# Indoxacarb susceptibility monitoring of Pollen Beetle (*Meligethes aeneus*) European populations 2008-2016 results

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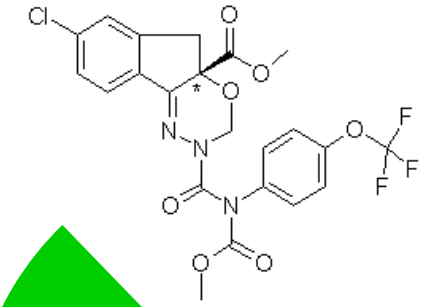
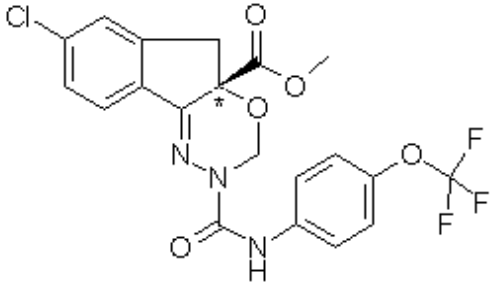
# Indoxacarb: IRAC MoA22

## Main activity on adults by ingestion but also by contact

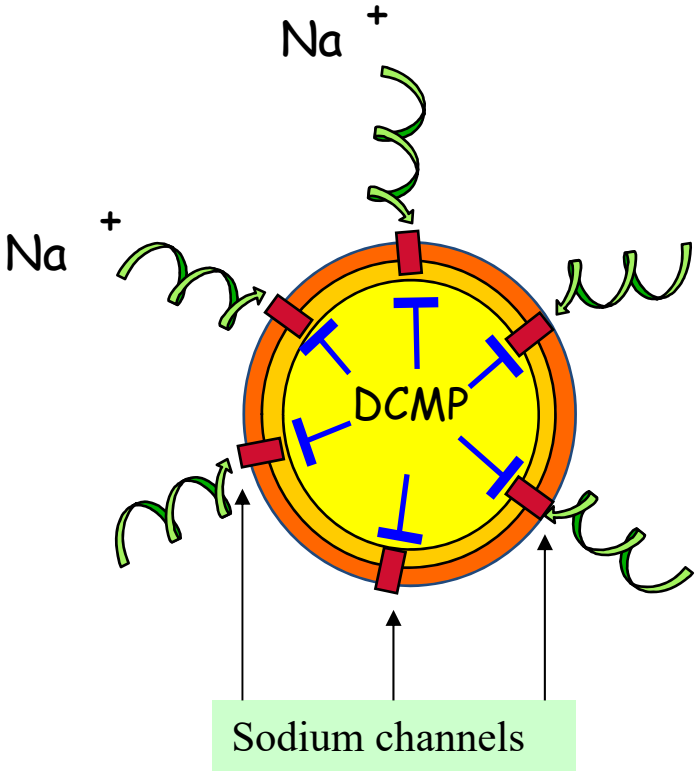
**Indoxacarb**



Transformation of indoxacarb into DCMP by enzymes of susceptible insects

**Active substance DCMP**




- Transformation of indoxacarb into active DCMP may vary according to insect species
- <u>Symptoms:</u>
  1) Insects stop feeding very quickly
  2) Insects get paralyzed
  3) Insect's death within 24 to 60 hours

# Method for testing the susceptibility of pollen beetle to indoxacarb

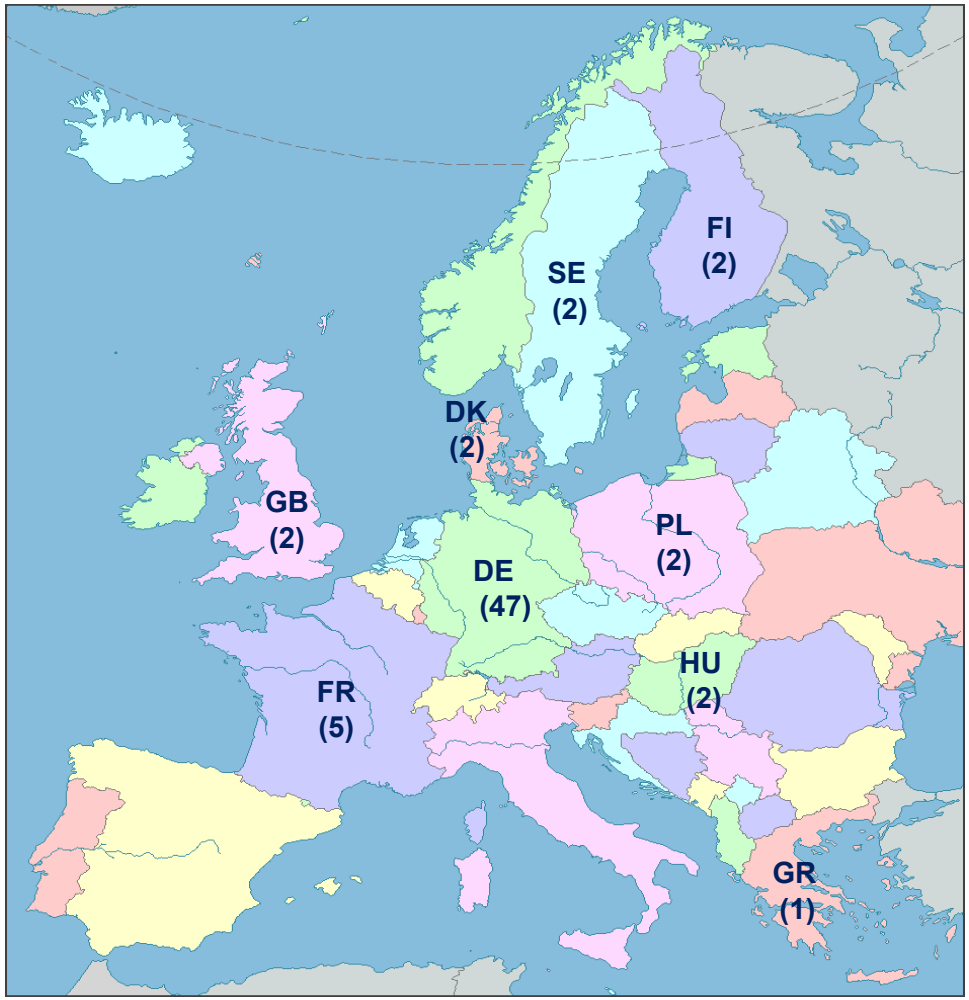
- IRAC Method #027
  - Glass vials coated with insecticide
  - 3-4 replicates of 10 adults
  - Incubation in the dark at 20°C
  - Evaluation 24 hours later

- Since 2010, tests are run with the liquid formulation Avaunt® (DPX-KN128 150EC)
- Rates tested:

| DC rates | ngai cm² | % Field rate | % Expected mortality |
|---|---|---|---|
| DC1 | 63.75 | 25% | >90 |
| DC2 | 255 | 100% | >90 |
| Untreated check | 0 | 0 | <20 |

# 2016 indoxacarb SM in European populations of *Meligethes aeneus*

- **2016 Populations' origin:**
  - 9 countries
  - 65 populations tested
  - in brackets: number of populations tested by country
- **2016 Testing laboratories:**
  - BTL – T. Thieme (Germany)
  - ERDC – M-O. Haxaire (France)
  - DuPont Representatives – P. Selzer and U. Reese (Germany)
  - German officials
    - SMUL Sachsen – B. Pölitz
    - LELF Brandenburg – S. Kupfer
    - RPGI Hessen– R. Gödecke
    - LLG Sachsen-Anhalt – K. Schwabe
    - TLL Thüringen – K. Gössner
    - LWK Schleswig-Holstein – M. Müller
    - LfL Bayern – S. Kügle
    - LTZ Augustenberg – K. Hüsgen



# 2016 indoxacarb SM in European populations of *Meligethes aeneus*

## Results of indoxacarb susceptibility monitoring of populations from Denmark, Finland, France, Greece, Hungary, Poland, Sweden and United Kingdom

| Year | Test by | Country | Site | DC1 62.75 µg/cm² | DC2 255 µg/cm² | Control | Total Number tested | Indoxacarb Susceptibility |
|---|---|---|---|---|---|---|---|---|
| 2016 | ERDC | France | Nambsheim | 100 | 100 | 0 | 126 | HS |
| 2016 | ERDC | France | Horbourg-Wihr | 100 | 100 | 0 | 121 | HS |
| 2016 | ERDC | France | Wittenheim | 100 | 100 | 0 | 121 | HS |
| 2016 | BTL Sagerheide | France | Nitry | 100 | 100 | 0 | 125 | HS |
| 2016 | BTL Sagerheide | France | Rumilly-lés-Vaudes | 100 | 100 | 0 | 124 | HS |
| 2016 | BTL Sagerheide | Hungary | Latokep | 100 | 100 | 0 | 126 | HS |
| 2016 | BTL Sagerheide | Hungary | Táplánszebtkereszt | 100 | 100 | 21 | 120 | HS |
| 2016 | BTL Sagerheide | Greece | Paraliaanio | 100 | 100 | 0 | 124 | HS |
| 2016 | BTL Sagerheide | France | Nambsheim | 100 | 100 | 0 | 125 | HS |
| 2016 | BTL Sagerheide | Poland | Ksiaz Wielkopolska | 100 | 100 | 0 | 126 | HS |
| 2016 | BTL Sagerheide | Poland | Prusice | 100 | 100 | 0 | 124 | HS |
| 2016 | BTL Sagerheide | England | Wilson | 100 | 100 | 17 | 119 | HS |
| 2016 | BTL Sagerheide | England | Church Broughton | 100 | 100 | 15 | 121 | HS |
| 2016 | BTL Sagerheide | Sweden | Stehag | 100 | 100 | 0 | 125 | HS |
| 2016 | BTL Sagerheide | Denmark | Røjle | 100 | 100 | 0 | 123 | HS |
| 2016 | BTL Sagerheide | Denmark | Vejlby Fed | 100 | 100 | 5 | 122 | HS |
| 2016 | BTL Sagerheide | Finland | Ypäjä | 100 | 100 | 7 | 129 | HS |
| 2016 | BTL Sagerheide | Finland | Jokioinen | 100 | 100 | 7 | 138 | HS |

HS = Highly susceptible

# 2016 indoxacarb SM in European populations of *Meligethes aeneus*

## Results of indoxacarb susceptibility monitoring of German populations – 1/2

| Year | Test by | Country | Site | DC1 62.75 µg/cm² | DC2 255 µg/cm² | Control | N | Indoxacarb Susceptibility |
|---|---|---|---|---|---|---|---|---|
| 2016 | BTL Sagerheide | Germany | Dichtelbach | 100 | 100 | 0 | 143 | HS |
| 2016 | BTL Sagerheide | Germany | Görsroth | 100 | 100 | 0 | 117 | HS |
| 2016 | BTL Sagerheide | Germany | Sanitz | 100 | 100 | 0 | 131 | HS |
| 2016 | BTL Sagerheide | Germany | Keindorf | 100 | 100 | 0 | 133 | HS |
| 2016 | BTL Sagerheide | Germany | Nandlstadt | 100 | 100 | 0 | 124 | HS |
| 2016 | BTL Sagerheide | Germany | Nandlstadt | 100 | 100 | 8 | 121 | HS |
| 2016 | TLL Thüringen (Katrin Gößner) | Germany | Backleben | 100 | 100 | 0 | 123 | HS |
| 2016 | TLL Thüringen (Katrin Gößner) | Germany | Bischofferode | 100 | 100 | 0 | 121 | HS |
| 2016 | TLL Thüringen (Katrin Gößner) | Germany | Caaschwitz | 100 | 100 | 0 | 123 | HS |
| 2016 | TLL Thüringen (Katrin Gößner) | Germany | Friedrichsthal | 100 | 100 | 0 | 122 | HS |
| 2016 | TLL Thüringen (Katrin Gößner) | Germany | Großeutersdorf | 100 | 100 | 0 | 128 | HS |
| 2016 | LfL Bayern (S.Kügle) | Germany | Pettenhofen | 100 | 100 | 0 | 60 | HS |
| 2016 | LELF Brandenburg | Germany | Schönefeld bei Luckenwalde | 100 | 100 | 2 | 152 | HS |
| 2016 | LELF Brandenburg | Germany | Lindchen | 100 | 100 | 0 | 125 | HS |
| 2016 | LELF Brandenburg | Germany | Groß Schönebeck | 100 | 100 | 0 | 124 | HS |
| 2016 | LELF Brandenburg | Germany | Steinhöfel | 100 | 100 | 0 | 128 | HS |
| 2016 | LELF Brandenburg | Germany | Sonnenberg | 100 | 100 | 0 | 122 | HS |
| 2016 | LTZ Augustenberg | Germany | Odenheim | 100 | 100 | 0 | 120 | HS |
| 2016 | Landratsamt Tübingen | Germany | Neustetten | 100 | 100 | 10 | 141 | HS |
| 2016 | Petra Selzer (DP) | Germany | Wehrheim | 100 | 100 | 2 | 144 | HS |
| 2016 | LWK Schleswig-Holstein | Germany | Schillsdorf | 100 | 100 | 0 | 51 | HS |
| 2016 | LWK Schleswig-Holstein | Germany | Schleswig | 100 | 100 | 0 | 50 | HS |
| 2016 | LWK Schleswig-Holstein | Germany | Wulfsdorf | 100 | 100 | 0 | 55 | HS |

HS = Highly susceptible

# 2016 indoxacarb SM in European populations of *Meligethes aeneus*

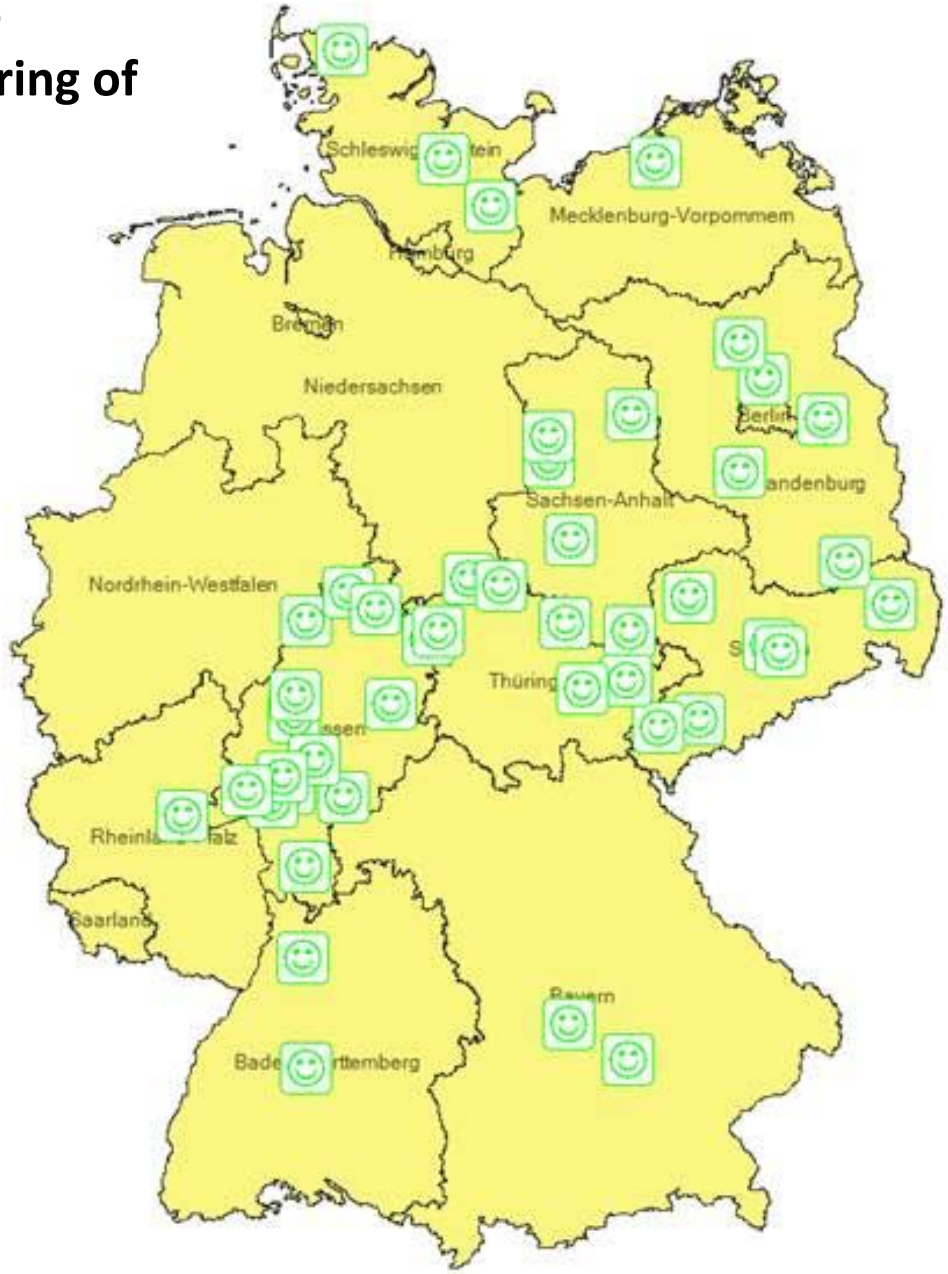
## Results of indoxacarb susceptibility monitoring of German populations – 2/2

| Year | Test by | Country | Site | DC1 62.75 µg/cm² | DC2 255 µg/cm² | Control | N | Indoxacarb Susceptibility |
|---|---|---|---|---|---|---|---|---|
| 2016 | LLG (K. Schawbe) | Germany | Eimersleben | 100 | 100 | 0 | 120 | HS |
| 2016 | LLG (K. Schawbe) | Germany | Ermsleben | 100 | 100 | 0 | 120 | HS |
| 2016 | LLG (K. Schawbe) | Germany | Redekin | 100 | 100 | 0 | 120 | HS |
| 2016 | LLG (K. Schawbe) | Germany | Pettstädt | 100 | 100 | 0 | 120 | HS |
| 2016 | RGPI (Ruben Gödecke) | Germany | Gelnhausen | 100 | 100 | 0 | 120 | HS |
| 2016 | RGPI (Ruben Gödecke) | Germany | Reichensachsen | 100 | 100 | 0 | 120 | HS |
| 2016 | RGPI (Ruben Gödecke) | Germany | Jestädt | 100 | 100 | 0 | 120 | HS |
| 2016 | RGPI (Ruben Gödecke) | Germany | Korbach | 100 | 100 | 0 | 120 | HS |
| 2016 | RGPI (Ruben Gödecke) | Germany | Obererlenbach | 100 | 100 | 0 | 120 | HS |
| 2016 | RGPI (Ruben Gödecke) | Germany | Krofdorf | 100 | 100 | 0 | 120 | HS |
| 2016 | RGPI (Ruben Gödecke) | Germany | Liederbach | 100 | 100 | 0 | 120 | HS |
| 2016 | RGPI (Ruben Gödecke) | Germany | Echzell | 70 | 100 | 0 | 120 | ? |
| 2016 | RGPI (Ruben Gödecke) | Germany | Wettesingen | 100 | 100 | 0 | 120 | HS |
| 2016 | RGPI (Ruben Gödecke) | Germany | Kassel | 100 | 100 | 0 | 120 | HS |
| 2016 | RGPI (Ruben Gödecke) | Germany | Crumbach | 100 | 100 | 0 | 120 | HS |
| 2016 | RGPI (Ruben Gödecke) | Germany | Wehrshausen | 100 | 100 | 0 | 120 | HS |
| 2016 | RGPI (Ruben Gödecke) | Germany | Haunetal | 100 | 100 | 0 | 120 | HS |
| 2016 | SMUL (B. Pölitz) | Germany | Wiesenburg | 100 | 100 | 10 | 60 | HS |
| 2016 | SMUL (B. Pölitz) | Germany | Christgrün | 100 | 100 | 0 | 60 | HS |
| 2016 | SMUL (B. Pölitz) | Germany | Machern | 100 | 100 | 0 | 60 | HS |
| 2016 | SMUL (B. Pölitz) | Germany | Nossen | 100 | 100 | 0 | 61 | HS |
| 2016 | SMUL (B. Pölitz) | Germany | Grumbach | 100 | 100 | 15 | 60 | HS |
| 2016 | SMUL (B. Pölitz) | Germany | Baruth | 100 | 100 | 5 | 61 | HS |

HS = Highly susceptible

# 2016 indoxacarb SM in European populations of *Meligethes aeneus*

**Results of indoxacarb susceptibility monitoring of German populations**

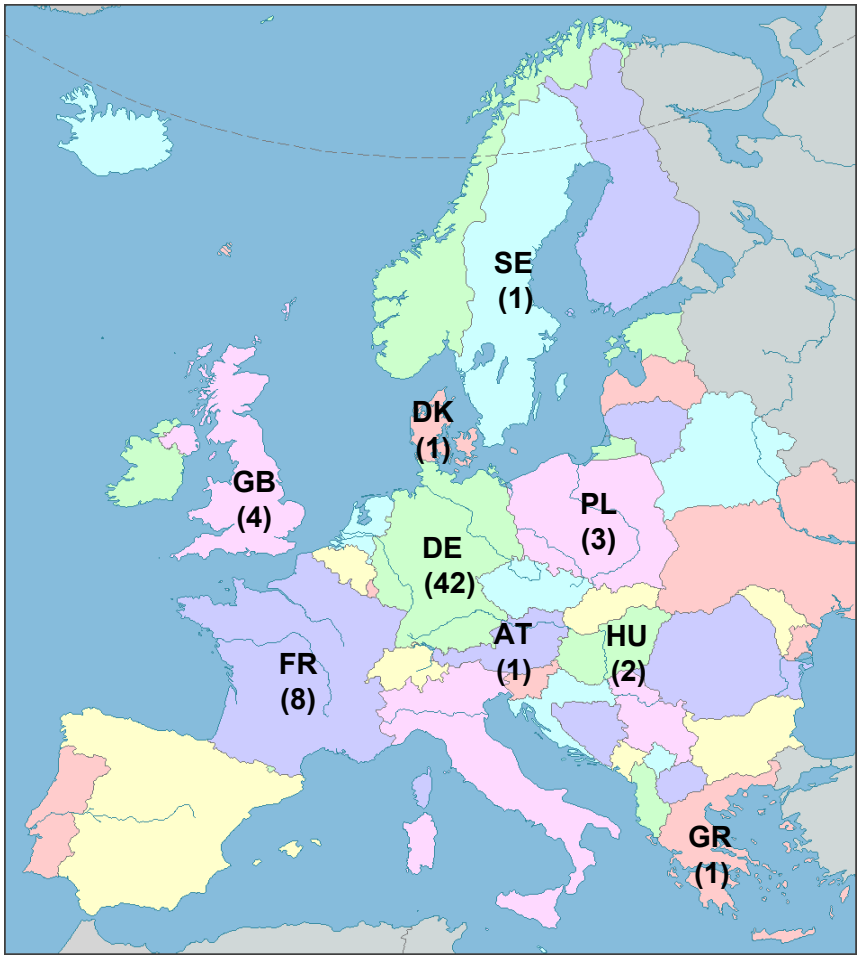



HS = Highly susceptible

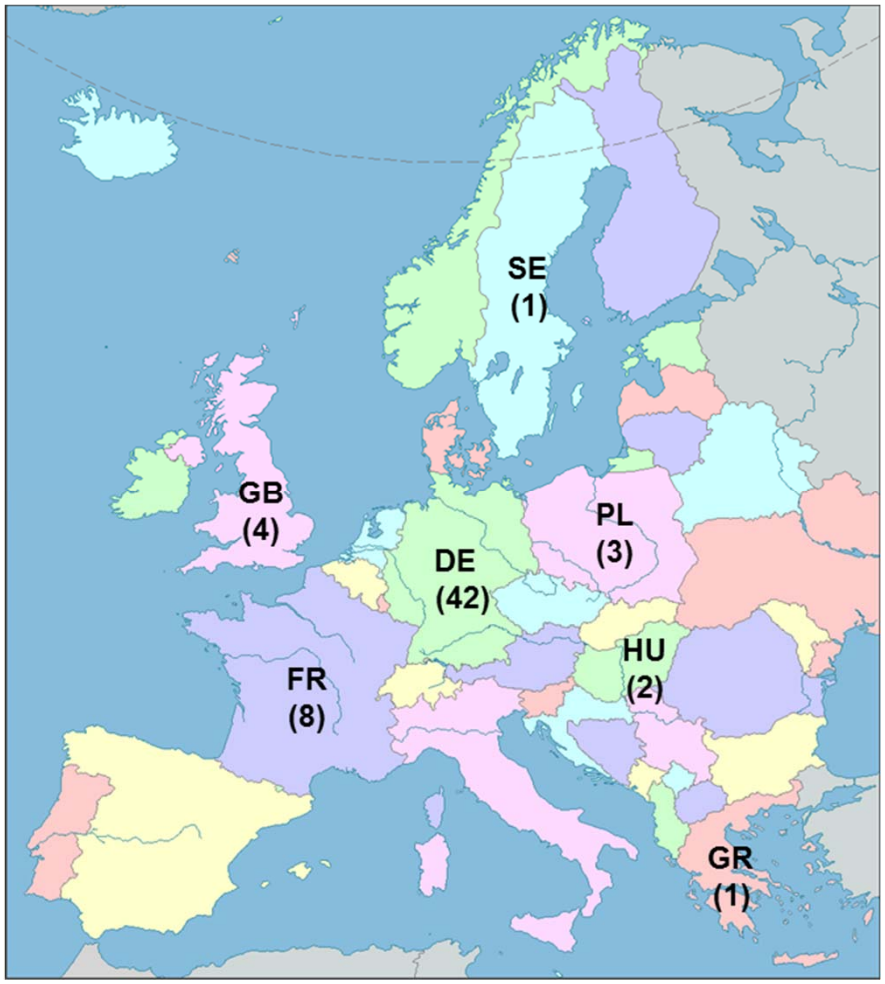
# 2015 indoxacarb IRM in EU populations of *Meligethes aeneus*

- **2015 origin of MELIAE populations**
  - 9 EU countries
  - 64 populations tested
  - in brackets: number of populations tested by country
- **2015 Testing laboratories**

  monitoring tests were conducted by the following laboratories
    - BTL – T. Thieme (Germany)
    - SMUL of Sachsen – B. Pölitz (Germany)
    - LELF Brandenburg – S. Kupfer (Germany)
    - RGPI Hessen – R. Gödecke (Germany)
    - LLG Sachsen-Anhalt – K. Schwabe (Germany)
    - ERDC DuPont (France)



# 2015 indoxacarb IRM in EU populations of *Meligethes aeneus*




**Results => All 64 MELIAE populations collected and tested in 2015 were classified as susceptible to indoxacarb.**

# Indoxacarb SM for MELIAE in OSR; 2008-16

| Country | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Austria | 0 | 2 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | **7** |
| Denmark | 1 | 0 | 2 | 0 | 1 | 0 | 2 | 2 | 2 | **10** |
| England | 1 | 3 | 3 | 3 | 0 | 5 | 2 | 4 | 2 | **23** |
| Finland | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | **4** |
| France | 1 | 6 | 6 | 7 | 5 | 7 | 6 | 9 | 5 | **52** |
| Germany | 2 | 4 | 6 | 3 | 16 | 36* | 23 | 42 | 47** | **179** |
| Greece | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 1 | 1 | **5** |
| Hungary | 0 | 0 | 2 | 2 | 1 | 1 | 2 | 2 | 2 | **12** |
| Poland | 0 | 0 | 4 | 1 | 1 | 2 | 2 | 3 | 2 | **15** |
| Sweden | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 2 | **11** |
| Grand Total | **6** | **16** | **25** | **18** | **26** | **54** | **44** | **64** | **65** | **318** |

*A single German site showed unexpected results in 2013 (EMA06), the Keindorf pollen beetle population was checked for sensitivity to indoxacarb in 2014 and 2015. No reduced sensitivity was observed.

**One population collected in Hessen area in Germany, did not provide the expected performance at the lowest Discriminant Concentration. Test repeated in 2017: DC1 and DC2 provided 100% mortality.

In a total of 318 pollen beetle field populations tested from 2008 to 2016, no reduced efficacy of indoxacarb was found.

## Side by side comparison of the susceptibility of European Pollen beetle populations to pyrethroids and indoxacarb (kits produced by DuPont)

| Year | Test by | Country | Site | Pyrethroids resistance Classification | Indoxacarb Susceptibility |
|---|---|---|---|---|---|
| 2016 | ERDC | France | Nambsheim | R | HS |
| 2016 | ERDC | France | Horbourg-Wihr | MR | HS |
| 2016 | ERDC | France | Wittenheim | R | HS |
| 2016 | BTL Sagerheide | France | Nitry | HR | HS |
| 2016 | BTL Sagerheide | France | Rumilly-lés-Vaudes | HR | HS |
| 2016 | BTL Sagerheide | Greece | Paraliaanio | HS | HS |
| 2016 | BTL Sagerheide | France | Nambsheim | R | HS |
| 2016 | BTL Sagerheide | Poland | Ksiaz Wielkopolska | HR | HS |
| 2016 | BTL Sagerheide | Poland | Prusice | HR | HS |
| 2016 | BTL Sagerheide | Germany | Dichtelbach | R | HS |
| 2016 | BTL Sagerheide | Germany | Görsroth | HR | HS |
| 2016 | BTL Sagerheide | England | Wilson | S | HS |
| 2016 | BTL Sagerheide | England | Church Broughton | HS | HS |
| 2016 | BTL Sagerheide | Sweden | Stehag | HR | HS |
| 2016 | BTL Sagerheide | Germany | Sanitz | R | HS |
| 2016 | BTL Sagerheide | Denmark | Røjle | R | HS |
| 2016 | BTL Sagerheide | Denmark | Vejlby Fed | MR | HS |
| 2016 | BTL Sagerheide | Germany | Keindorf | R | HS |
| 2016 | BTL Sagerheide | Germany | Nandlstadt | R | HS |
| 2016 | BTL Sagerheide | Germany | Nandlstadt | R | HS |
| 2016 | BTL Sagerheide | Finland | Ypäjä | HR | HS |
| 2016 | BTL Sagerheide | Finland | Jokioinen | MR | HS |
| 2016 | BTL Sagerheide | Sweden | Kolbäck | R | HS |
| 2016 | BTL Sagerheide | Hungary | Latokep | R | HS |
| 2016 | BTL Sagerheide | Hungary | Táplánszebtkereszt | MR | HS |

**Same as in previous years, all the populations resistant to pyrethroids were found highly susceptible to Indoxacarb which confirm the absence of cross resistance between the 2 modes of action.**

# Conclusions

- Indoxacarb is so far the only MoA22 insecticide registered on OSR to control *M. aeneus* adults.
- A wide susceptibility monitoring program was run in major European OSR-cultivating countries since the beginning of the commercialization of indoxacarb based products.
- Results of the monitoring show no change in the susceptibility of *M. aeneus* populations to indoxacarb, underlining the importance of this active in the pest control program and the resistance management strategy.
- It is critical to implement rotational programs with different MoA to control PB in OSR, to avoid or delay resistance development.

# Thank you  for attention!

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