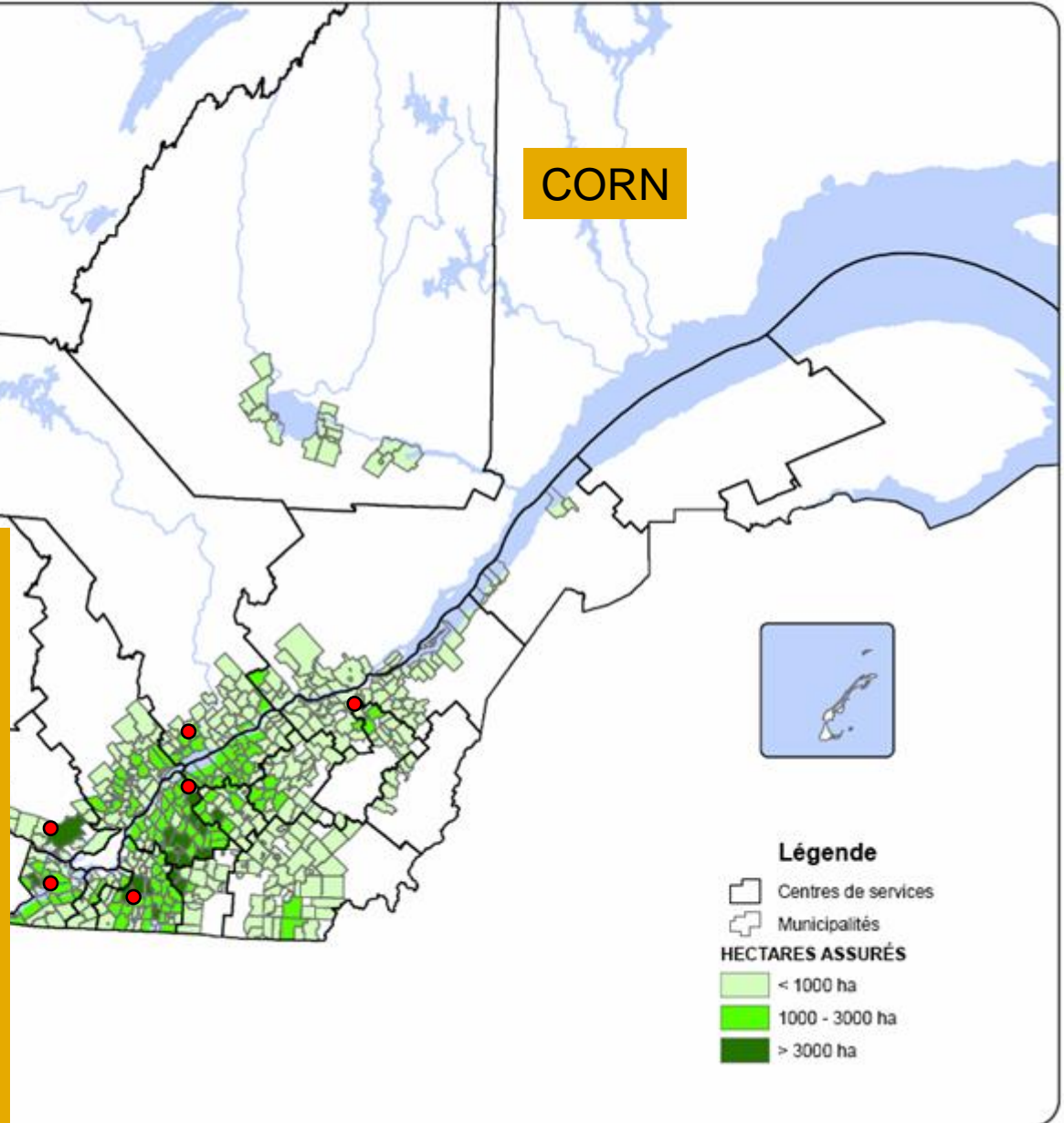
A study was recently initiated to assess the current large scale use of new systemic pesticides (neonicotinoids) in corn as one of the multifactorial causes of observed honeybee losses.



SUPERFICIES ASSURÉES EN MAIS-GRAIN PAR MUNICIPALITÉ EN 2007

(individuel + collectif)

CORN

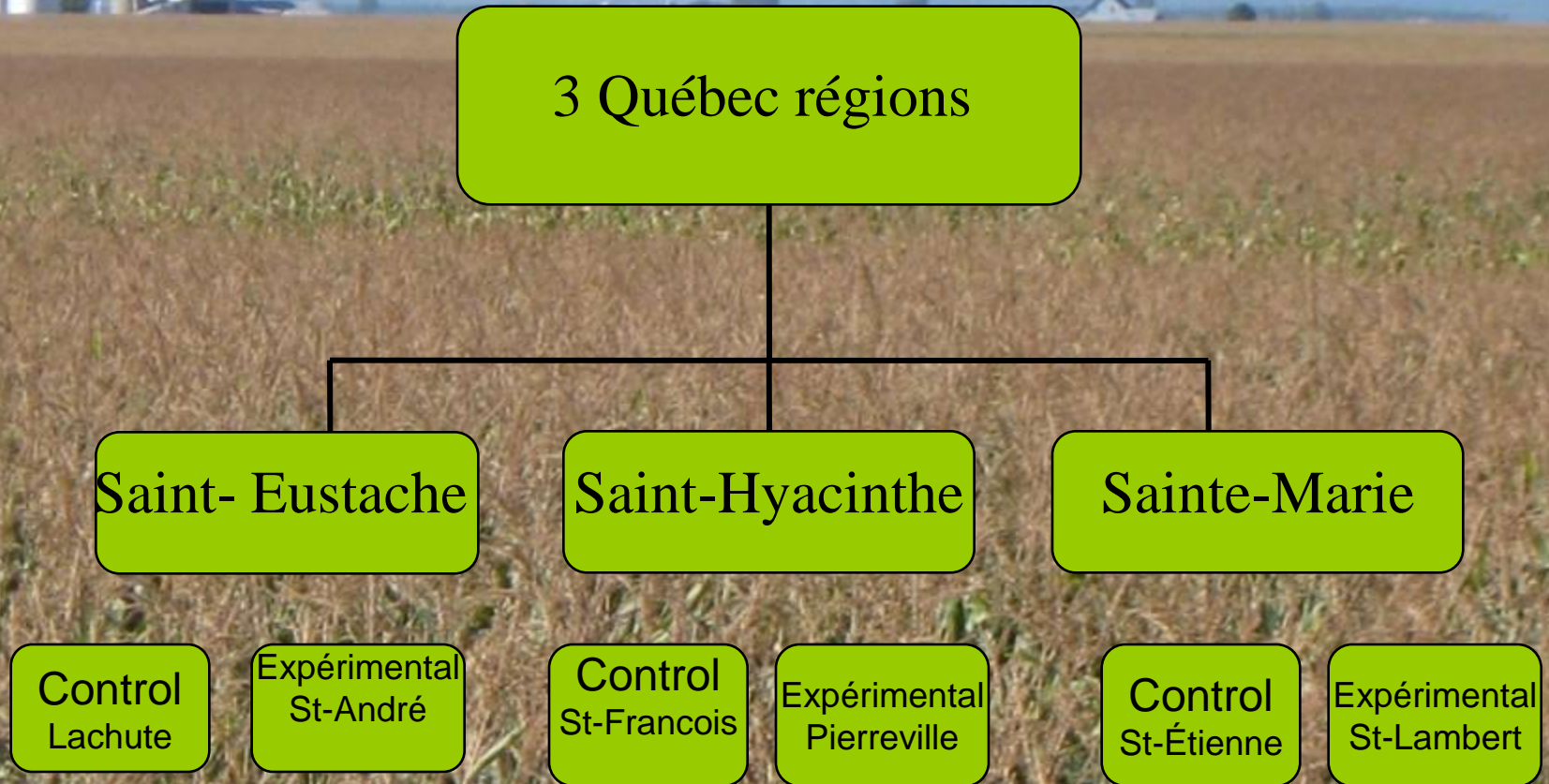


In Quebec 95 to 100% of canola, soya or corn seeds plated were treated with either "Poncho" (clothianidin) - Bayer

Or

"Cruiser" (thiamethoxam) - Syngenta.

Materials and methods



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graph TD; A["Capturing surviving foragers and counting dead Honeybee"] --> B["LABORATORY"]; B --> C["Chemical analysis<br/>Wing wear To estimate age of Honeybees"]; B --> D["Toxicological analyses et developpement of biomarkers"];
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Capturing surviving foragers and counting dead Honeybee

LABORATORY

Chemical analysis

Wing wear To estimate age of Honeybees

Toxicological analyses et developpement of biomarkers



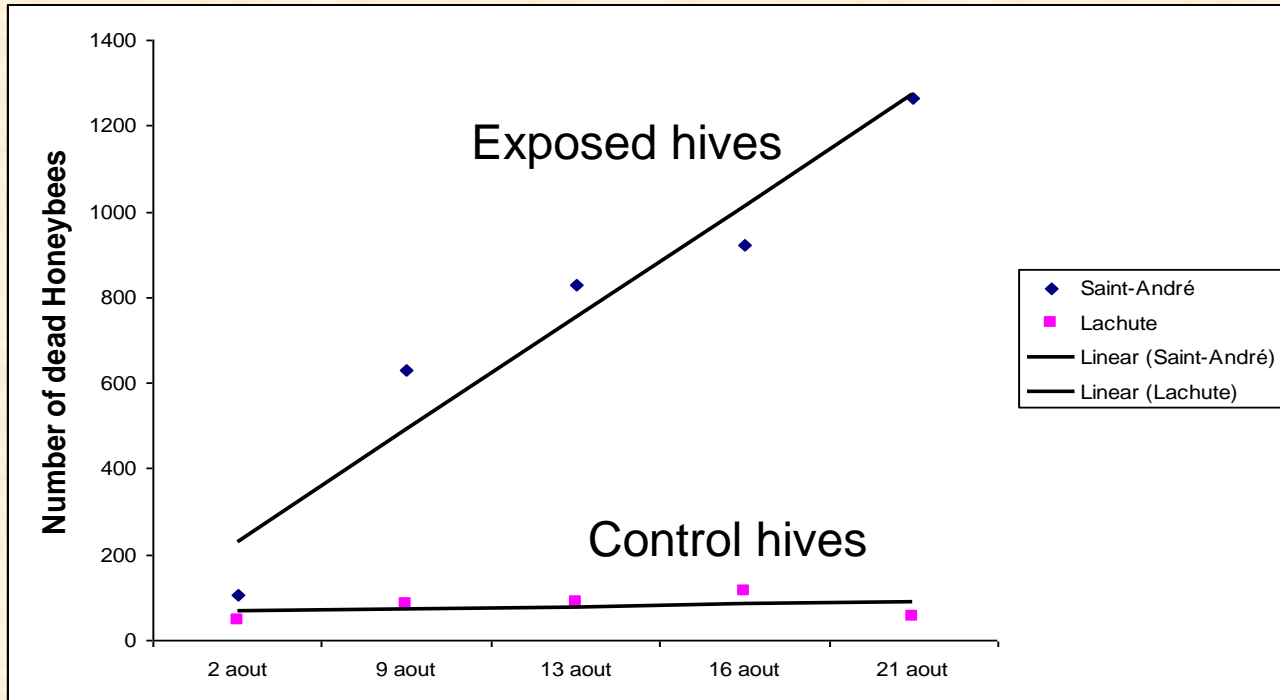
High mortality of bees showing symptoms of the Chronic Bee Paralysis Virus was observed in exposed hives while control hives remained healthy



SYMPTOMS OBSERVED

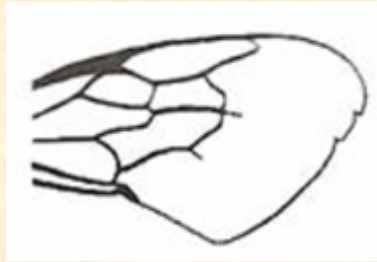
- paralysis
- abnormal wobbly movements
- spinning on the back
- fighting and confusion at the hive entrance

Resultats on Honeybee mortality



- Queenless hives
- Severely weakened or queenless colonies that did not survive the following winter.
- Honeybees displaying symptoms of viral paralysis disease (symptoms that may be confused with bee poisoning).

Estimation of wing wear



Undamaged



Category 1



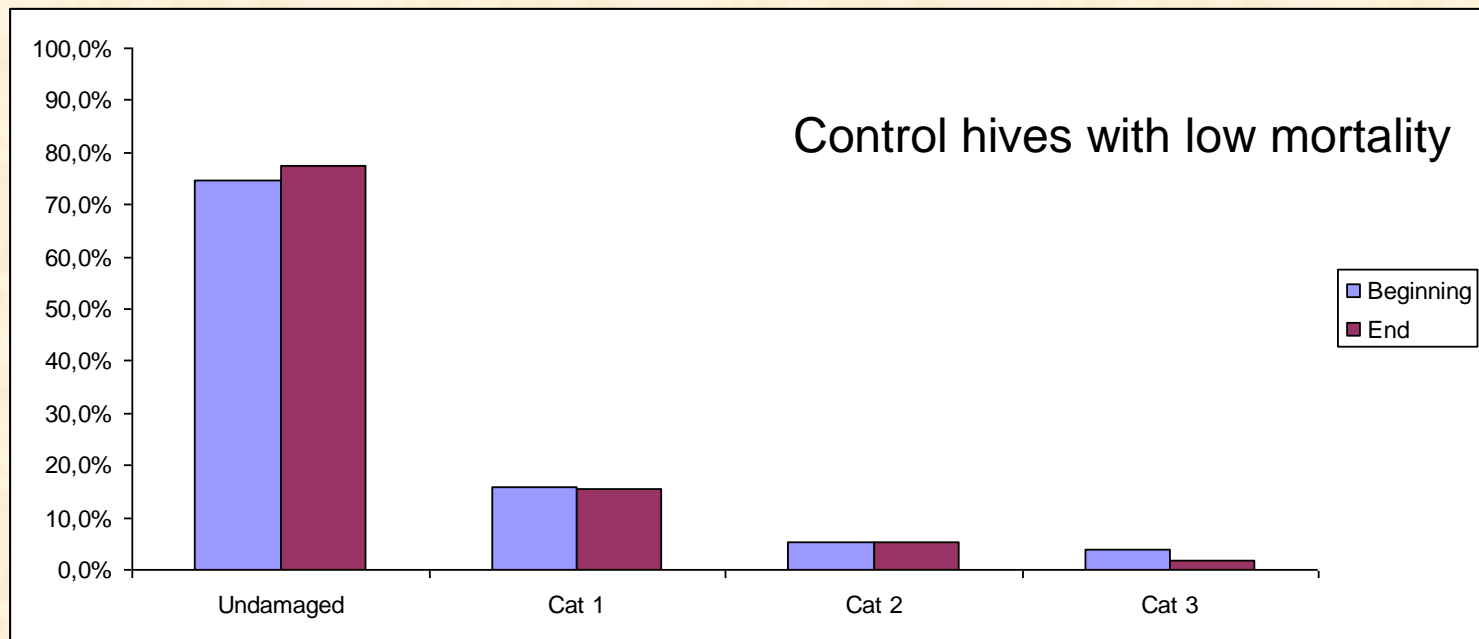
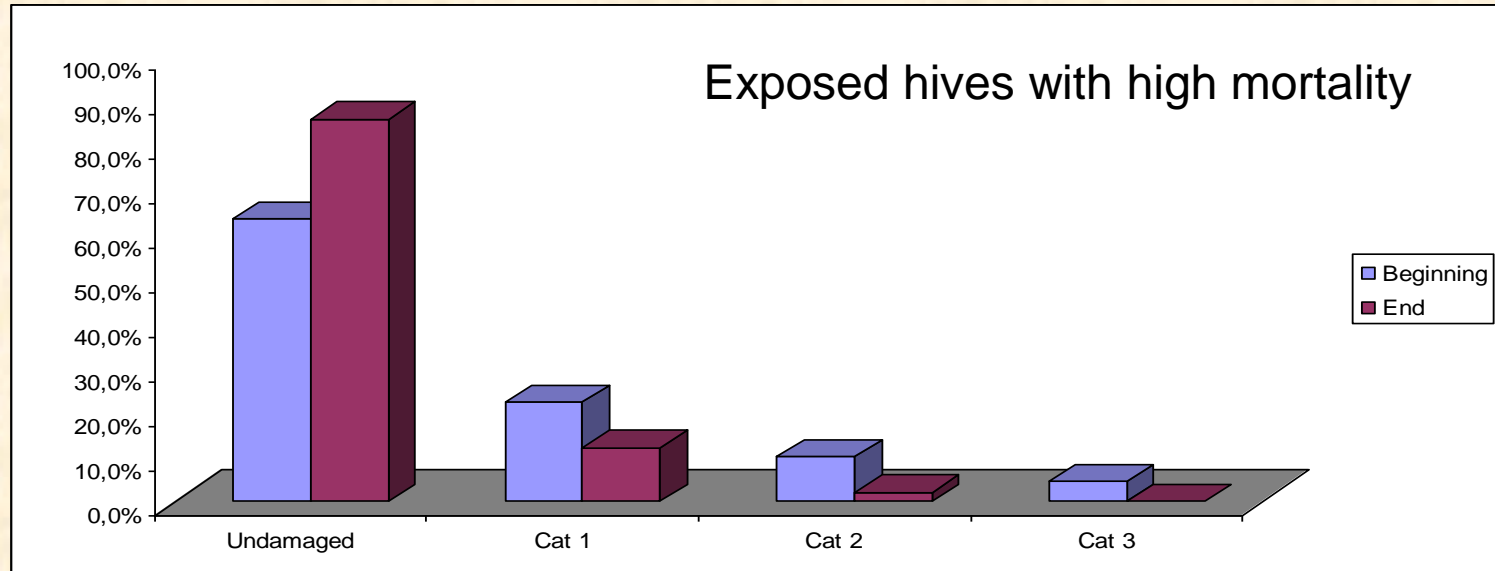
Category 2



Category 3



First year results on wing wear : high morality causes worker bee to leave hive : advancing their foraging role



Ectotoxicology – UQAM/TOXEN

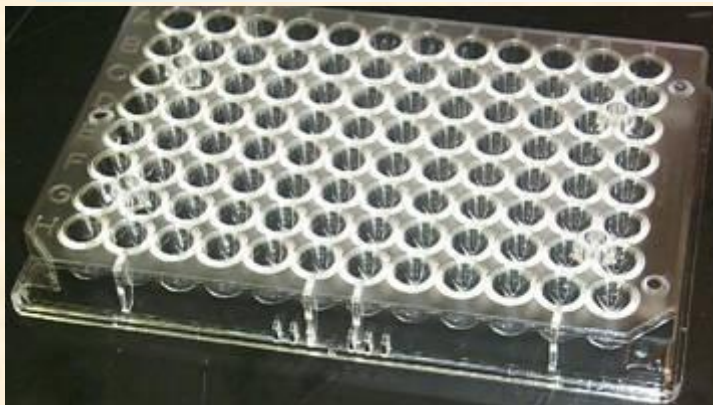
(Madeleine Chagnon, Monique Boily et Geneviève Beaunoyer)

Developement of biomarkers to evaluatate the impacts of Honeybee (*Apis mellifera*)exposition to pesticides used in large corn field environnements

Dosage of bee head acetylcholinesterase (AChE) using microplate spectrofluorometry

Expected results: a decrease in acetylcholinesterase as an indicator of exposure to an antiholinesterase pesticide (This enzymatic essay is not capable of distinguishing between different pesticides)

First results : The AChE increase in surviving Honeybees showed that AChE activity might be used as biomarker to reveal an exposure to .



The pesticides used are constantly changing as well as their mode of action: Example - Movento

We are now working on the development of certain tests that can help us to judge Honeybee health, including its immune system

- Weakened immune systems can facilitate the spreading viral infections.
- This hypothesis has been largely suggested for the varroa mite

Ongoing work

Dosage of vitamine A and enzymes playing a rôle in the immune system of the Honeybee

The enzymes phénol oxydase (PO) and glucose déshydrogénase (GLD) play a critical role in cellulare response (Xiaolong et al., 2005)

These levels of the immunity-related enzymes are thus prioritised

