Overview of the current sensitivity of *Alternaria solani* to fungicides in Europe

(TUM, SLU, WUR, BASF)

EuroBlight Workshop, Ourense, Spain

18-21 May 2026

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Fungicide control of *Alternaria solani*

Quinone Outside Inhibitors (QoI)

- Inhibitor of respiration in complex III at Qo-site

Succinate Dehydrogenase Inhibitors (SDHI)

- Inhibitor of respiration in complex II at SDH

Demethylation Inhibitors (DMI)

- Inhibitor of ergosterol biosynthesis

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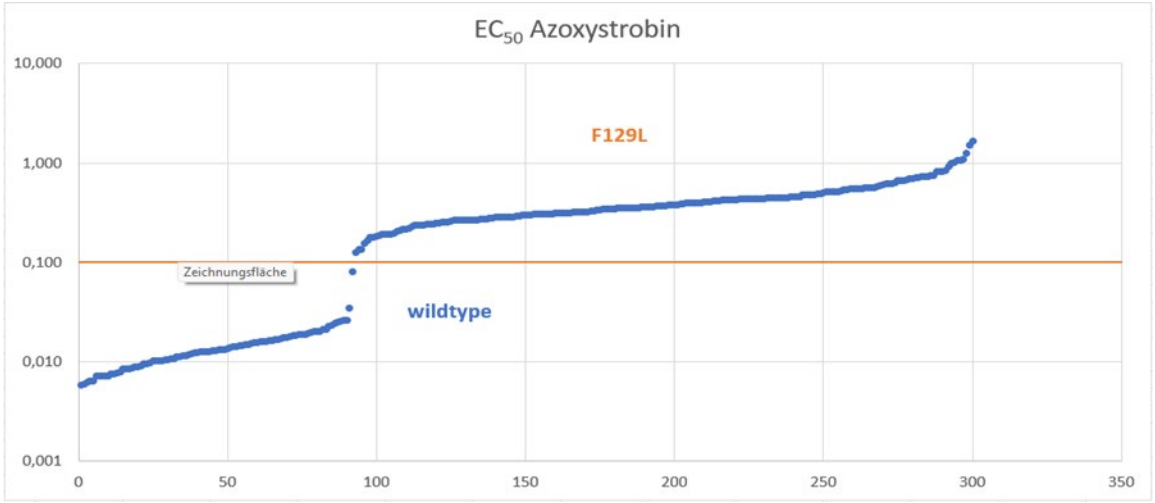
- Sterol biosynthesis Inhibitor

Alternaria solani
Mechanism for QoI adaptation is the F129L mutation

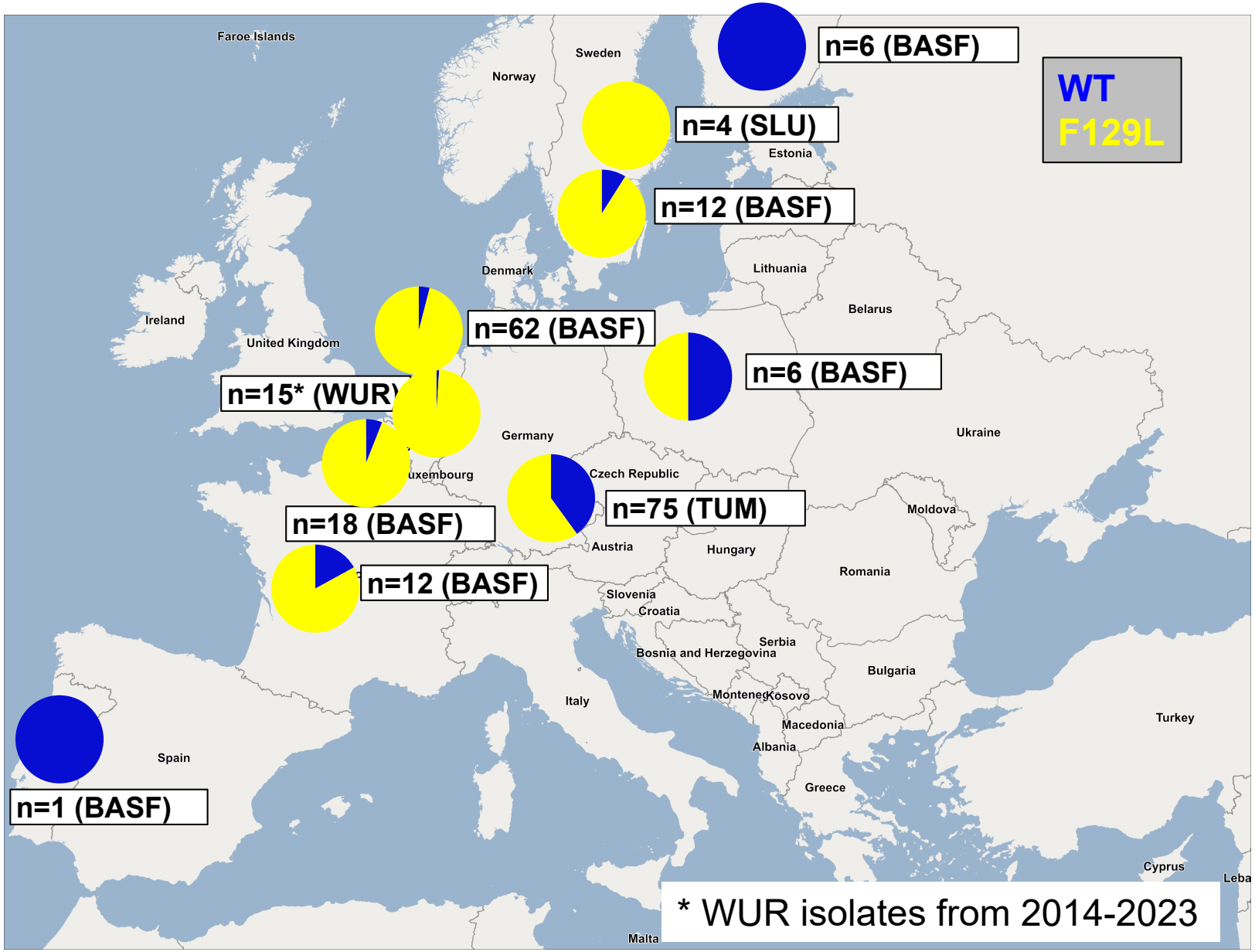
- **Detection of adapted isolates**
  - Phenotypically in sensitivity tests
    - Caveat: QoIs are differently affected

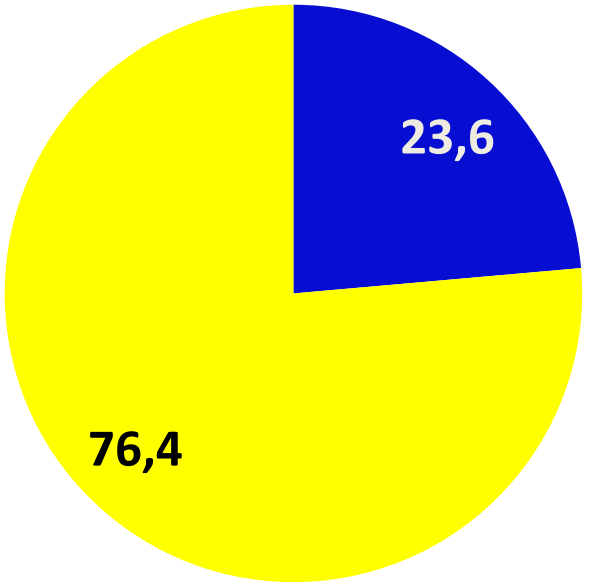


  - Genetically by e.g. pyrosequencing
    - 2 genotypes can be found, different codons for L
    - 2 pyro-assays necessary
    - Genotype 1 rarely, in most cases wildtype, but some F129L detected
    - Genotype 2, frequently and most with F129L

Cytb					
Genotyp I			Genotyp II		F129L
% F129L (CTC)	% F129L (TTA)	% F129L (TTG)	% F129L (CTC)	% F129L (TTA)	F129L
100	0	0	x	x	100
x	x	x	100	0	100
x	x	x	100	0	100
x	x	x	0	100	100

Alternaria solani: Frequency of F129L in samples from 2024
Samples from the Alternaria subgroup and BASF Monitoring





n=211 isolates or samples

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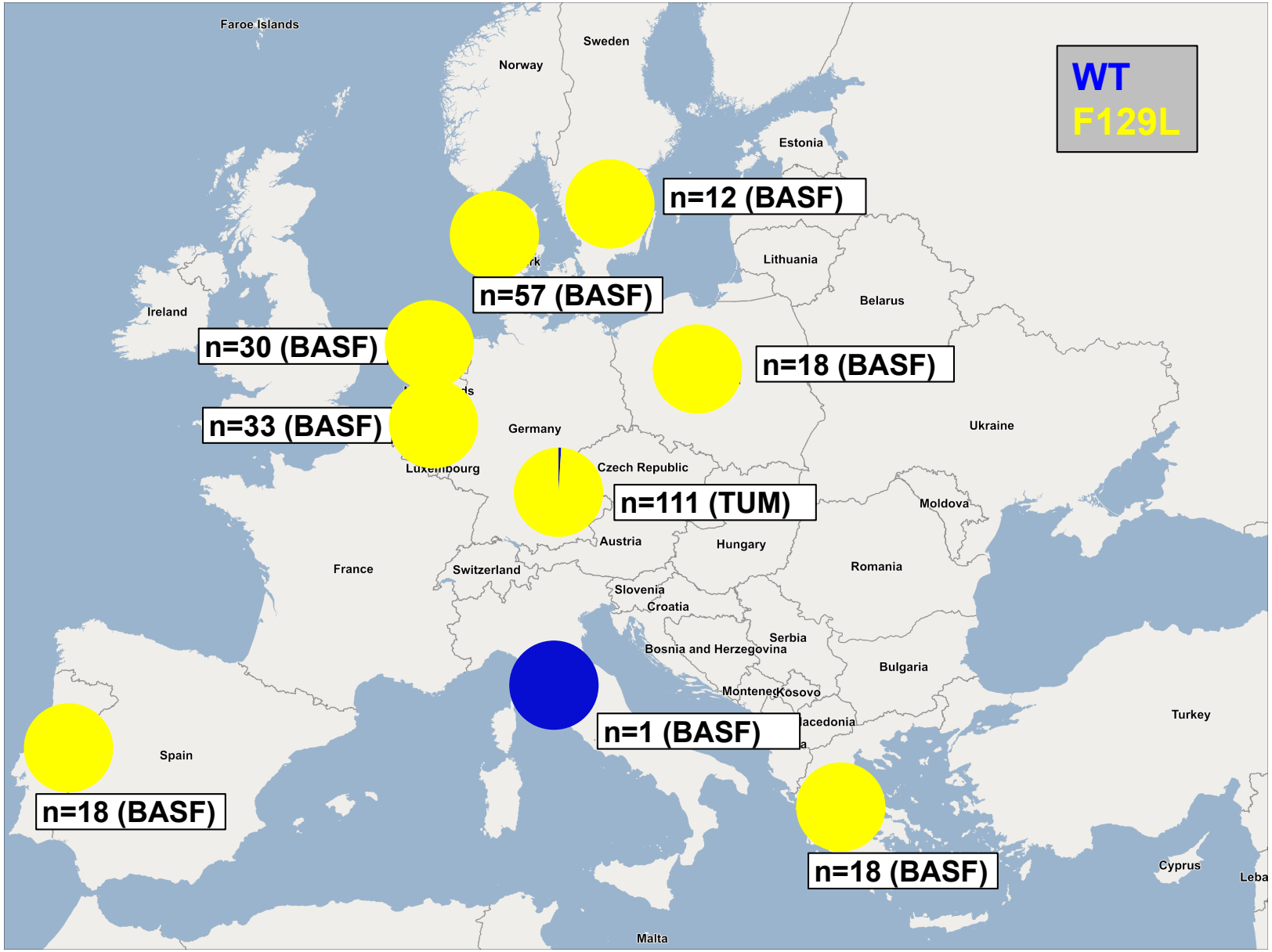
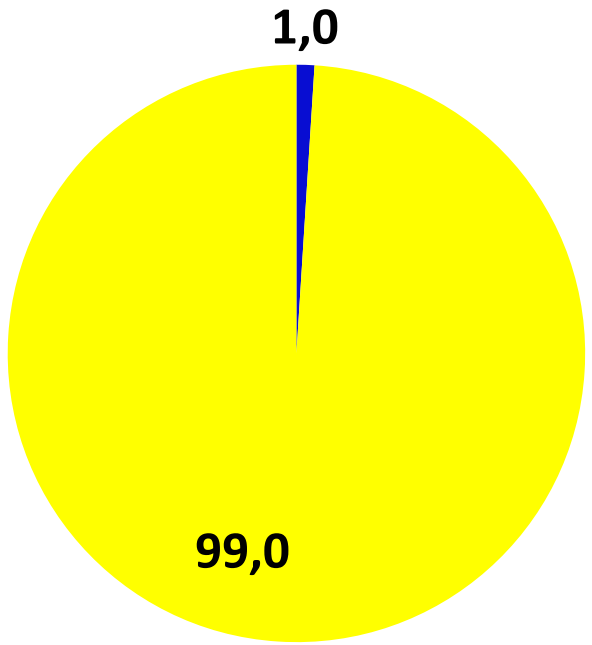
Alternaria solani: Frequency of F129L in samples from 2025 (ongoing)
Samples from the Alternaria subgroup and BASF Monitoring





n=299 isolates

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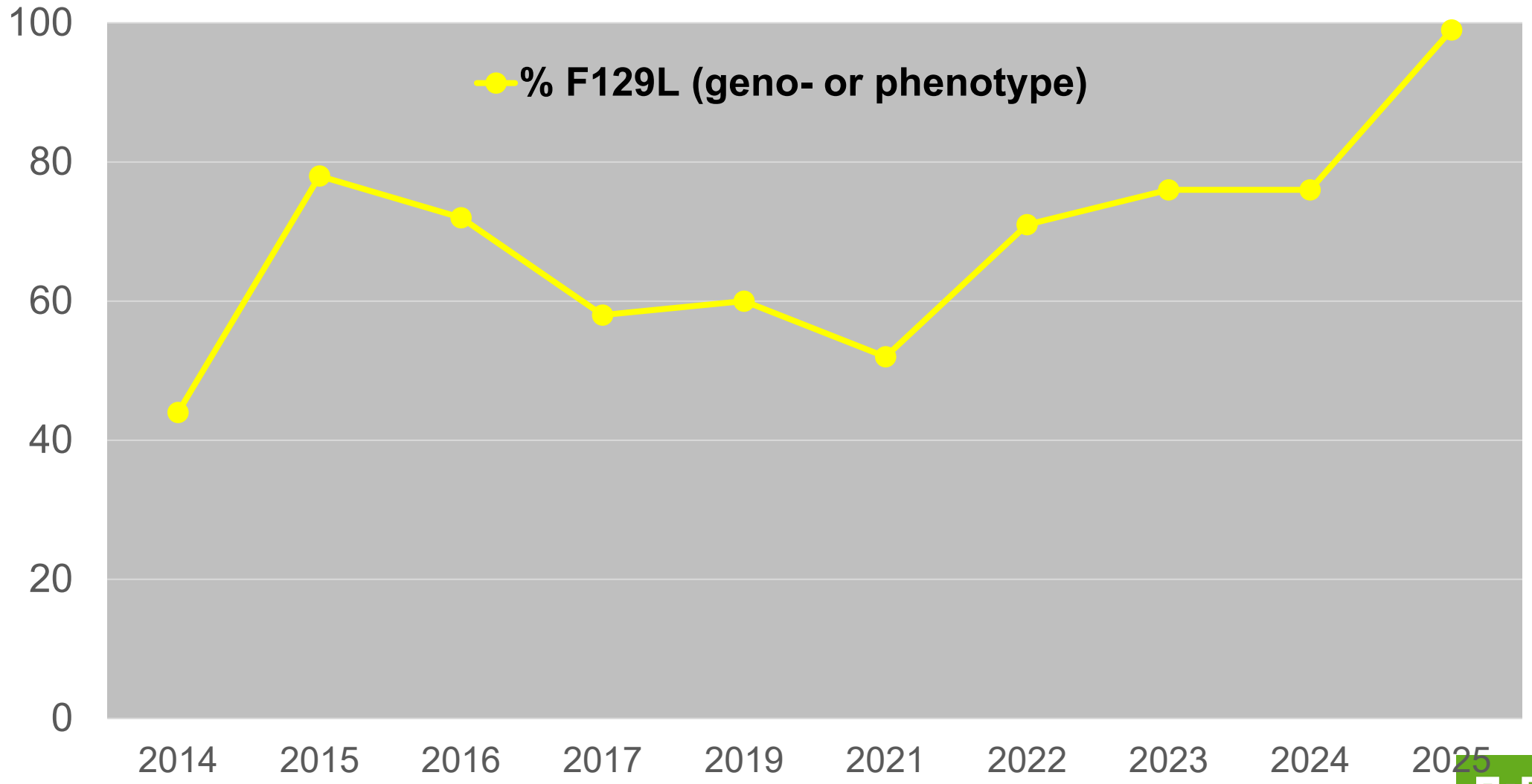
Alternaria solani: Frequency of F129L in samples from 2014 until today Samples from BASF Monitoring and *Alternaria* subgroup (2024 and 2025)



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Effects and frequency of F129L in *Alternaria solani*

Pasche et al. (2004) *Plant Disease*

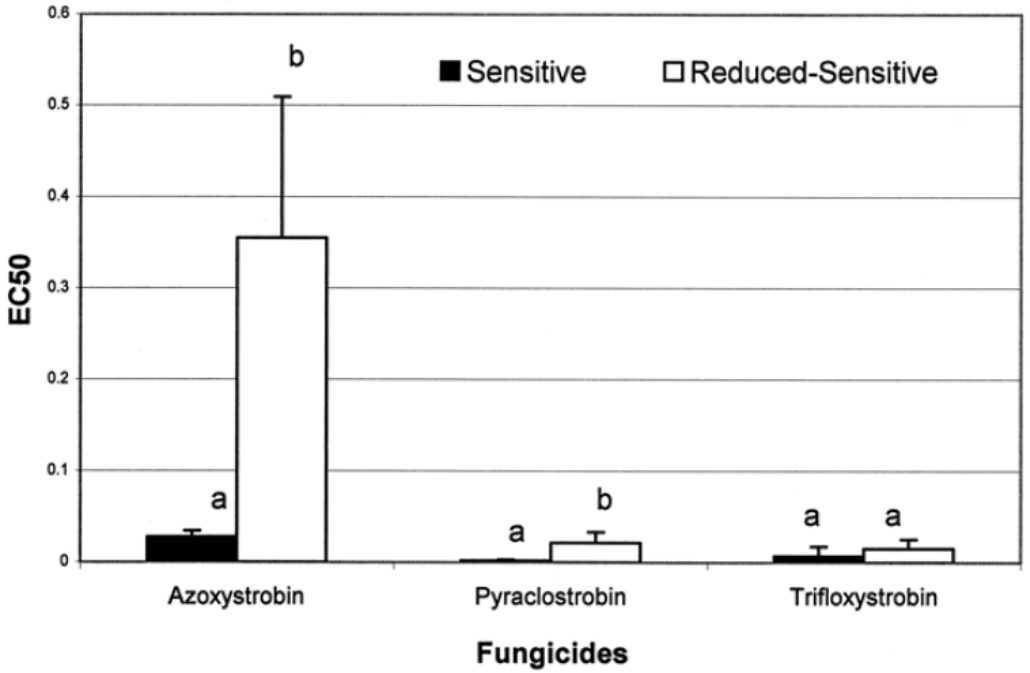

Fig. 2. Mean EC_{50} values (effective fungicide concentration that inhibited spore germination by 50%) for sensitive and reduced-sensitive *Alternaria solani* isolates obtained from the in vitro cross-sensitivity assessment of azoxystrobin, pyraclostrobin, and trifloxystrobin. Mean separation provided by Student's *t* tests ($P = 0.05$). Within fungicides, columns with the same letter are not significantly different. Vertical bars indicate standard deviation for all tests performed on each isolate group.

Pyraclostrobin and Trifloxystrobin are only marginal affected by F129L in *Alternaria solani*

Latest FRAC statement on ALTESO

Resistance to QoI is associated to the presence of the F129L mutation and molecular information are provided below:

Monitoring has been carried out in 2025 in Austria, Belgium, Denmark, Germany, Netherlands, Sweden and United Kingdom.

Wide spread of F129L mutated strains was observed in all countries.

Extensive monitoring in 2024 based on bioassay and molecular studies showed moderate to high frequency of mutation F129L in Belgium, Germany, Netherlands, Poland, Serbia and Sweden. Heterogeneous situation was observed in France, while samples from Finland, Portugal showed full sensitivity.

Data from 2023 showed a situation as known from previous years:

High frequency was detected in Austria, Belgium, Denmark, Germany, Netherlands and Sweden.

Moderate frequency was detected in France, Latvia and Poland.

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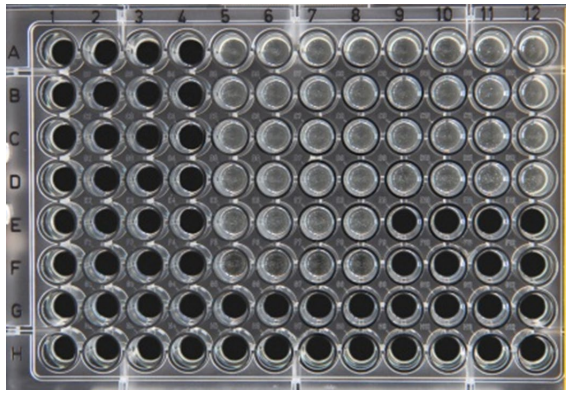
- Sterol biosynthesis Inhibitor

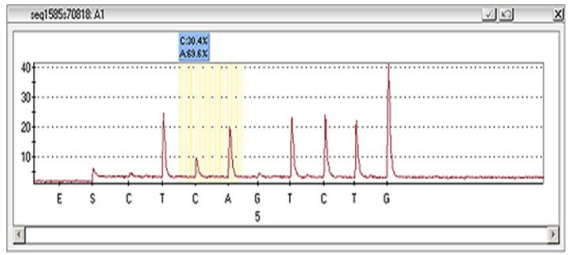
Alternaria solani
Mechanism for SDHI resistance are mutations in the sdh-b, -c and -d subunits

- **Detection of adapted isolates**



  - Phenotypically in sensitivity tests
    - Caveat: SDHIs were differently affected with „first mutations“, meanwhile strong mutations dominate

  - Genetically by e.g. pyrosequencing
    - B-H278Y/R dominating many years ago nearly disappeared
    - I280V and H278L found
    - Mainly C-H134R, Combination with D-D123E seldom



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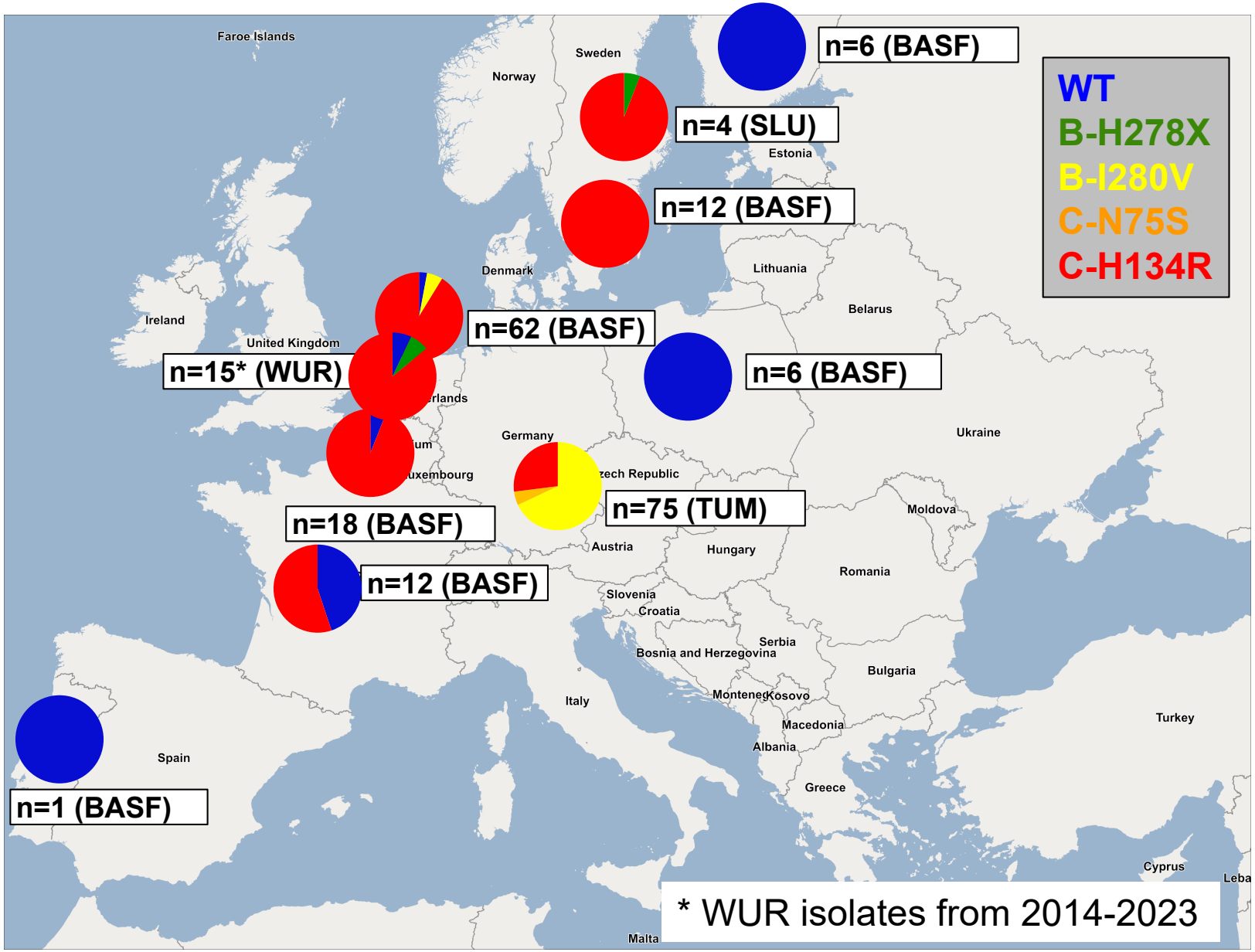
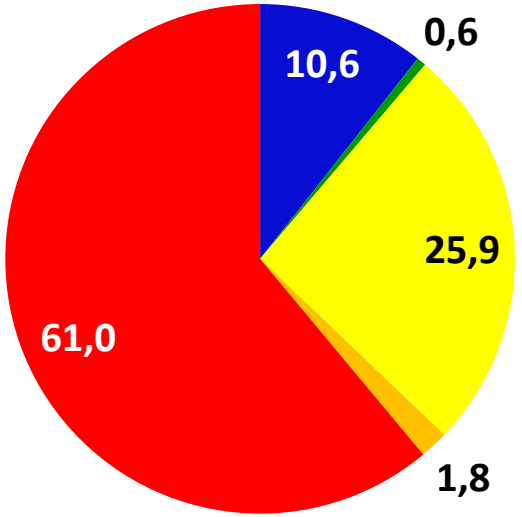
Alternaria solani: Frequency *of* SDHI mutations in samples from 2024
Samples from the Alternaria subgroup and BASF Monitoring





n=211 isolates or samples

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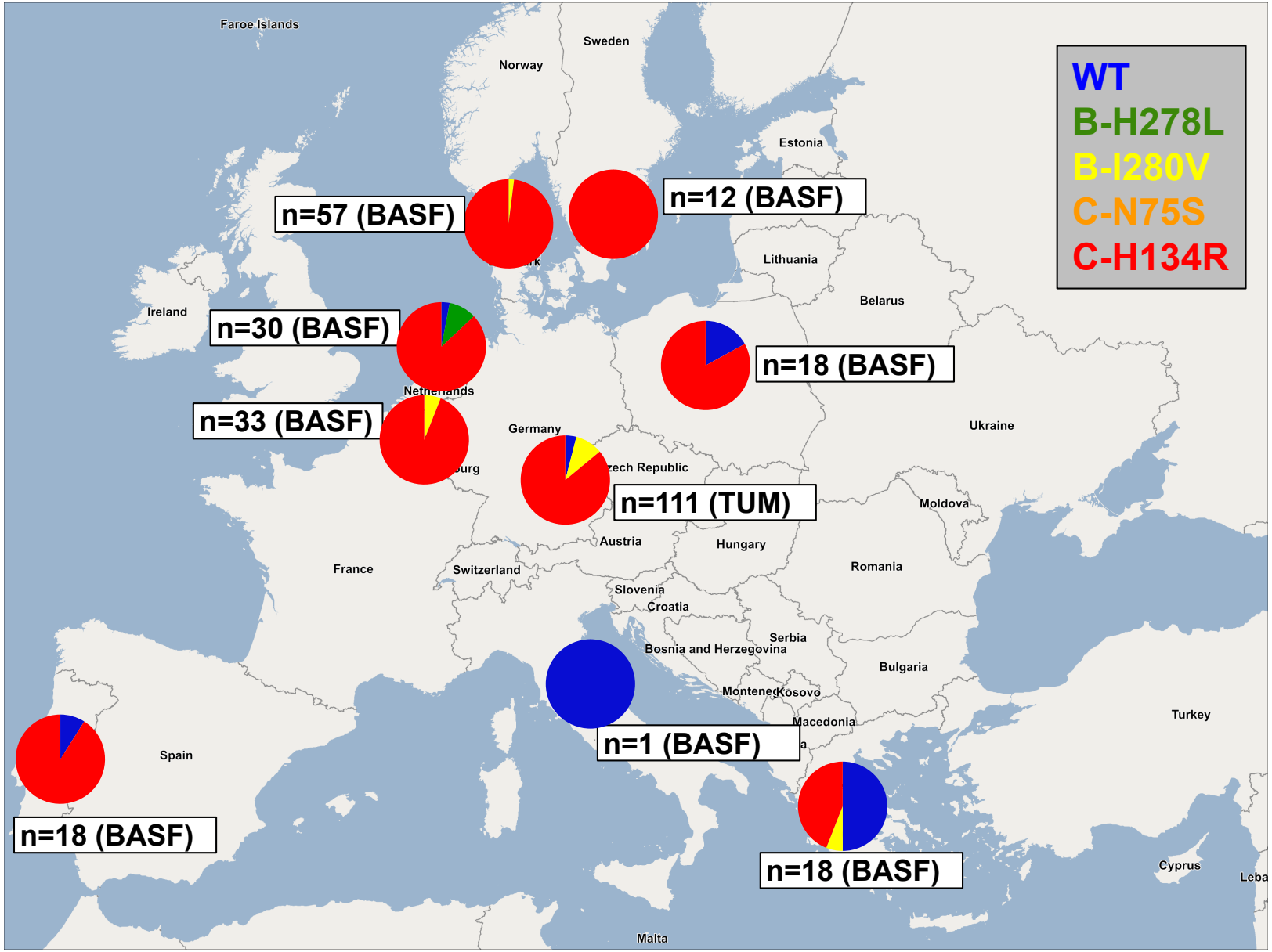
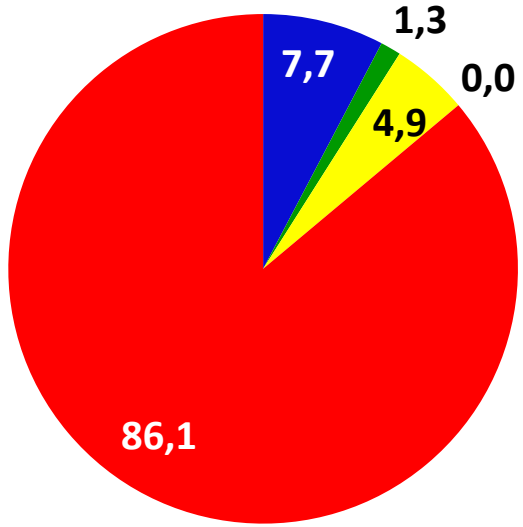
Alternaria solani Frequency *of* SDHI mutations in samples from 2025 (ongoing)
Samples from the Alternaria subgroup and BASF Monitoring





n=299 isolates

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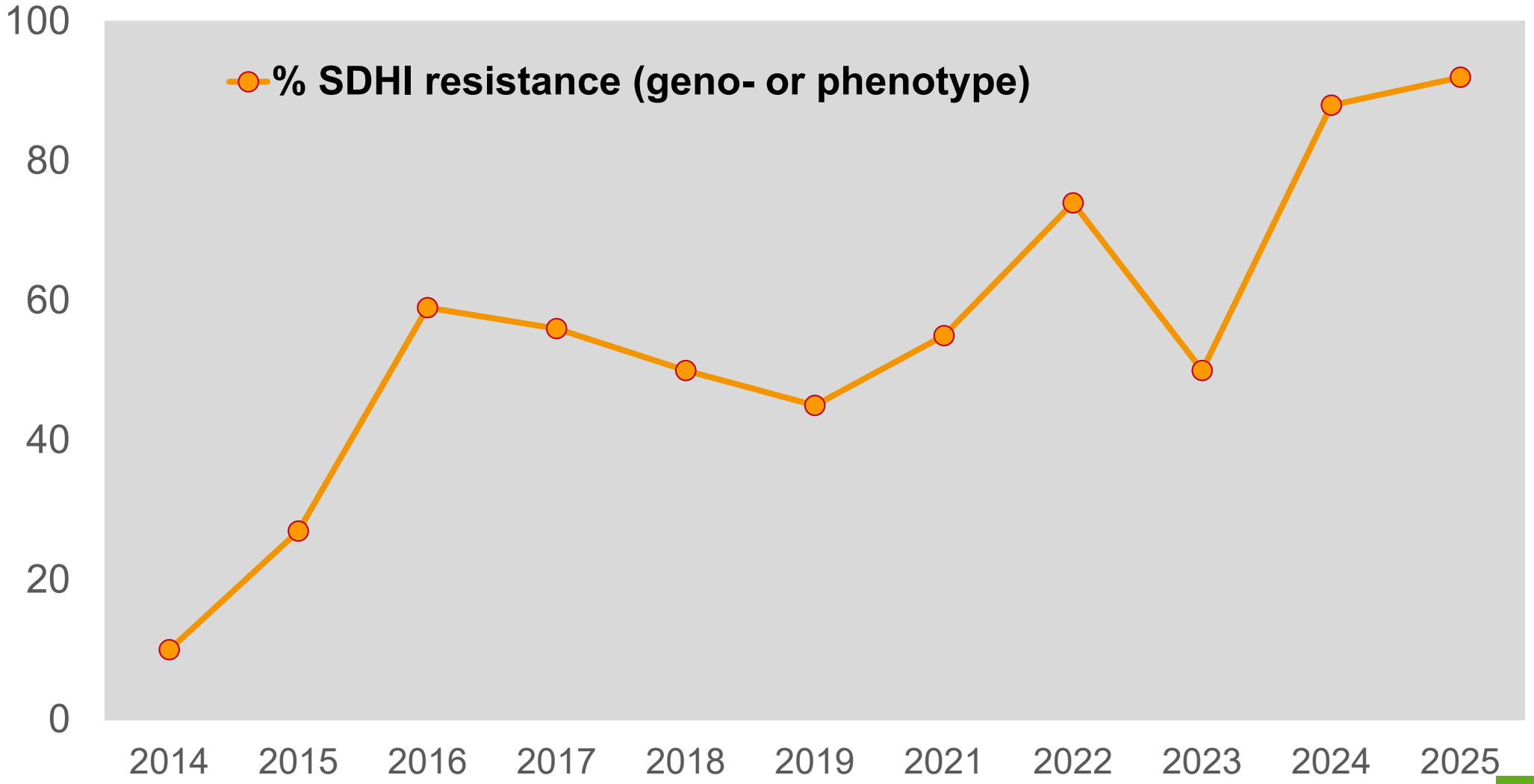
Alternaria solani: Frequency of SDHI-resistance from 2014 until today in Europe Samples from BASF Monitoring and *Alternaria* subgroup (2024 and 2025)



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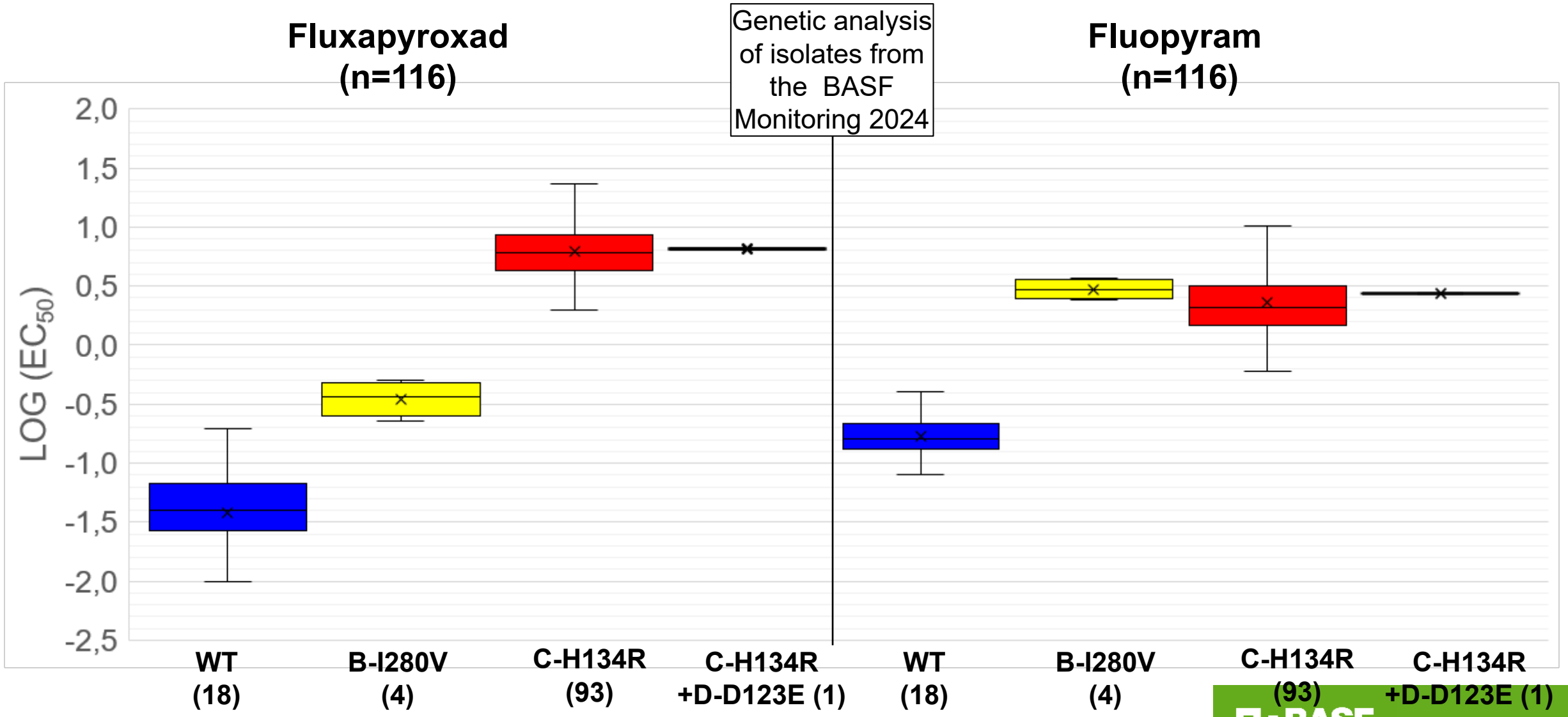
EC_{50} values of wildtype, B-I280V, C-H134R and C-H134R+D-D123E – data from 2024



➲ No B-H278Y/R in 2024. Dominance of C-H134R in FRAC confirmed

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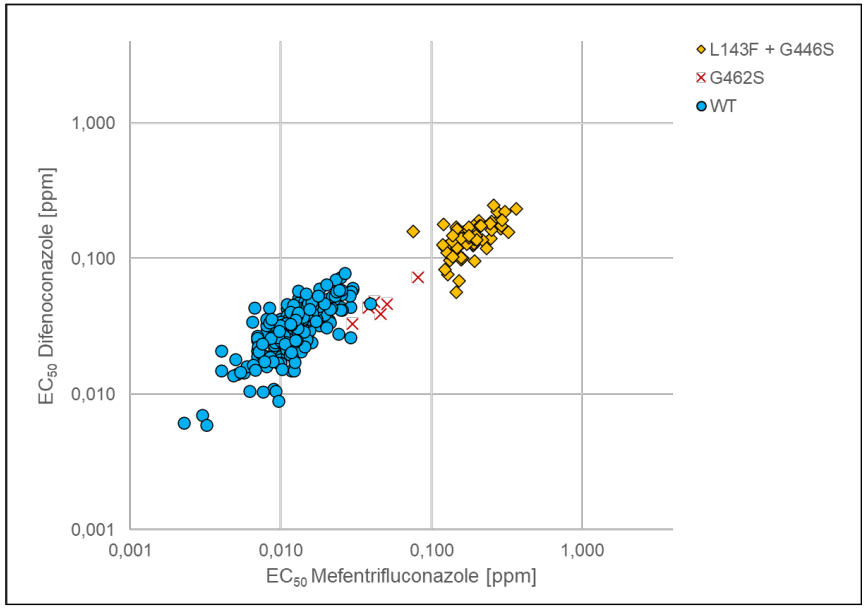
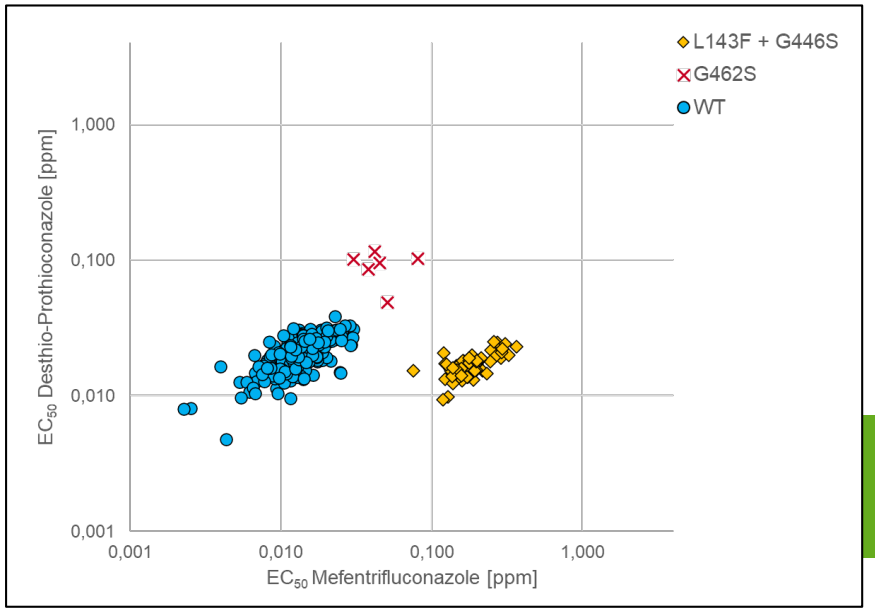
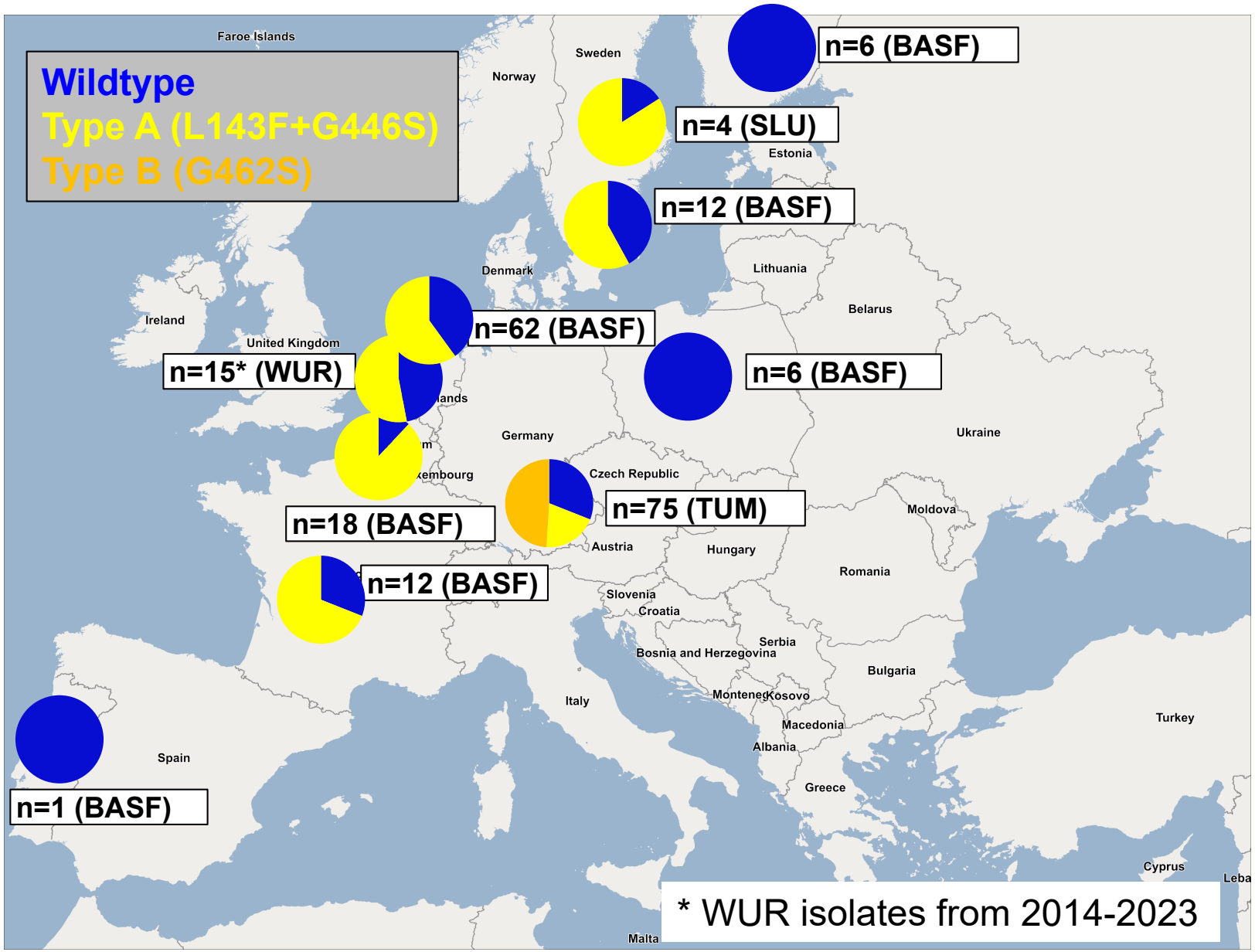
Alternaria solani
Mechanism for DMI adaptation are mutations in the cyp51 gene

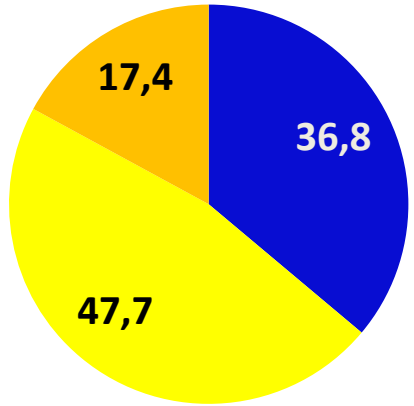
- **Detection of adapted isolates**
  - Phenotypically in sensitivity tests with Difenoconazole, Prothioconazole and Mefentrifluconazole
  - Genetically by e.g. pyrosequencing
    - L143F+G446S
    - G462S
    - Mutations have low effects (low resistance factors)
    - So far, no other mechanisms detected





Alternaria solani: Frequency *of* CYP51 mutations in samples from 2024
Samples from the Alternaria subgroup and BASF Monitoring





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Alternaria solani: Frequency *of* CYP51 mutations in samples from 2025 (ongoing)
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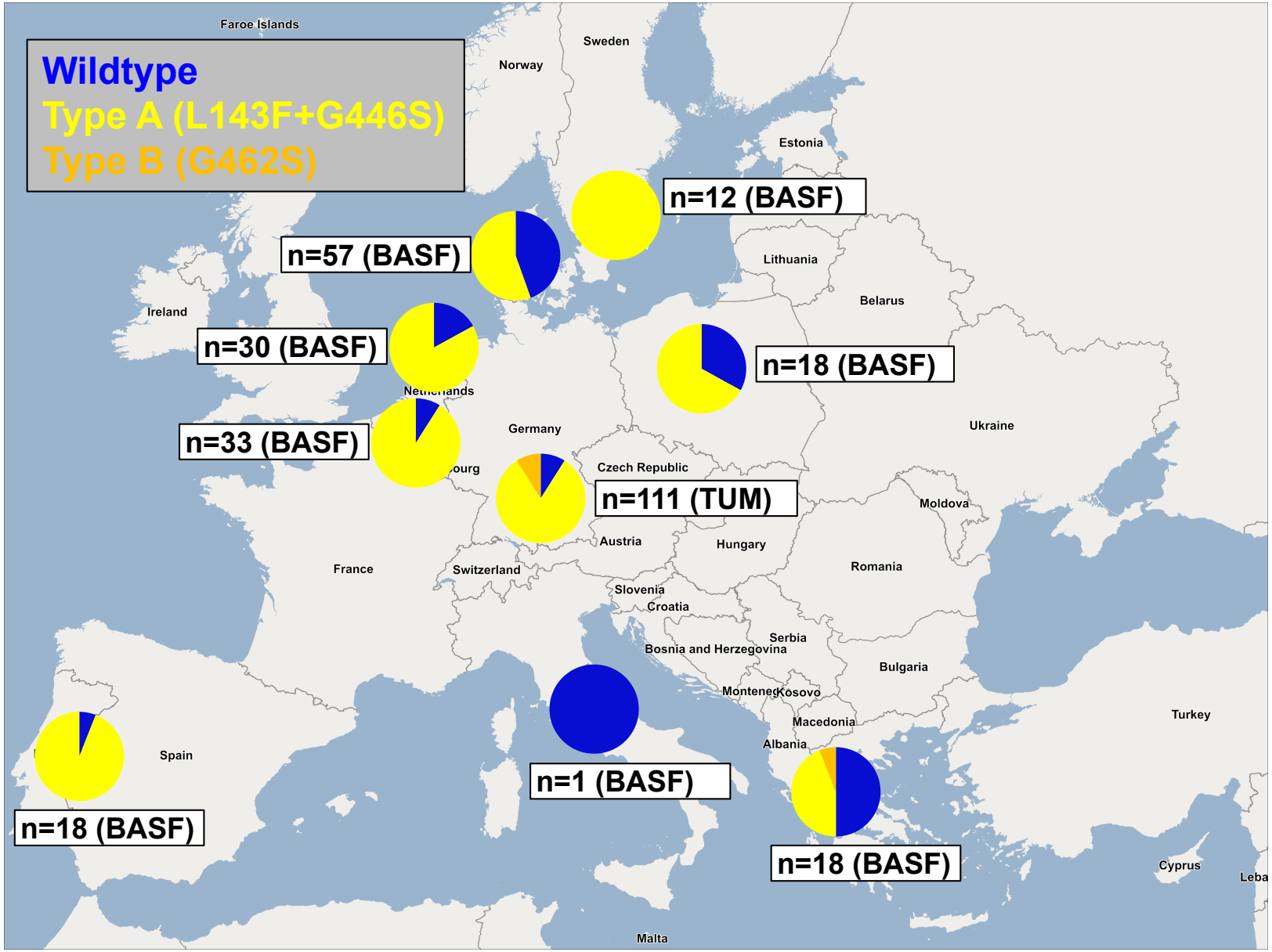

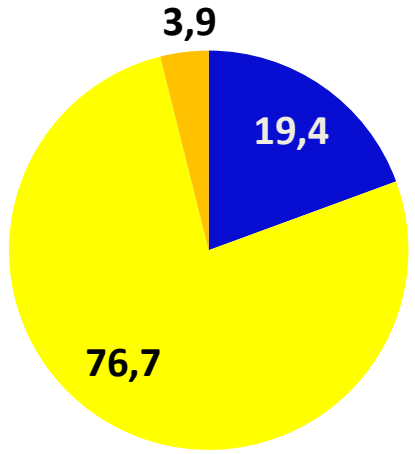

n=299 isolates or samples

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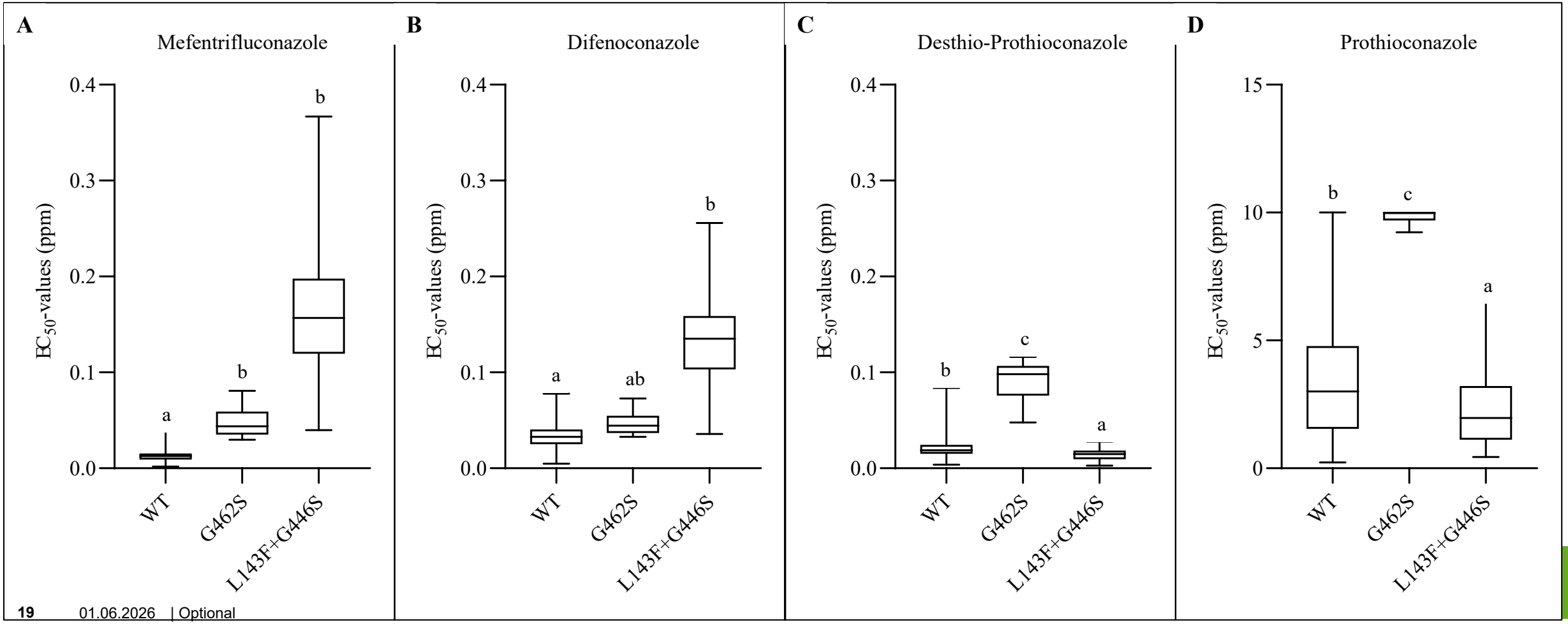
Different mutations with different effect on DMI-sensitivity in *Alternaria solani*

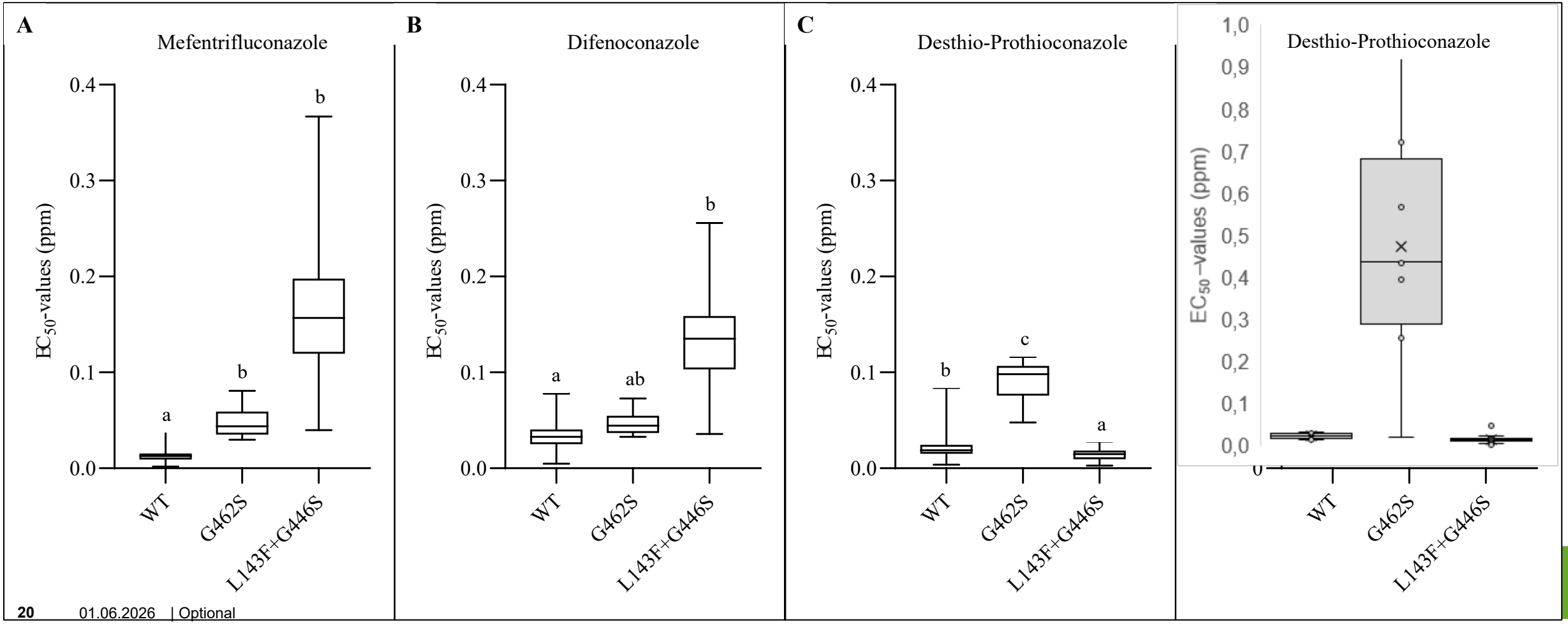
Europe 2021-2023



Different mutations with different effect on DMI-sensitivity in *Alternaria solani*

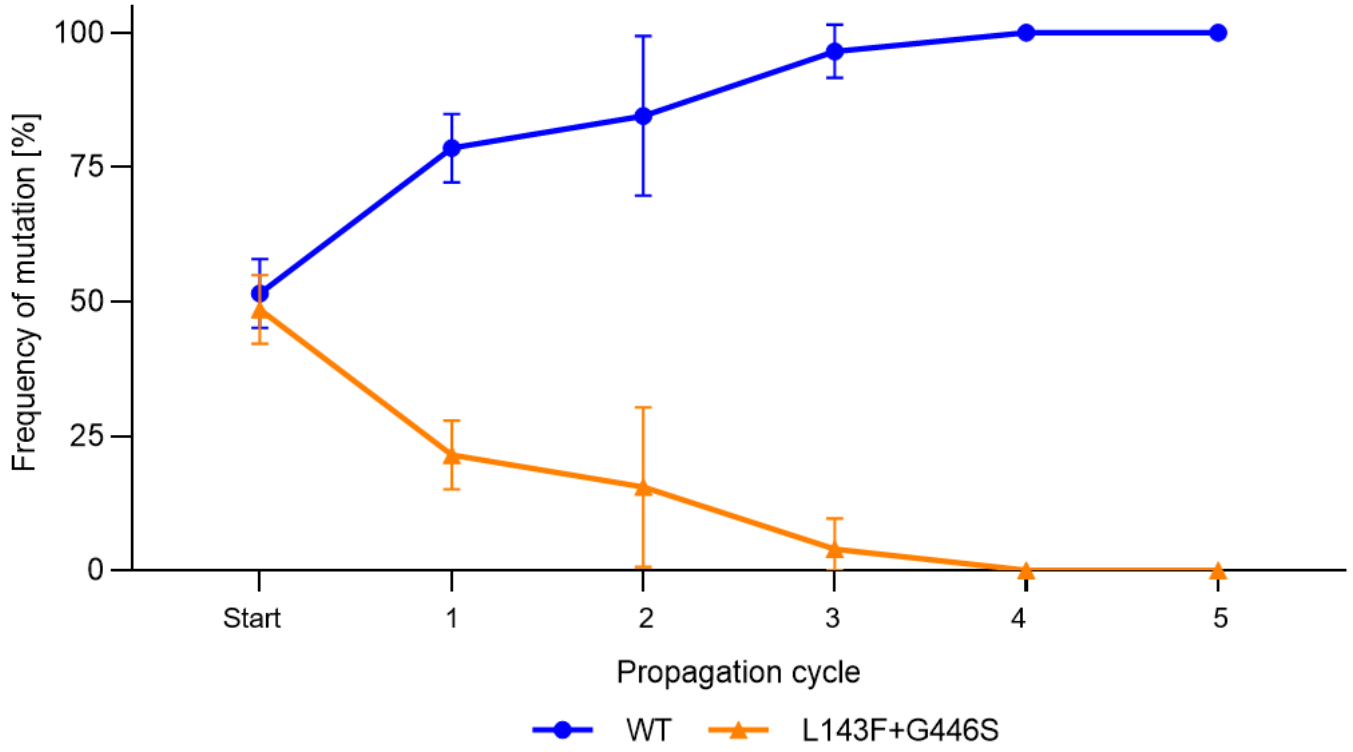
Europe 2021-2023

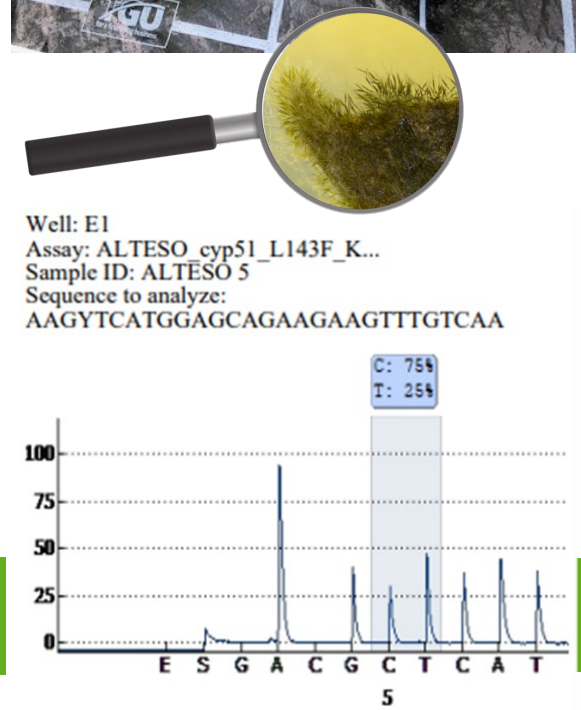
Isolates TUM 2025



Are double mutants (Type A, L143F+G446S) fit?

- Inoculation of tomato plants with a mix of 5 L143F+G446S and 5 wildtypes
- After each cycle, quantitative detection of L143F+G446S by pyrosequencing
- L143F+G446S haplotypes decreased rapidly

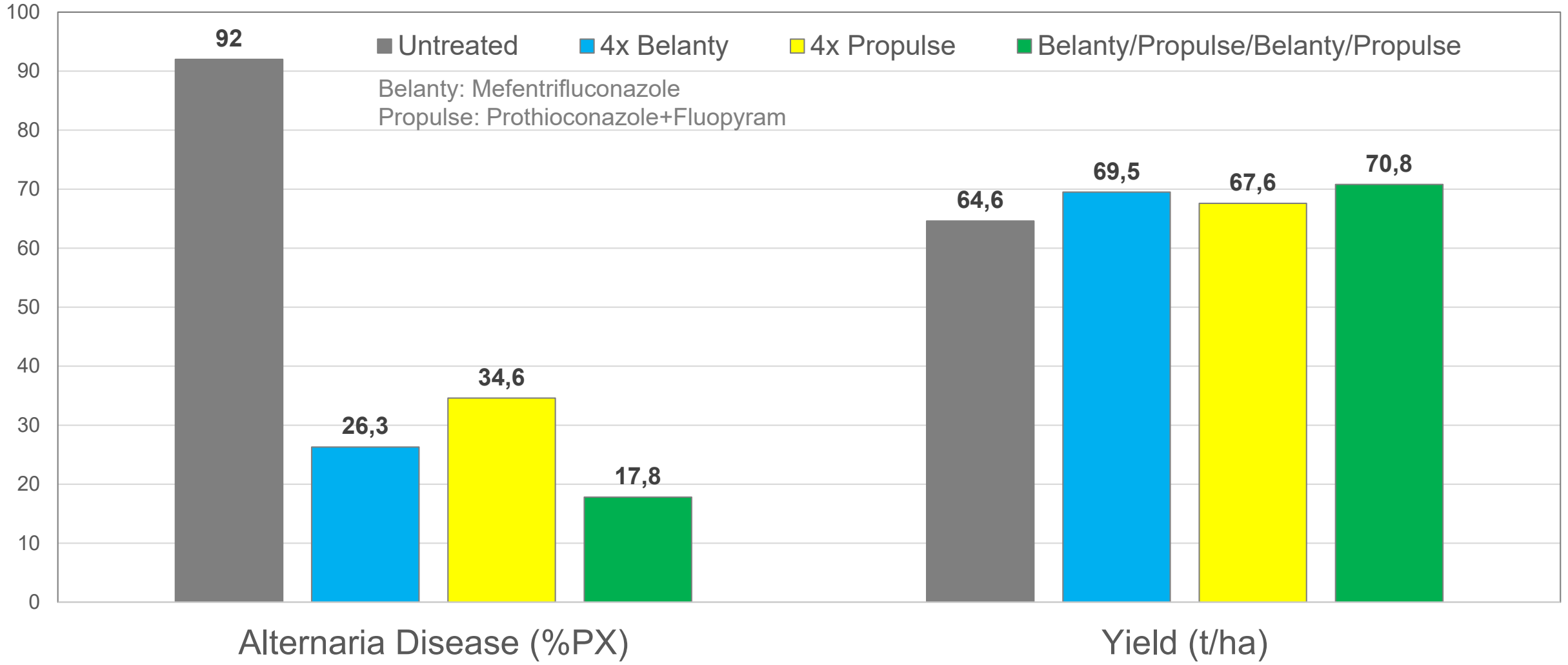




➲ **Type A seems to be less fit compared to wildtype in the greenhouse**

Alternaria solani: Alternation of DMIs in the field

N=3
Locations: NL (Emmeloord, Dordrecht, Valthermond)
Year: 2021 und 2022



→ DMI alternation decrease disease and increase resistance management

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Conclusions on fungicide sensitivity in Alternaria solani - 2026

- **QoI**
  - F129L widespread, influence on QoI adaptation is limited
  - Still contribution to disease and resistance management
- **SDHI**
  - C-H134R mutation dominates adaptation to SDHI nowadays → cross-resistance between SDHIs
  - More B-I280V detected in last seasons
- **DMI**
  - Slight adaptations found in microtiter tests with low resistance factors
  - Target site mutation types (L143F+G446S, G462S) present in population
  - Mutation types (A and B) with different effects → Spray programmes containing different DMIs recommended
  - Sensitivity monitoring established and should be continued to follow up development of haplotypes

Many thanks to everyone who contributed and thank you for your attention

Hans Hausladen
Claire Maria Haumann
Trudy van den Bosch
Bert Evenhuis
Chiara de Pascal
Asa Lankinen
Marjo Kruts
Jonas Schorer
Gerd Stammler