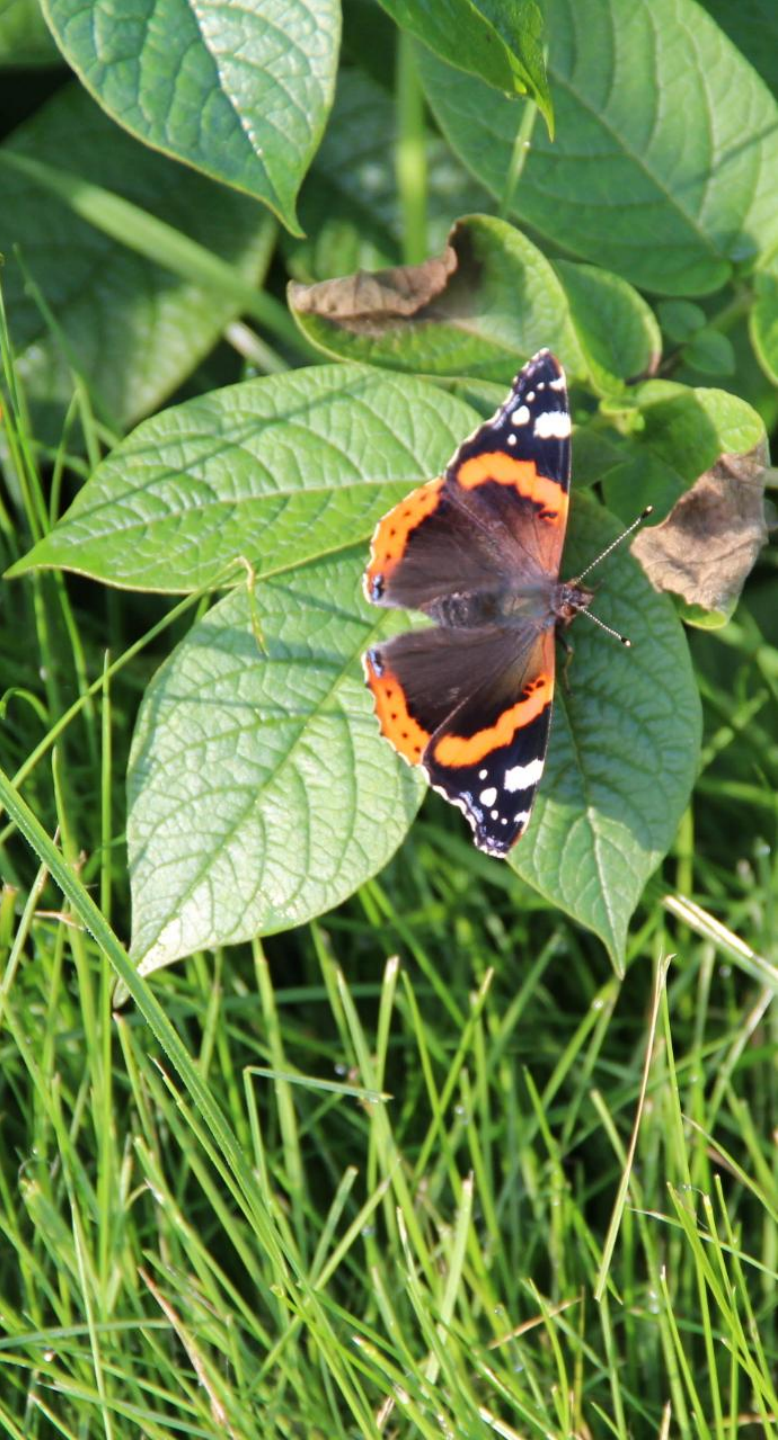

# Drivers of *Phytophthora infestans* population change in Denmark as a result of fungicide strategy

Isaac K. Abuley & Jens G. Hansen, Aarhus University

**Outline**

- Follow up on the emergence and spread of EU43 in Denmark
- Phenotypic traits of clones EU13, EU41 and EU43
- Conclusions

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A potato late blight network for Europe

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# 28 April 2023

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## The EU43 genotype of *Phytophthora infestans* displays resistance to mandipropamid

Isaac K. Abuley, James S. Lynott, Jens G. Hansen, David E. L. Cooke, Alison K. Lees

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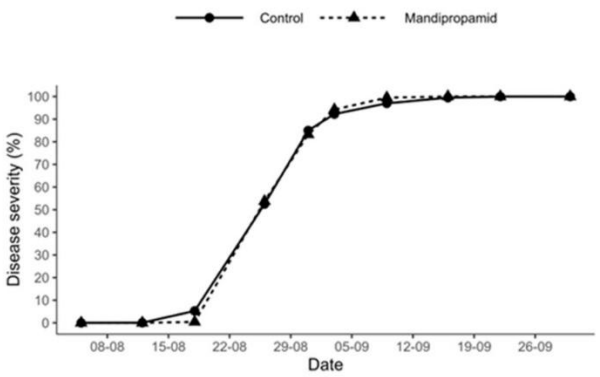
## Abstract

Mandipropamid is an active ingredient in the carboxylic acid amide group of fungicides and plays a key role in current potato late blight (*Phytophthora infestans*) management programmes. However, reports from Danish potato growers in 2022 suggested that mandipropamid had lost its efficacy. A study was therefore conducted to investigate the sensitivity of isolates collected from fields in which mandipropamid had been reported to be ineffective. Seventy-two isolates of *P. infestans* collected from potato fields in Denmark were genotyped using microsatellite markers, revealing a dominance of the clonal lineage EU43 and fewer isolates of EU41 and 'other' genetically distinct genotypes. Isolates belonging to the EU43 and EU41 lineages were selected, in addition to representative isolates of clones EU36 and EU37 from Scotland, and tested for sensitivity to mandipropamid at five concentrations ranging from 0.1 to 10 µg/mL on potato leaf discs (cultivar Maris Piper). The EU43 genotype infected leaf discs at all tested concentrations, and therefore no dose–response curve could be calculated. A dose response was observed for isolates of genotypes EU36, EU37 and EU41 with $EC_{50}$ values ranging from 0.35 to 0.75 µg/mL. Field experiments confirmed resistance of tested isolates of genotype EU43 to mandipropamid, with no significant difference in the area under the disease curve between the untreated and mandipropamid treatments. Analysis of the Danish population of *P. infestans* showed that EU43 was widely distributed across the country. To our best knowledge, this is the first report of resistance to mandipropamid in *P. infestans*.

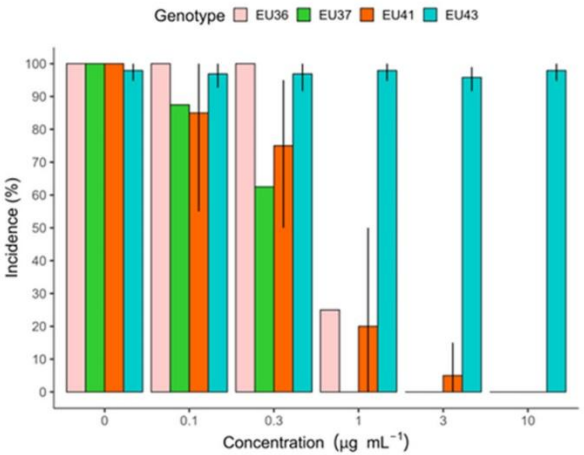

***Phytophthora infestans* was isolated from late blight lesions**

**Isolates were tested for their sensitivity to mandipropamid**


**Field experiment with EU43**




**Disease development in the untreated control and mandipropamid treated plots**




**EU43 infected leaf discs at all concentrations of mandipropamid**

# A New Pathogen Population Challenges the Prevention and Control of Potato Late Blight in Denmark

Open access | Published: 13 January 2026
Volume 69, article number 8, (2026) Cite this article



Jens G. Hansen, Lars Bødker & Isaac K. Abuley

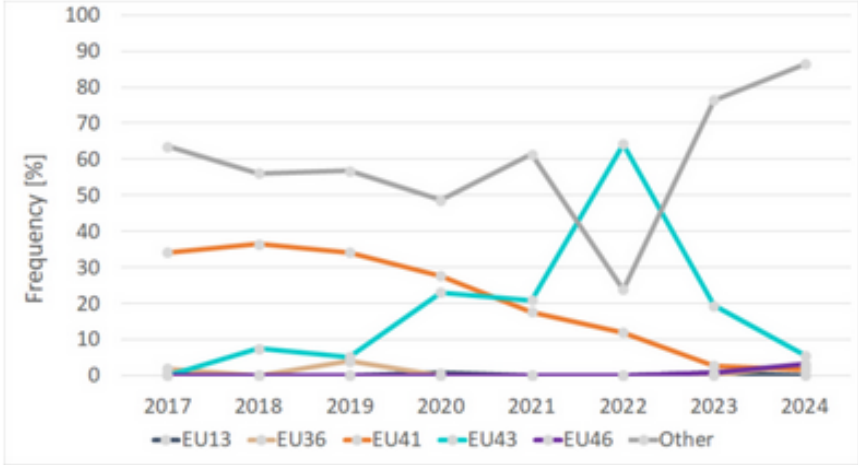


Jan 2026

## Abstract

Unexpected and severe outbreaks of potato late blight occurred in Denmark during the 2022 growing season due to the emergence and rapid spread of a new SSR genotype, EU43, which exhibited 100% resistance to mandipropamid. This prompted a shift in control recommendations from block applications of fungicides to fungicide mixing and alternation. Three early warning components played a critical role in the effective management of late blight in the 2023 season: (1) Disease surveillance using the BlightTracker app; (2) Blight risk forecasting via the BlightManager decision support system; and (3) An early sampling campaign followed by rapid reporting of genotyping and phenotyping results. In 2022, the EU43 genotype accounted for 64% of the *Phytophthora infestans* population. Following the new control strategy and intensified use of early warning tools, the frequency of the EU43 genotype declined to 19% in 2023 and 5% in 2024. Amongst samples collected from different field types between 2022 and 2024, EU43 prevalence was 40% in experimental plots and conventional fields, 11% in volunteer plants, and 3% in organic fields. These findings support the hypothesis that EU43's success was driven by its reduced sensitivity to mandipropamid. With the frequency of EU43 now reduced to 5%, mandipropamid can be reintroduced as part of a fungicide mixture and alternation strategy.

## Fig. 1

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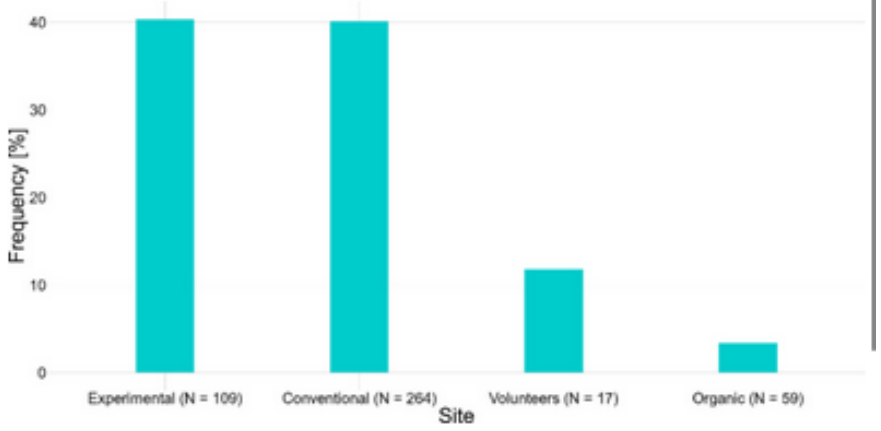
## Fig. 2

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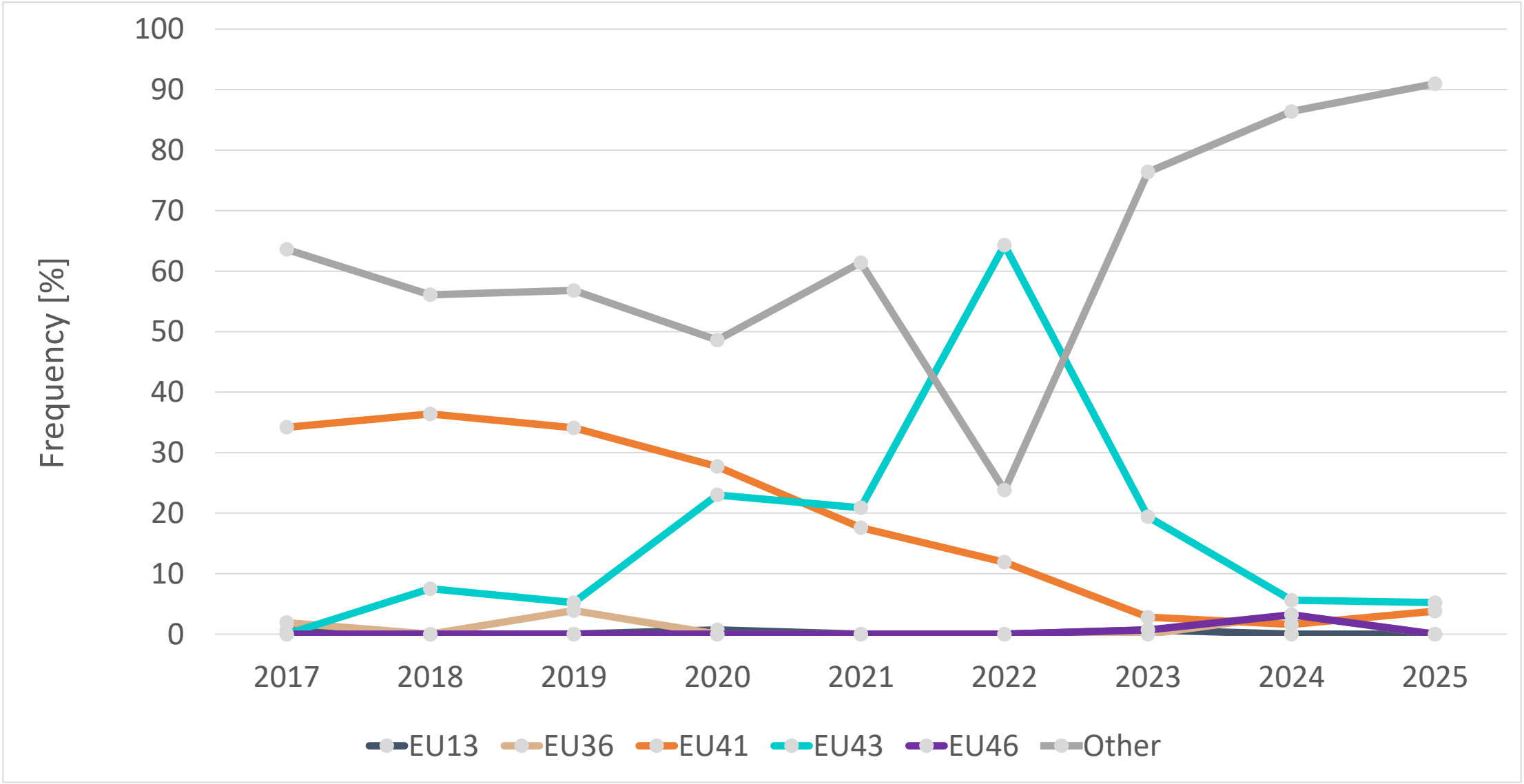
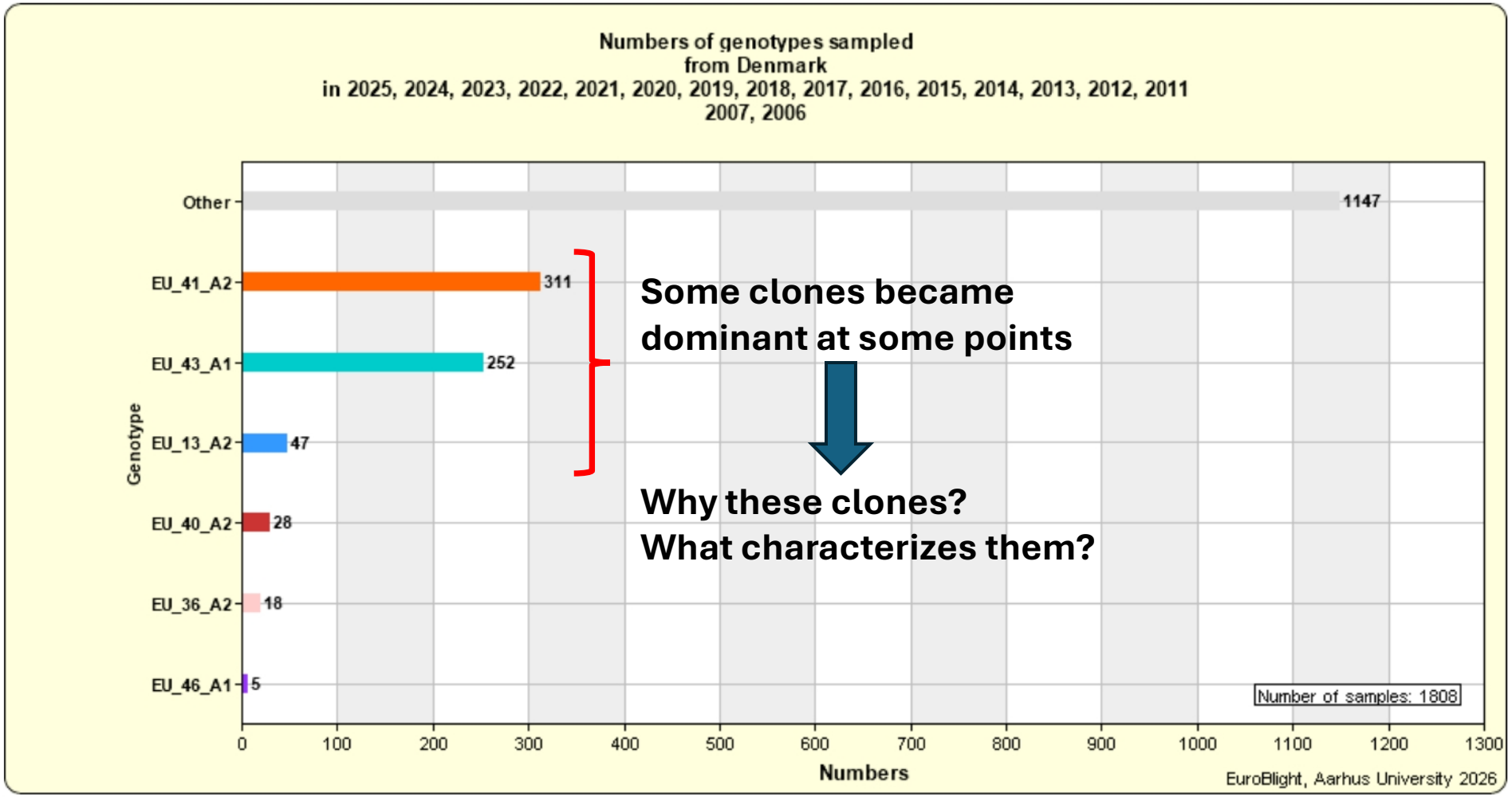
## Fig. 3

# Genotypes across years in DK, Updated with 2025 results

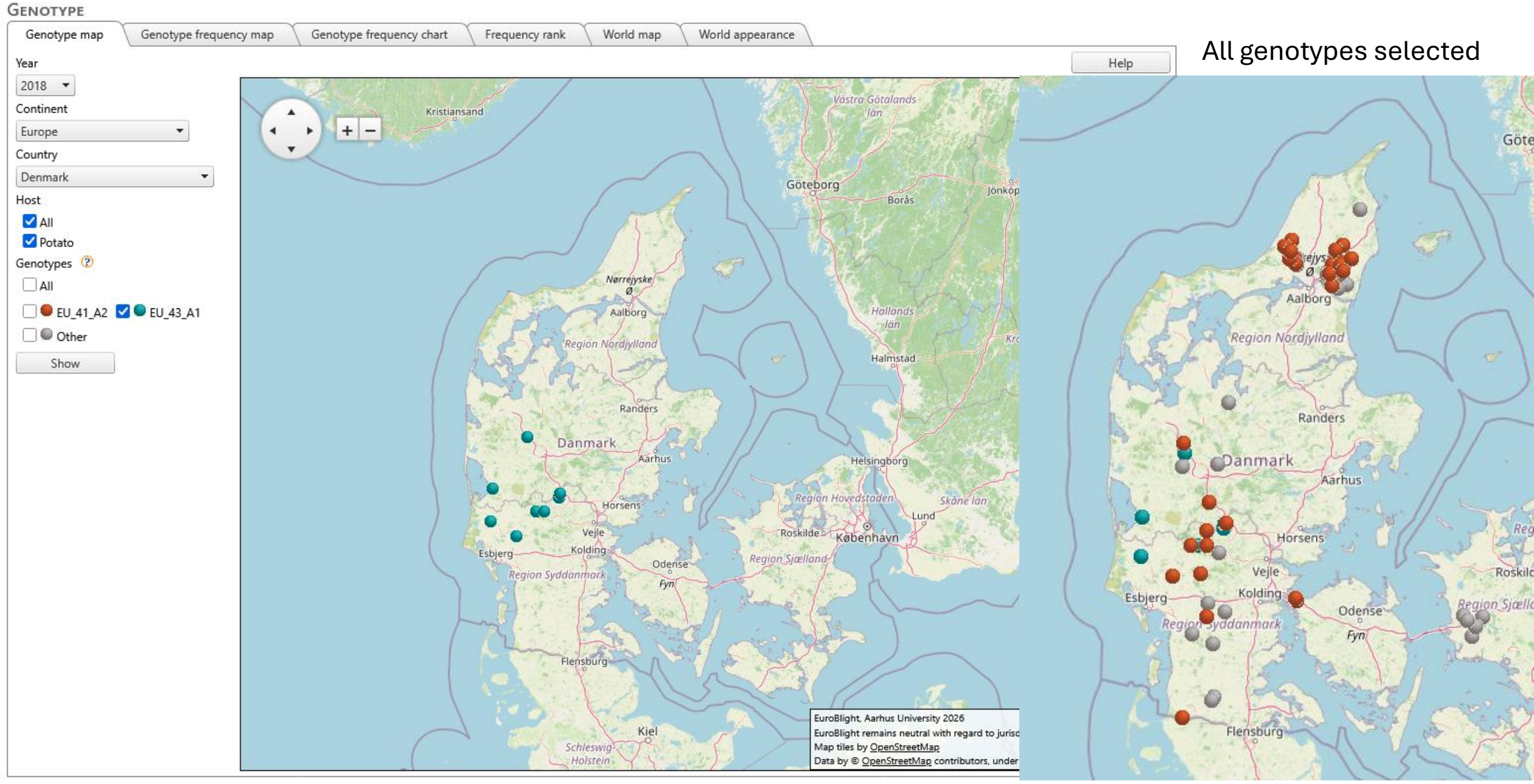
Except in 2022, “Others” have dominated the Danish *P. infestans* population



# Overall “Others” have dominated Danish populations, but some clones became dominant at some points

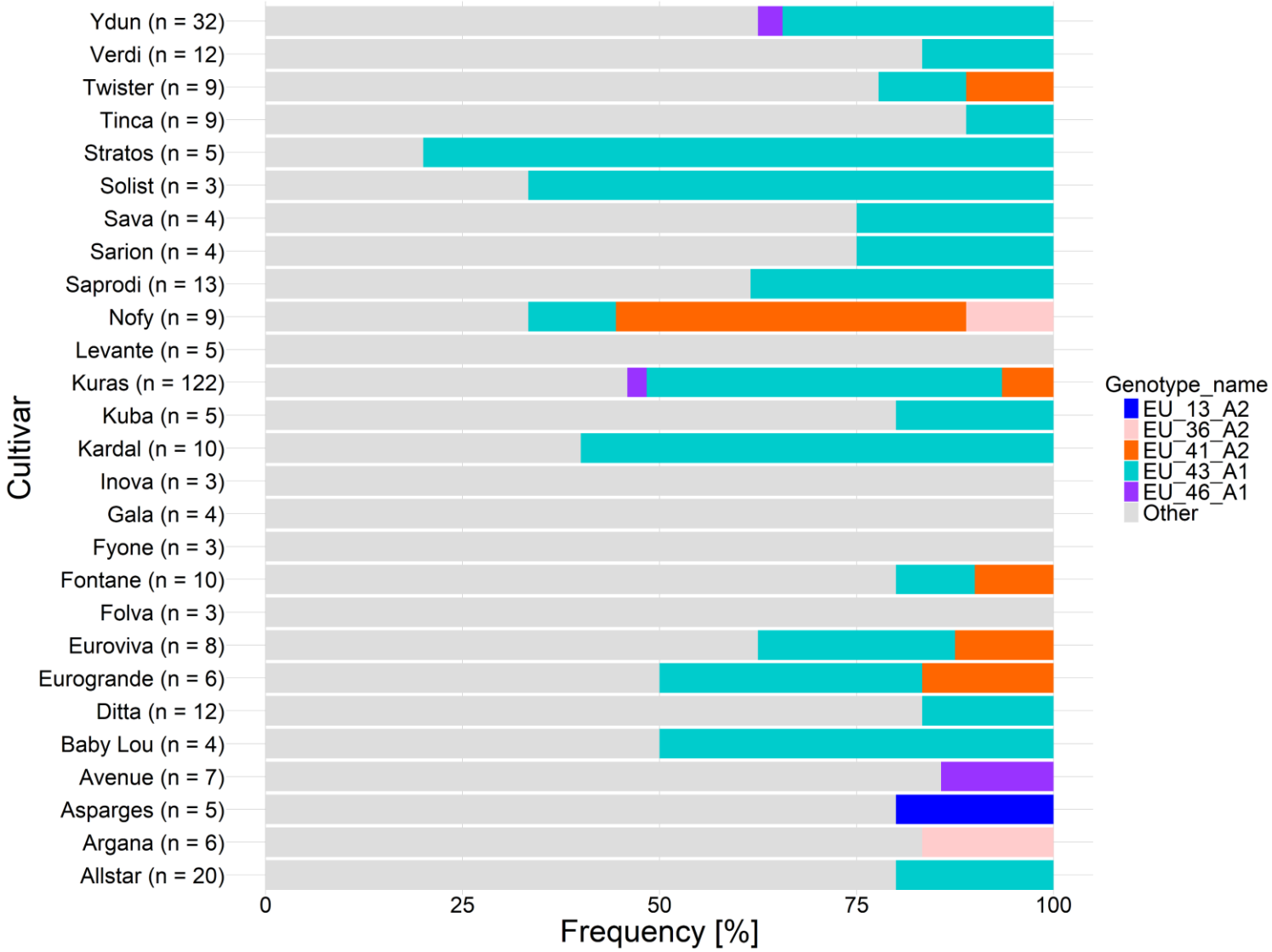


# EU43 was found in 2018, from conventional fields (Sprayed with Mandipropamid)



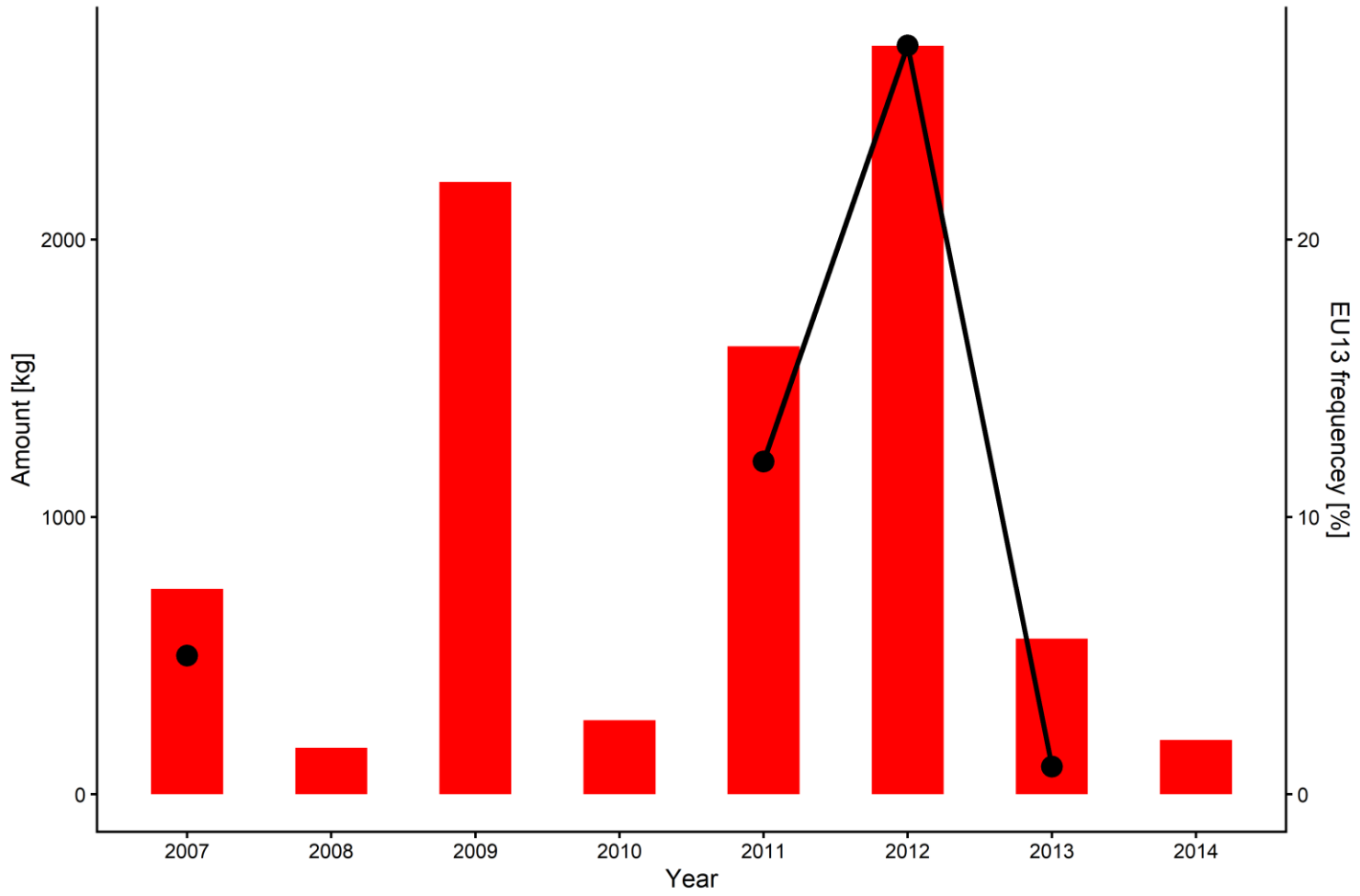

All genotypes selected

# Most clones appear to infect all varieties (Data: 2022-2024)




Although some genotypes (EU41) appears to be more frequent on varieties containing vnt1 (e.g., Nofy), the general conclusion is that the genotypes seems to infect all cultivars in Denmark

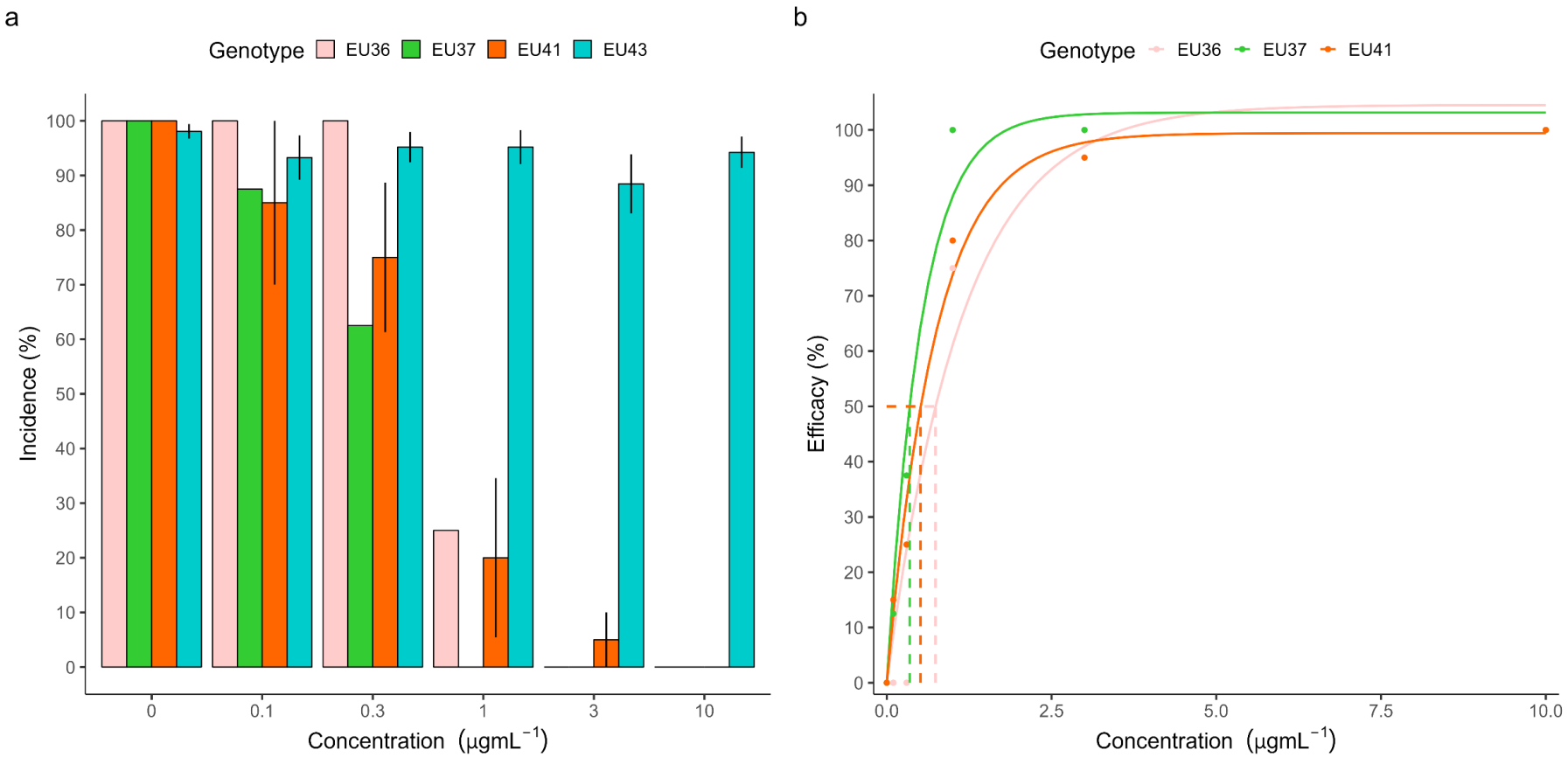
# EU13 (Blue 13) – well-known for resistance against metalaxyl



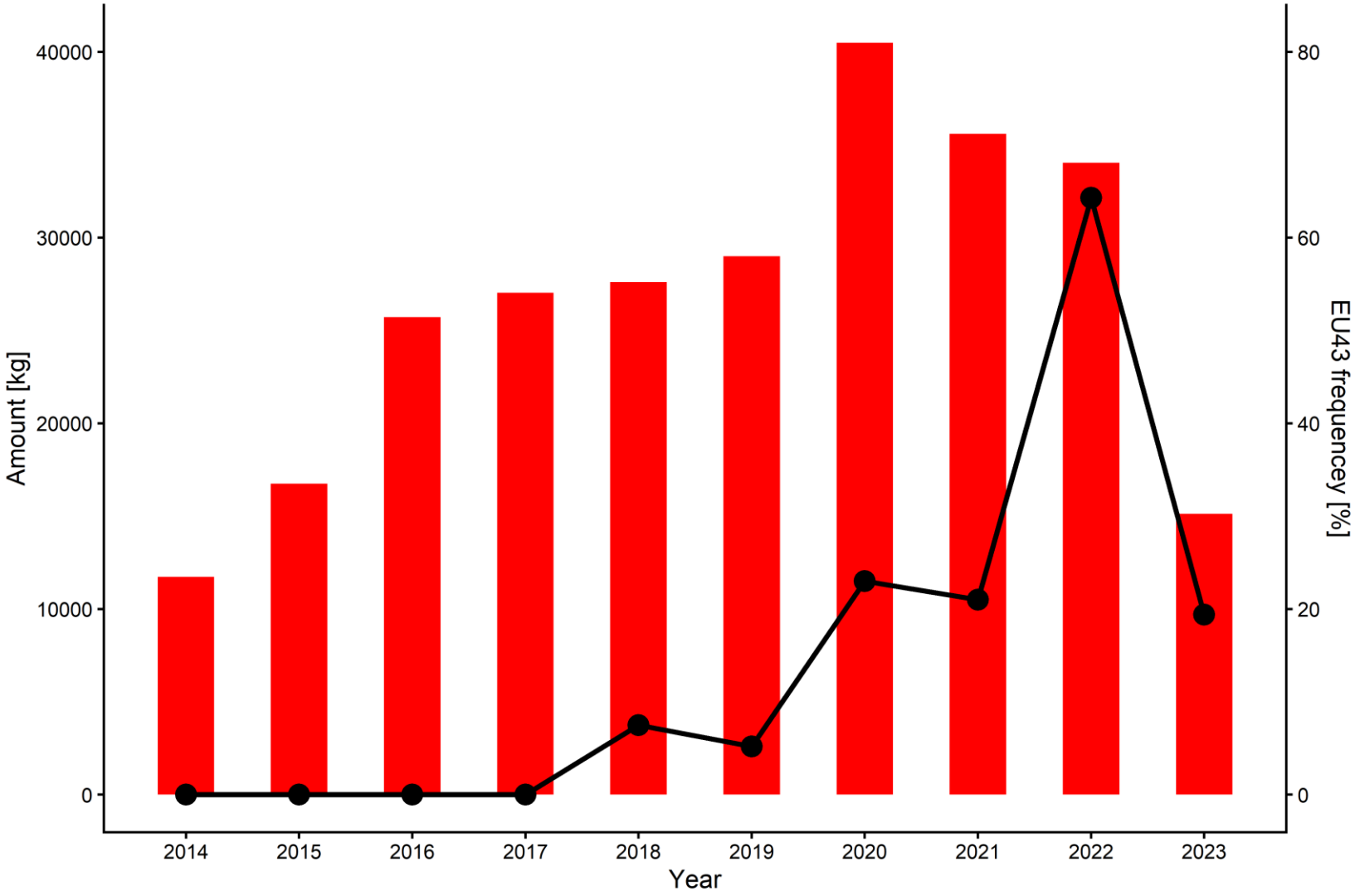

- EU13 was found in 2007 most likely due to Metalaxy use
- EU13 increased with increase of Metalaxy use
- Since the withdrawal of Metalaxyl in 2014 the frequency of EU13 has decline to <0.1% (mostly not found in DK)

  - Red bar = Fungicide usage
  - Black line = EU13 frequency in Denmark

# EU43 is characterized by “full” resistance to CAA fungicides (e.g., Mandipropamid)

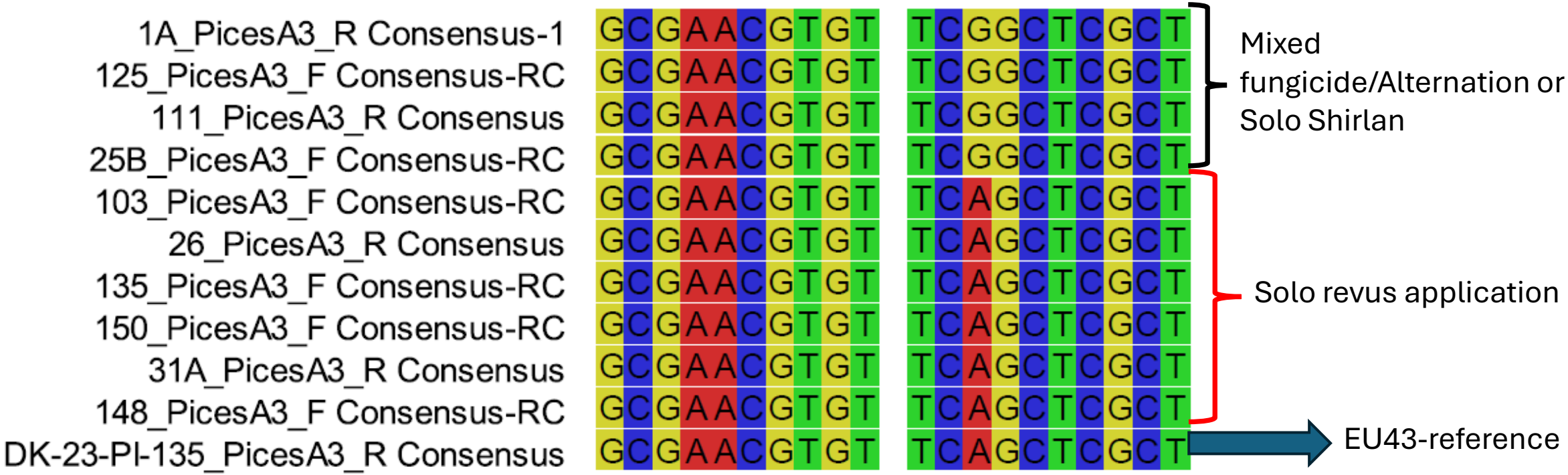


# The emergence and spread of EU43 and Mandipropamid usage in Denmark



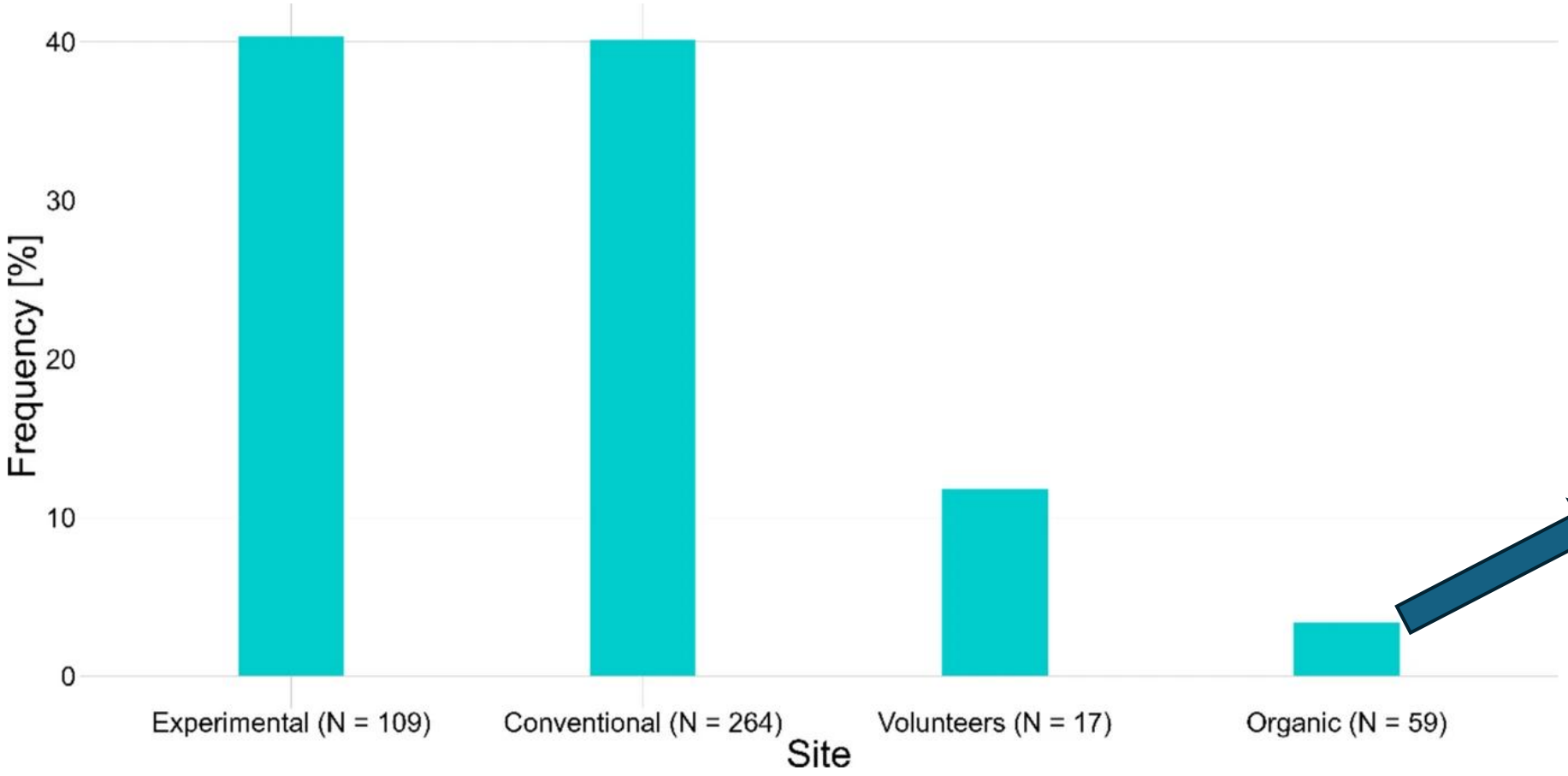

The emergence / spread and decline of EU43 (Black line) correlates with mandipropamid usage (Red bars) in Denmark

# The link between control strategy and the G1105- mutation, causing resistance to mandipropamid (and other CAAs)




The only mutation found in the Danish isolates was G11055 (i.e., Glycine (GGC)-> Serine (AGC))

# FTA card sampling (2022-2024) shows that EU43 was mostly found in conventional or experimental fields sprayed with a CAA fungicide




Fields were very close to conventional fields, so likely a spread from the nearby convention field

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Population Biology

e-Xtra*

# Examining Phenotypic Traits Contributing to the Spread in Northern European Potato Crops of EU_41_A2, a New Clonal Lineage of *Phytophthora infestans*

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Accepted for publication 1 June 2021.

**ABSTRACT**

Until recently, genotypes of *Phytophthora infestans* were regionally distributed in Europe, with populations in western Europe being dominated by clonal lineages and those in northern Europe being genetically diverse because of frequent sexual reproduction. However, since 2013 a new clonal lineage (EU_41_A2) has successfully established itself and expanded in the sexually recombining *P. infestans* populations of northern Europe. The objective of this study was to study phenotypic traits of the new clonal lineage of *P. infestans*, which may explain its successful establishment and expansion within sexually recombining populations. Fungicide sensitivity, aggressiveness, and virulence profiles of isolates of EU_41_A2 were analyzed and compared with those of the local sexual populations from Denmark, Norway, and Estonia. None of the phenotypic data obtained from the isolates collected from Denmark, Estonia, and Norway independently explained the invasive success of EU_41_A2 within sexual Nordic populations. Therefore, we hypothesize that the expansion of this new genotype could result from a combination of fitness traits and more favorable environmental conditions that have emerged in response to climate change.

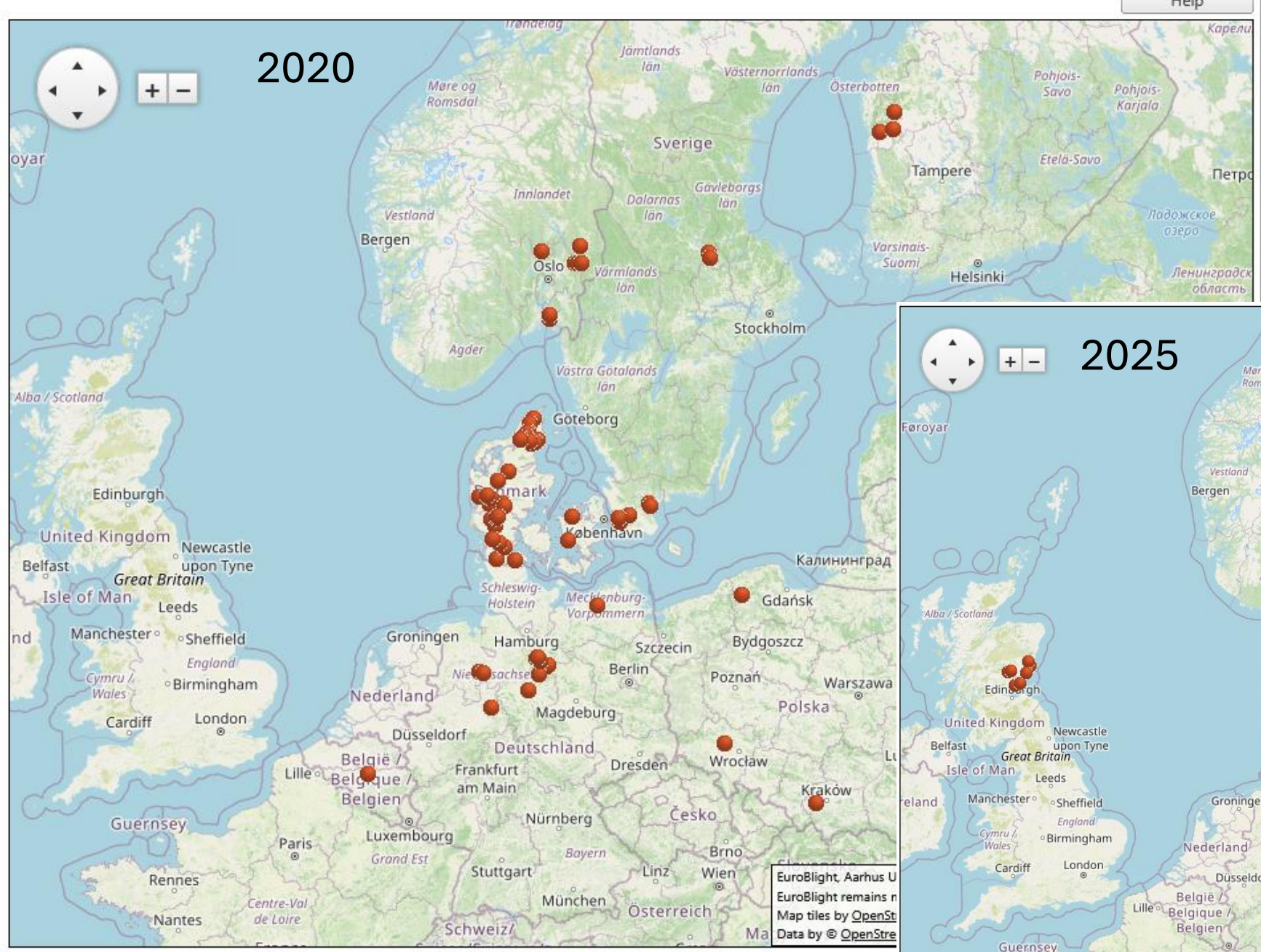
*Keywords*: clonal lineage, fungal pathogens, late blight, oomycetes, phenotype, sexual reproduction, *Solanum tuberosum*

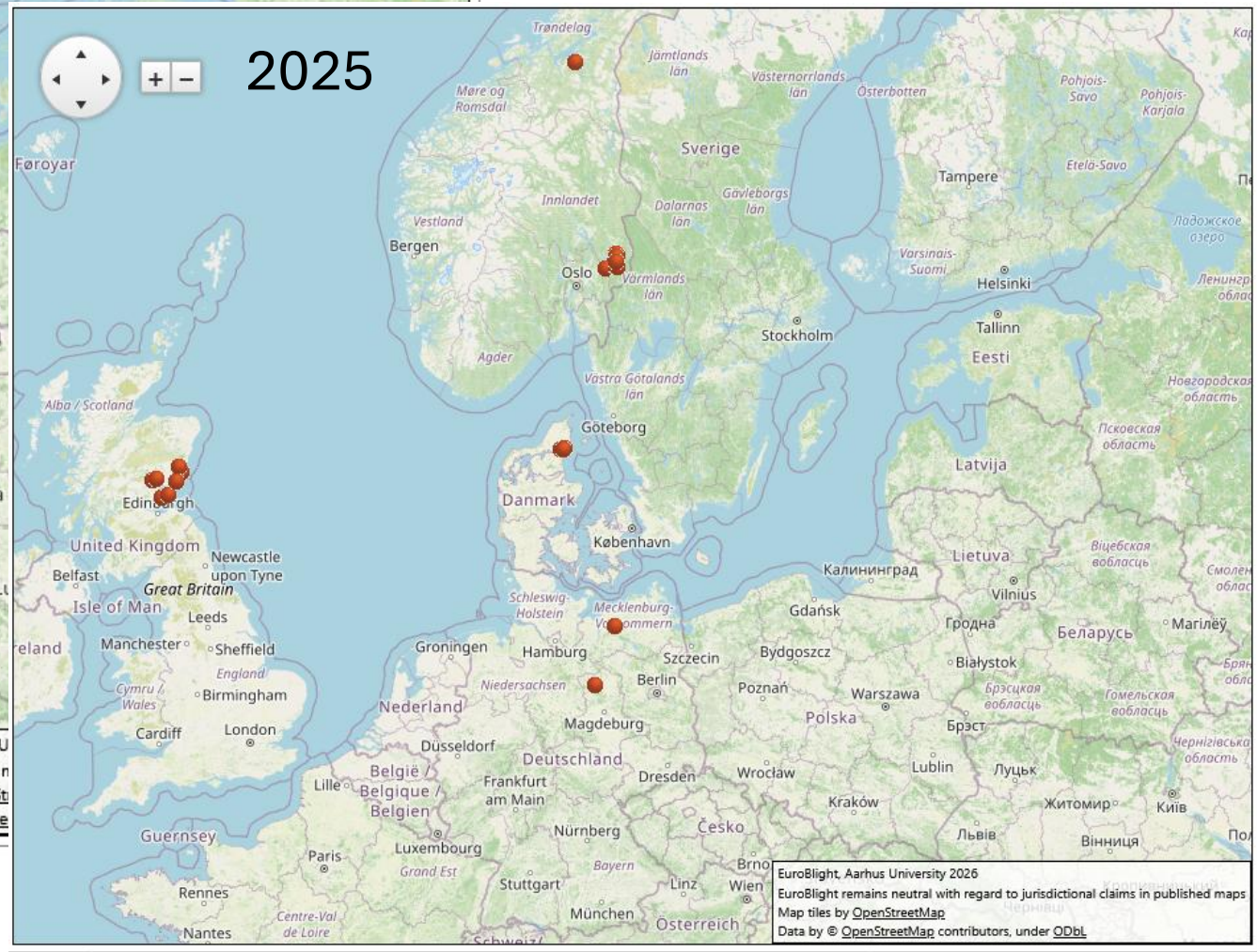
*Phytophthora infestans* (Mont.) de Bary, the causal agent of late blight in potatoes (*Solanum tuberosum* L.) and tomatoes (*S. lycopersicum* L.), is a heterothallic oomycete with two mating types, A1 and A2. Mating type A1 was first detected in Europe in

continent, research has shown that in western Europe, clonal lineages resulting from asexual multiplication prevail (Cooke et al. 2012; Mariette et al. 2016b). By contrast, the pathogen population in northern Europe is genetically diverse, because of high rates of

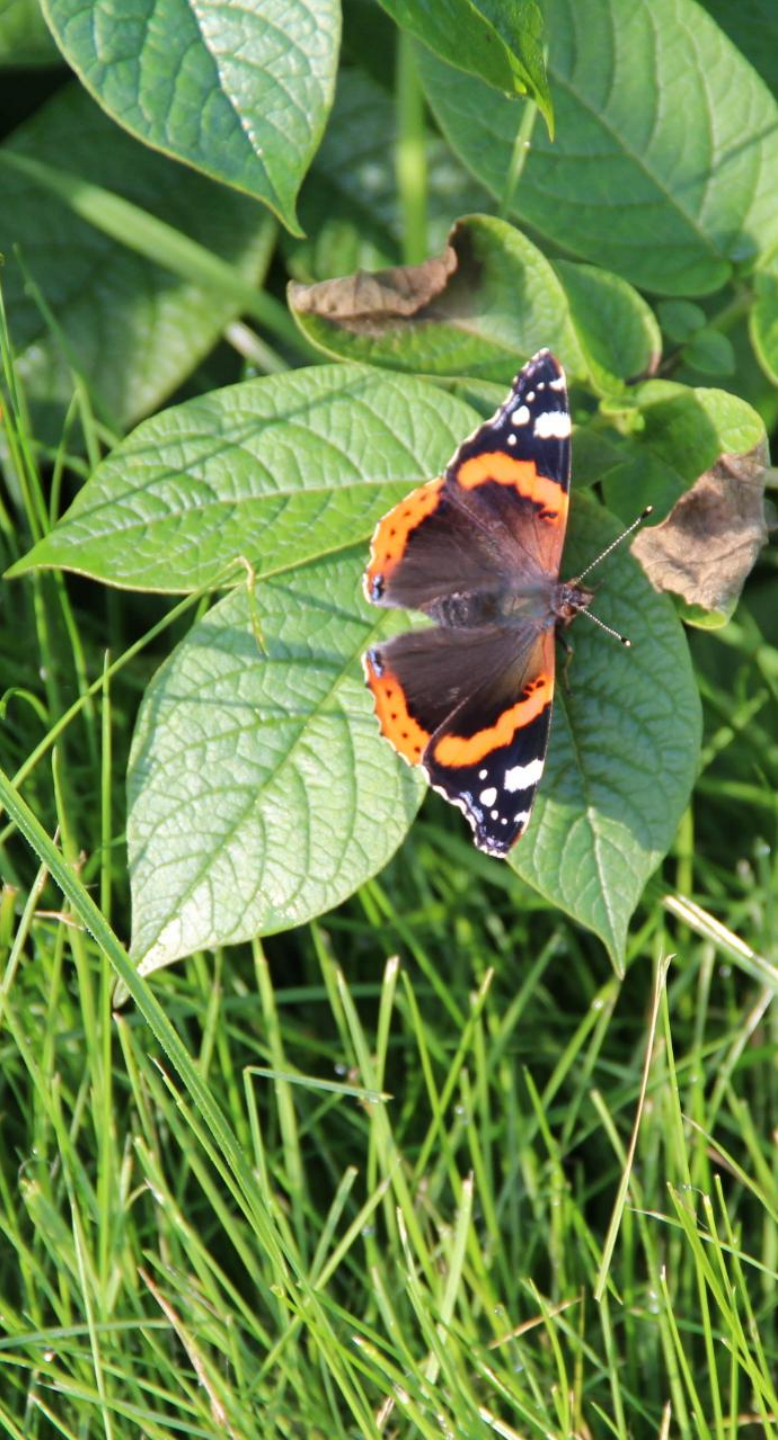
# We don't really know what might have aided the spread of EU41

- The spread of EU_41_A2 in Denmark (and Northern Europe cannot be explained by any single phenotypic trait (e.g., fungicide resistance, aggressiveness, or virulence)
- Instead, its success is likely due to a combination of moderate advantages + favorable environmental conditions




- [ ] EU_2_A1
- [ ] EU_6_A1
- [ ] EU_8_A1
- [ ] EU_13_A2
- [ ] EU_23_A1
- [ ] EU_36_A2
- [ ] EU_37_A2
- [ ] EU_39_A1
- [x] EU_41_A2
- [ ] EU_43_A1
- [ ] EU_44_A1
- [ ] EU_45_A1
- [ ] EU_46_A1
- [ ] EU_47_A1
- [ ] Other



# Conclusions

- Past and recent changes in the *P. infestans* population in Denmark have largely been driven by fungicide selection pressure:
  - EU43 associated with mandipropamid use
  - EU13 associated with metalaxyl use

- Changes in fungicide use (reduction or withdrawal) resulted in rapid declines of these Clones

- EU41 is the exception: Its spread cannot be explained by fungicide use, aggressiveness, or virulence. Suggests additional drivers (e.g., environmental or fitness-related factors)

# Thank you for your attention

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EuroBlight
A potato late blight network for Europe

Thanks to many partners and colleagues for contributing

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Internationalt Center for Forskning i Økologisk Jordbrug og Fødevaresystemer

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