BlightManager

EuroBlight
A potato late blight network for Europe

New diverse population of the late blight pathogen – what does it mean for practice

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

Syngenta Potato Academy, 2021

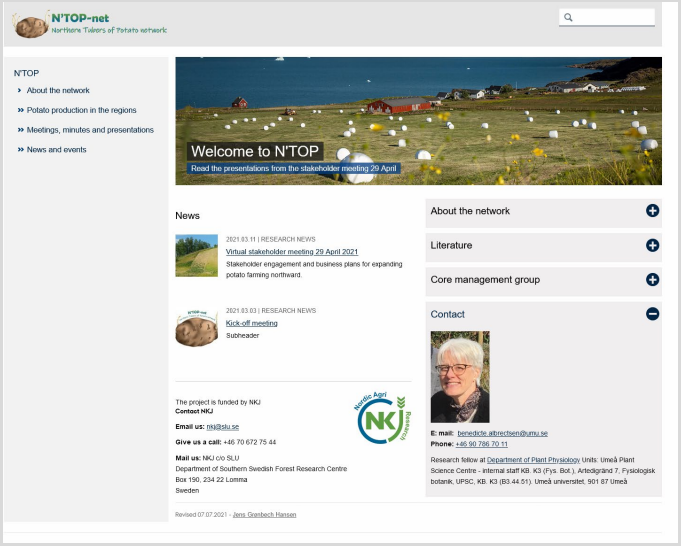
Outline:

- Late blight pathogen in context – Green transition, F2F and Nordic collaboration
- EuroBlight, BlightManager, IPMBlight2.0 and Ecosol – know your enemy and prevent attack
- Disease surveillance, genotyping and phenotyping using smartphone Apps and Dashboard
- Results from the BlightManager project and evolution of the Danish P.i. population
- European perspective. What are the phenotypic traits of the most common genotypes
- Conclusions and recommendations

- Green transition - Potato is a climate friendly crop
- EU- F2F wants to halve use of pesticides by 2030
- EU wants to increase organic production to 25% of arable land by 2030
- The potato industry in the Nordic region is challenged by a diverse sexual recombining population of P.i., more aggressive and multi-virulent genotypes, climate change and access to a reduced number and types of a.i.

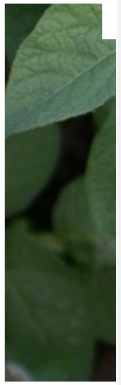
We have a better chance of success if we work (more) together and if we make use of all IPM principles.

- “Northern tubers of potato” new opportunities – new emerging plant health problems



Press release

Reduced sensitivity to fluazinam detected in the rapidly increasing Phytophthora infestans clonal lineage EU-37 (Dark Green 37)



June 28, 2017

Results from Wageningen University & Research shows that all P. infestans EU-37 isolates tested, displayed a reduced sensitivity to fluazinam. There is a strong indication that the rise of EU-37 in Europe is not only caused by its better fitness but also by a selection advantage in situations in which fluazinam is used.

EuroBlight annually monitors and reports upon the development of Phytophthora genotypes in Europe. The results of 2016, which in many countries was a serious late blight year, showed that two relatively new genotypes are on the rise. Their survival and spread at a time when other clones have failed to establish suggests they are evolutionarily fit and may pose challenges to disease control. One of these genotypes is EU-37.

Spreading

A single sample of EU-37 was first detected in the Netherlands in 2013 and was sampled locally at a low frequency in the following two seasons. However, it comprised 5.5% of the EU-population sampled in 2016, having spread as widely as England, Germany, Belgium, the Netherlands and NW France.

So far it was assumed that EU-37 could establish due to its fitness. Current results indicate that other characteristics also contribute to the increase of this genotype.

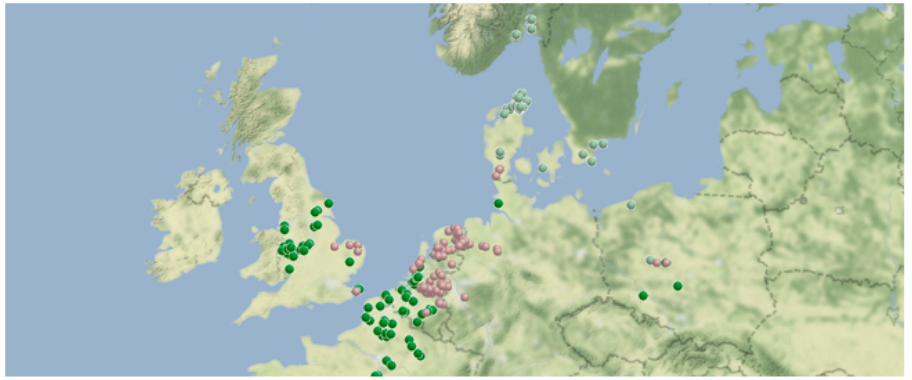
Results from Wageningen University & Research shows that all P. infestans EU-37 isolates tested, displayed a reduced sensitivity to fluazinam. The isolates tested originate from the Netherlands and Germany. They were obtained from fields with a clear reduced efficacy of fluazinam or from potato stores with unexpectedly high tuber blight infection levels. Further research has to establish whether all EU-37 isolates display excellent fitness and reduced sensitivity to fluazinam.

Strategy to reduce risks

New, emerging clones of Phytophthora infestans in Europe

- what do we know about them?

05.06.2018 | JENS GRØNBECH HANSEN



Distribution of EU_36_A2, EU_37_A2 and EU_41_A2.

Over the last five years, EuroBlight has undertaken and coordinated an extensive survey of European populations of the late blight pathogen, *P. infestans*. The most recent data from the EuroBlight monitoring initiative highlighted the emergence of three new clonal lineages, named EU_36_A2, EU_37_A2 and EU_41_A2, in different parts of Europe. As ever, this raises the question of the epidemic potential of these newcomers, and of their impact on late blight management strategies. Are those strains more aggressive than other types? Are they less sensitive to fungicides? What cultivars are now under threat? Do I have to change my control strategy? These are the questions farmers and potato advisors are asking.

Alongside the genotypic analyses carried out within the EuroBlight survey, several research teams have committed themselves, as part of the IPMBlight2.0 project, to also generate and analyse important phenotypic traits, in particular aggressiveness (disease severity on compatible hosts), virulence, (the ability to overcome identified host resistance genes) and fungicide sensitivity. Since the number of isolates analysed is still limited and because not all analyses are complete yet, the results from these studies are still preliminary. However, the findings suggest that the reasons behind the success of these lineages are different.

EU_37_A2: a fluazinam insensitive, fit lineage?

EuroBlight
A potato late blight network for Europe

EuroBlight › ... › News › News ›

- › Home
- › About EuroBlight
- » EuroBlight workshop 9-12 May, 2022
- » EuroBlight Zoom meetings 2021 - presentations
- » Pathogen monitoring
- » Control strategies
- » Alternaria
- › Late blight Survey Mapper
- » News
  - › News
- » Workshop proceedings 1996-2015
- » Research projects
- › Protocols

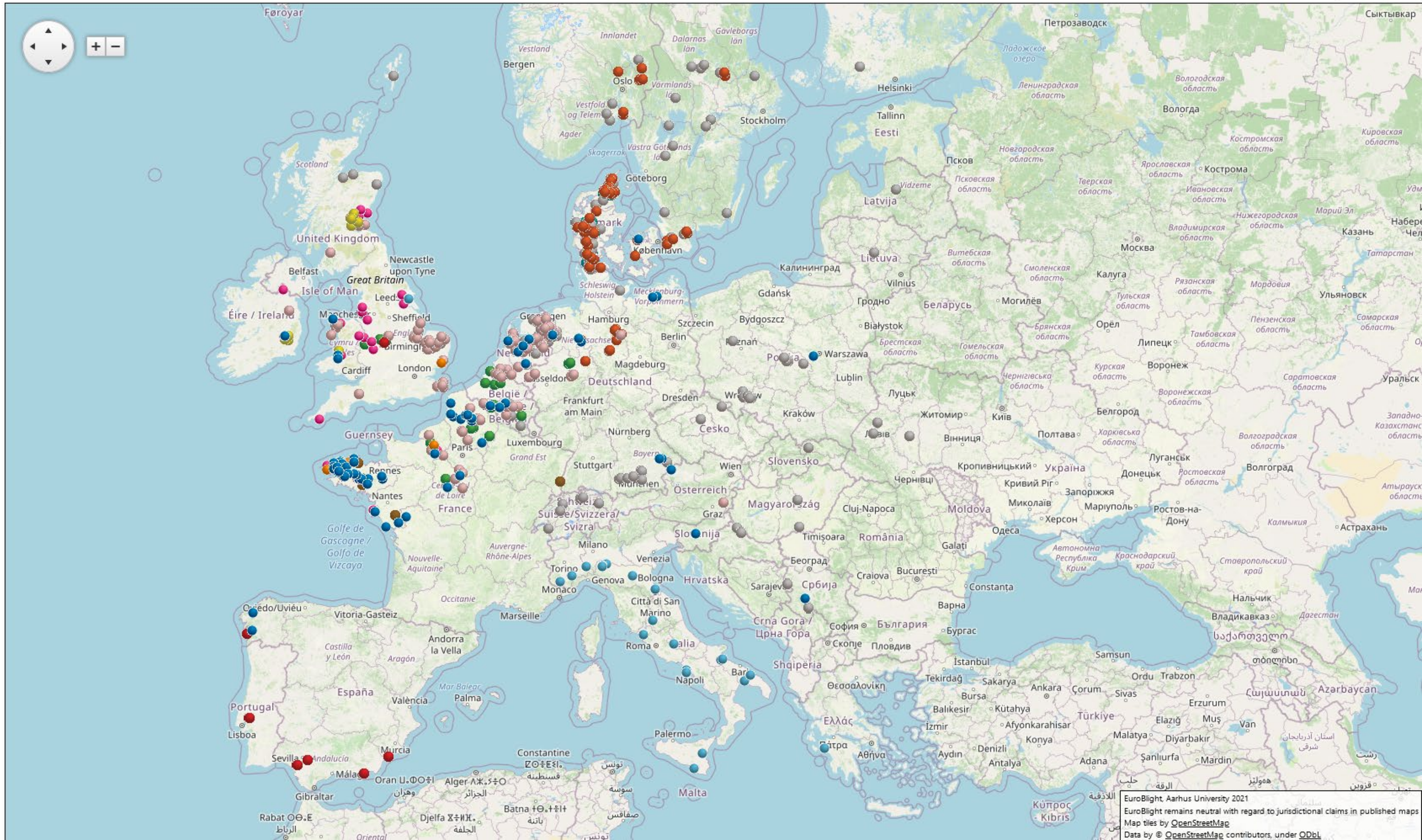
FACULTY OF TECHNICAL SCIENCES

Results of the EuroBlight potato late blight monitoring in 2020

EuroBlight is continuously examining the ongoing evolution of the Euro late blight pathogen results. Approximate countries genotyped

Year
2020
Continent
Europe
Country
All countries selected
Host
All
N/A Other Potato Tomato
Genotypes
All
EU_1_A1 EU_2_A1
EU_6_A1 EU_8_A1
EU_12_A1 EU_13_A2
EU_23_A1 EU_36_A2
EU_37_A2 EU_39_A1
EU_41_A2 EU_43
EU_42_A2 Other
Show

Help



Blight lesion photo by James Lynott of The Ja

9. april 2021 af Jens Grønbech Hansen

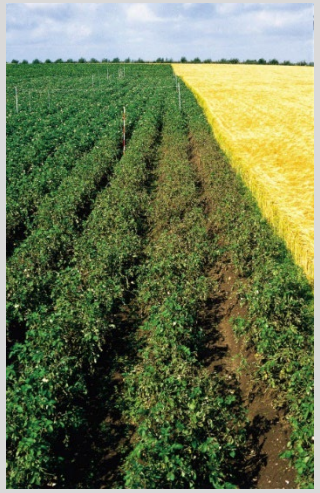
Key findings:

- EuroBlight continuously inve population of the potato late now reports on the 2020 resu

Nyhedsarkiv

- › 2021
  - › maj 2021 (1 post)
  - › april 2021 (1 post)
  - › februar 2021 (1 post)
- › 2020
  - › september 2020 (1 post)
  - › marts 2020 (1 post)

BlightManager



Decision support - prevention and control of late blight and early blight

January 2019 – 31 December 2021

IPMblight2.0 ⟶ BlightManager ⟶ Ecosol

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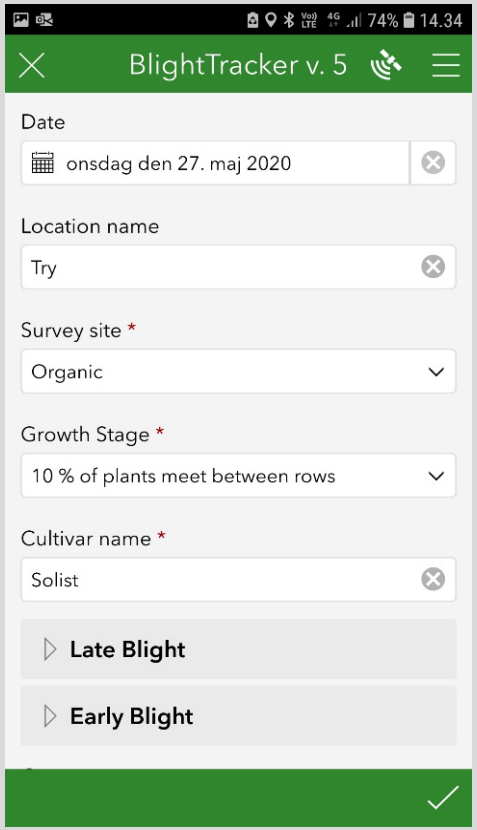
Fo
Photo JGH

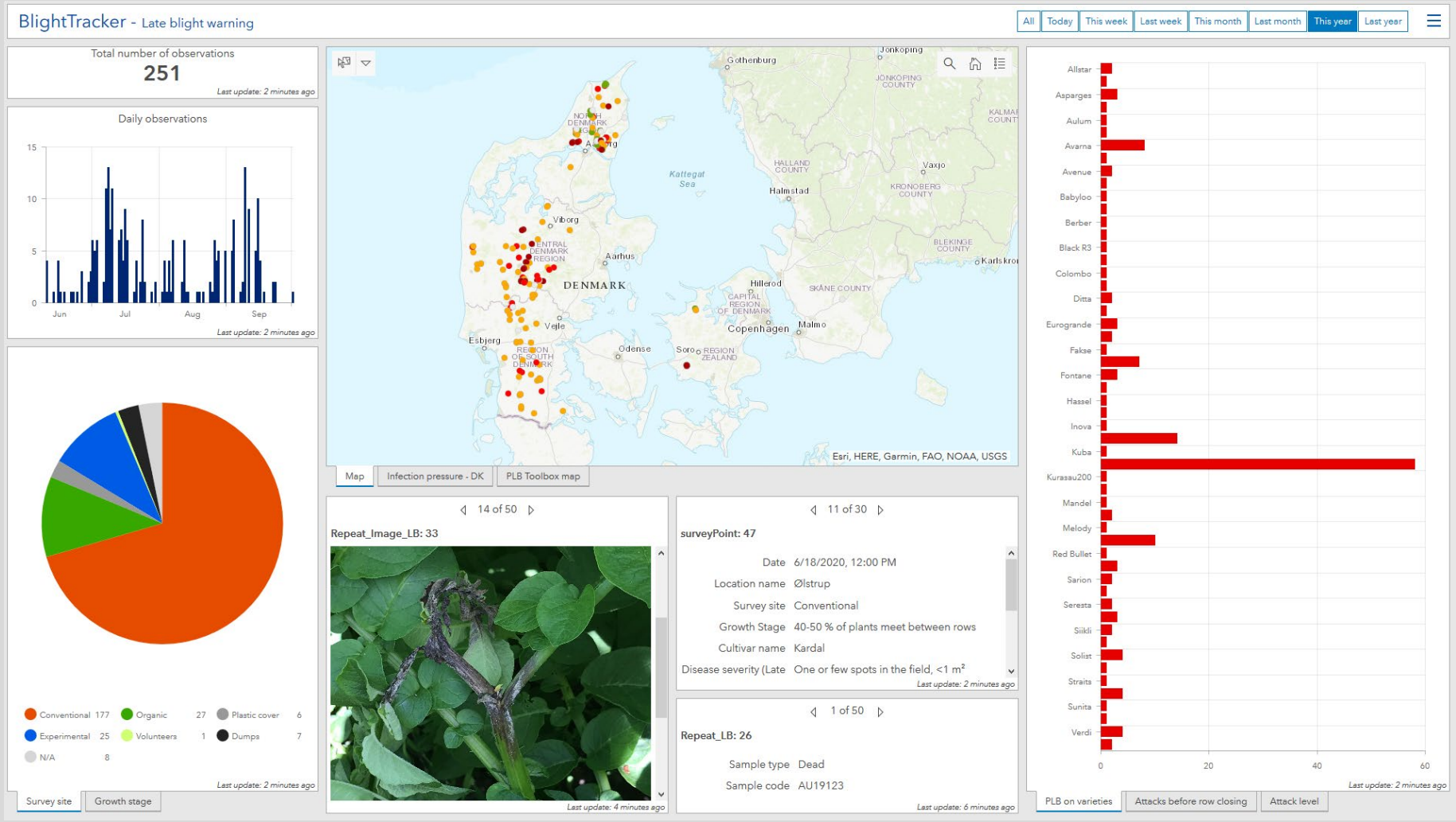
Disease surveillance and monitoring for all Nordic countries.

400% more observations

BlightTracker App

Dashboard – When, where, how much and which varieties are affected



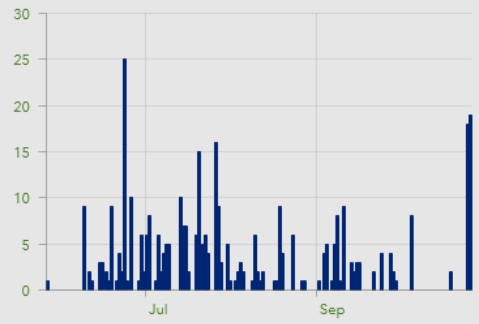


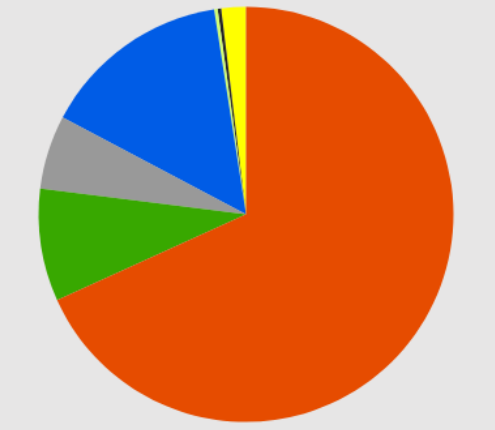
BlightTracker – LB surveillance

Select a date
This year

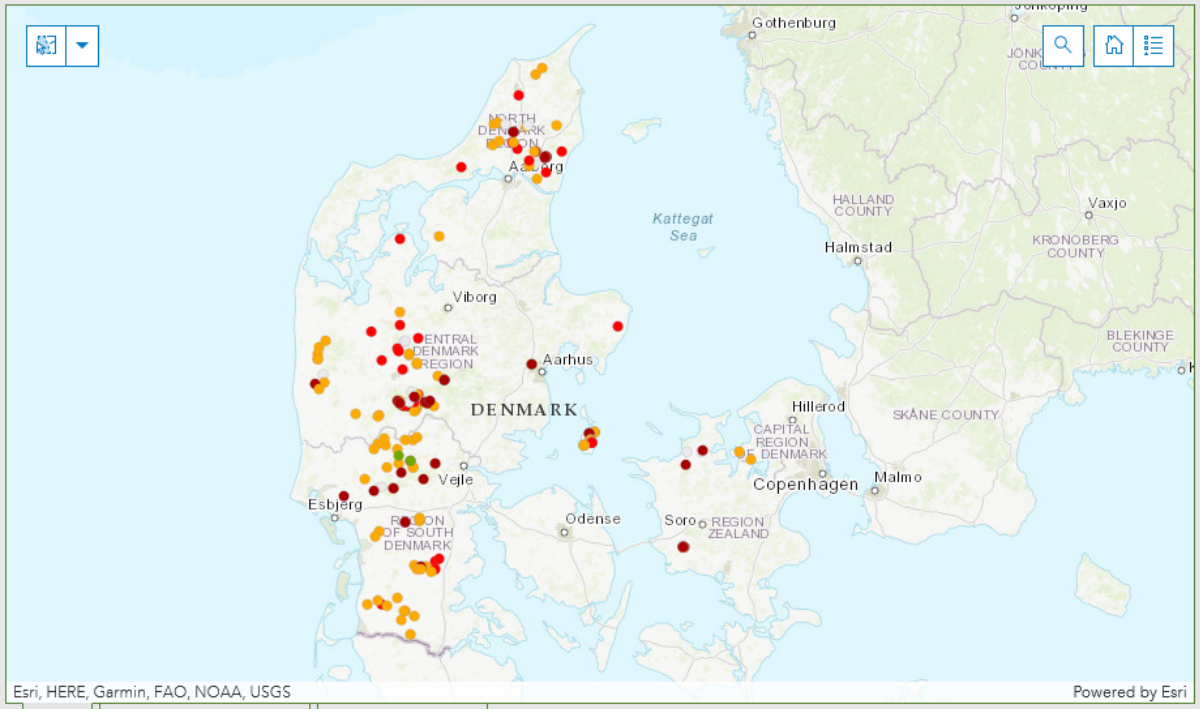
Total number of observations
365

Daily observations





Survey site | Growth stage



Map | Infection pressure - DK | PLB Toolbox map

1 of 50

Repeat_Image_LB: 241

Image_LateBlight-20210526-075839.JPG

Last edited by jrs_gis_au on 5/26/2021, 7:59 AM.

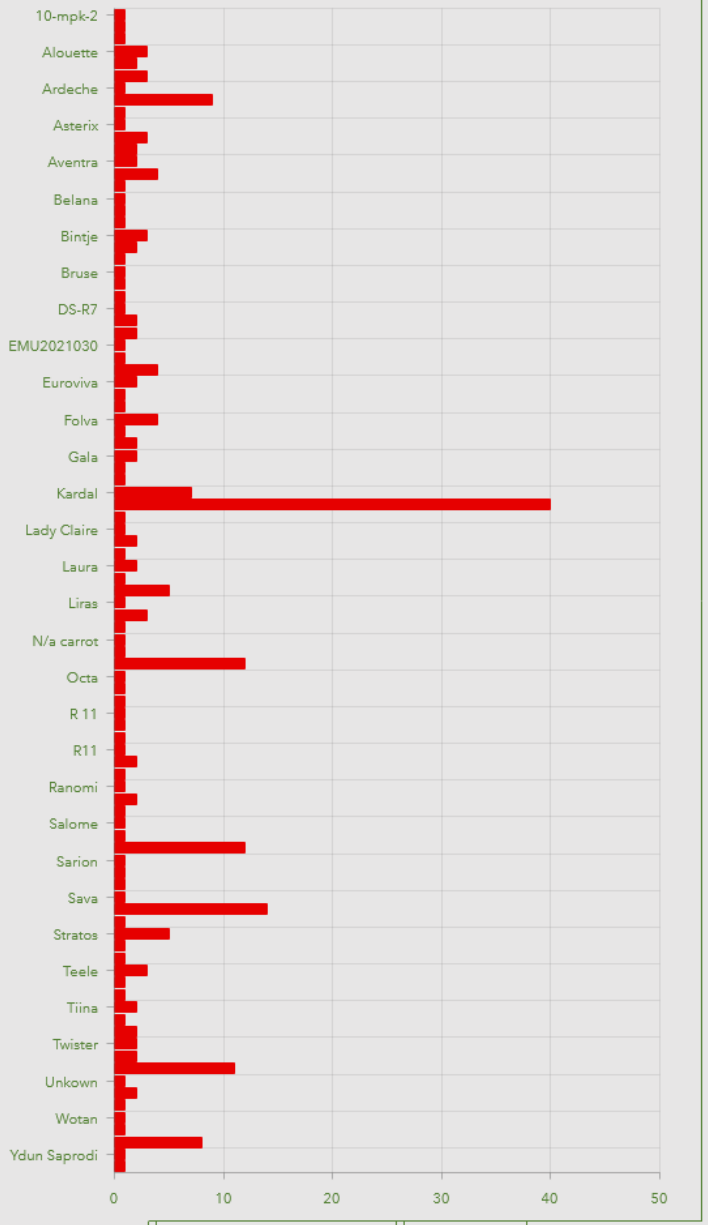
ID 300: Folva?
Location name: Store Vildmose
Survey site: Dumps
Growth stage: More than 5 side shoots visible, plants 15-20 cm high
Comments: Dump destroyed and live (infected leaves in cut tubers) samples and FTA card dead sample sent to Flakkebjerg

ID 312: Eurogrande
Location name: Sønderlykkevej
Survey site: Conventional
Growth stage: More than 5 side shoots visible, plants 15-20 cm high
Comments: Recorded by Henrik Kjærgaard Rasmussen, uploaded by jgh browser version

ID 315: Folva
Location name: Vridsted
Survey site: Conventional
Growth stage: Buds of first inflorescence extended to 5 mm
Comments:

ID 317: Eurogrande
Location name: Sønderlykkevej
Survey site: Conventional

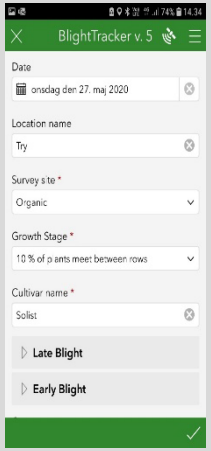
Field data | Sample code

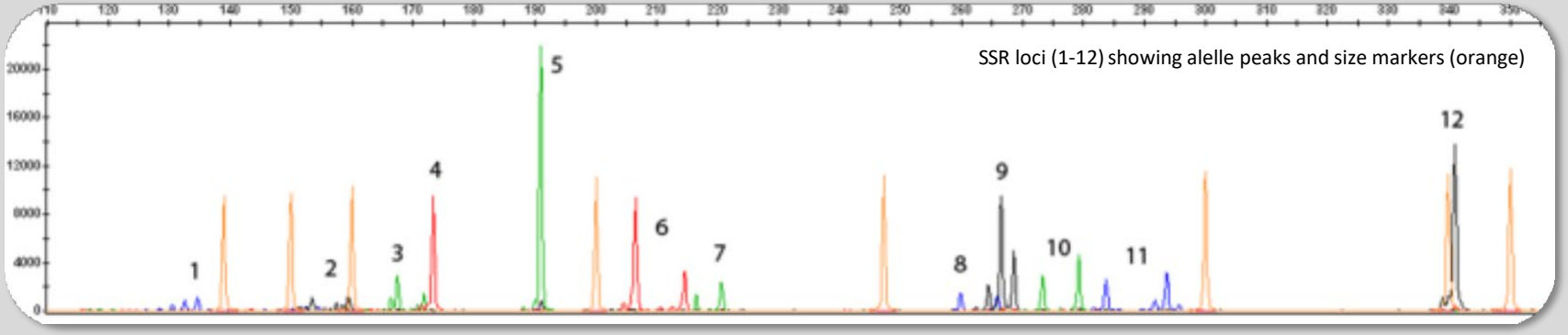


PLB on varieties | Attacks before row closing | Attack level

Monitoring methods

- Scouts issued with sample forms and FTA cards (also live cultures collected for phenotyping)
- Outbreak data (e.g. location, crop type, cultivar) recorded
- Lesions pressed onto FTA cards to capture pathogen DNA
- DNA fingerprinted using 12-plex SSRs (Li *et al.* 2013)
- Genotypes defined & data stored in Euroblight database
- Transfer to ESRI cloud
- Data mapped on www.euroblight.net and ESRI Dashboard

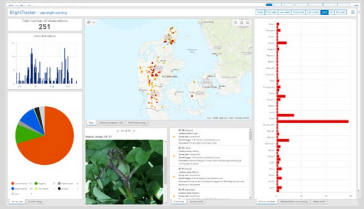




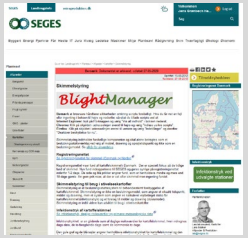
BlightTracker
Browser App

or

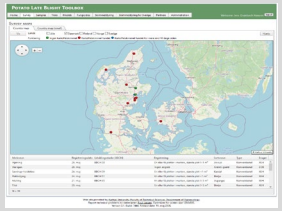
BlightTracker
Smartphone App



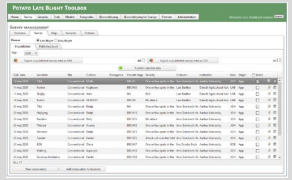
ESRI Cloud dashboard



Extension service / farmers

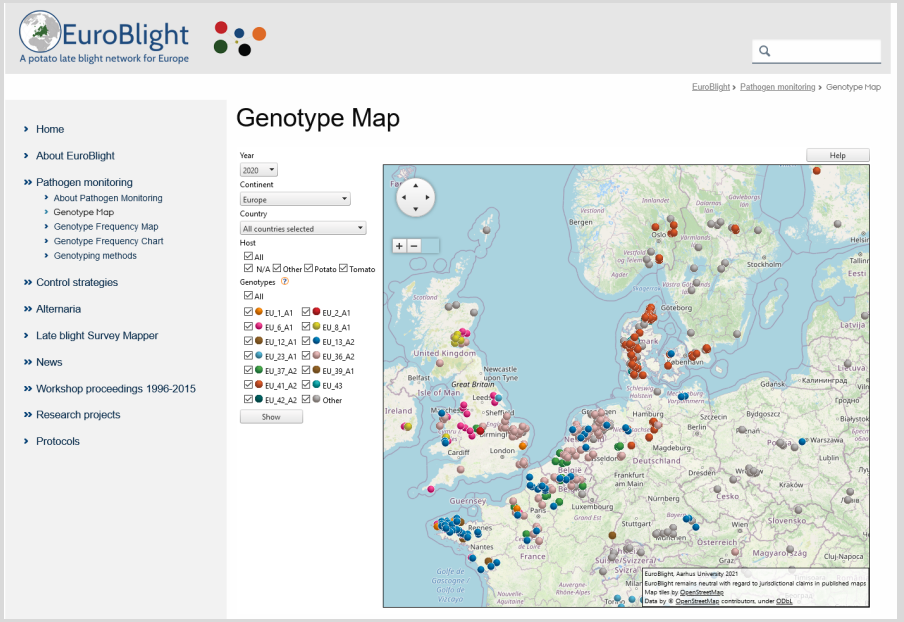


Common Nordic disease surveillance

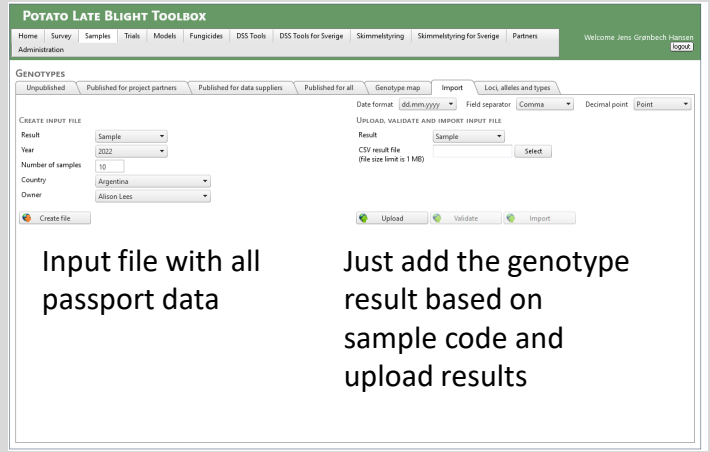


Potato late blight toolbox
Data Management and QC

Public in EuroBlight



Inform data providers

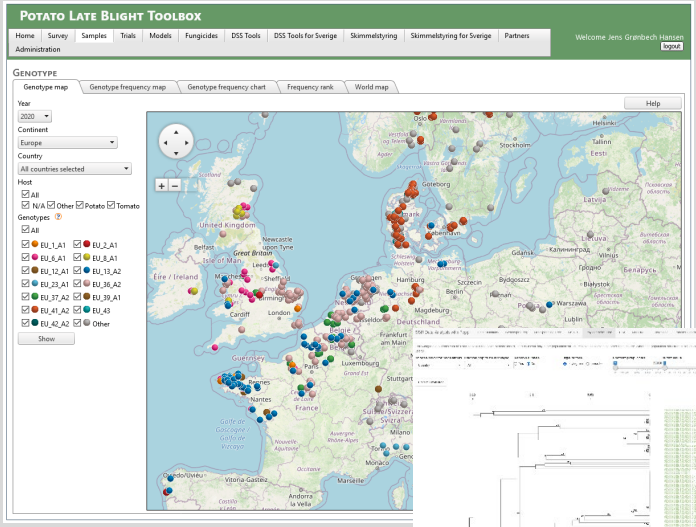


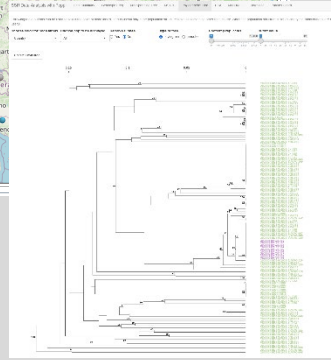
Input file with all passport data

Just add the genotype result based on sample code and upload results

Import genotype results

\+





Quality control and analysis before release

Roles in the EuroBlight infrastructure:

JHI: SSR genotyping
WUR: storage of live isolates
AU: Databases, Apps and website
AgChem: sponsoring EuroBlight Workshops

BlightManager

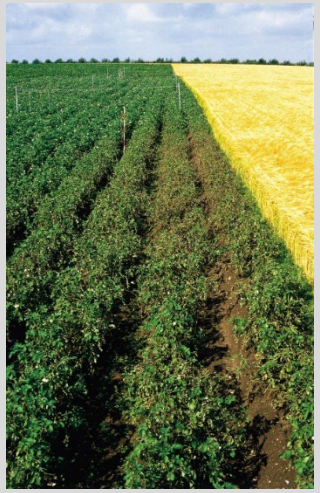


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Photo JGH

Oospores in Denmark. Documented since 1997

Primary attack at Foulum, 1988

Oospores 2014
Foulum

1997

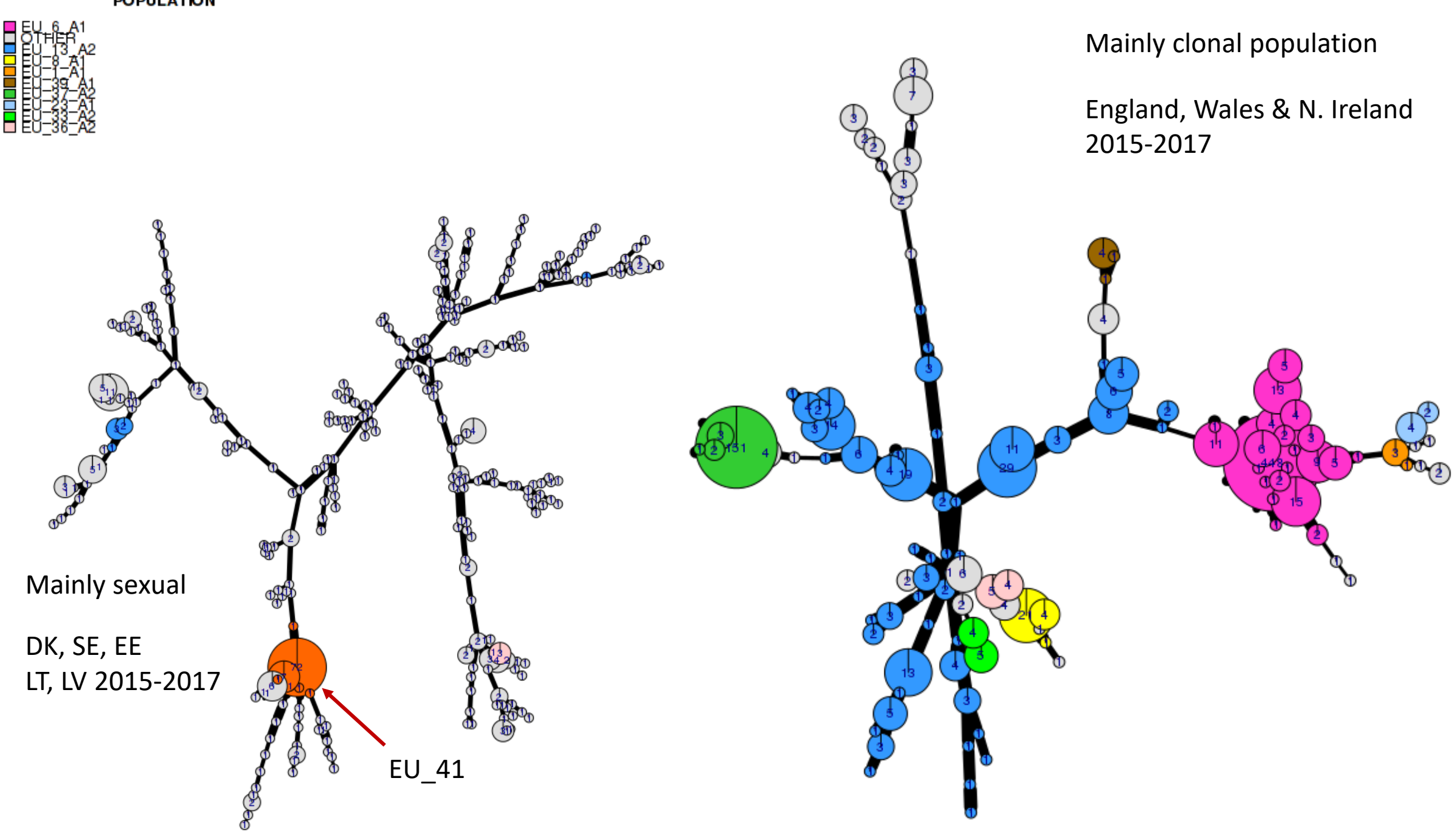
Volunteer plant with blight
2015, Foulum

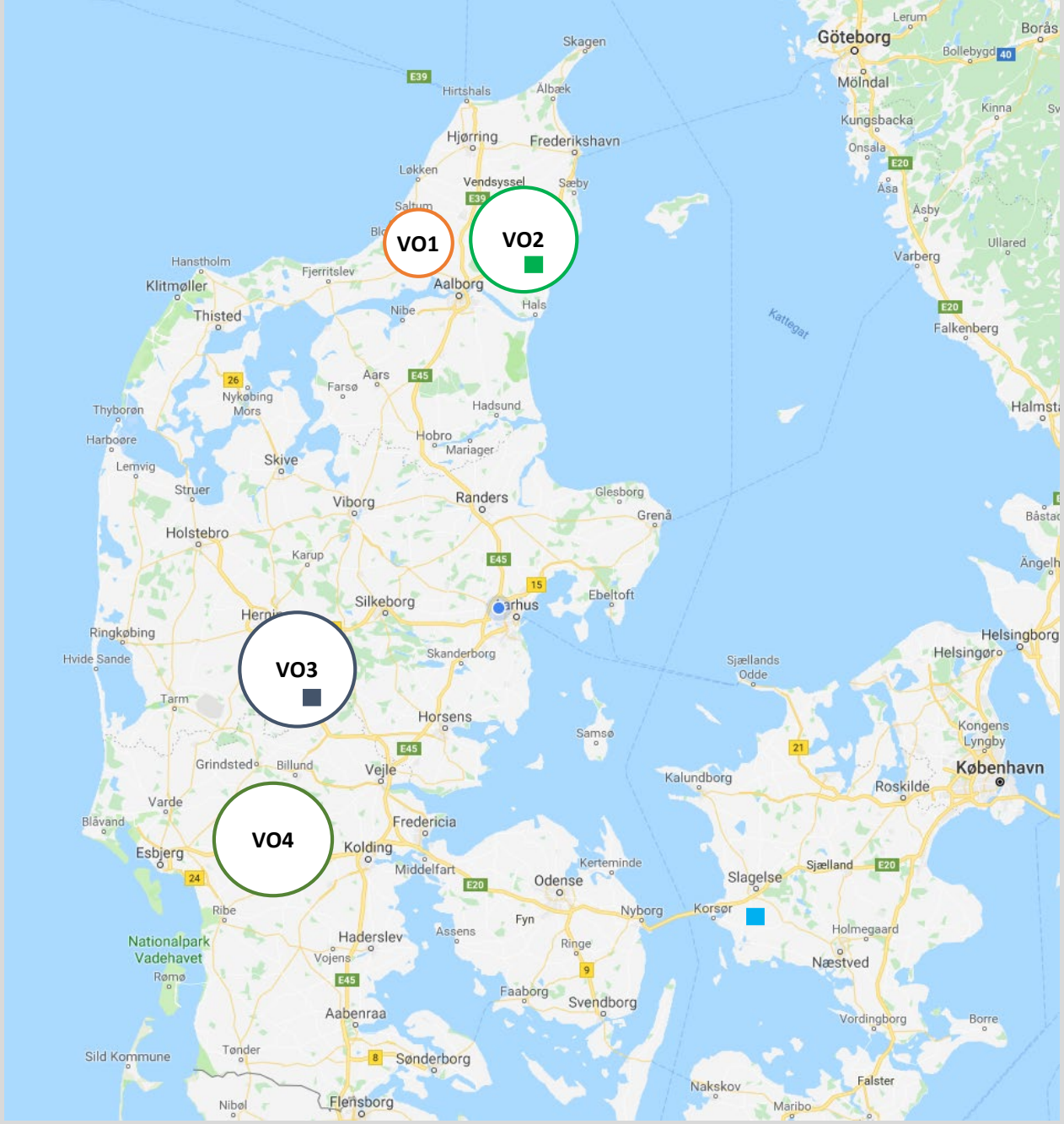
Sexual recombination:

- Early season soil-borne disease
- Generates genetic variation in *P. infestans* population

→ Risk of fungicide resistance and host specificity

→ More difficult to control


POPULATION
EU_6_A1
OTHER
EU_13_A2
EU_8_A1
EU_1_A1
EU_39_A1
EU_37_A2
EU_23_A1
EU_33_A2
EU_36_A2
Mainly sexual
DK, SE, EE
LT, LV 2015-2017
EU_41
Mainly clonal population
England, Wales & N. Ireland
2015-2017



Four Case study regions (VO1-VO4)

VO1 VO2 VO3 VO4

1. VO1: Store Vildmose (Jannie R. Sørensen)
2. VO2: AKV Dronninglund (Henrik Pedersen)
3. VO3: KMC Brande (Kristian Elkjær)
4. VO4: BJ-Agro (Benny Jensen)

Three Trial sites:

- Dronninglund (VO2)
- Arnborg (VO3)
- Flakkebjerg (close to Slagelse)

Early sampling campaign in 2019

Suspected Oospore fields
Sampled 8 isolates per Field
SSR genotyped at JHI

Other (3 different)

EU_36_A2

Other (5 different)

Other (8 different)

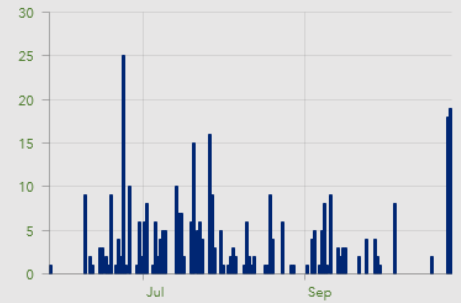
BlightTracker Dashboard Original

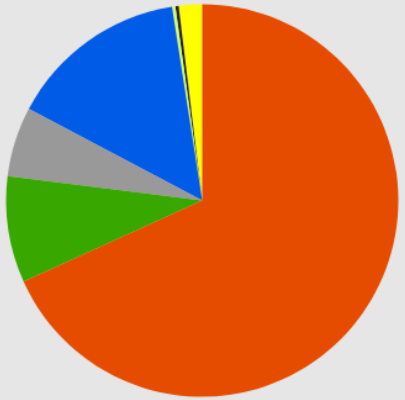
BlightTracker – LB surveillance

Select a date
This year

Total number of observations
365

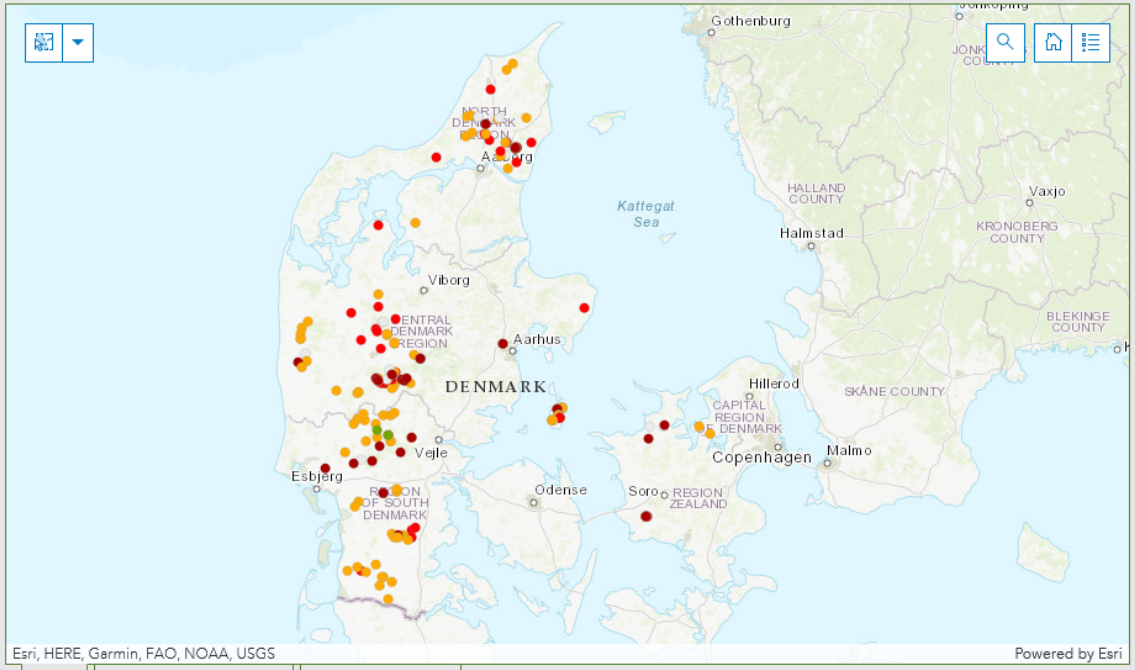
Daily observations





Conventional 249 | Organic 32 | Plastic cover 21
Experimental 54 | Volunteers 1 | Dumps 1
Home garden 7

Survey site | Growth stage



Map | Infection pressure - DK | PLB Toolbox map

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Comments:

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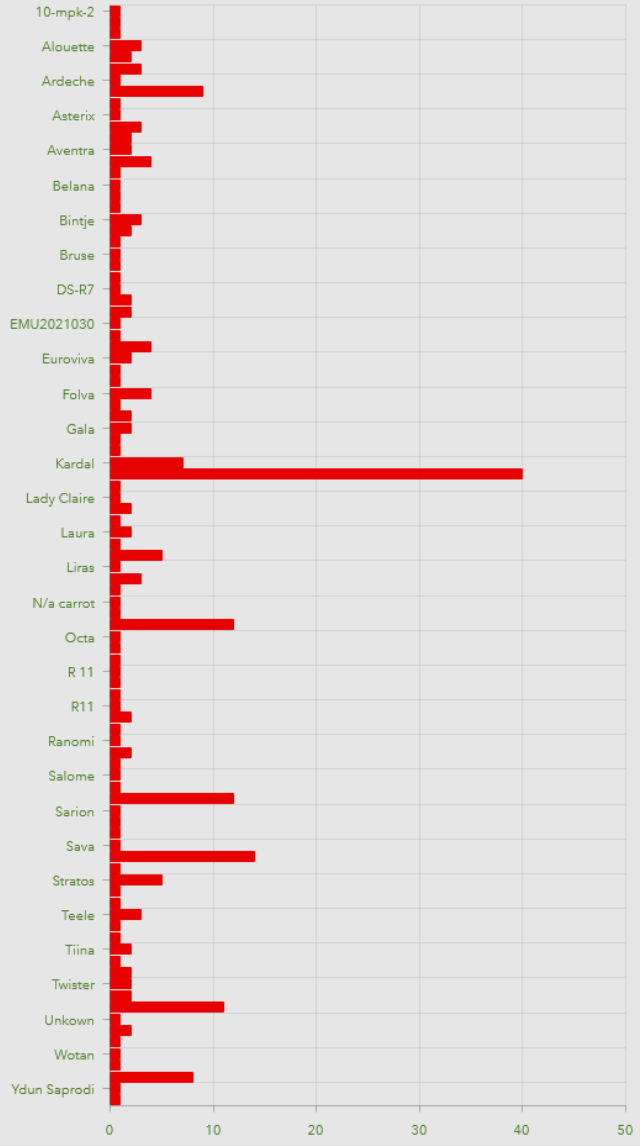
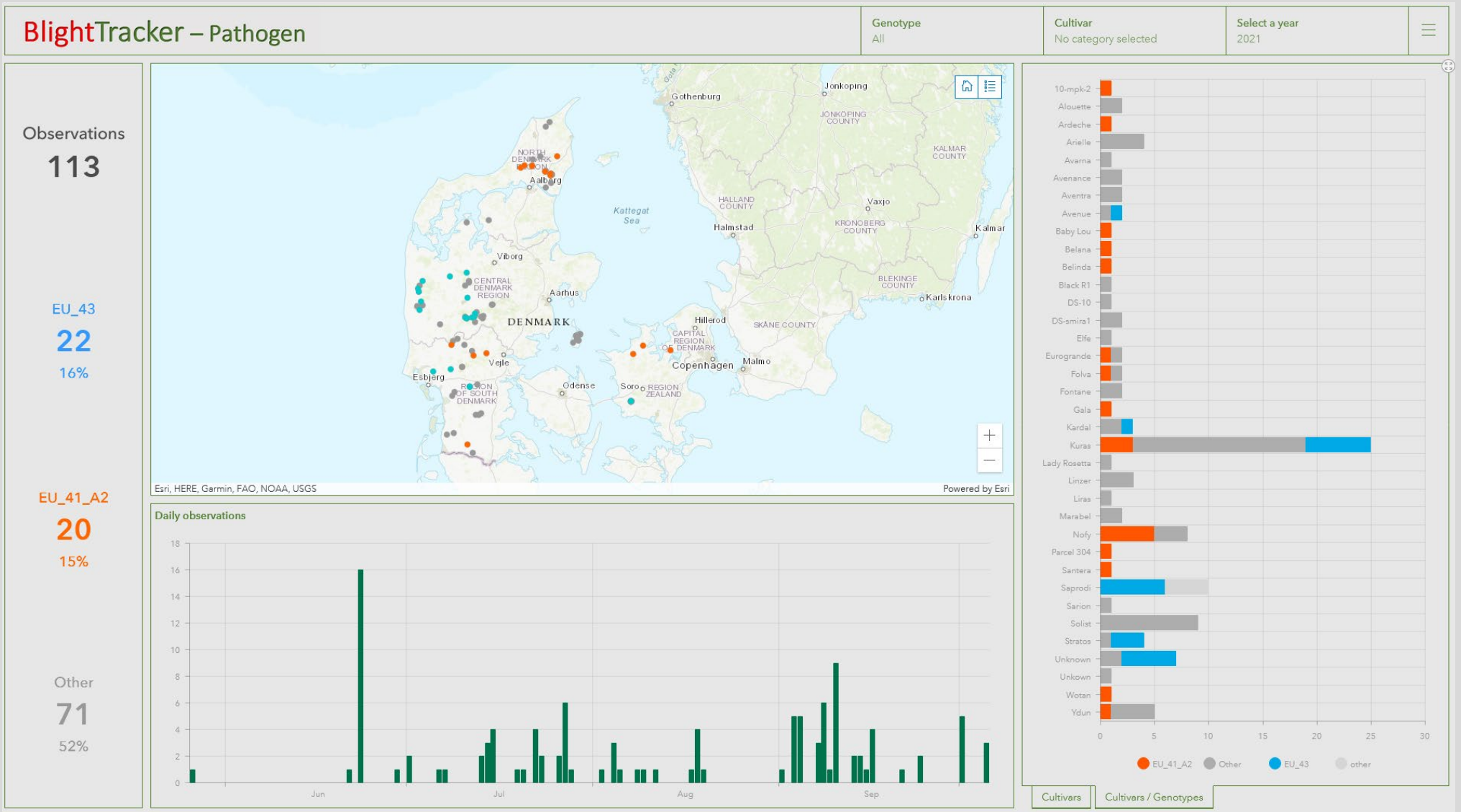
Survey site: Conventional

Field data | Sample code



PLB on varieties | Attacks before row closing | Attack level



New: DK Pop, 2021

113 observations
EU43: 22 (16%)
EU41: 20 (15%)
Other: 71 (52%)

User can

Select a genotype from top menu and see where it was sampled, on which cultivars and on which dates

Select a cultivar and see which genotypes were sampled from this cultivar

Select a date or a period and see which genotypes were sampled on which cultivars

Genotype

Genotype map | Genotype frequency map | Genotype frequency chart | Frequency rank | World map

Help

Continent

Europe

Country

Denmark

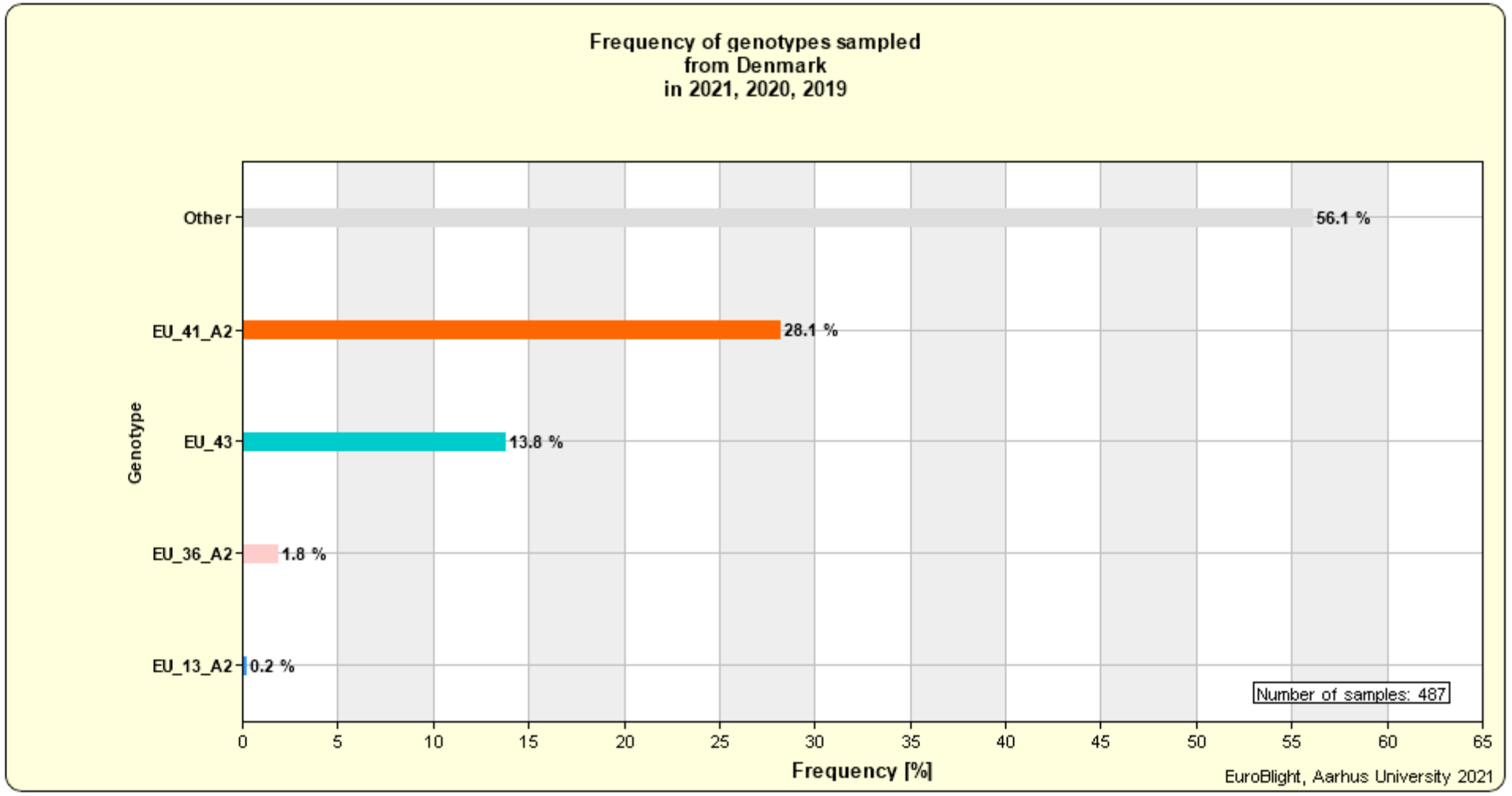
Year

- [ ] All
- [x] 2021
- [x] 2020
- [x] 2019
- [ ] 2018
- [ ] 2017
- [ ] 2016
- [ ] 2015
- [ ] 2014
- [ ] 2013
- [ ] 2012
- [ ] 2011
- [ ] 2007
- [ ] 2006

Show

Genotype

- ( ) Observations
- (•) Frequency
- [x] Show values



Genotype

Genotype map | Genotype frequency map | Genotype frequency chart | Frequency rank | World map

Continent

Europe

Country

Denmark

Host

- [x] All
- [x] Potato

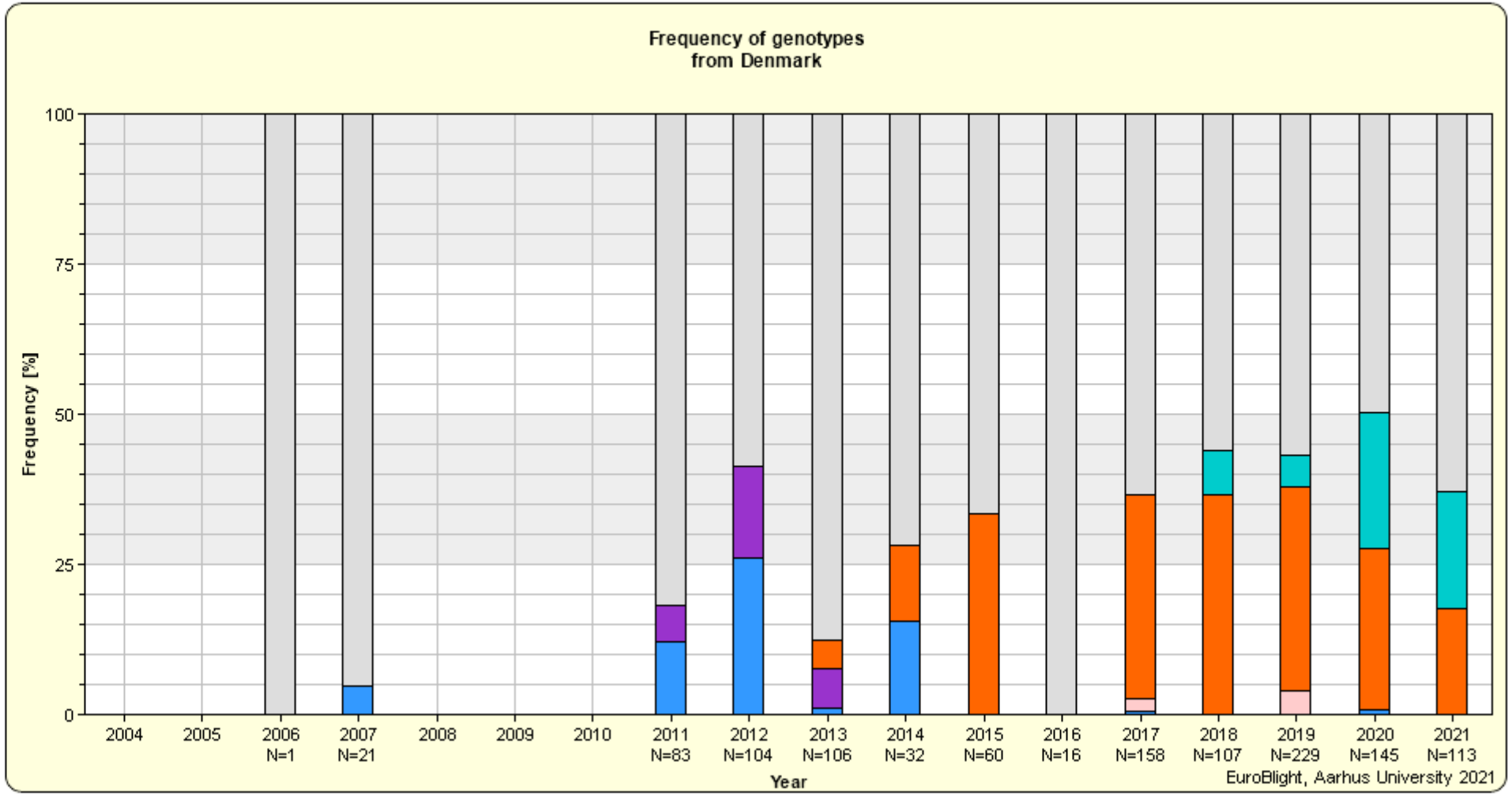
Show

Genotype legend

- EU_13_A2
- EU_36_A2
- EU_40_A2
- EU_41_A2
- EU_43
- Other

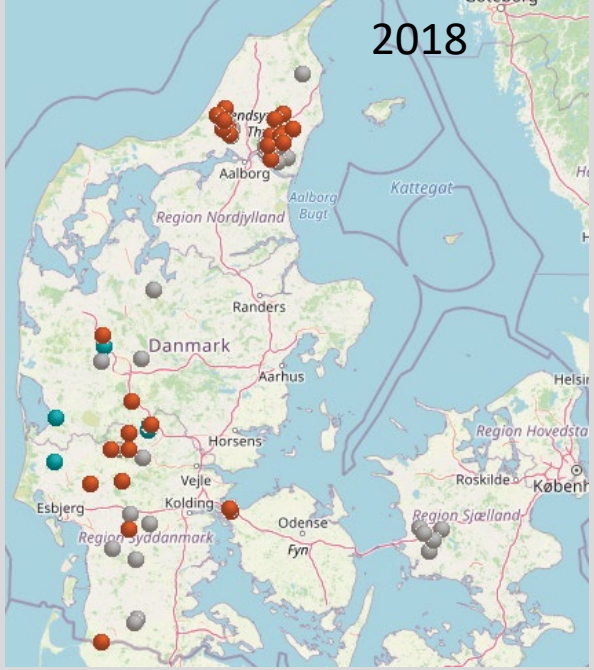
Genotype frequency distribution

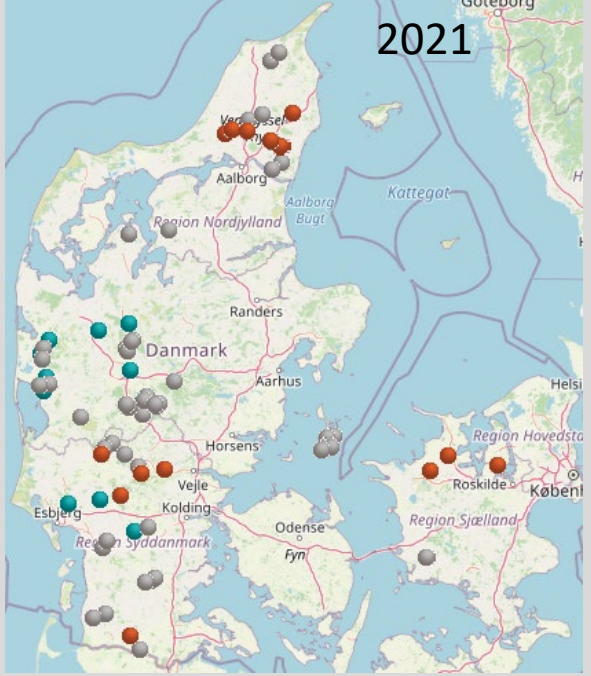
Help




2012
Aalborg
Aalborg Bugt
Kattegat
Region Nordjylland
Randers
Aarhus
Horsens
Vejle
Kolding
Esbjerg
Odense
Fyn
Roskilde
Region Sjælland
Region Syddanmark

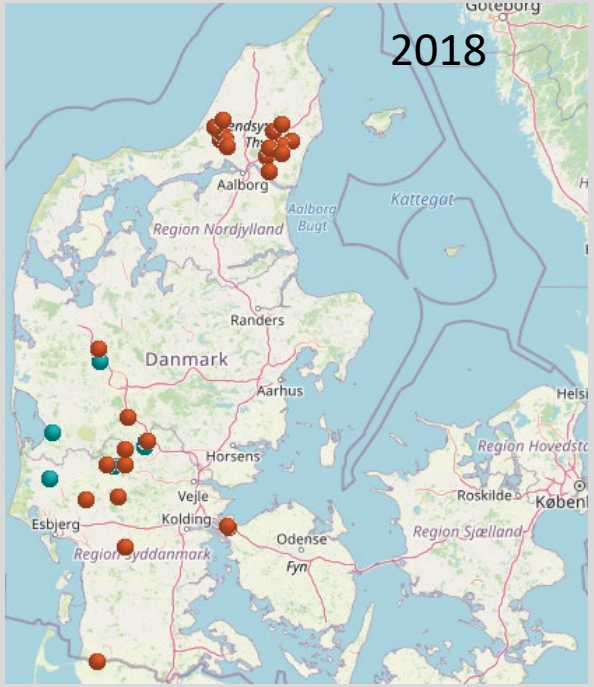

2014
Vendsyssel-Thy
Aalborg
Aalborg Bugt
Kattegat
Region Nordjylland
Randers
Aarhus
Horsens
Vejle
Kolding
Esbjerg
Odense
Fyn
Roskilde
Region Sjælland
Region Syddanmark


2018
Aalborg
Aalborg Bugt
Kattegat
Region Nordjylland
Randers
Danmark
Aarhus
Horsens
Vejle
Kolding
Esbjerg
Odense
Fyn
Roskilde
Region Sjælland
Region Syddanmark


2021
Aalborg
Aalborg Bugt
Kattegat
Region Nordjylland
Randers
Danmark
Aarhus
Horsens
Vejle
Kolding
Esbjerg
Odense
Fyn
Roskilde
Region Sjælland
Region Syddanmark

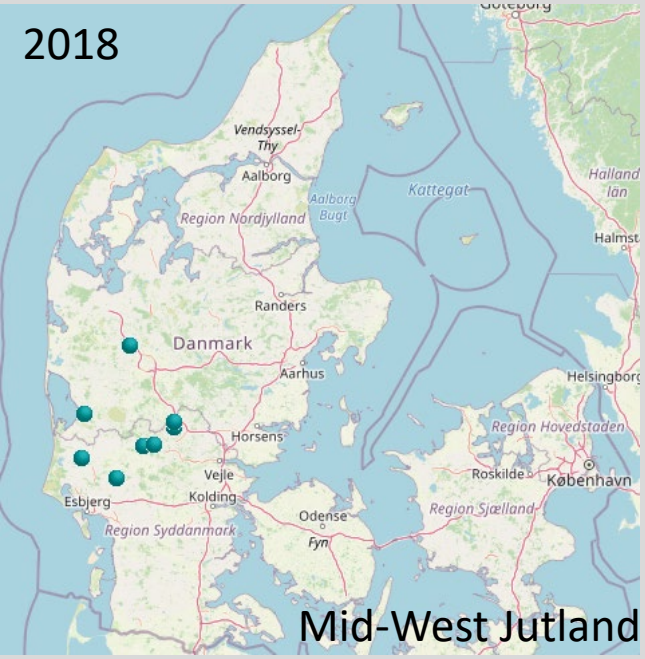

2012
Aalborg
Aalborg Bugt
Kattegat
Region Nordjylland
Randers
Aarhus
Horsens
Vejle
Kolding
Esbjerg
Odense
Fyn
Roskilde
Region Sjælland
Region Syddanmark

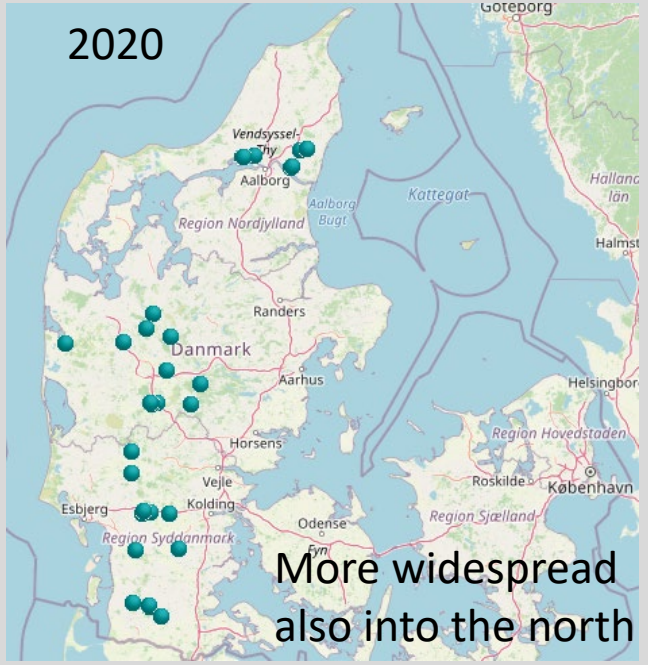

2014
Vendsyssel-Thy
Aalborg
Aalborg Bugt
Kattegat
Region Nordjylland
Randers
Danmark
Aarhus
Horsens
Vejle
Kolding
Esbjerg
Odense
Fyn
Roskilde
Region Sjælland
Region Syddanmark

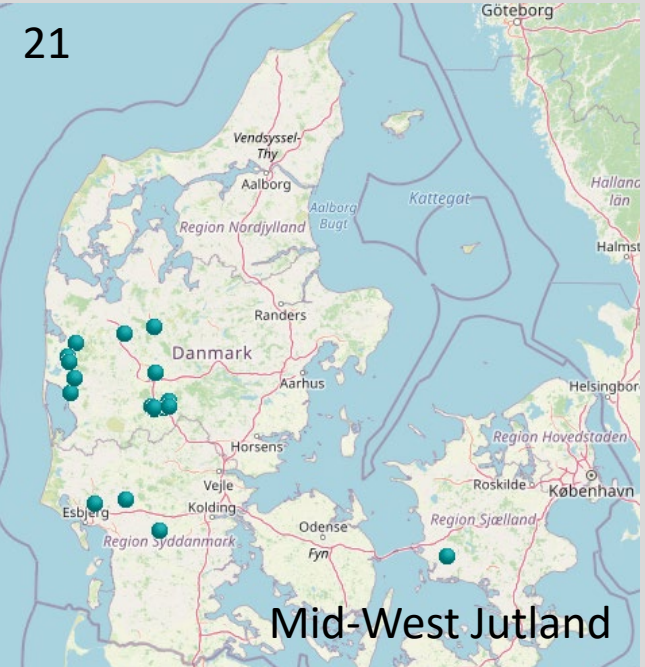

2018
Aalborg
Aalborg Bugt
Kattegat
Region Nordjylland
Randers
Danmark
Aarhus
Horsens
Vejle
Kolding
Esbjerg
Odense
Fyn
Roskilde
Region Sjælland
Region Syddanmark


2021
Aalborg
Aalborg Bugt
Kattegat
Region Nordjylland
Randers
Danmark
Aarhus
Horsens
Vejle
Kolding
Esbjerg
Odense
Fyn
Roskilde
Region Sjælland
Region Syddanmark

EU43 – a new genotype only found in Denmark. Named in 2020 and recognised via SSR *poppr* analysis in 2018 and 2019 (not earlier)







We do not yet understand these regional patterns

Can be a mixture of:

- Use of different Cultivars?
- Difference in management practices / traditions by region?
- Differences in soil types and weather patterns / Blight risk?
- Difference in recommendation from regional starch industries (KMC, AKV Langholt)?

Year

2020

Continent

Europe

Country

All countries selected

Host

All

N/A Other Potato Tomato

Genotypes

All

EU_1_A1 EU_2_A1

EU_6_A1 EU_8_A1

EU_12_A1 EU_13_A2

EU_23_A1 EU_36_A2

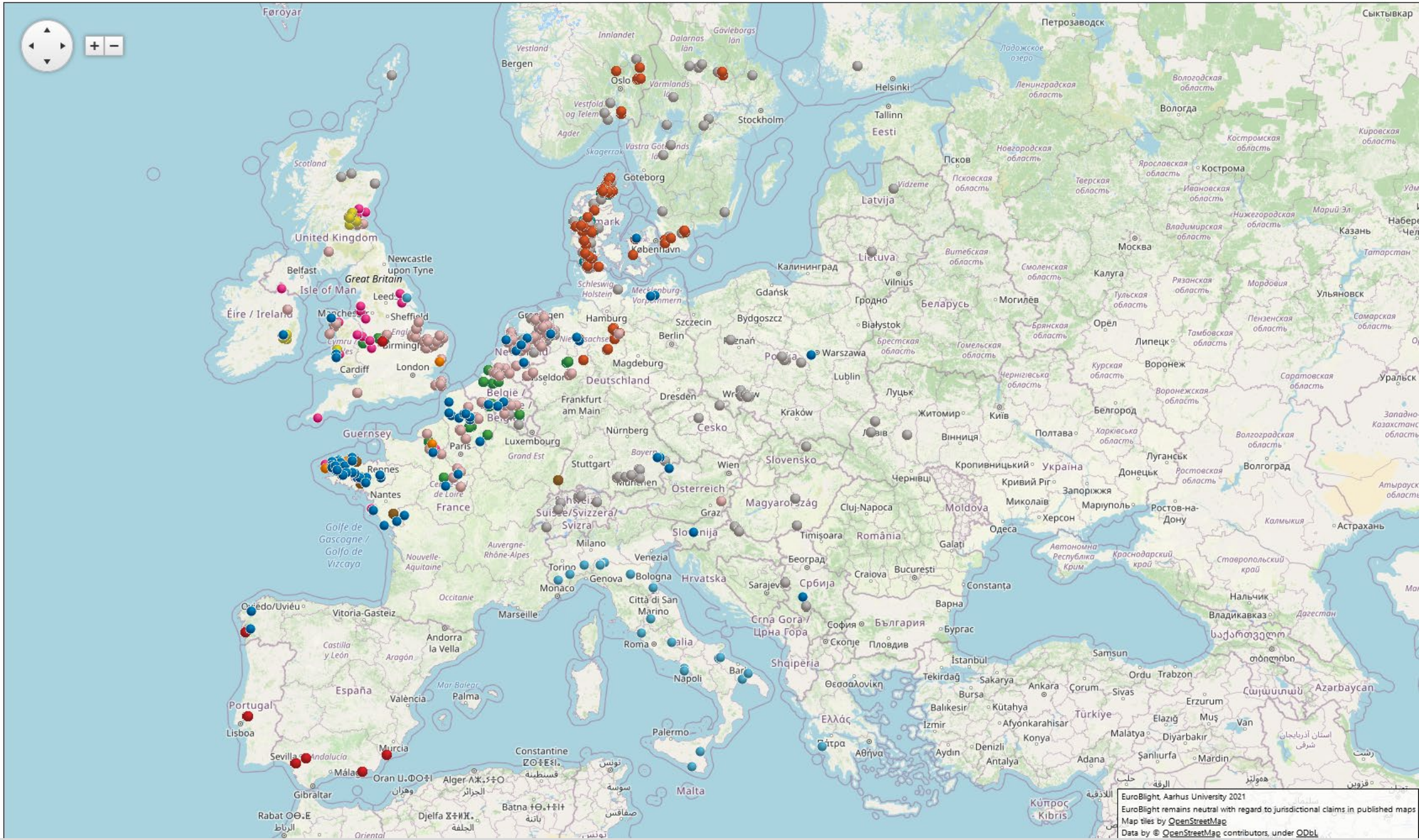
EU_37_A2 EU_39_A1

EU_41_A2 EU_43

EU_42_A2 Other

Show

Help



Genotype

Genotype map | Genotype frequency map | Genotype frequency chart | Frequency rank | World map

Continent

Europe

Year

- [ ] All
- [x] 2021 [x] 2020
- [x] 2019 [x] 2018
- [ ] 2017 [ ] 2016
- [ ] 2015 [ ] 2014
- [ ] 2013 [ ] 2012
- [ ] 2011 [ ] 2010
- [ ] 2009 [ ] 2008
- [ ] 2007 [ ] 2006
- [ ] 2005 [ ] 2004

Host

- [x] All
- [x] N/A [x] Other
- [x] Potato [x] Tomato

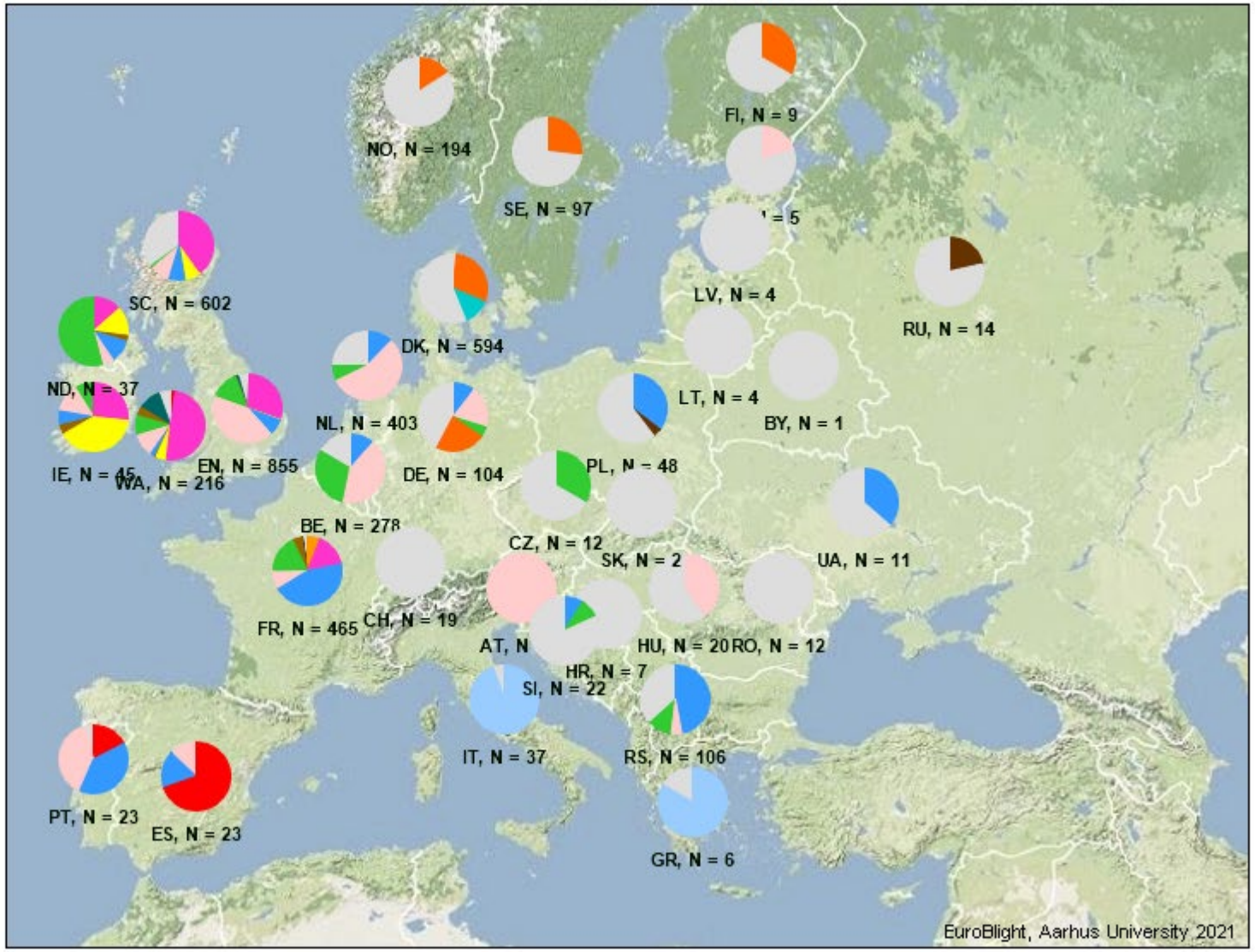
Show

Genotype legend

- EU_1_A1
- EU_2_A1
- EU_6_A1
- EU_8_A1
- EU_12_A1
- EU_13_A2
- EU_23_A1
- EU_36_A2
- EU_37_A2
- SIB_1_A1
- EU_39_A1
- EU_38_A2
- EU_41_A2
- EU_43
- EU_42_A2
- Other

Genotype frequency distribution

Help



Genotype

Genotype map | Genotype frequency map | Genotype frequency chart | Frequency rank | World map

Continent

Europe

Country

All countries selected

Host

All

N/A Other Potato

Tomato

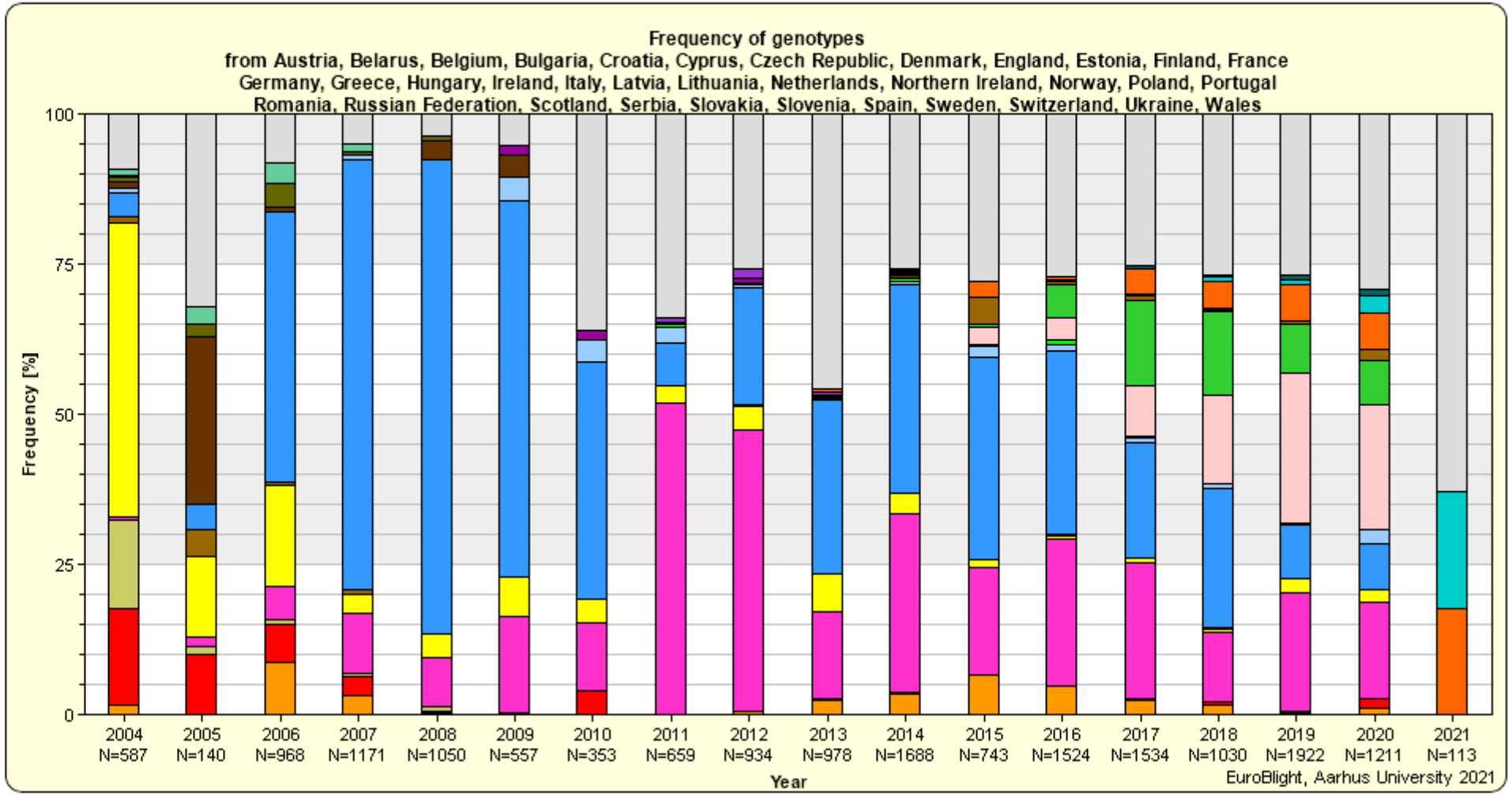
Show

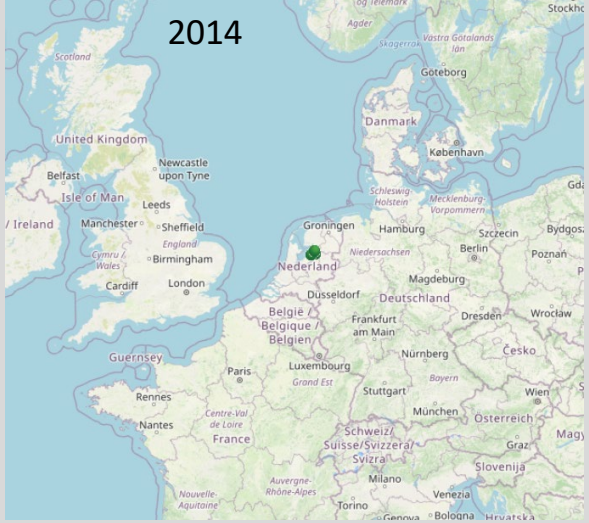
Genotype legend

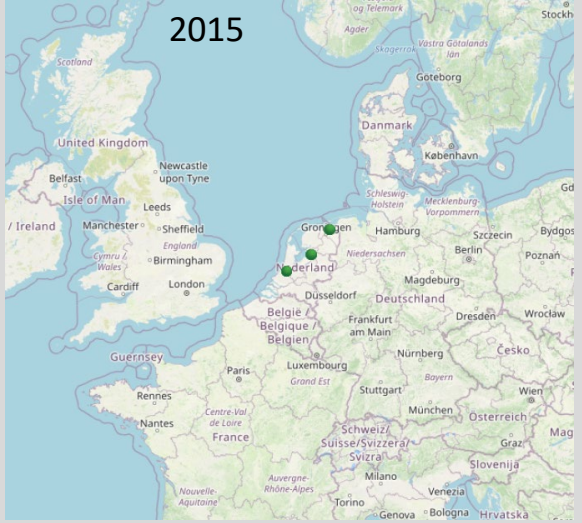
EU_1_A1
EU_2_A1
EU_5_A1
EU_6_A1
EU_8_A1
EU_12_A1
EU_13_A2
EU_23_A1
EU_33_A2
EU_34_A1
EU_35_A2
EU_36_A2
EU_37_A2
SIB_1_A1
EU_39_A1
EU_38_A2
EU_40_A2
EU_41_A2
EU_10_A2
EU_22_A2
EU_3_A2
EU_43
EU_42_A2
Other

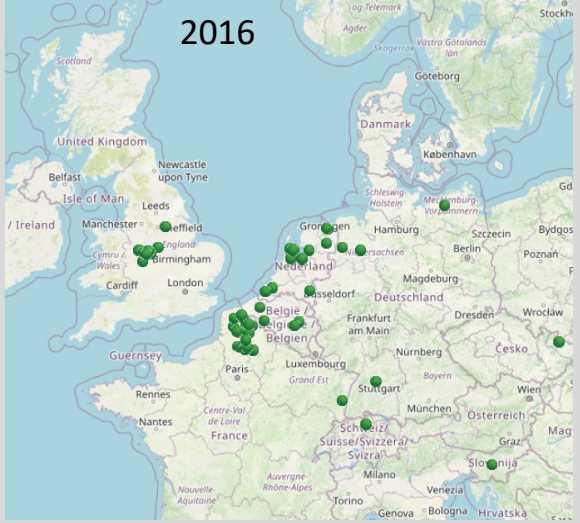
Genotype frequency distribution

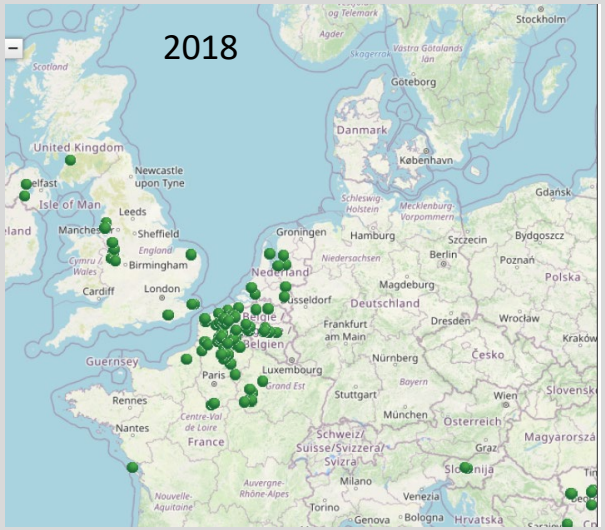
Help

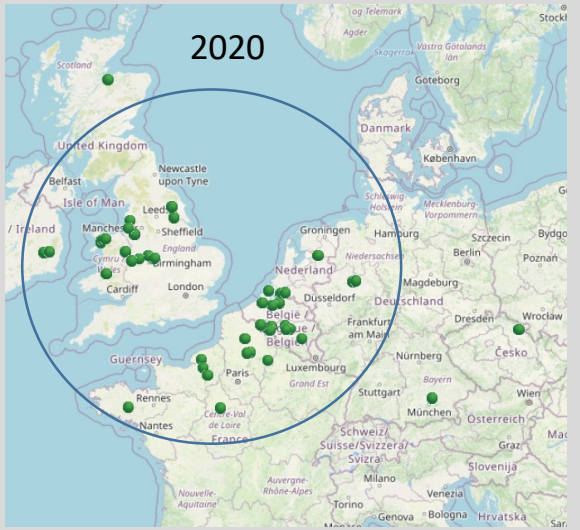




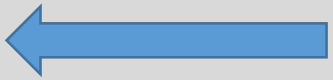




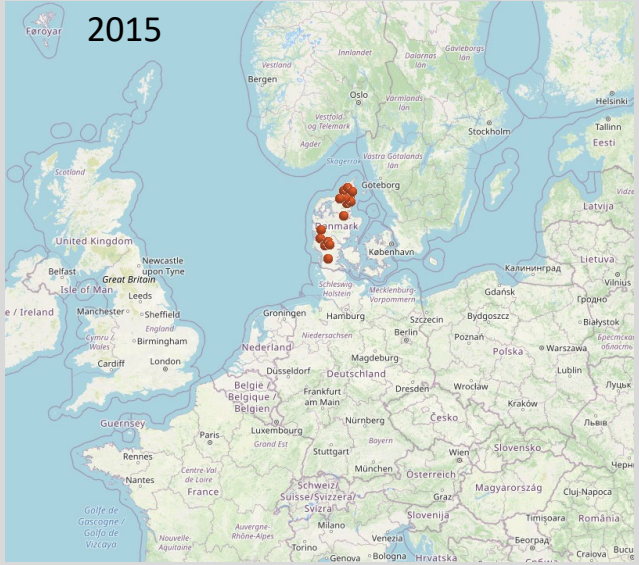


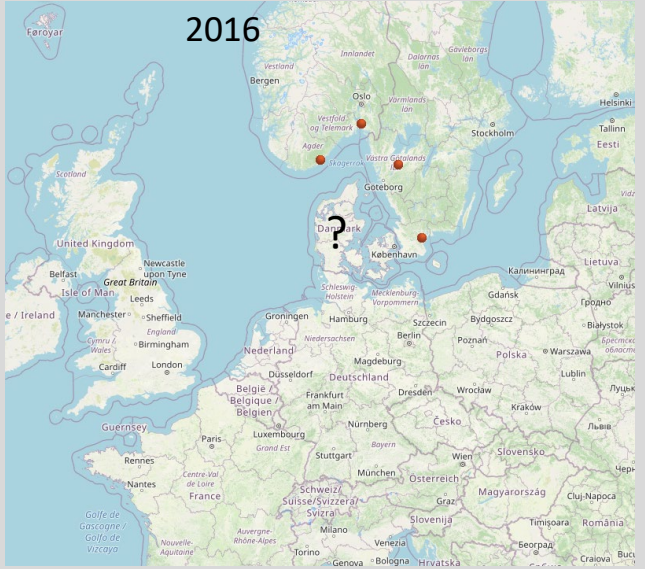


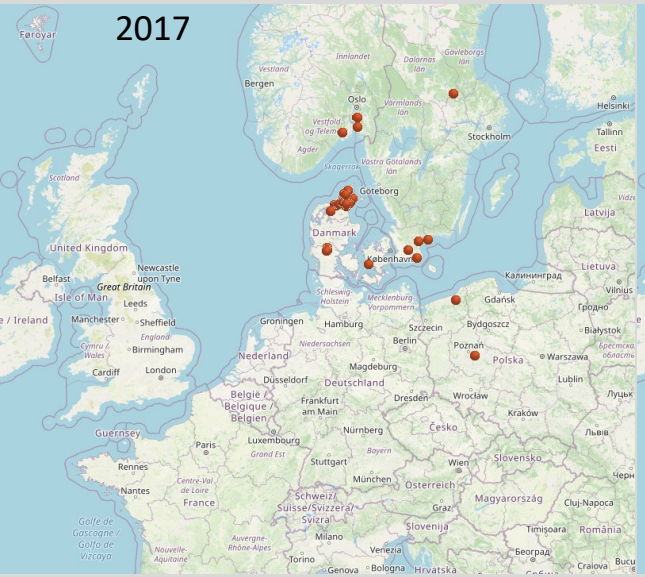
The evolution and spread of a new clone: EU37

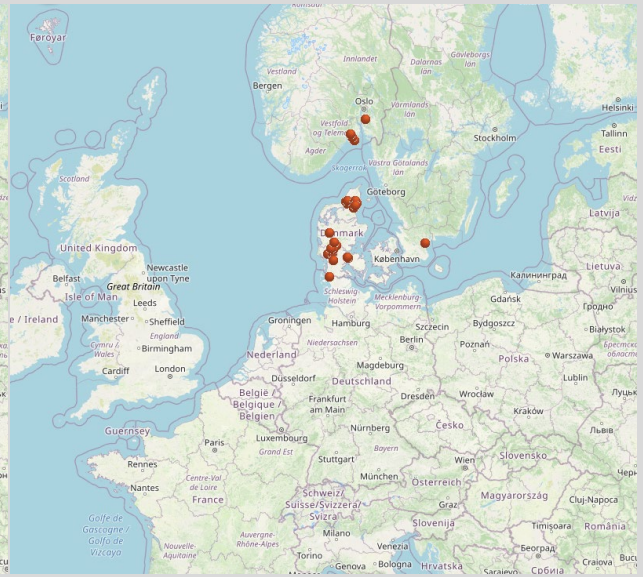


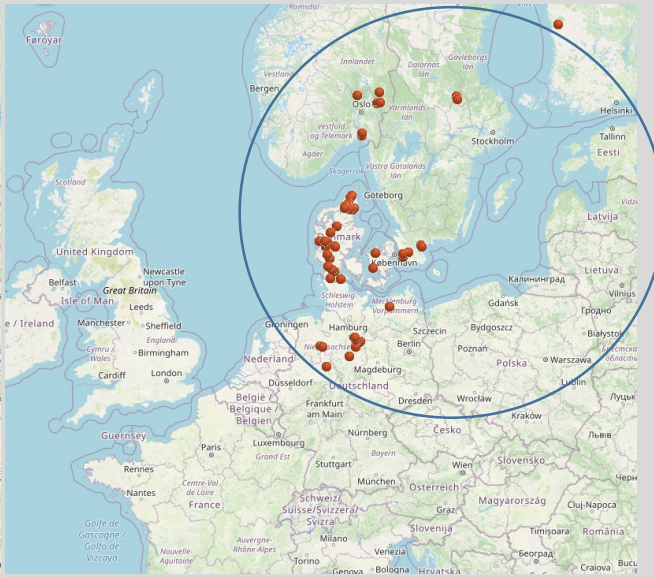
Go west



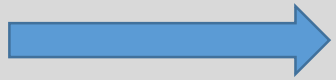








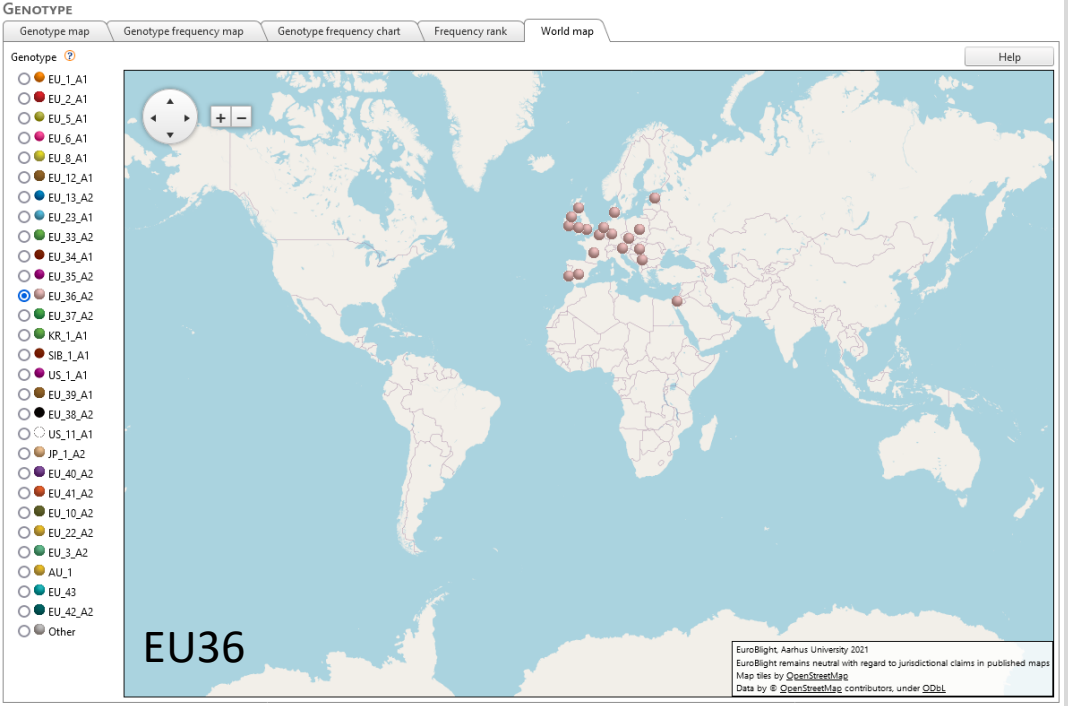
The evolution and spread of a new clone: EU41



Go East

Phenotypic traits of some known genotypes

Genotype	Country and year first identified	Phenotypic traits
EU13	NL in 2004	Aggressive and less sensitive to matalaxyl
EU33	UK in 2011	Less sensitive to fluazinam
EU36	NL and DE in 2014	Aggressive – indications that it can infect at very low dosages
EU37	NL in 2013	Aggressive and less sensitive to fluazinam products
EU41	DK in 2013	Multi-virulent and relatively aggressive (sporulation capacity)
EU42	UK in 2020	Unknown
EU43	DK in 2018 (2020)	Unknown


Genotype
Genotype map
Genotype frequency map
Genotype frequency chart
Frequency rank
World map
Help
Genotype
EU_1_A1
EU_2_A1
EU_5_A1
EU_6_A1
EU_8_A1
EU_12_A1
EU_13_A2
EU_23_A1
EU_33_A2
EU_34_A1
EU_35_A2
EU_36_A2
EU_37_A2
KR_1_A1
SIB_1_A1
US_1_A1
EU_39_A1
EU_38_A2
US_11_A1
JP_1_A2
EU_40_A2
EU_41_A2
EU_10_A2
EU_22_A2
EU_3_A2
AU_1
EU_43
EU_42_A2
Other
EU36
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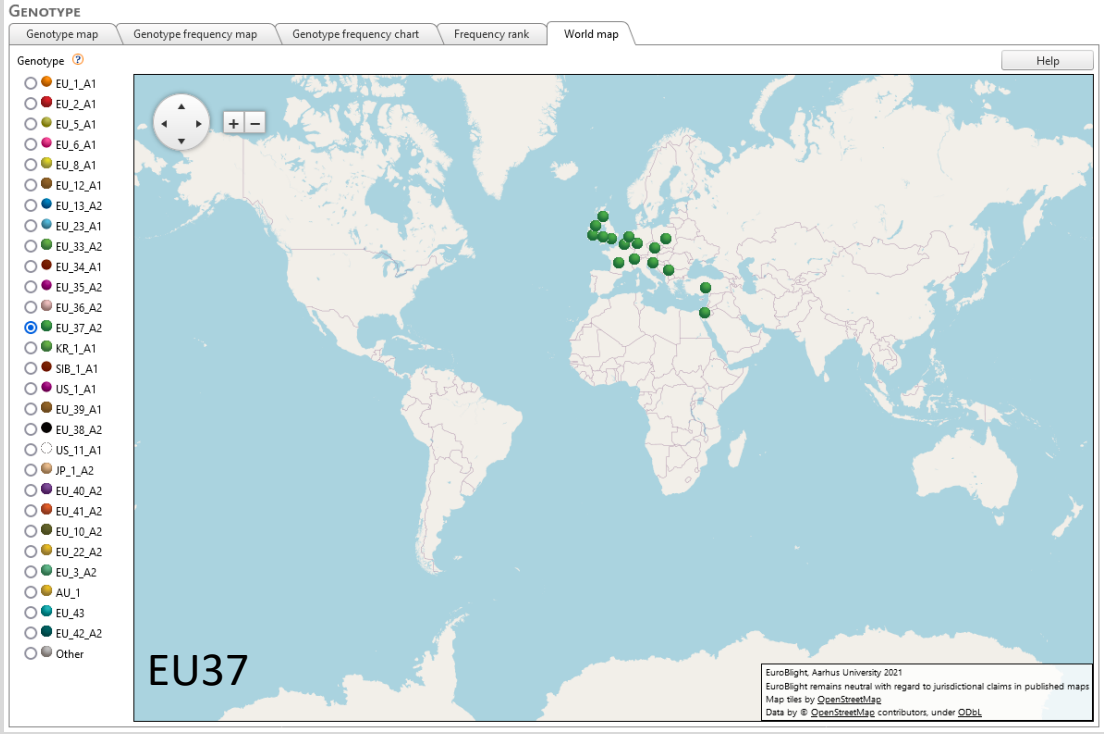
Genotype
Genotype map
Genotype frequency map
Genotype frequency chart
Frequency rank
World map
Help
Genotype
EU_1_A1
EU_2_A1
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EU_34_A1
EU_35_A2
EU_36_A2
EU_37_A2
KR_1_A1
SIB_1_A1
US_1_A1
EU_39_A1
EU_38_A2
US_11_A1
JP_1_A2
EU_40_A2
EU_41_A2
EU_10_A2
EU_22_A2
EU_3_A2
AU_1
EU_43
EU_42_A2
Other
EU37
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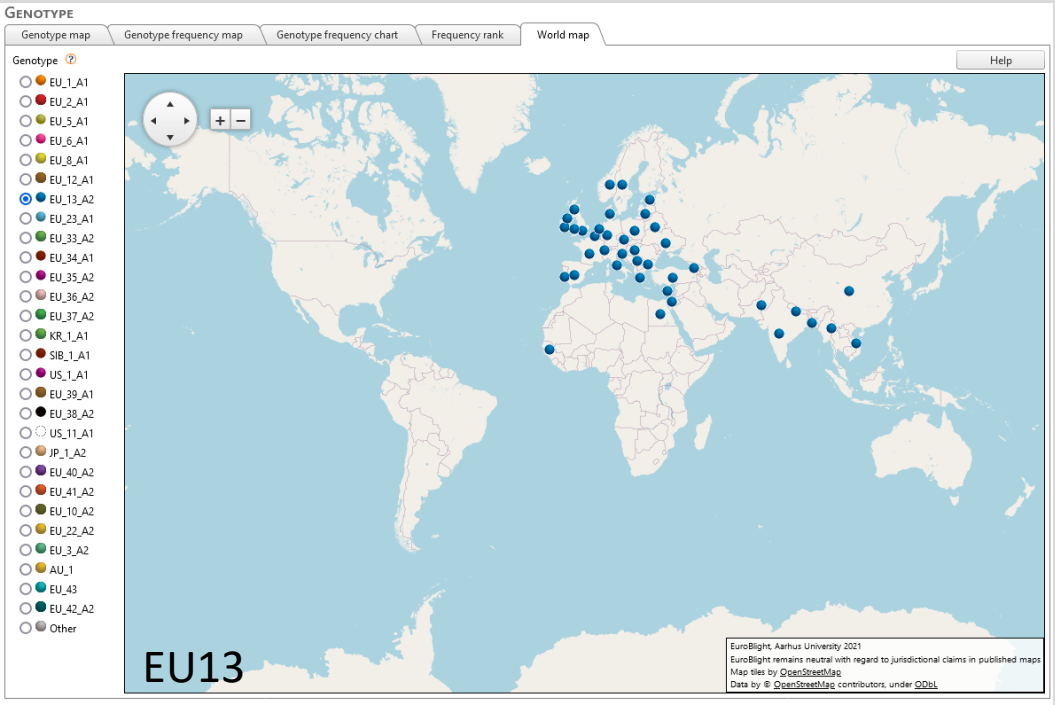
Genotype
Genotype map
Genotype frequency map
Genotype frequency chart
Frequency rank
World map
Help
Genotype
EU_1_A1
EU_2_A1
EU_5_A1
EU_6_A1
EU_8_A1
EU_12_A1
EU_13_A2
EU_23_A1
EU_33_A2
EU_34_A1
EU_35_A2
EU_36_A2
EU_37_A2
KR_1_A1
SIB_1_A1
US_1_A1
EU_39_A1
EU_38_A2
US_11_A1
JP_1_A2
EU_40_A2
EU_41_A2
EU_10_A2
EU_22_A2
EU_3_A2
AU_1
EU_43
EU_42_A2
Other
EU13
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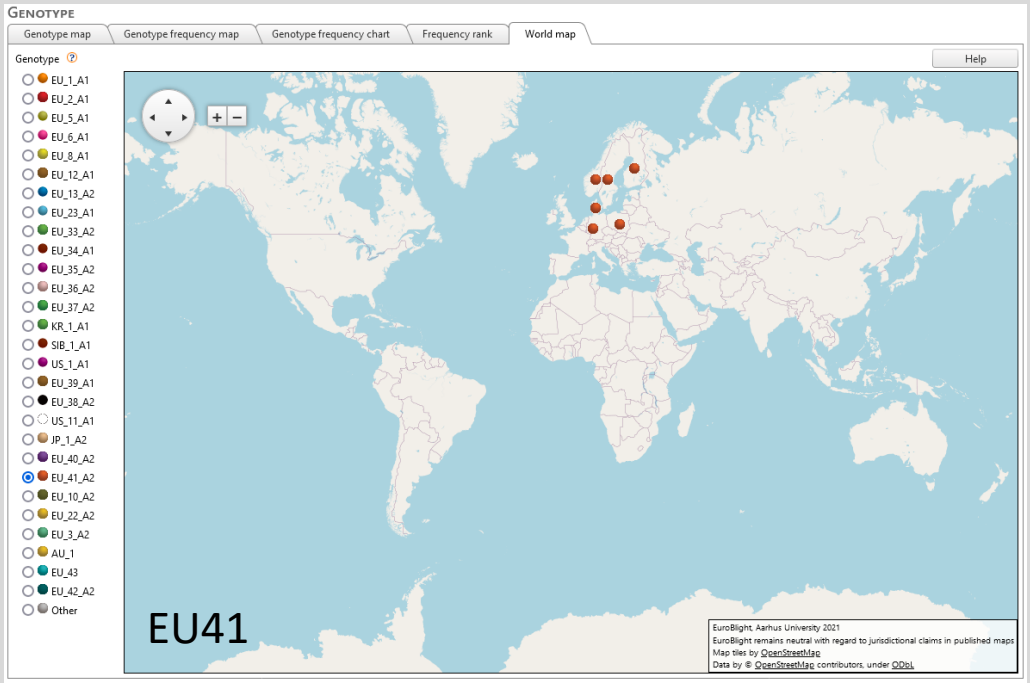
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Genotype frequency chart
Frequency rank
World map
Help
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EU_38_A2
US_11_A1
JP_1_A2
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EU_10_A2
EU_22_A2
EU_3_A2
AU_1
EU_43
EU_42_A2
Other
EU41
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Genotype

Genotype map | Genotype frequency map | Genotype frequency chart | Frequency rank | World map

Genotype

Help

- EU_1_A1
- EU_2_A1
- EU_5_A1
- EU_6_A1
- EU_8_A1
- EU_12_A1
- EU_13_A2
- EU_23_A1
- EU_33_A2
- EU_34_A1
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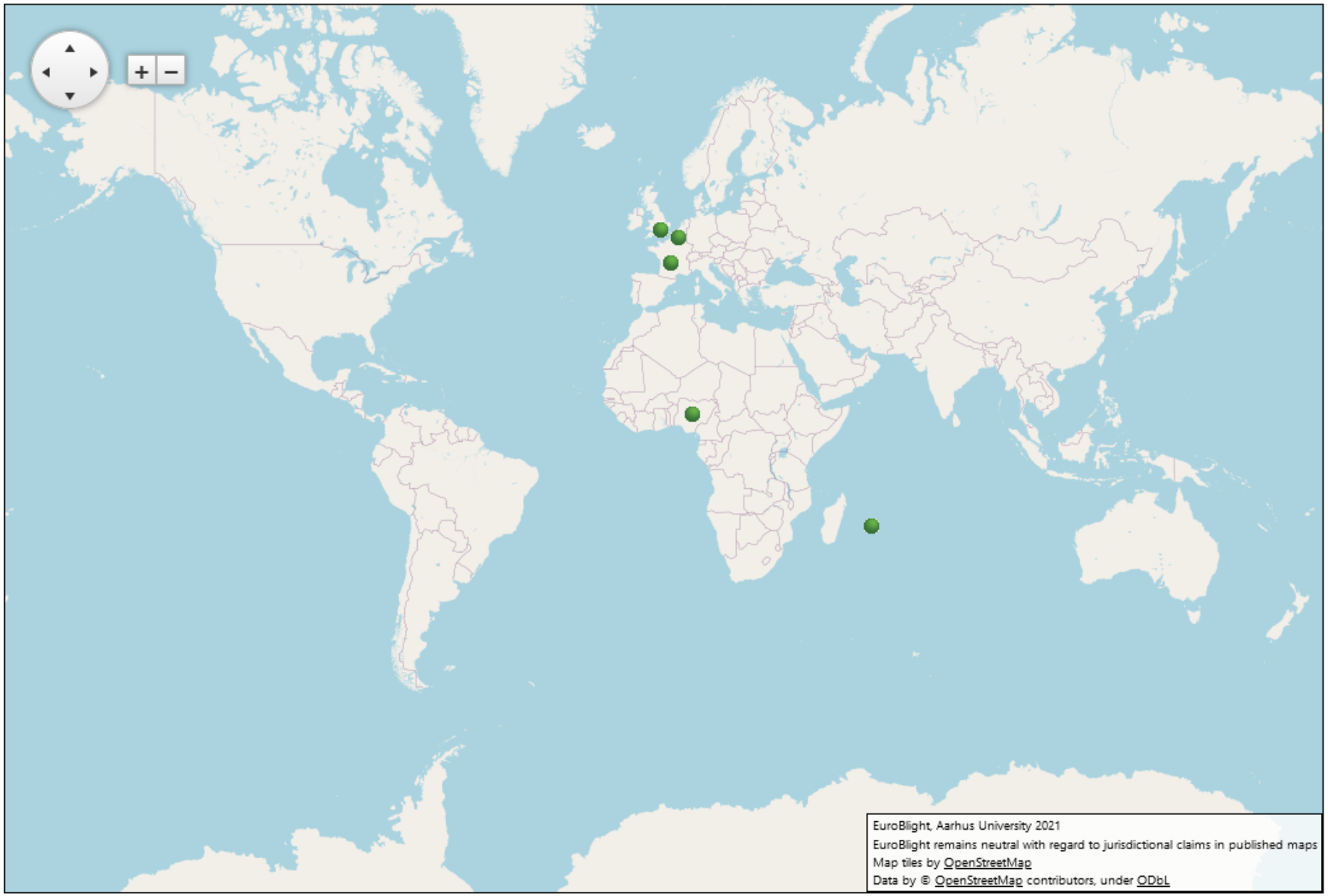
- EU_36_A2
- EU_37_A2
- KR_1_A1
- SIB_1_A1
- US_1_A1
- EU_39_A1
- EU_38_A2
- US_11_A1
- JP_1_A2
- EU_40_A2
- EU_41_A2
- EU_10_A2
- EU_22_A2
- EU_3_A2
- AU_1
- EU_43
- EU_42_A2
- Other



Year

2021

Continent

Europe

Country

All countries selected

Host

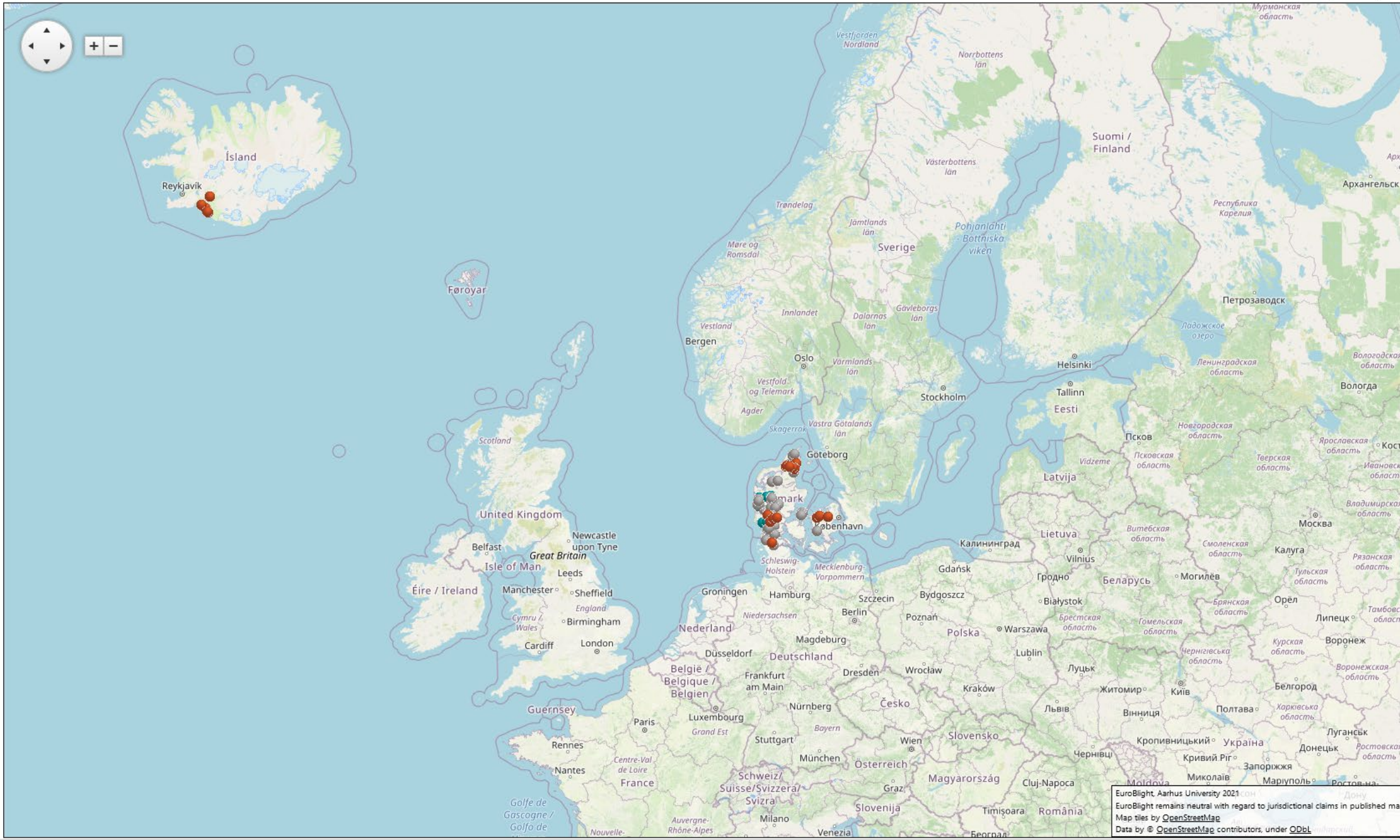
- [x] All
- [x] Potato

Genotypes

- [x] All
- [x] EU_41_A2
- [x] EU_43
- [x] Other

Show

Help



Potato Late Blight Toolbox

Home | Survey | Samples | Trials | Models | Fungicides | DSS Tools | DSS Tools for Sverige | Skimmelstyring | Skimmelstyring for Sverige | Partners | Administration

Welcome Jens Grønbech Hansen
logout

Genotype

Genotype map | Genotype frequency map | Genotype frequency chart | Frequency rank | World map

Year
2021

Continent
Europe

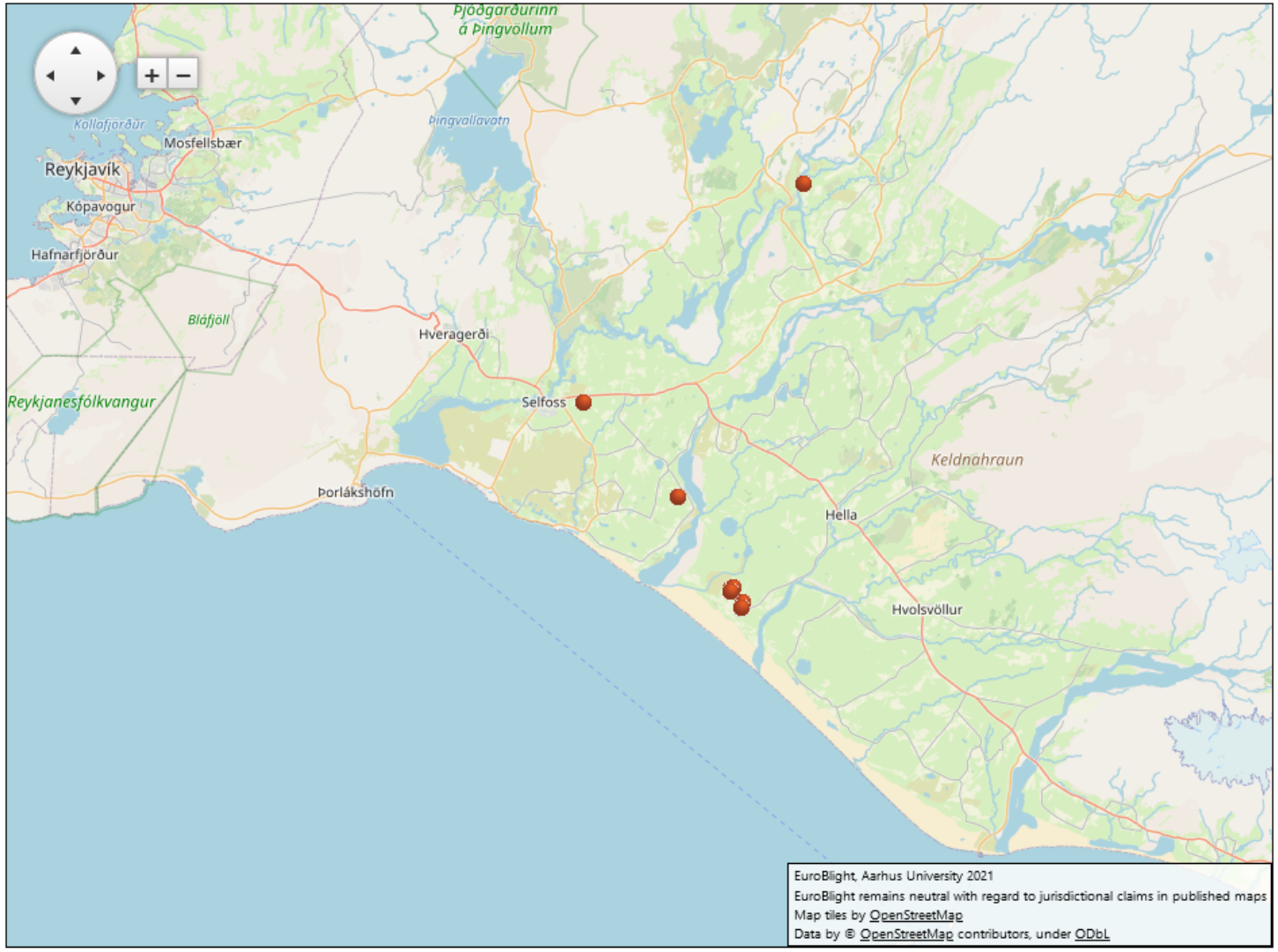
Country
All countries selected

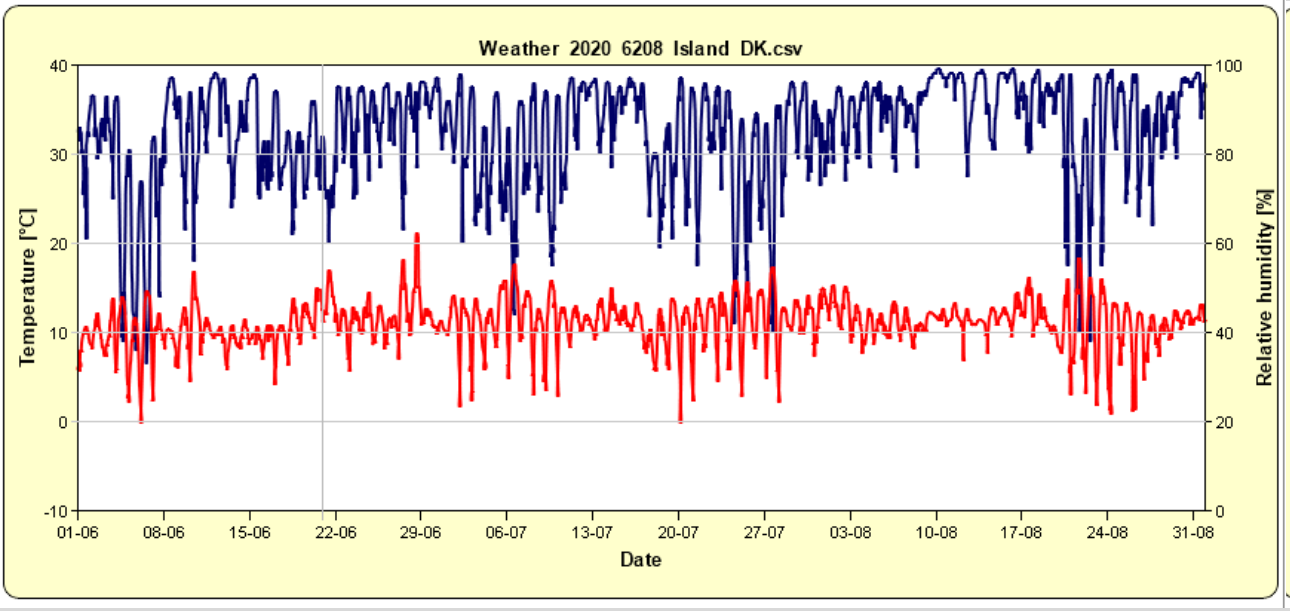
Host
- [x] All
- [x] Potato

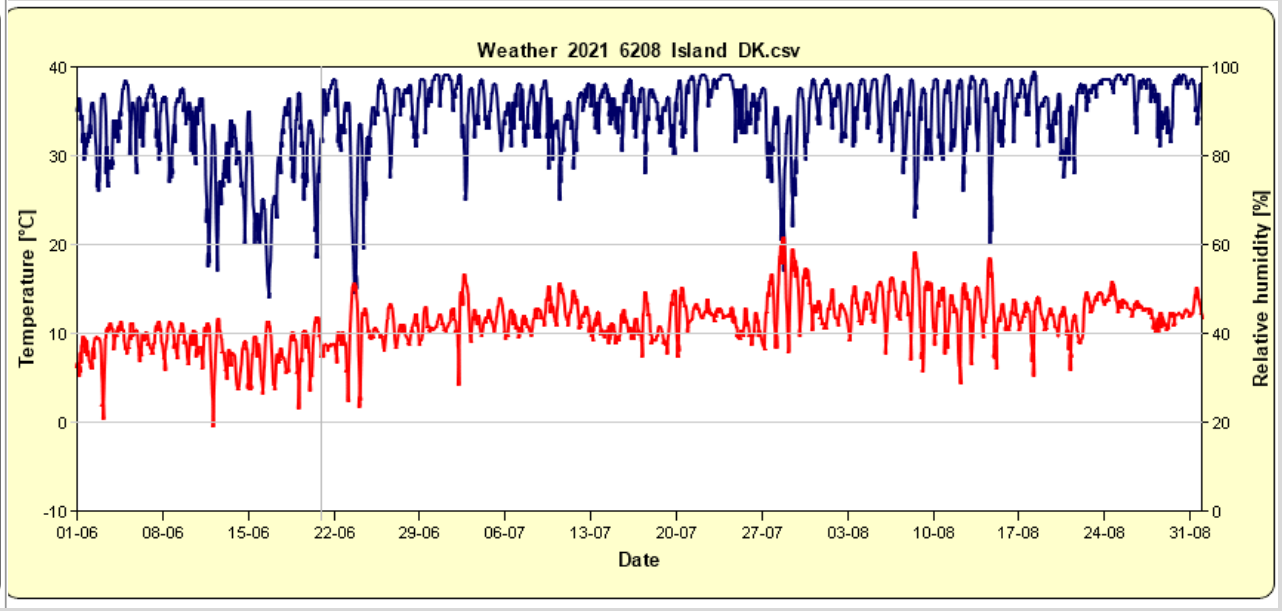
Genotypes
- [x] All
- [x] EU_41_A2

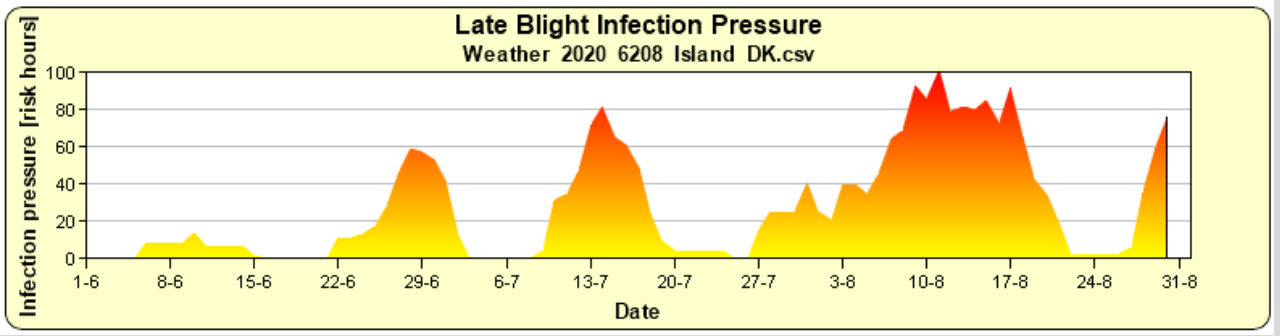
Show

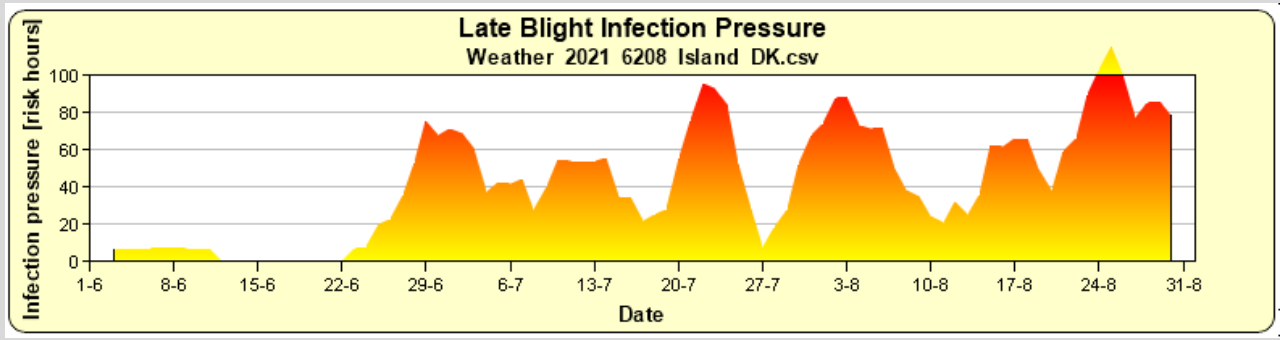
Help



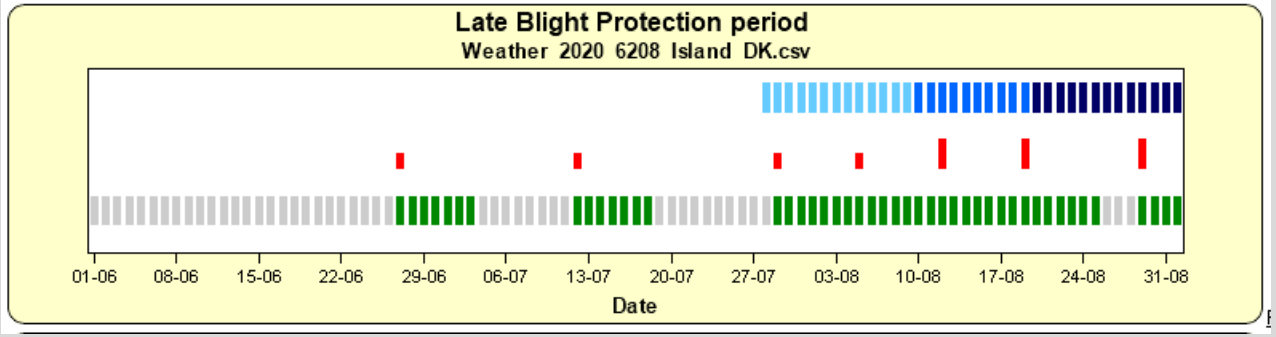




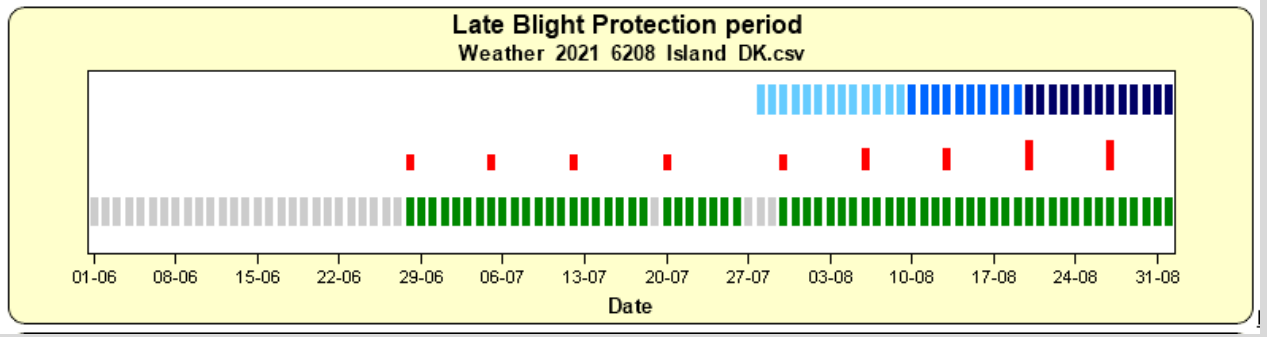




Late Blight: Number of treatments: 7 Treatment frequency index: 5,00
Early Blight: Number of treatments: 1 Treatment frequency index: 0,50



Late Blight: Number of treatments: 9 Treatment frequency index: 6,00
Early Blight: Number of treatments: 1 Treatment frequency index: 0,50



SSR Data Analysis with Poppr | Data Summary | Genotype Freq | Min.Spanning Tree | MST JS | Phylogenetic Tree | PCA | MLG INFO | Download | Parallel Coord

Following radio buttons can be used to select the color of node labels. This is useful only if the population structure is set as something other than coutry. When the population structure is set as coutry,the radio buttons are n
useful.

Choose color for node labels: Country

Choose pop to be displayed: All

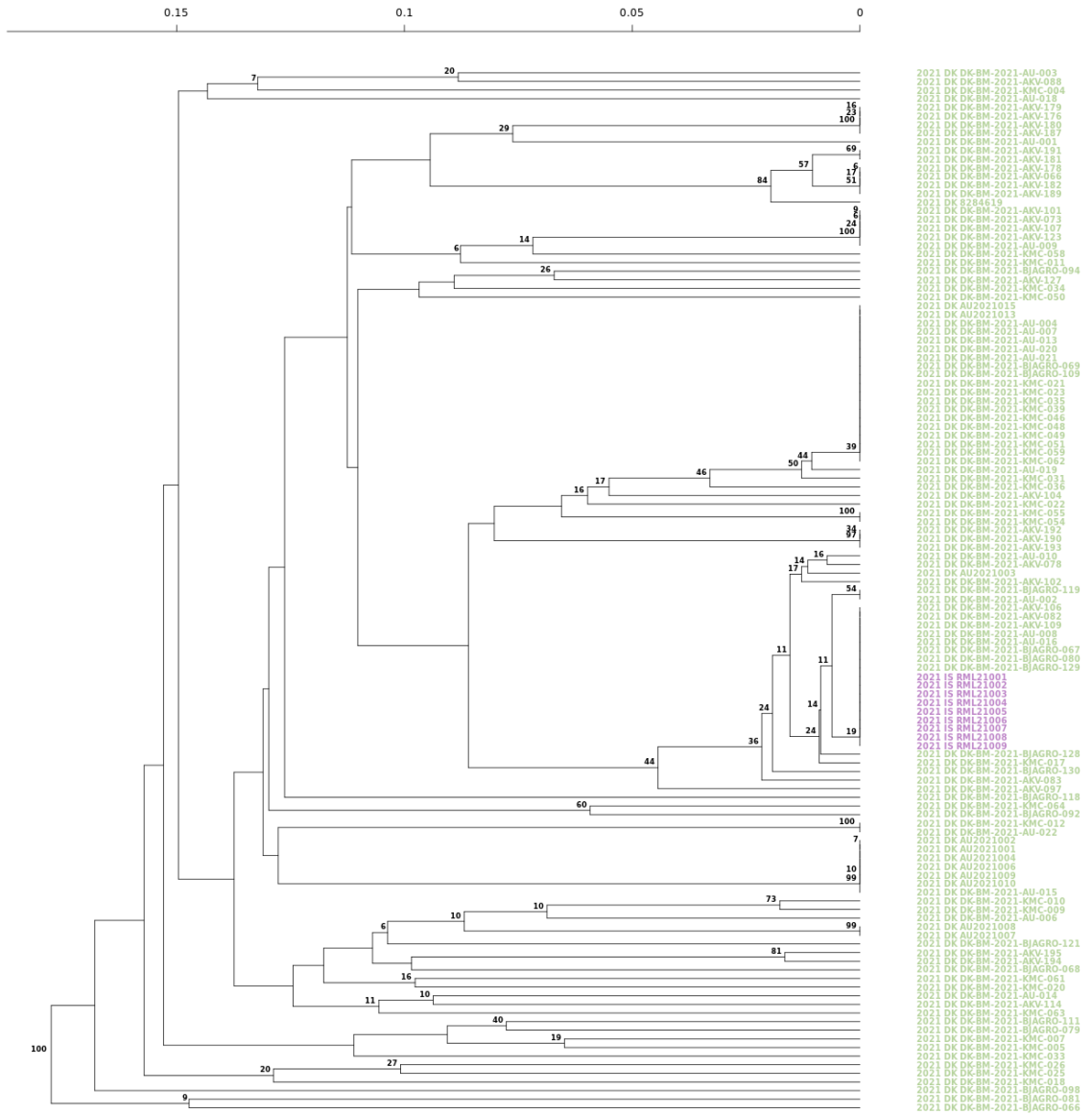
Remove Clones: Yes / No

Type of tree: phylogram / unrooted

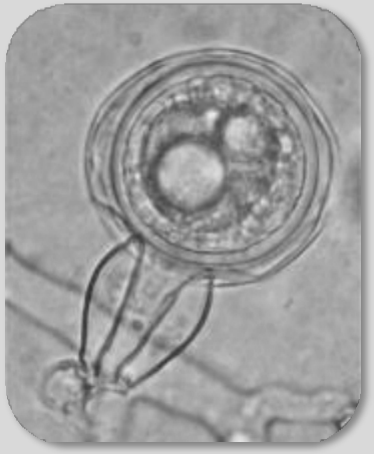
Bootstrap replicates: 70 | 10,000

Cutoff value: 5 | 95

Update Phylo tree



Conclusions and recommendations



- Europe-wide dataset - valuable insights on pathogen diversity
- Dominance of a few clones across large areas of European crops - EU growers/industry share management challenges
- New clones (EU_36_A2, 37_A2 and 41_A2) established and displacing older genotypes (EU_13_A2, 6_A1 and 1_A1)
- EU41 was identified via SSR analysis in Iceland in 2021 after PLB attacks in 2020 and 2021
- New clones identified in 2020 New clones **EU_43** (DK) **EU_42_A2** (GB)
- Reduced sensitivity of EU_37_A2 to fluazinam has reduced its use, prevented management failures & driven a decline of this genotype in most countries.
- Population displacement suggests EU_36_A2 more fit but we need more evidence of specific fitness trait.
- Primary inoculum is locally generated and spread. Better management of inoculum sources needed
- 'Other' populations highly diverse, ephemeral, occurring more in the north and east & most likely the result of sexual oospore germination
- High genetic diversity increases risk management failure: virulence against novel host resistance or reduced sensitivity to specific fungicide active ingredients
- Genotyping on-the-fly and dedicated labs to undertake phenotyping of new types
- Combine with a network of Trap nurseries and field nurseries
- Increased collaboration with breeders and value chain stakeholders

Recommendations

Recommendations and discussion points

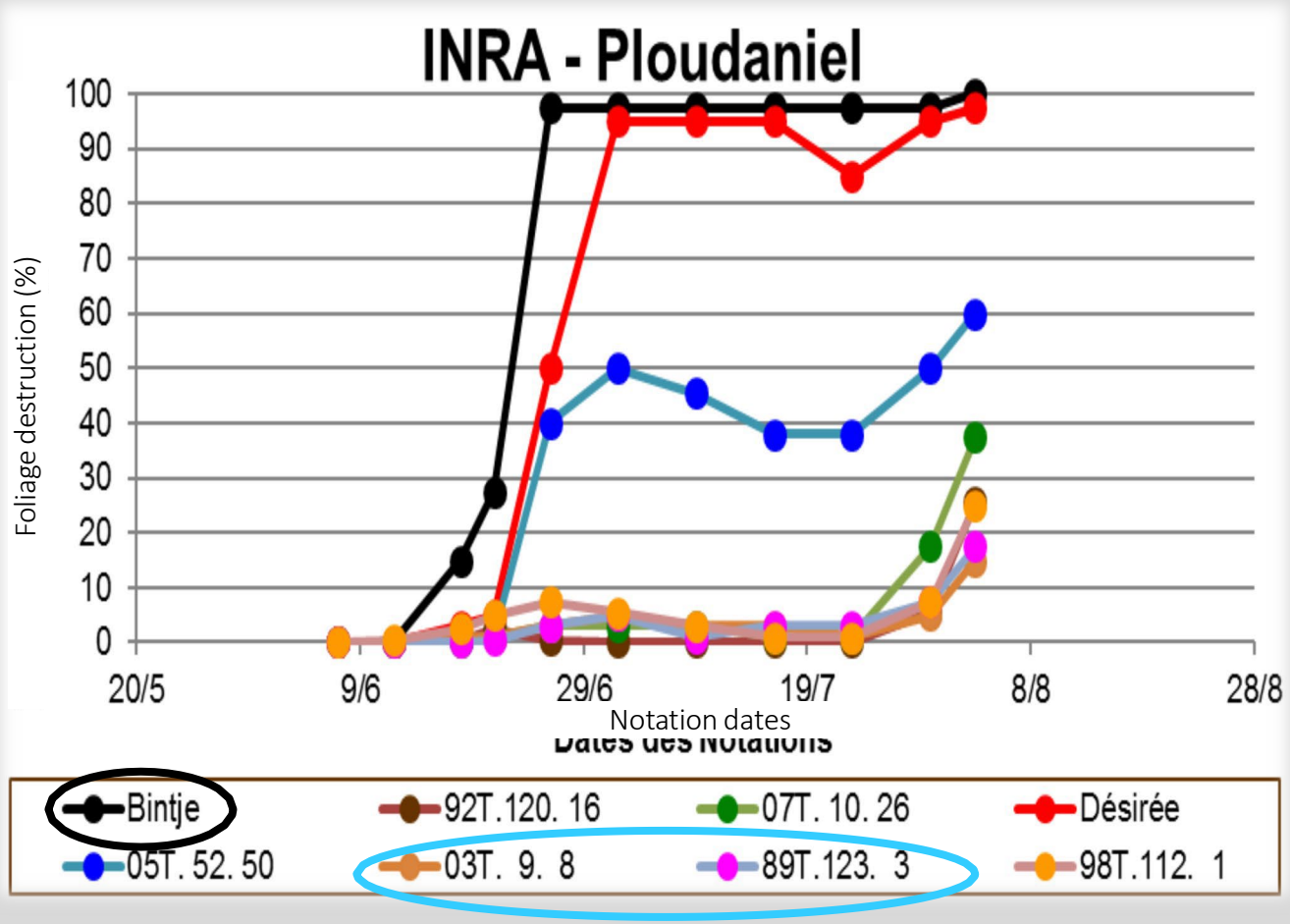
- Actions: DIVERSIFICATION (Introduce more resistant cultivars) SANITATION (no dumps, more years between potatoes, control of volunteers), Further improve EDUCATION and KNOWLEDGE TRANSFER.
- Introduce more resistant cultivars. Growing the same cultivars across many years will increase the risk of: severe epidemics, more fields with oospores, less sensitivity of important fungicides, low yields in organic potato production and, lead to increase in fungicide use.
- Use more components of IPM measures and not only rely on chemicals e.g. reduce primary inoculum sources and volunteers

Discussion points

- What are your experiences with the new genotypes in the Nordic region? And did you change control strategy?
- What are the needs of the industry for a continues genotyping and phenotyping of new types of *P. infestans* and *Alternaria spp.*
- How to exploit better the knowledge of the pathogen in control strategies and DSSs

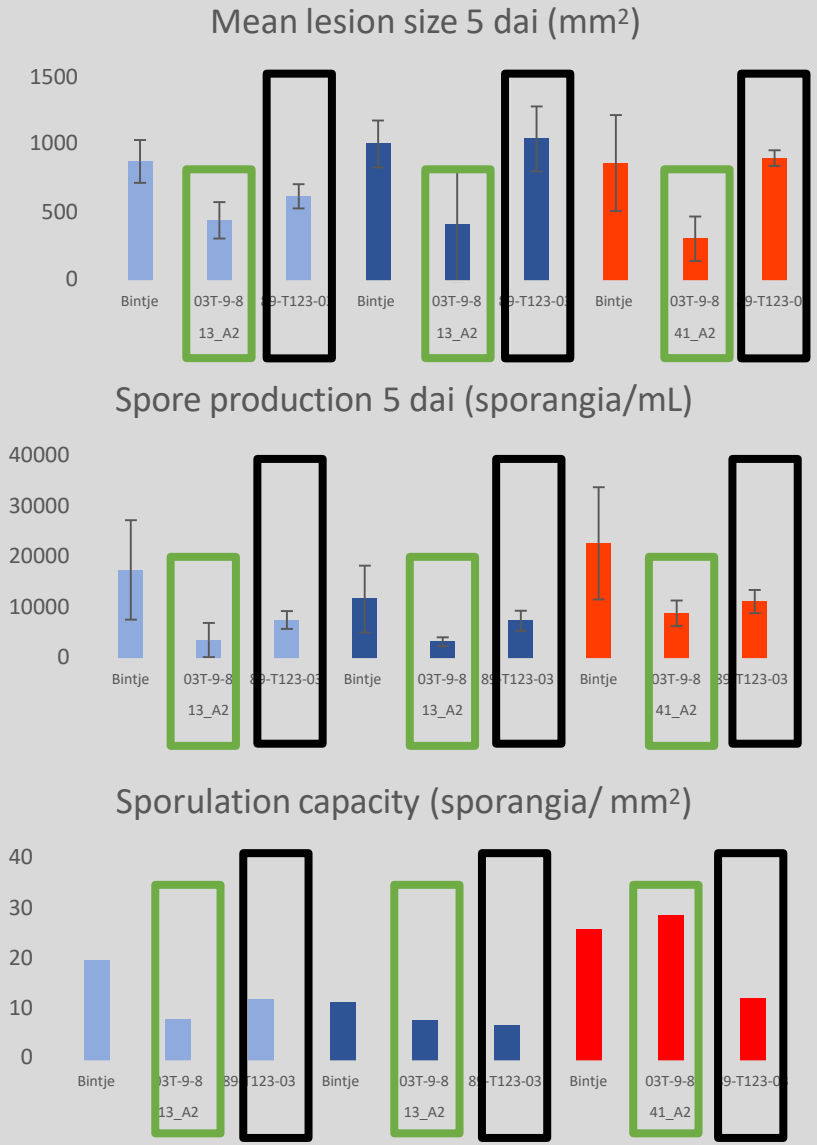

Thank you for your attention

Field behaviour of some resistant and susceptible accessions



Source: Romain Mabon et al, EuroBlight workshop 2021

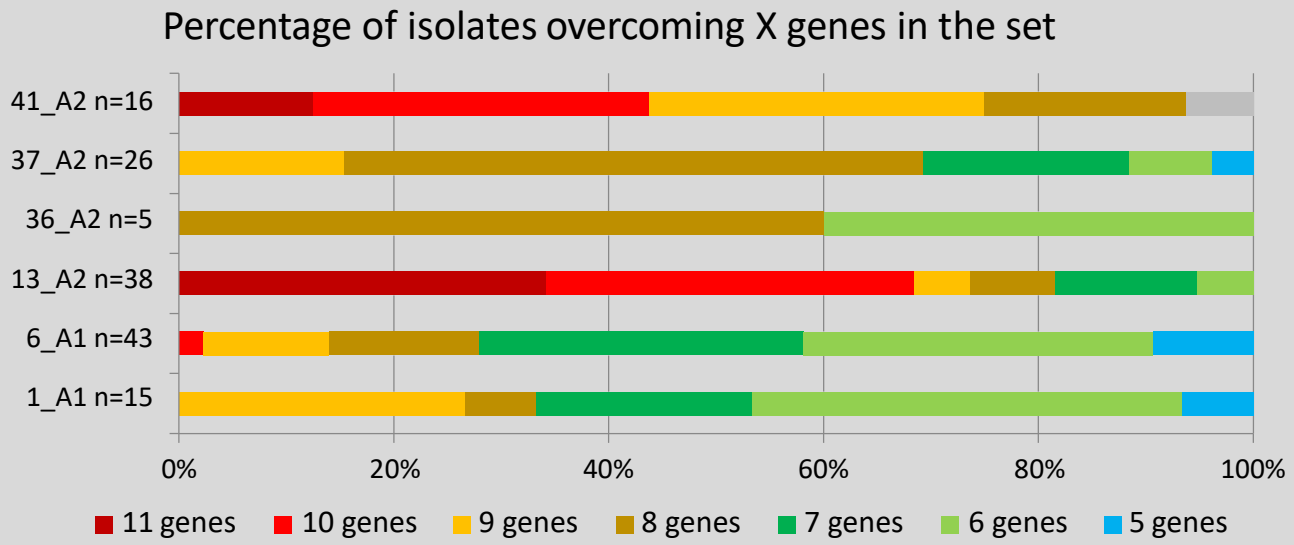
Other aggressiveness LHT



- **13_A2 (2 isolates)** & **41_A2 (1 isolate) only** ;
- **03T-9-8** : *warnng :longer latent period on this genotype*
  - ✓ Lower lesion size
  - ✓ Lower spore production
- **89-T123-03** :
  - ✓ Lesion size equivalent to that on Bintje
  - ✓ Reduced spore production
- **41_A2** may have a higher sporulation capacity than **13_A2** on 03T-9-8 & Bintje.

Source: Romain Mabon et al, EuroBlight workshop 2021

Virulence of the various clonal lineages



Over 50% of isolates overcome:

- ✓ all 11 genes *R* : lineages 13_A2 & 41_A2;
- ✓ 8 genes *R* : lineages 6_A2 & 37_A2;
- ✓ 6 to 7 genes *R* : lineages 1_A1 & 6_A1

Source: Romain Mabon et al, EuroBlight workshop 2021