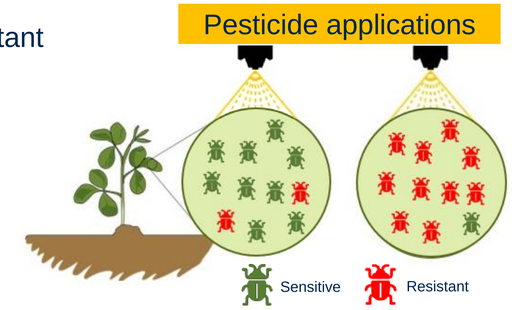
Pesticide Resistance: The Need for Bioassays!

Elisabeth Ménard, Clarisse Bannery, Alexander Faigan, Kim Ostiguy, Mick Wu, Célia Bordier
Institut de recherche et de développement en agroenvironnement

In 70 years, more than 500 species worldwide became resistant to at least one active ingredient! (Andow, 2008)

©Laboratoire d'expertise et de diagnostic en phytoprotection

In Quebec:4 insects resistant to insecticides. (Fortin *et al.*, 2012)



Why?
Agronomic issues and insect properties can rapidly lead to resistance development.

But!
In absence of selective pressure, the strain can lose resistance.
After 8 generations = 3 times more susceptible. (Alyokhin *et al.*, 2015)

How?
Bioassays = resistance analysis method approved for repeatability even when mechanisms involved are unknown. (R4P Network, 2016)

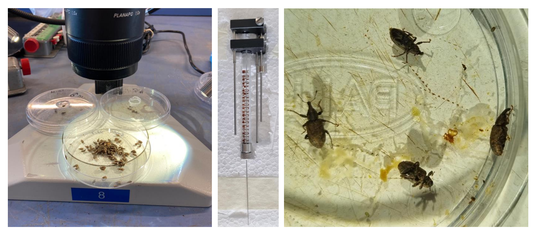
PROBLEMATIC PEST

Colorado Potato Beetle
(*Leptinotarsa decemlineata)*

Carrot Weevil
(*Listronotus oregonensis*)

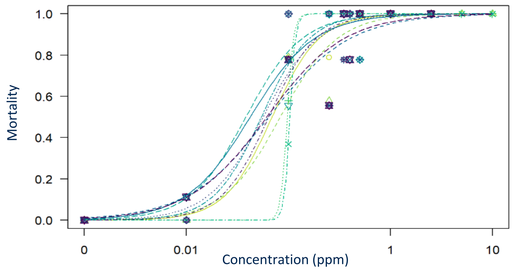
APPROPRIATE METHODOLOGY

Dipping leaf discs and larval ingestion



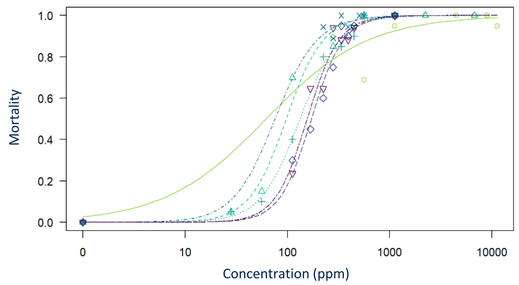
Hamilton syringe micro-application on adult elytra

DOSE RESPONSE CURVES ON SENSITIVE STRAIN



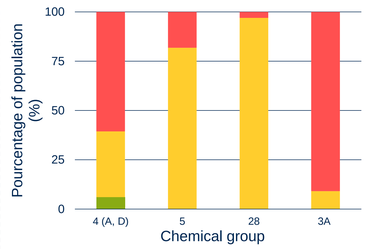
- Actara®
- Delegate™
- Coragen®
- Entrust™
- Matador®
- Sivanto Prime®
- Titan®
- Vayego®
- Verimark®

Minimum 8 dilutions per pesticide
Lethal or discriminating doses estimated by statistical modeling



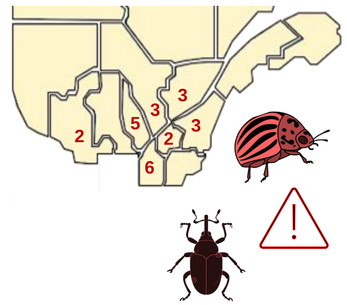
- Imidan®
- Matador®

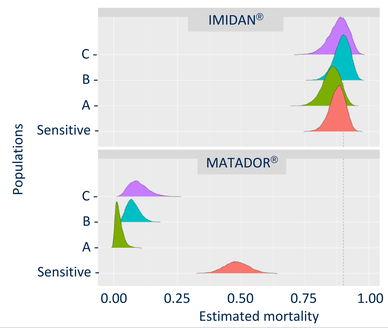
RESISTANCE EVALUATION OF WILD STRAINS



- **Resistant:** mortality < 30%
- **Tolerant:** 30% < mortality > 70%
- **Sensitive:** mortality > 70%

24 WILD STRAINS CONFIRMED TO BE RESISTANT TO AT LEAST ONE ACTIVE INGREDIENT!

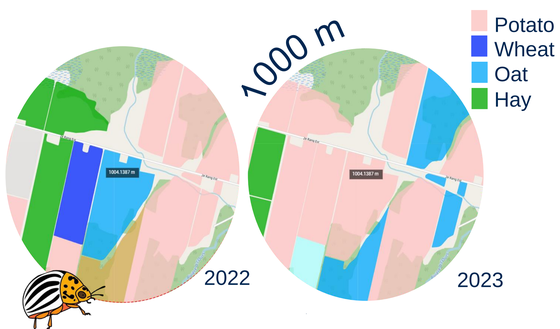




GUIDELINES

Dispersal ability:
up to 1km! (Weisz *et al.*, 1994)
Distance between potato field: 500 m

Current crop rotations do not allow for the control of resistant Colorado potato beetle populations' dispersal.



AGRONOMIC ISSUES

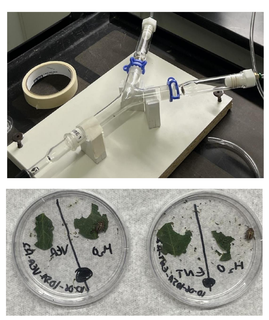
- Pesticide choice
- Dosage and application timing
- Sprayer calibration
- Weather
- Water quality and quantity

CULTURAL MANAGMENT

INSECTS PROPERTIES

AVOIDANCE BEHAVIOUR

- Cuticular properties
- **Metabolic mechanism**
- Genetic mutation
- Sequestration



Our tests suggest no olfactory response to insecticides for Colorado potato beetle larvae nor adults. We believe it can be removed from the resistance development hypothesis.

TAKE HOME MESSAGE

Properly designed **bioassays** are essential and can be done at the **beginning** of a resistance suspicion.

Bioassays can be combined with a **molecular biology** approach to be even more accurate.

Omakele et al._ 2024 – SEQESC POSTER

References
- Alyokhin, A., Mota-Sanchez, D., Baker, M., Snyder, W.E., Menasha, S., Whalon, M., Dively, G. and Moarsi, W.F., 2015. The Red Queen in a potato field: integrated pest management versus chemical dependency in Colorado potato beetle control. Pest management science, 71(3), pp.343-356.
- Andow, D.A. 2008. The Risk of Resistance Evolution in Insects to Transgenic Insecticidal Crops. Collection of Biosafety Reviews
- Fortin, R., Bernier, D. et Bachand, D. 2012. Enquête sur la résistance des ennemis des cultures aux pesticides. Programme Cultivons l'avenir, CRAAQ. 40 p.
- Réseau de réflexion et de recherche sur la résistance (R4P). https://www.r4p-inra.fr/fr/home/
- Weisz et al. 1994., Distance, Rotation, and Border Crops Affect Colorado Potato Beetle (Coleoptera: Chrysomelidae) Colonization and Population Density and Early Blight (*Alternaria Solani*) Severity in Rotated Potato Fields, *Journal of Economic Entomology*, 87(3), pp.723-729.

Thanks to the 10 students who did internships on this project, 2 technicians for bioessays manipulations and agronomists with their producers for the wild strains. This project was funded by the Ministère de l'Agriculture, des Pêcheries et de l'Alimentation as part of component 2 of the Prime-Vert program.