Pyrethroid resistance monitoring in French coleoptera populations in oilseed rape

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Terres Inovia (French technical institute for oil and protein crop and hemp)

IOBC Integrated Control in Oilseed Crops
On line meeting, May 17th-18th ,2022

Summary

- Introduction
- Cabbage stem flea beetle
- Rape winter stem weevil
- Other beetles

Several insect species are resistant to insecticides

In France

Resistance with loss of efficiency in the field.

First mutations detected - no return of loss of efficiency in the field

1997:
Green peach aphid(*Myzus persicae*) resistance to PYR

1999:
Pollen beetle (*Meligethes aeneus*) resistance to PYR

2009:
Green peach aphid (*Myzus persicae*) resistance to pirimicarb

2014-2015:
Rape winter stem weevil (*Ceutorhynchus picitarsis*) and cabbage stem flea beetle (*Psylliodes chrysocephala*) resistance to PYR.

2015
Detection of the 1st mutations that can confer resistance to pyrethroids in some populations of the cabbage pod weevil (*C.obstrictus*) and cabbage stem weevil (*C.pallidactylus*) populations.

2019
Detection of the 1st mutations that can confer resistance to pyrethroids in some populations of the rape stem weevil (*C.napi*) populations.

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Methods used in Terres Inovia laboratory

VIAL TESTS with insecticide
(adults - since 2013)

- Presence of resistance
- Global level of resistance
- But many live insects are needed

VIAL TESTS with insecticide
+/- inhibitors (PBO, DEM, DEF)
(adults – since 2015)

- Detection of resistance by detoxification

MOLECULAR ANALYSIS
(adults and larvae – since 2015)

- Detection target gene mutations conferring resistance

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Cabbage stem flea beetle
-
Results

Symbols

Bioassays - λ-cyhalothrin
Detection of all involved mechanisms

Bioassays - λ-cyhalothrin + inhibitors
Detection of metabolic resistance

Molecular analysis
Detection of pyrethroids target gene mutations

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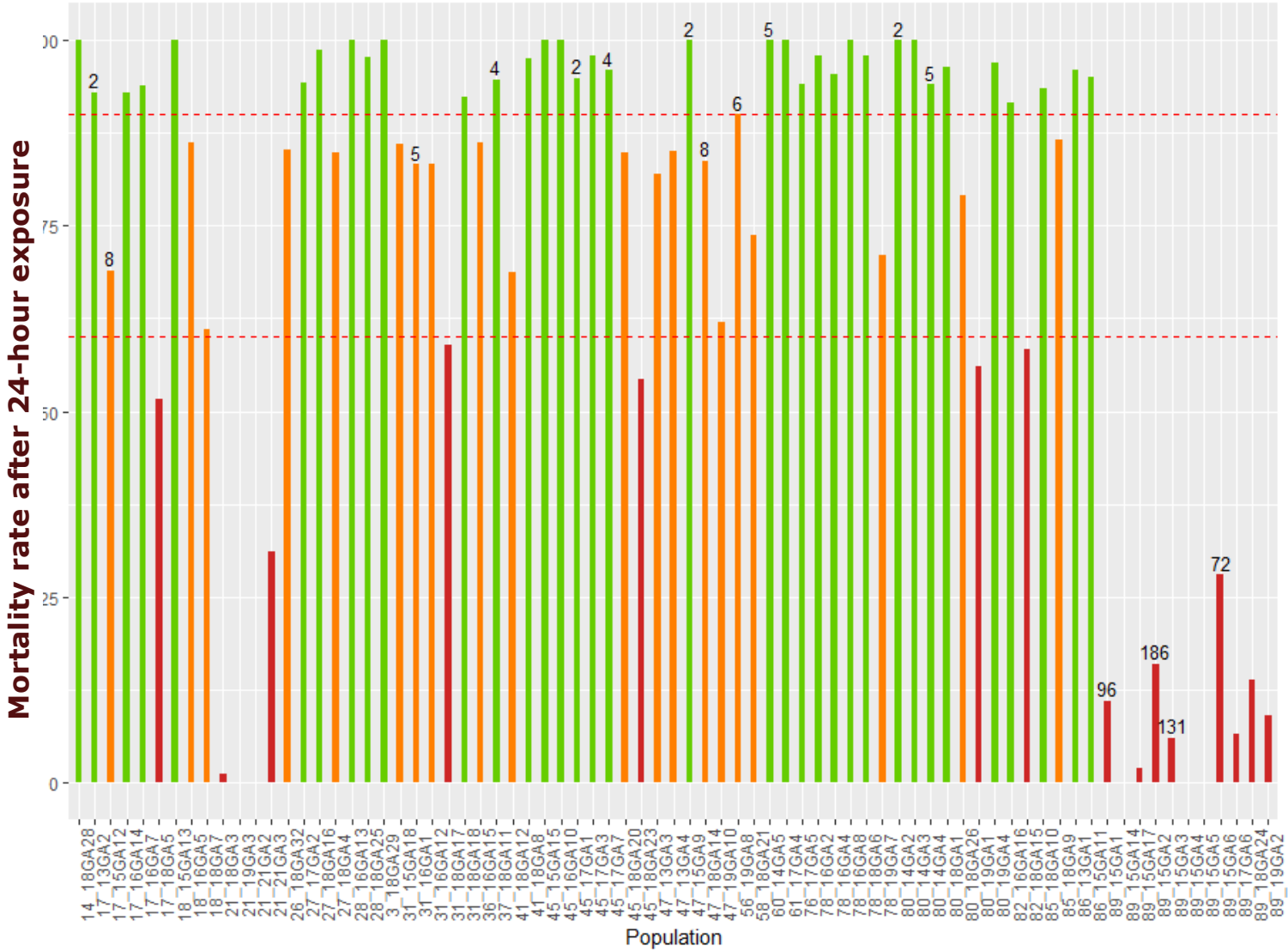
Bioassays - very variable mortality rates



Since 2014, vial tests have been carried out for 75 populations at a dose of 15 ng λ-cyhalothrin /cm².

LC50 ratio between the 2 *most susceptible* and the 2 most resistant populations is very high : 93.

Mortality > 90% | **90%=>Mortality > 60%** | **Mortality< = 60%**

LC50 is indicated at the top of the bars of the histogram when it could be calculated

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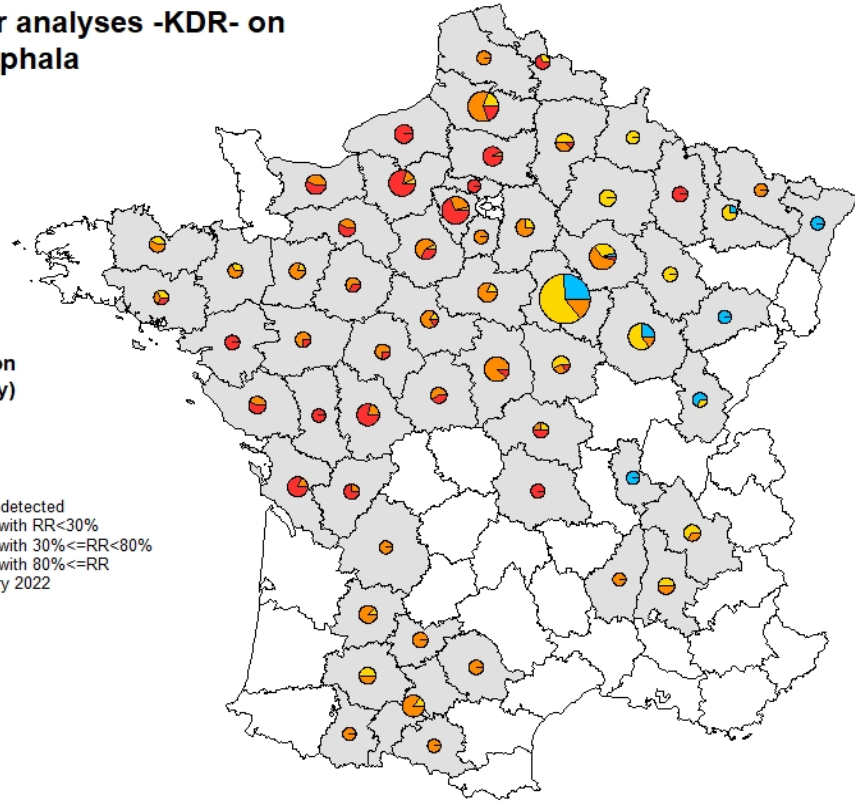
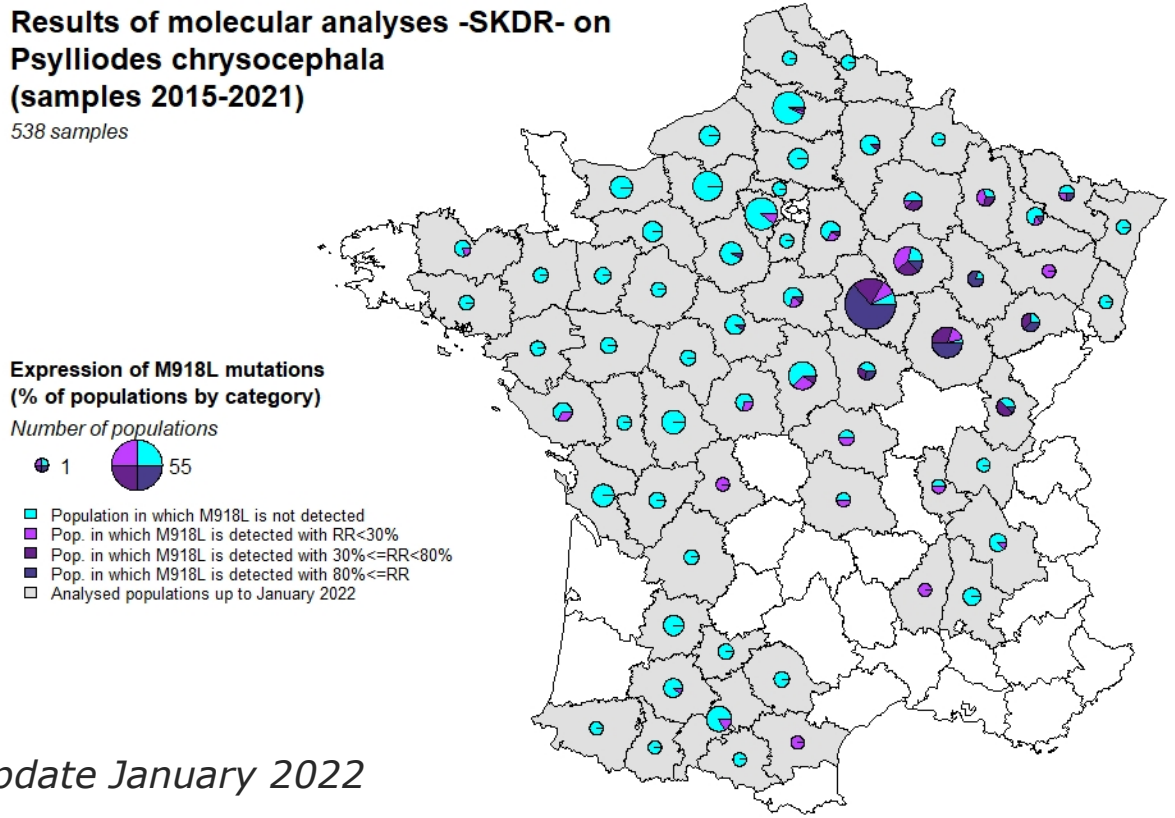
Two main gene target mutations





Update January 2022

Since 2015, molecular analyzes have been carried out for 538 populations. KDR (L1014F) and SKDR (M918L) mutations are the most common, although other mutations have been identified (L925I and T929N).

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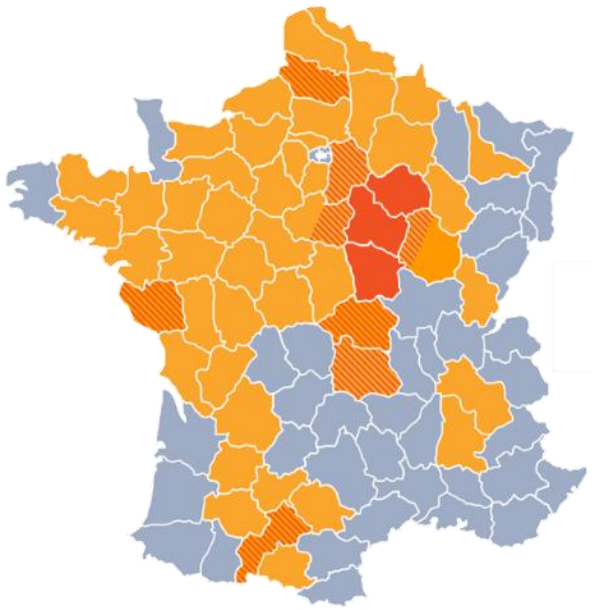
SKDR mutation detected in new departments

Generalized strong resistance (Super KDR)

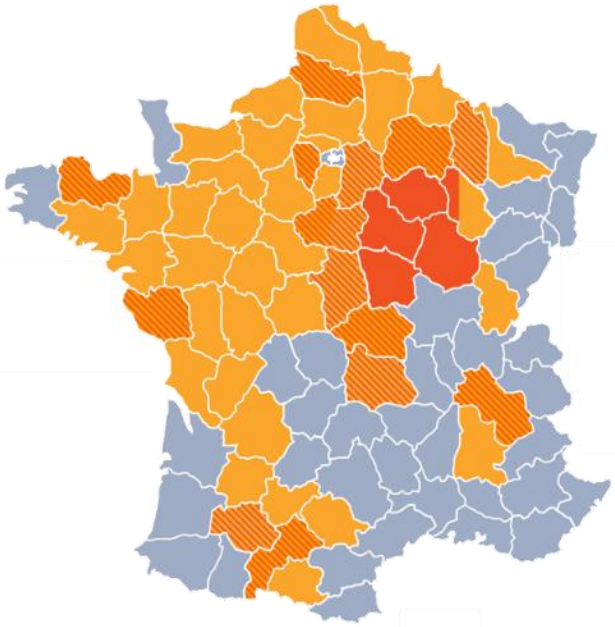
At least one case of strong resistance identified (Super KDR)

No strong resistsance identified (Super KDR) but low resistance (KDR)

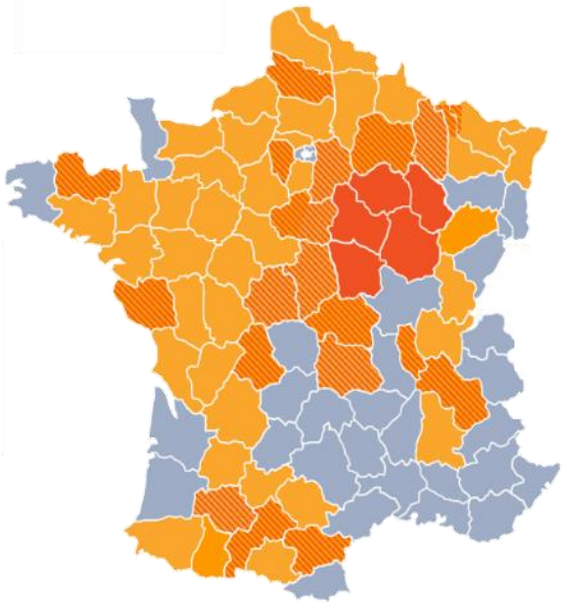
No information to date



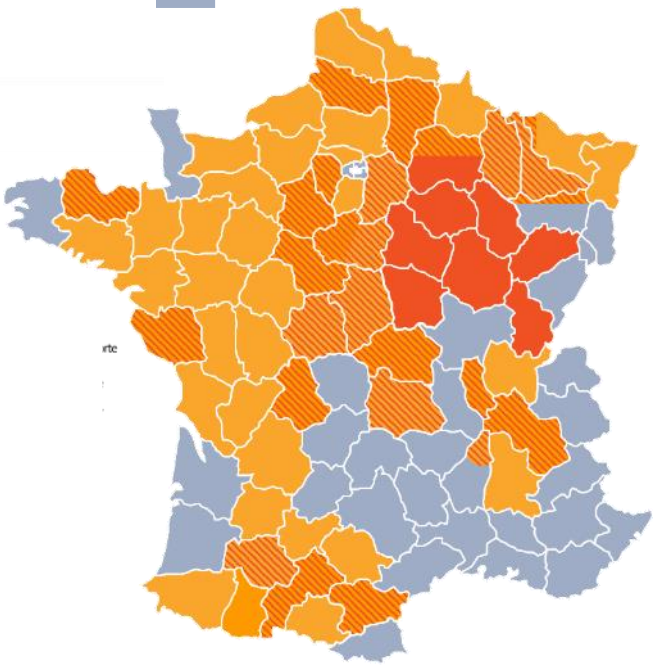
End of 2018



End of 2019



End of 2020



End of 01/2018

Very high levels of resistance due to SKDR mutations in high proportions are present in populations of 8 departments.

SKDR mutation is present more occasionally in 24 other departments.

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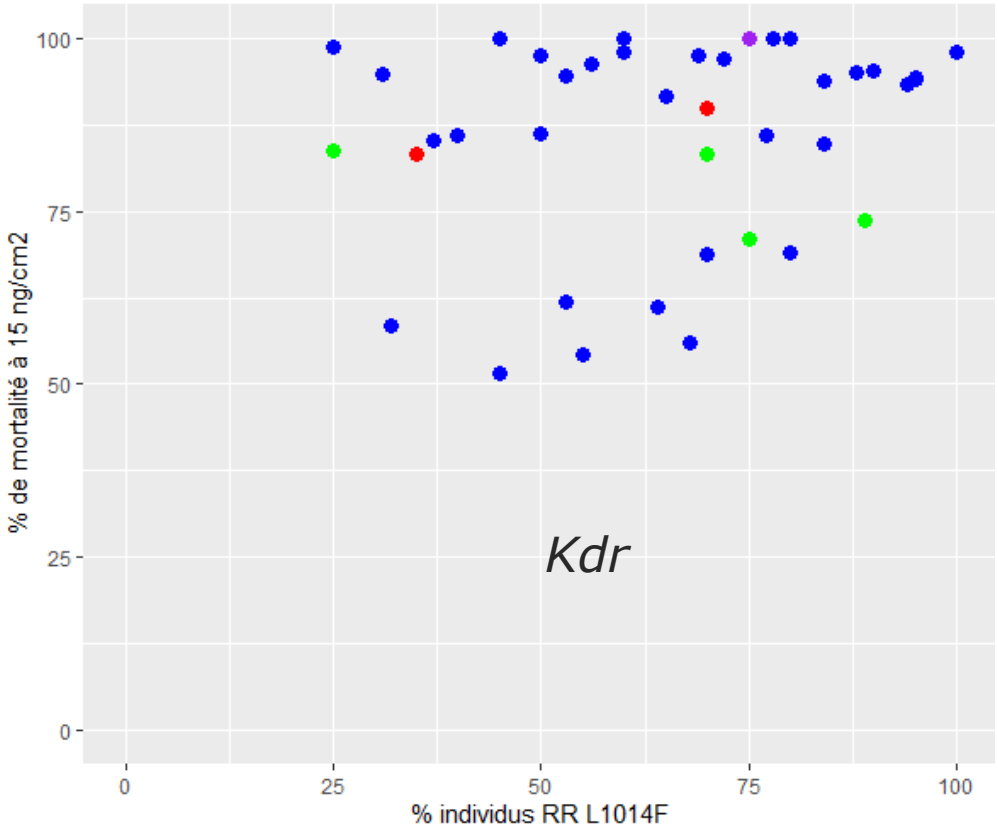
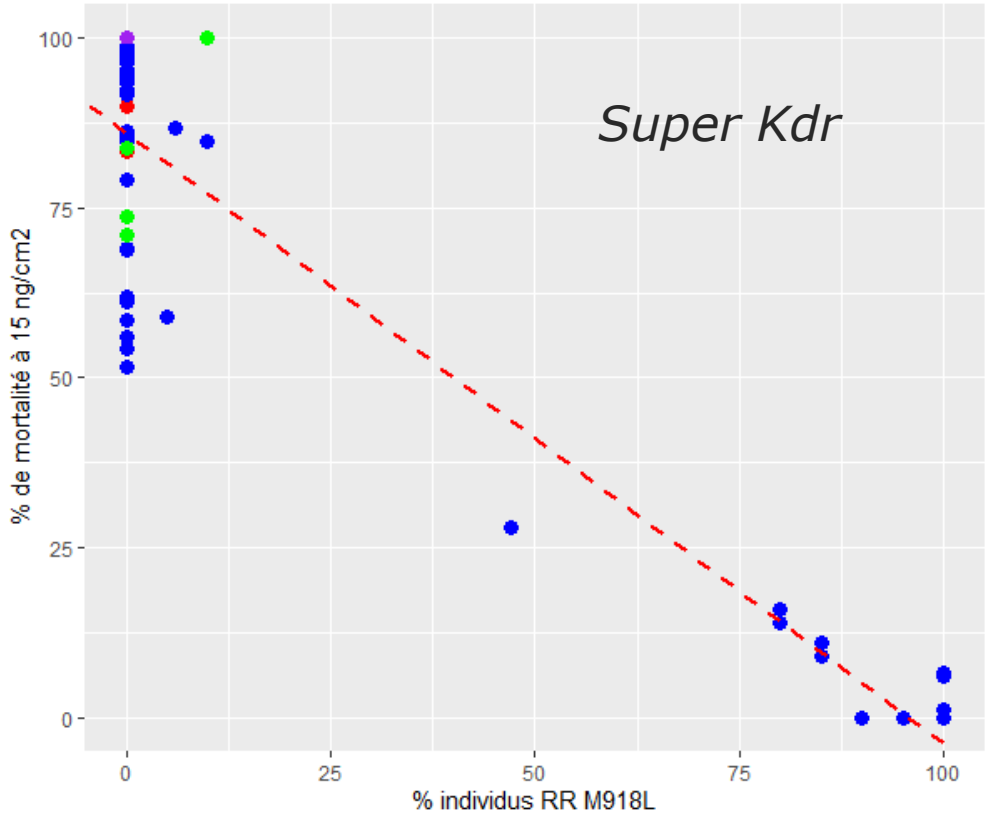
Correlations between bioassays and molecular analyses

Mortality observed in vial tests appears to be **more correlated** with presence of the **skdr mutation** than the kdr mutation

Correlation coefficient : not significant



Kendall's test
Correlation coefficient : r=-0.53 (p=3x10-7)



- <+50% mortality with inhibitors at 3.75 λ-cyhalothrine ng/cm2
- >+50 mortality with inhibitors at 3.75 λ-cyhalothrine ng/cm2
- unknown
- Unusable results

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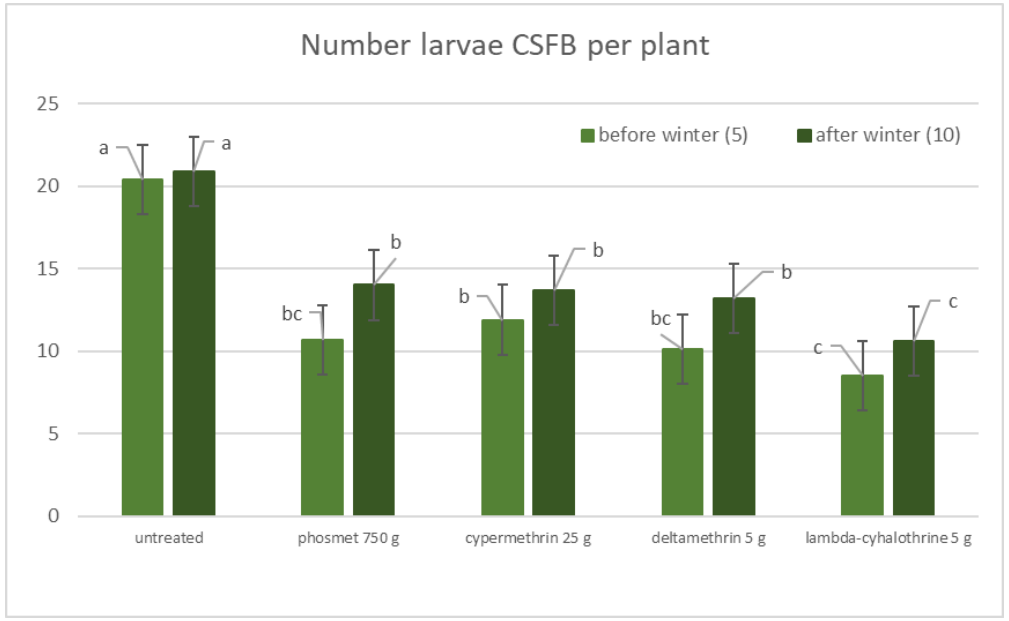
CSFB larvae – KDR area
Pyrethroid efficient ?

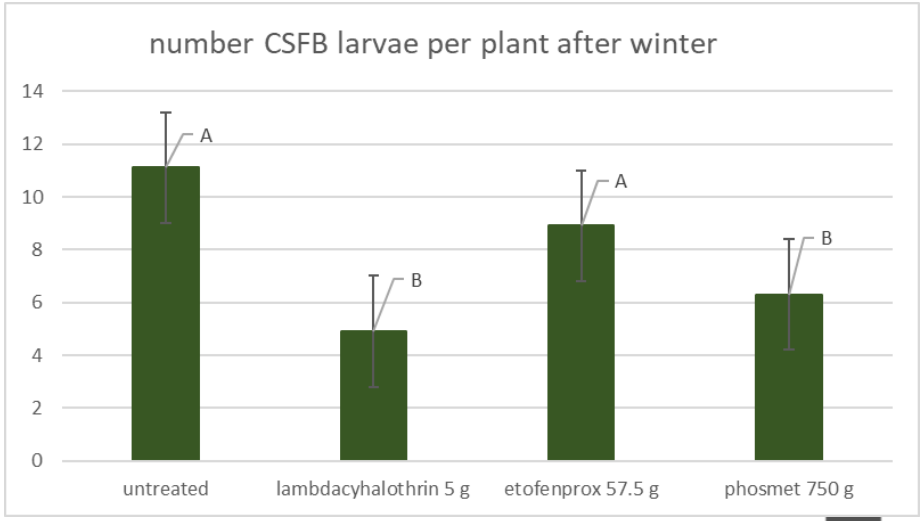
Deltamethrin (5 g/ha), cypermethrin (25 g/ha), lambda-cyhalothrin (5 g/ha)
5 or 10 trials

lambdacyhalothrin>cypermethrin, deltamethrin intermediate



Particular pyrethroids

Etofenprox (57.5 g/ha, 5 trials) inferior to lambdacyhalothrin (5 g/ha), phosmet 750 g/ha.
Taufluvalinate (48 g/ha) and esfenvalerate (15 g/ha): first results available not convincing. Continuation evaluation.



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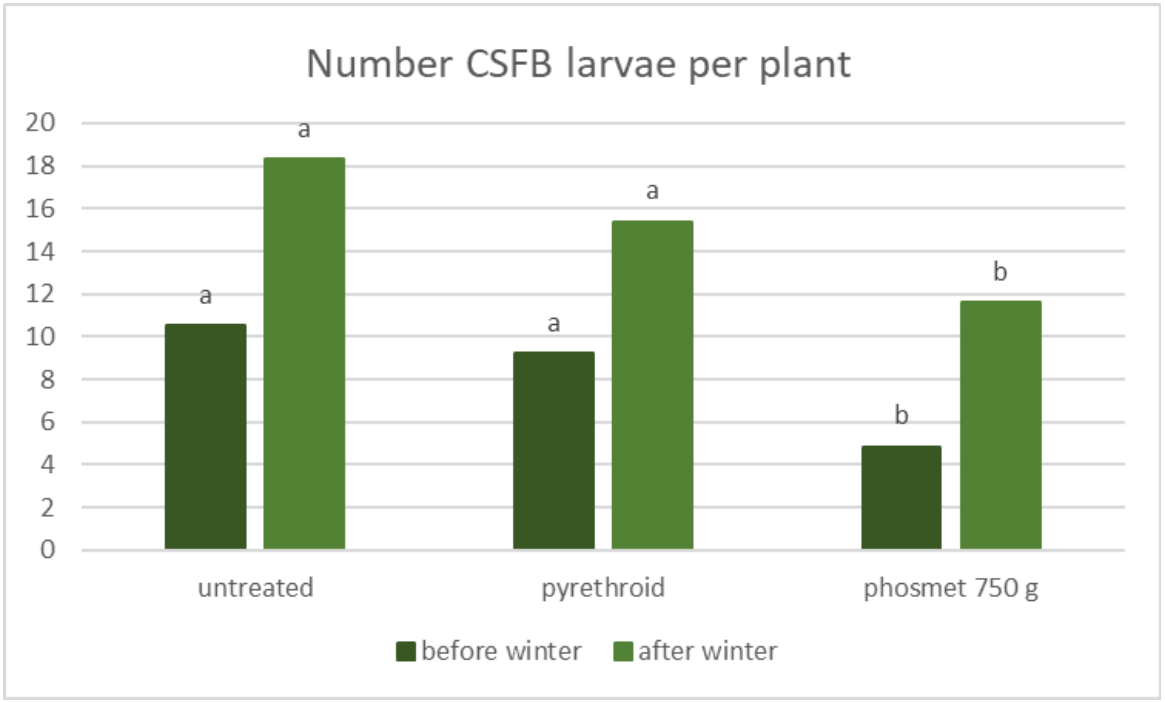
KARATE ZEON (lambda-cyhalothrine) appears to be the most effective pyrethroid

CSFB larvae – S-KDR area : Pyrethroids are not efficient

Synthesis of 7 trials
phosmet 750 g/ha vs pyrethroid*

Dijon 2017 to 2021



☞ Pyrethroids not efficient in S-KDR generalized situation

**Pyrethroids = cypermethrin, lambda-cyhalothrin, deltamethrin*

Ceutorhynchus picitarsis

Rape winter stem weevil - Results

Symbols

Bioassays - λ-cyhalothrin
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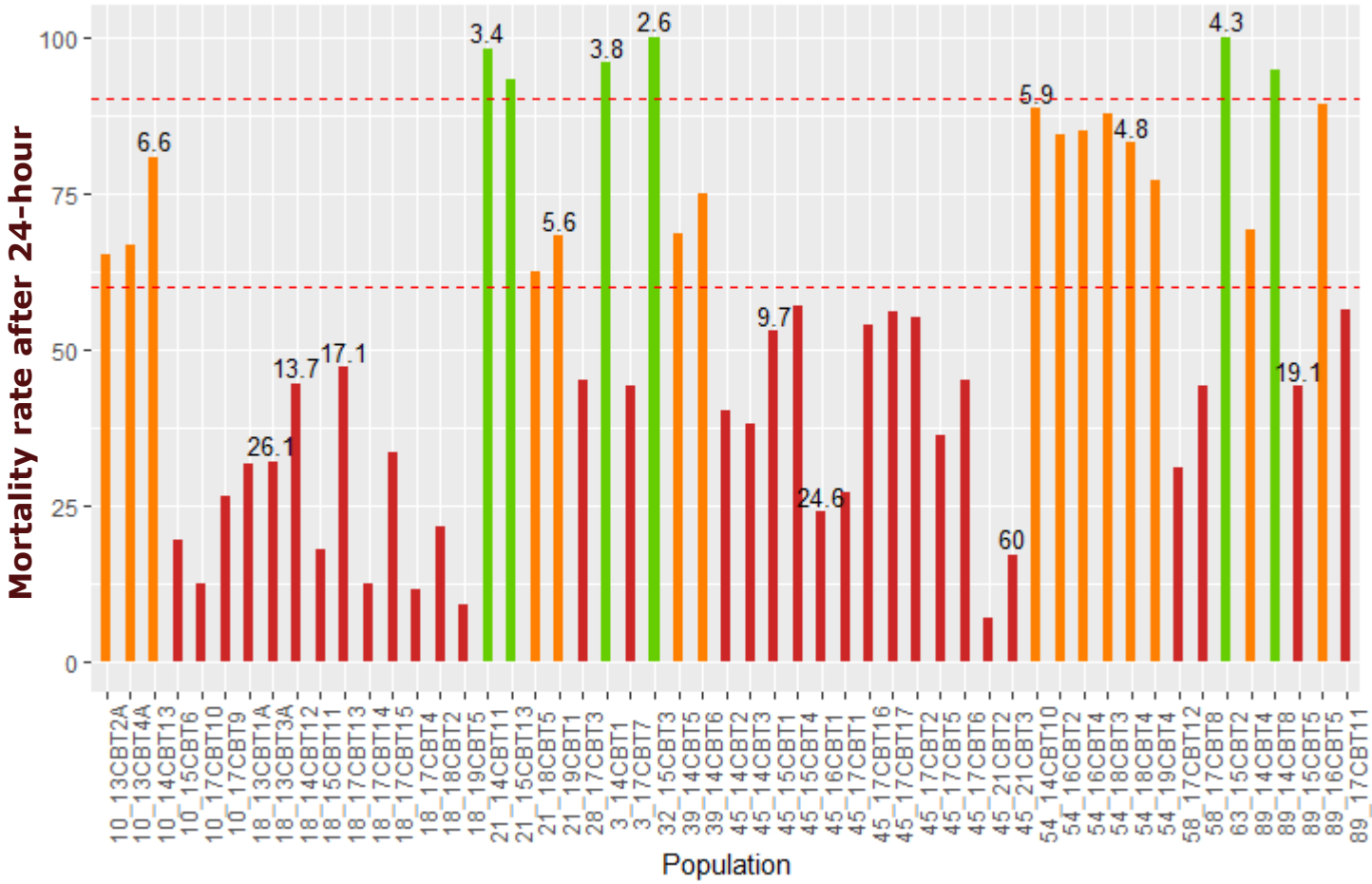
Bioassays – very variable mortality rates



- Since 2013, vial tests have been carried out for 53 populations at a dose of 15 ng λ-cyhalothrin/cm².
- LC50 ratio between the 2 most resistant and the 2 most susceptible populations = 14.

Mortality > 90% | **90%=>Mortality > 60%** | **Mortality < = 60%**

LC50 is indicated at the top of the bars of the histogram when it could be calculated

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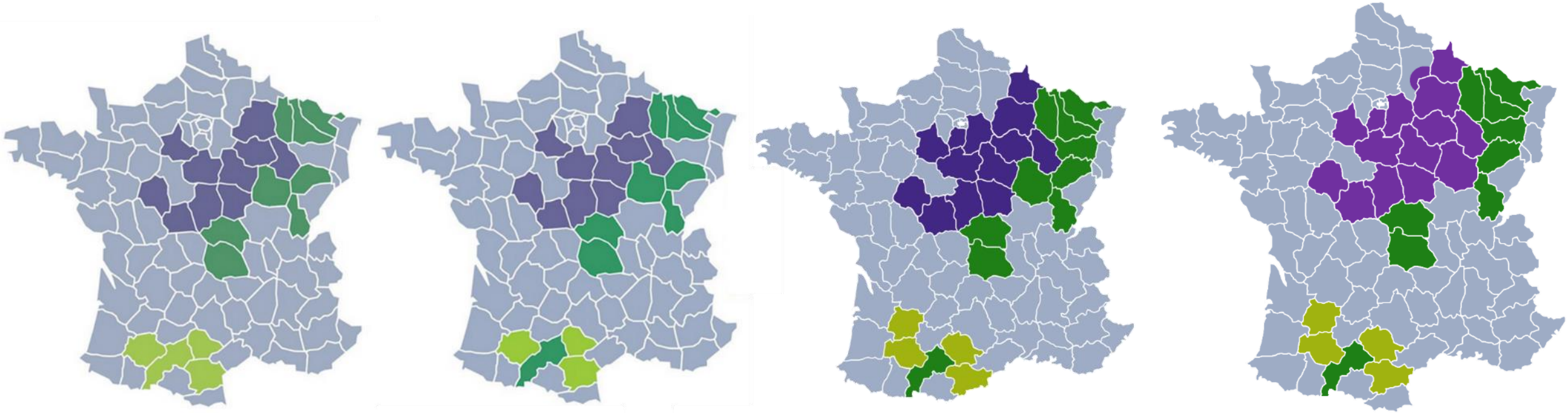
KDR mutation does not seem to progress over time

No resistance mechanisms detected

Resistance mechanisms in low to medium proportions in at least one population (KDR).

Resistance mechanisms in high proportions in populations (KDR).

No information to date



End of 2018 | End of 2019 | End of 2020 | 2021/06

Resistance (target gene mutation KDR) well established in the center and part of the north-east. First mutations were detected in the southwest.

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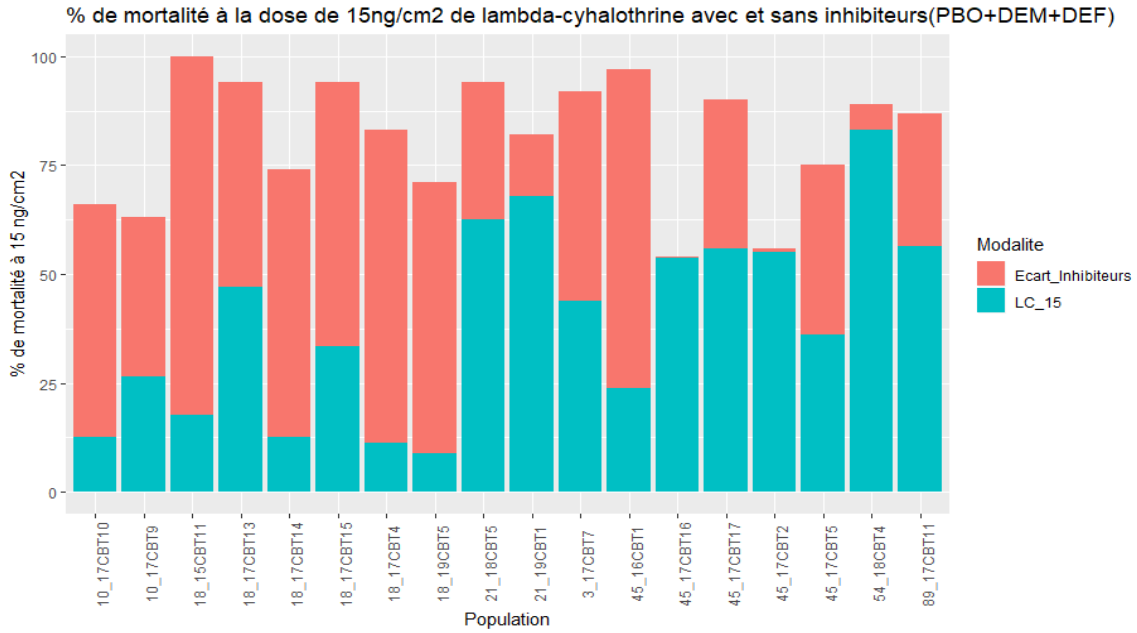
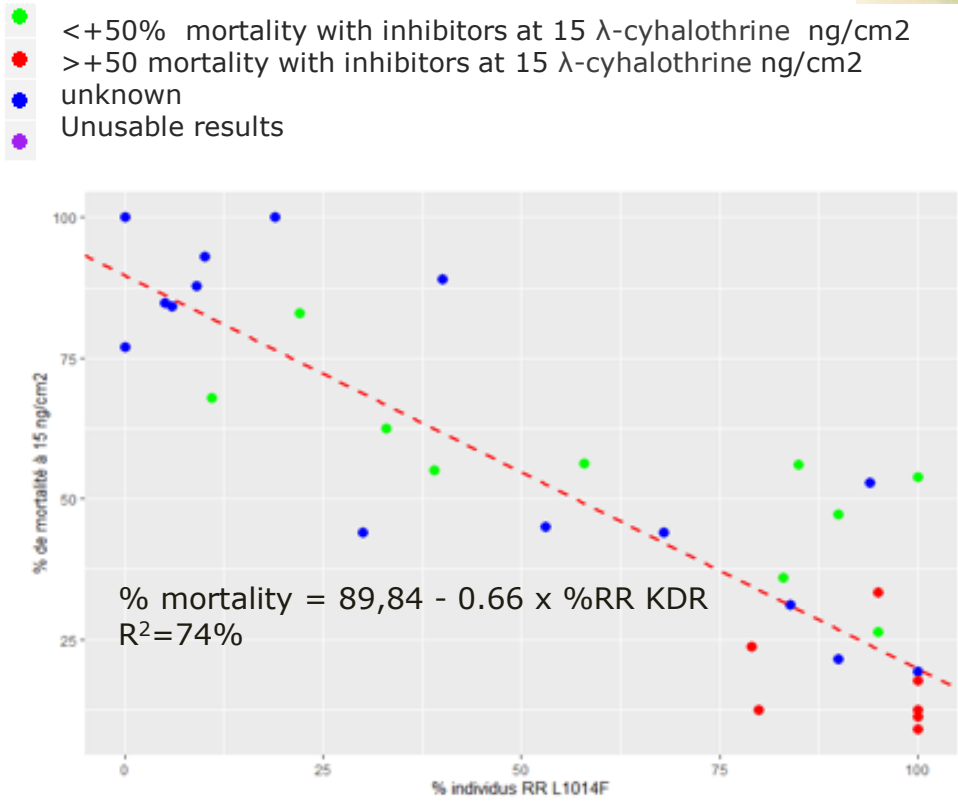
Metabolic resistance suspected





With inhibitors (of detoxification enzymes), mortality increases in some RWSW populations => metabolic resistance is suspected

In laboratory (vial test) less susceptible RWSW populations exhibit both target gene mutation (KDR) and detoxification

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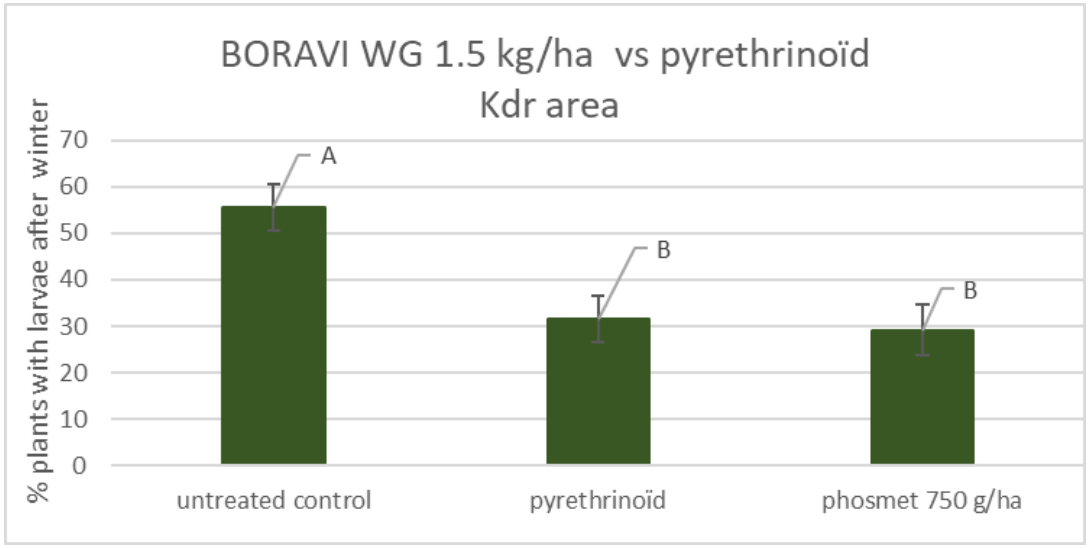
Protection against rape winter stem weevil

BORAVI WG and pyrethroids* are comparable.

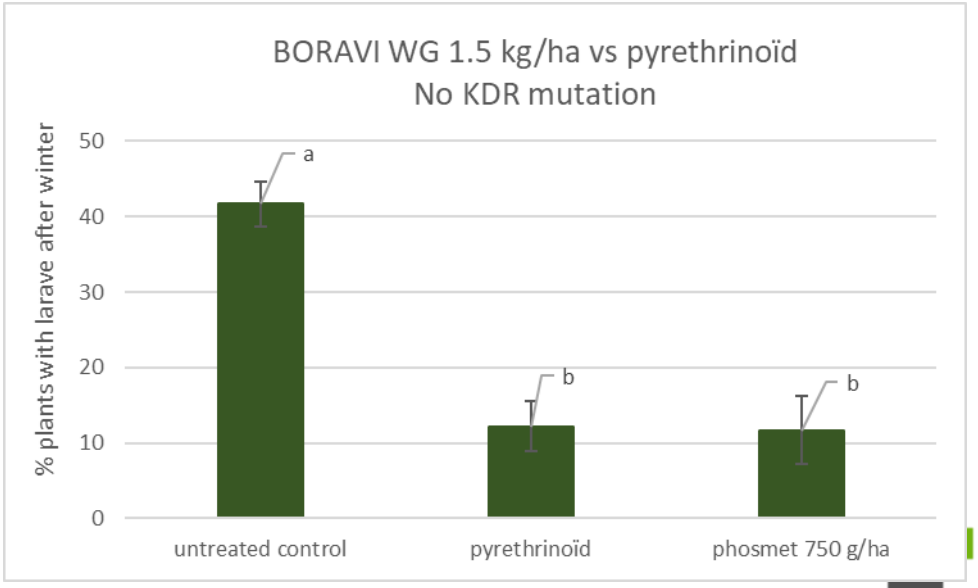
KDR Area

Efficiency ≈ 50%
8 trials: 2014-2016-2017-2018-2020
Departments: 10-18-36



No KDR mutation

Efficiency ≈70%
3 tests 2019 and 2020
Departments: 54-21



*KARATE ZEON, DECIS PROTECH, cypermethrin

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Monitoring other beetles

-

Results

Phyllotreta sp.

Cabbage stem weevil
Ceutorhynchus pallidactylus

Cabbage seed weevil
Ceutorhynchus obstrictus

Pollen beetle
Brassicogethes sp.

Rape stem weevil
Ceutorhynchus napi

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Results for other beetles

***Phyllotreta sp.* :**

- LC50 available for 7 populations. Resistance ratio between the most susceptible and the most resistant population is 7.9.

Rape stem weevil :

- Target gene mutations researched in 16 populations : 2 current KDR mutations (L1014F) at rates of homozygous individuals below 30%.

Cabbage stem weevil :

- Target gene mutations researched in 19 populations : 5 current KDR mutations (L1014F) at rates of homozygous individuals below 22 %.

Pollen beetle :

- Resistance to "ine" pyrethroids well established in France and Europe.
- Monitoring of susceptibility levels to tau-fluvanilate and etofenprox to be intensified

Cabbage seed weevil :

- Resistance ratio between the 2 most susceptible populations and the 2 most resistant = 5.7.
- Target gene mutations researched in 23 populations. KDR (L1014F) and SKDR (M918I) mutations were identified respectively in 52 and 4% of the populations (homozygous or heterozygous state).

Conclusions

- France is not the only country affected by pyrethroid resistance. The management of cabbage stem flea beetles is a major issue in many European countries.

- Knowledge of mechanisms and resistance levels involved is necessary to give farmers advice (to stop useless treatments, have the choice of insecticides, alternate modes of action, mixtures, ...) but the situation remains complex due to few solutions available (insecticides and biocontrol) and different resistance mechanisms.

- Terres Inovia continues to study and promote alternative levers, particularly agronomic ones, which constitute essential complements to insecticides.

- Decision support tools have been developed to show users the importance of agronomic levers, to better assess the risk and choose insecticides adapted to the resistance context.

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COLZA RISQUES altise adulte

COLZA RISQUES larve de grosse altise

COLZA RISQUES charançon du bourgeon terminal

Acknowledgments

- Végéphyl – Working group « Insecticides resistance »
- IRAC
- INRAE-Avignon
- Financial support

Avec la contribution financière du compte d'affectation spéciale développement agricole et rural CASDAR

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- Farmers
- …

Thank you for your attention !

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