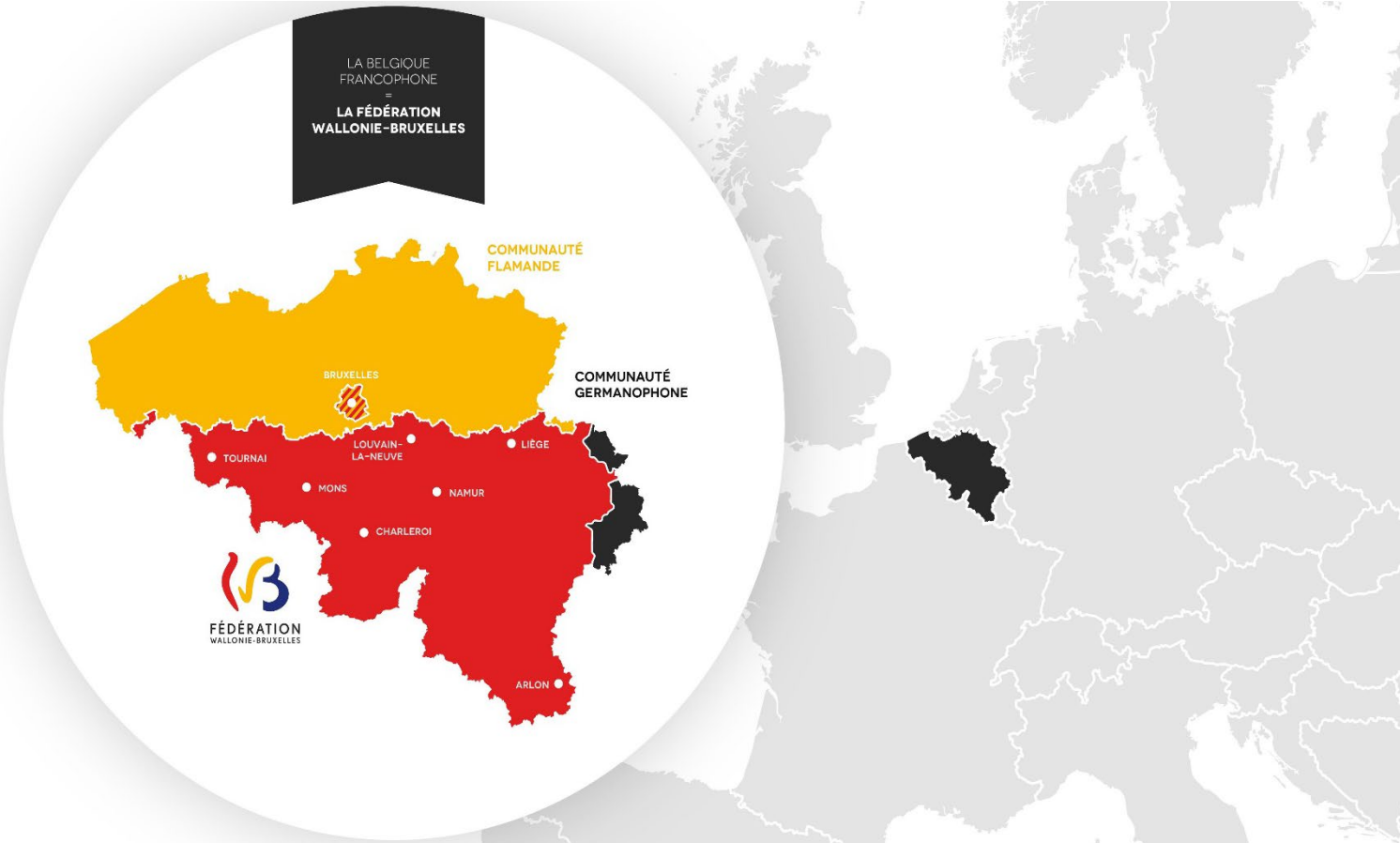


Contribution of airborne inoculum monitoring in the improvement of late blight management

Vivien Le Vourch, Alain Decroës, Vincent Cesar, Damien Rosillon, Pierre Lebrun, Anne Legrève



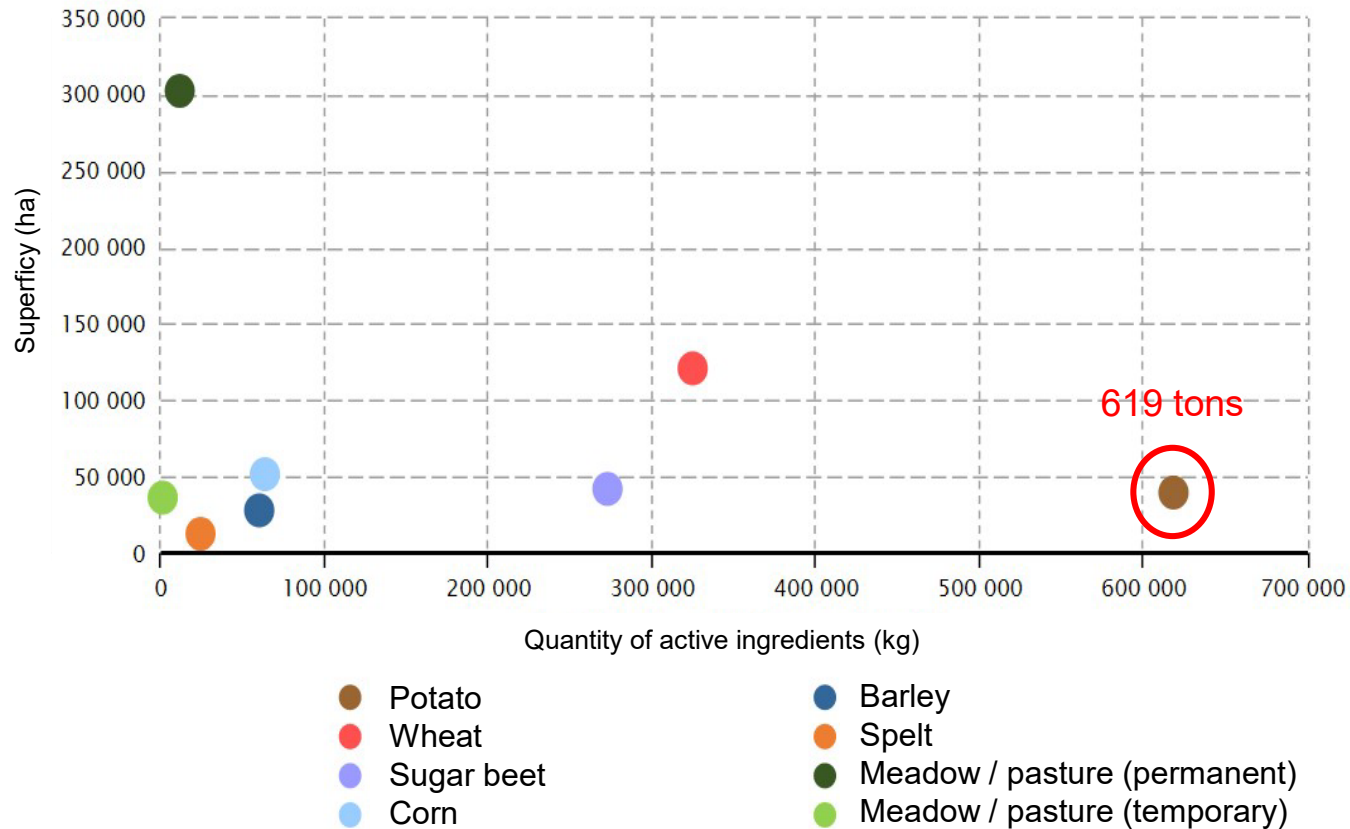
Potato is a major crop in Belgium



Statistics

- A 30 688 km² country divided in two regions
- 11,52 million inhabitants
- 98 028 ha of potato fields in 2020
- 4,4 million tons of potato produced in 2020
- 4000 employees in 2020

Potato is the greatest consumer of plant protection products

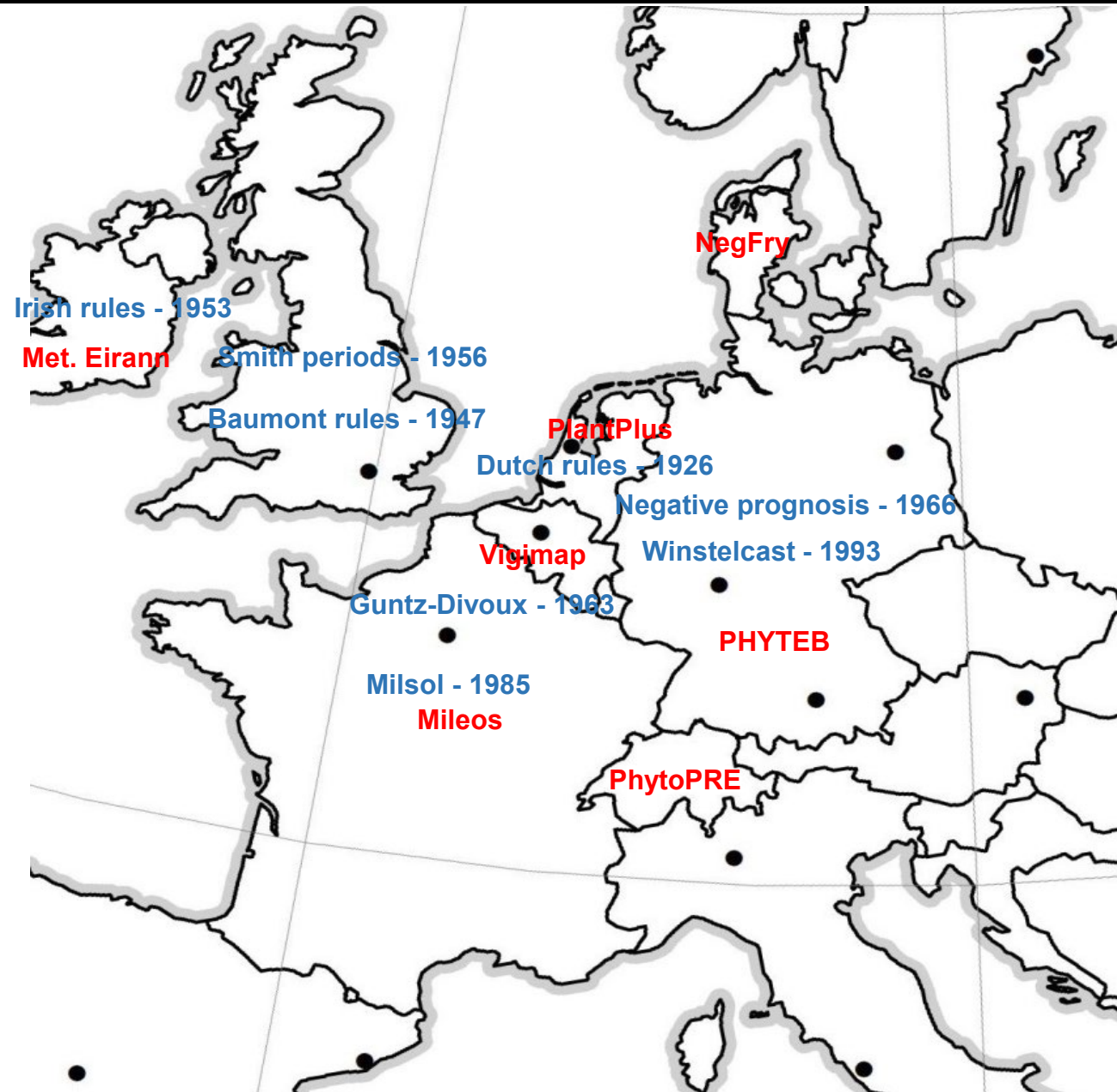


Relationship between the total quantities of active ingredients in plant protection products applied to the main crops and their area in Wallonia (2017) - CORDER ASBL - CRP

Country	Number of fungicide applications in 2008		
	min	max	mean
Finland	4	9	6
Norway	2	8	5,5
Denmark	4	14	8,5
Germany	4	15	7
England	10	12	11
Belgium	10	22	15
Netherlands	6	18	13
France	8	20	15

Modified from J. Gronbech Hansen and *et al.* 2008

Potato late blight forecasting models in Europe: a long story



Forecasting models

Decision Support System (DSS)

Almost all DSS assume that the primary inoculum is not limiting.

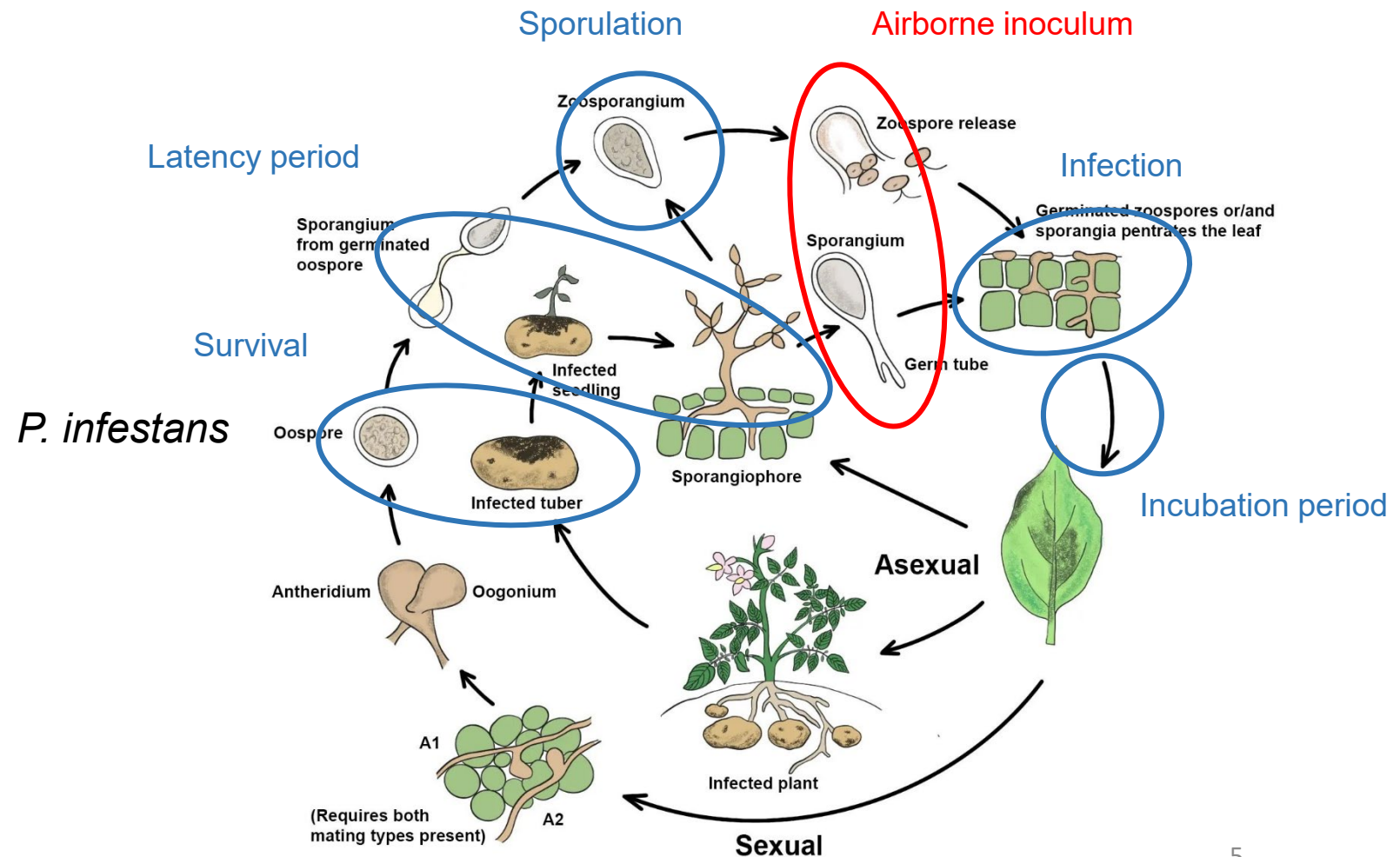
Environment

- Relative humidity
- Rainfall
- Temperature



S. tuberosum

- Susceptibility level
- Protection status
- Growth





← Wheat powdery mildew (*Blumeria graminis*)
Cao *et al* – 2015 – Plant Dis. vol 99



← Botrytis leaf blight (*Botrytis squamosa*) on onion
Carisse *et al.* 2012 – Plant Pathology vol 61



← Sclerotinia stem rot (*Sclerotinia sclerotiorum*) on oilseed rape
Rogers *et al* – 2009 - Plant Pathology vol 58



← Wheat leaf rust (*Puccinia triticiana*)
Duvivier *et al* – 2016 - Eur J Plant Pathol vol 145



← Fusarium head blight (*Fusarium graminearum*)
Hellin *et al* – 2018 - Eur J Plant Pathol vol 151

Epidemiology

Quantifying the Rate of Release and Escape of *Phytophthora infestans* Sporangia from a Potato Canopy

Donald E. Aylor, William E. Fry, Hilary Mayton, and Jorge L. Andrade-Piedra

→ United States

Am. J. Pot Res (2010) 87:32–40
DOI 10.1007/s12230-009-9114-y

Main outputs:

Modelling of the sporangia release rate and disease spread

Relation between temperature and airborne inoculum density

Contribution of airborne inoculum monitoring in late blight outbreak prediction ^{a*}

Improvement of molecular detection for airborne inoculum monitoring

→ United Kingdom

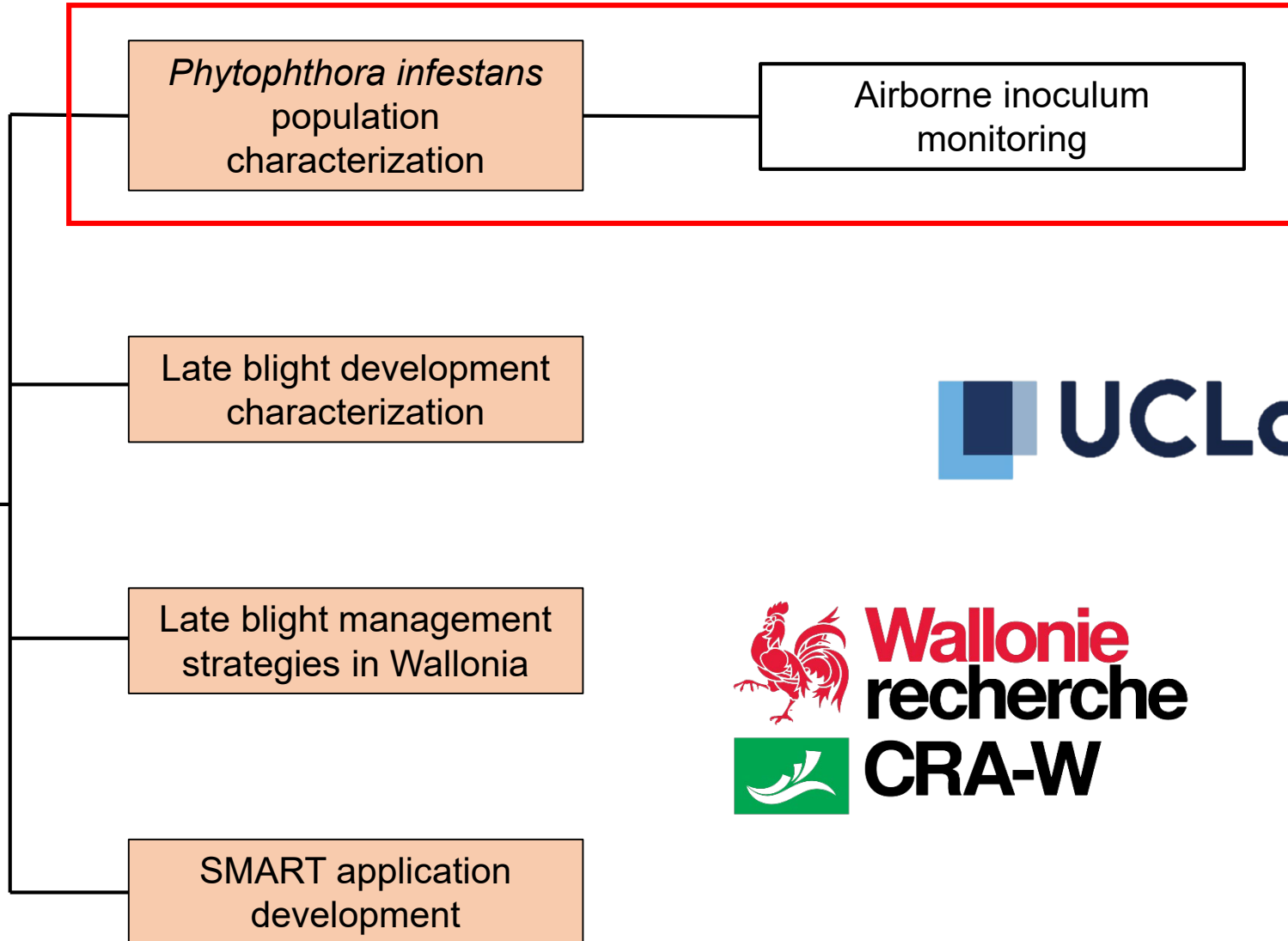
Plant Pathology (2015) 64, 178–190

Doi: 10.1111/ppa.12235

Spatiotemporal variation in airborne sporangia of *Phytophthora infestans*: characterization and initiatives towards improving potato late blight risk estimation

M. L. Fall^a, H. Van der Heyden^b, L. Brodeur^b, Y. Leclerc^c, G. Moreau^c and O. Carisse^{d*}

→ Canada



- Burkard 7-day volumetric spore sampler
 - 14,4 m³ aspirated each day
 - Daily data

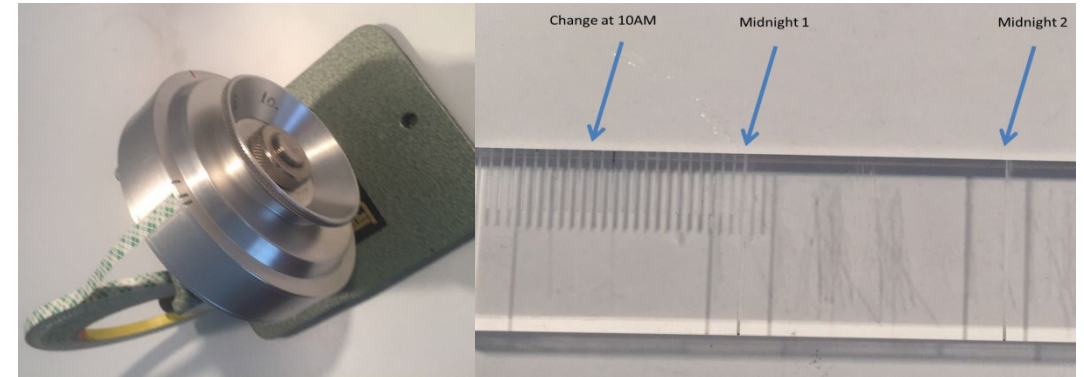


Burkard 7-day volumetric spore sampler

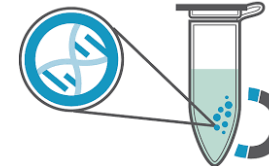


- Four localities: Ath, Louvain-la-Neuve, Gembloux, Libramont
- Monitoring since 2018
- In field late blight symptom monitoring close to spore traps

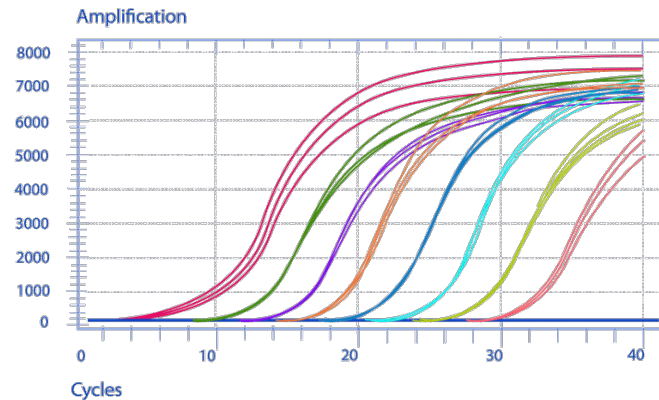
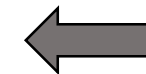
Quantification process



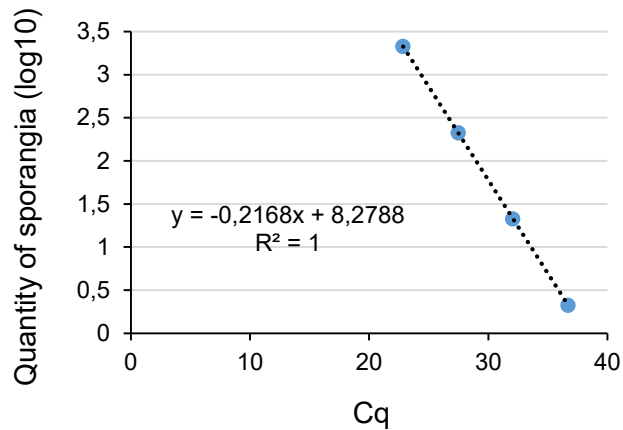
Cutting of the tape into daily fragments



Total DNA extraction
(Modified from M. Duvivier *et al*, 2013)

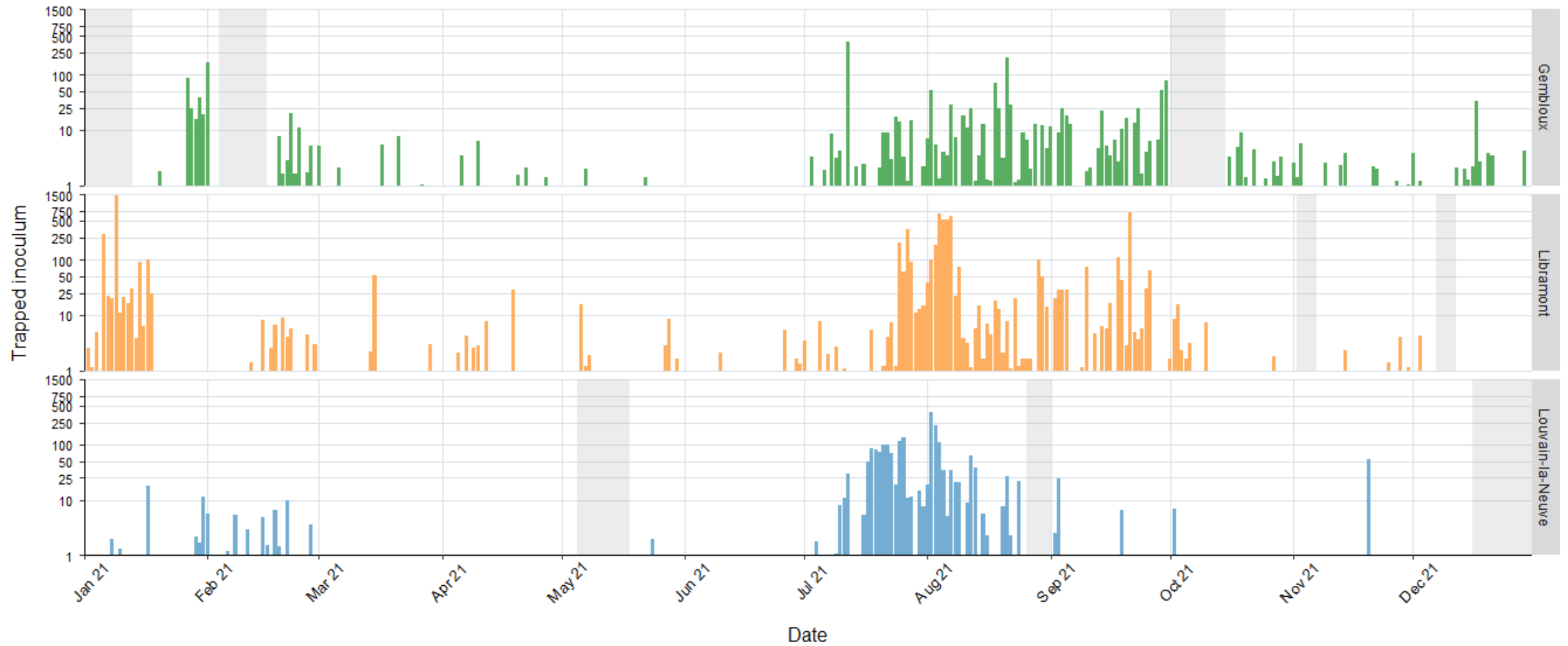



qPCR quantification
using specific primers
(Lees *et al*, 2012)



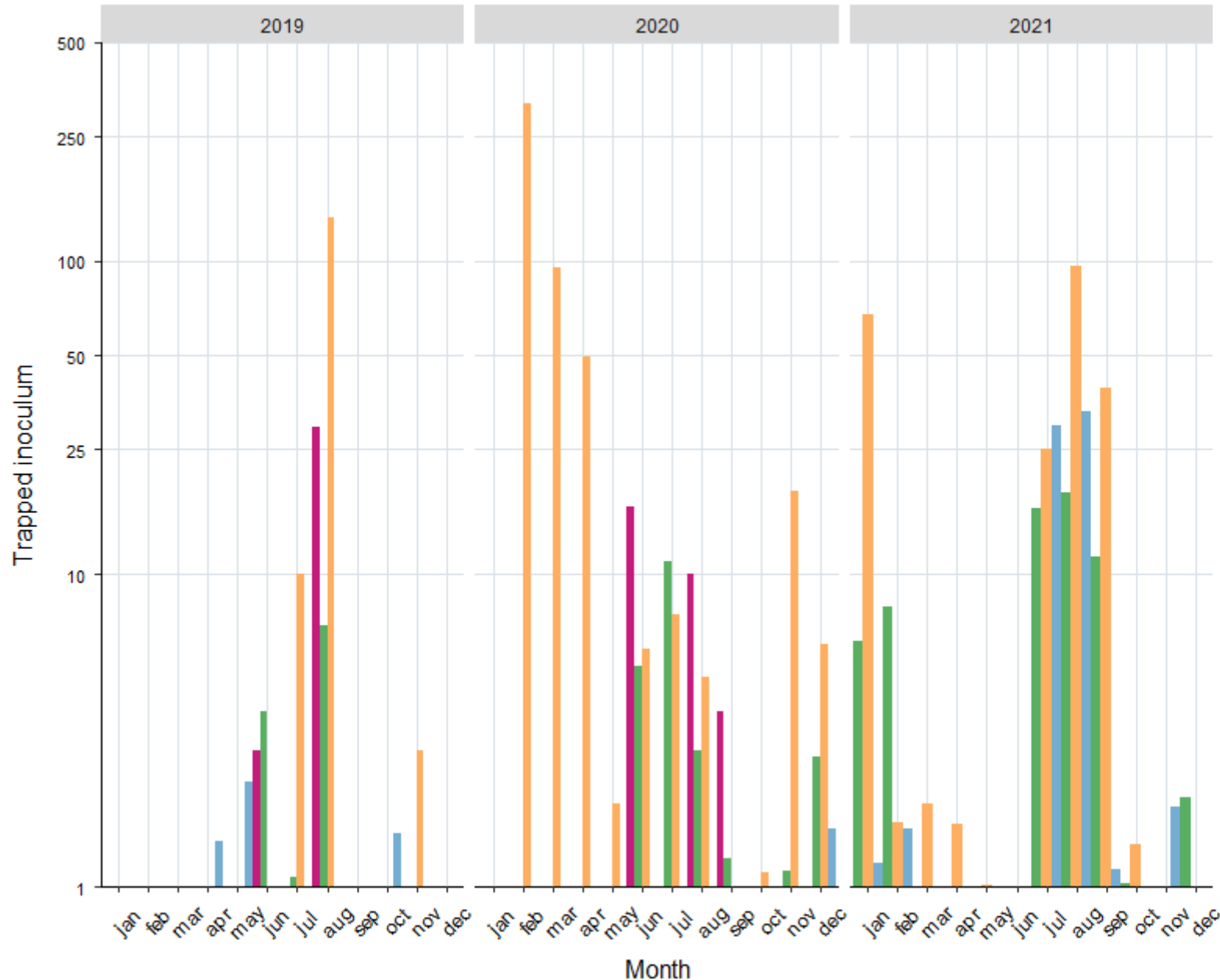
Airborne inoculum
quantification using a
calibration curve

Airborne inoculum monitoring in 2021

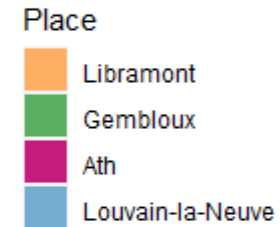


 No monitoring period

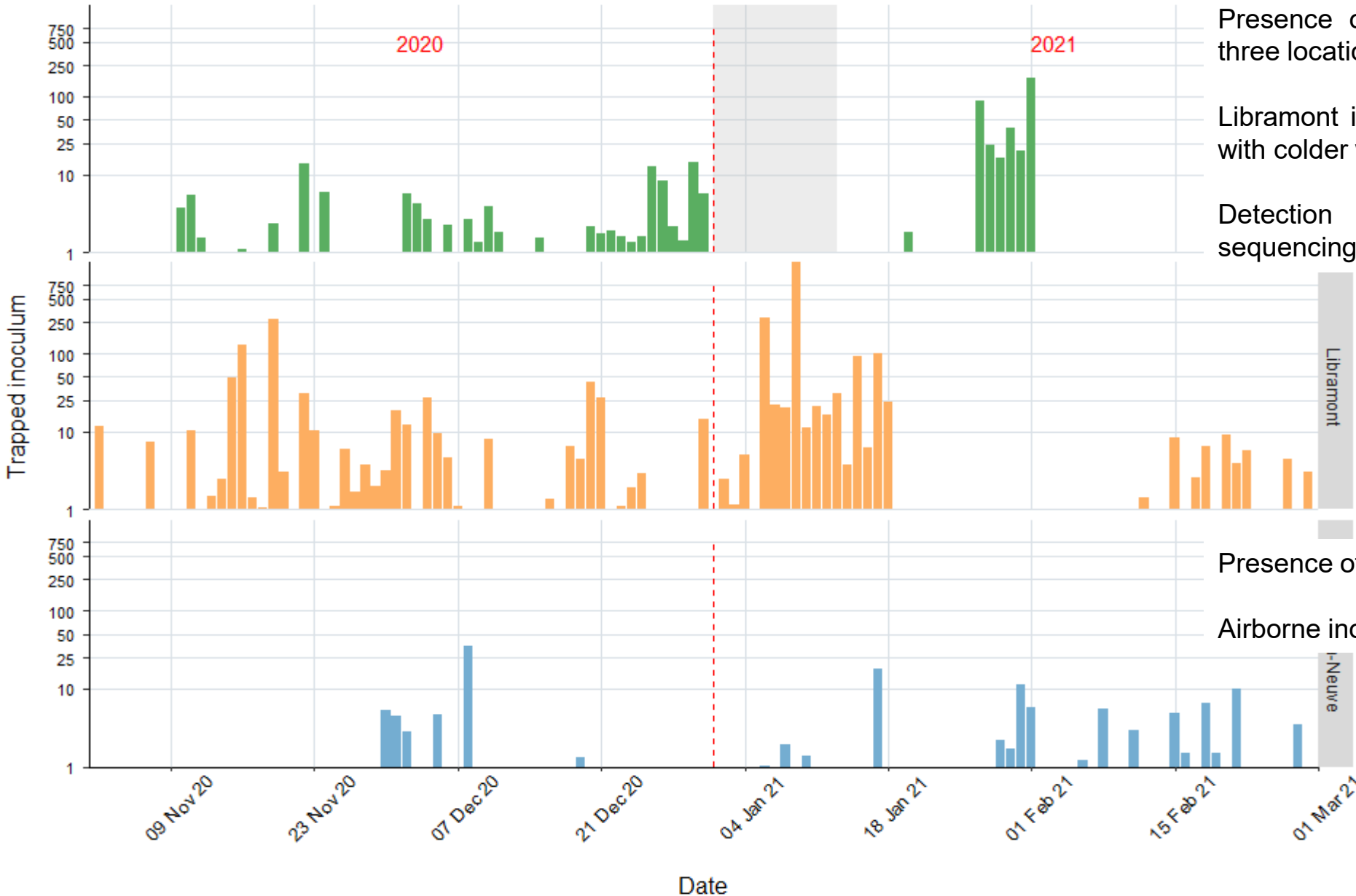
Disparities between years and locations



- Disparities between locations
- Disparities between years
- Highest in **Libramont** despite the absence of industrial-scale potato production in this region.



Overwinter airborne inoculum monitoring: a surprise



Presence of airborne inoculum in winter at three locations

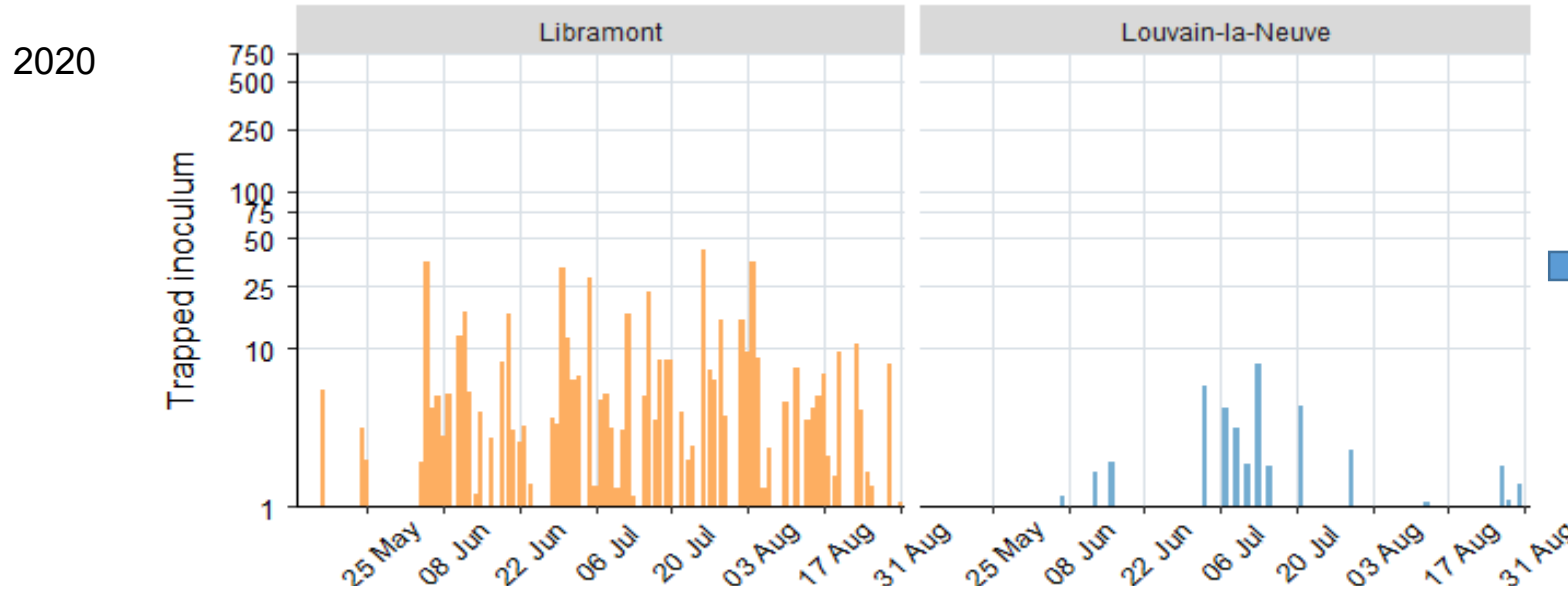
Libramont is in the southern part of Wallonia with colder winters.

Detection of *P. Infestans* confirmed by sequencing

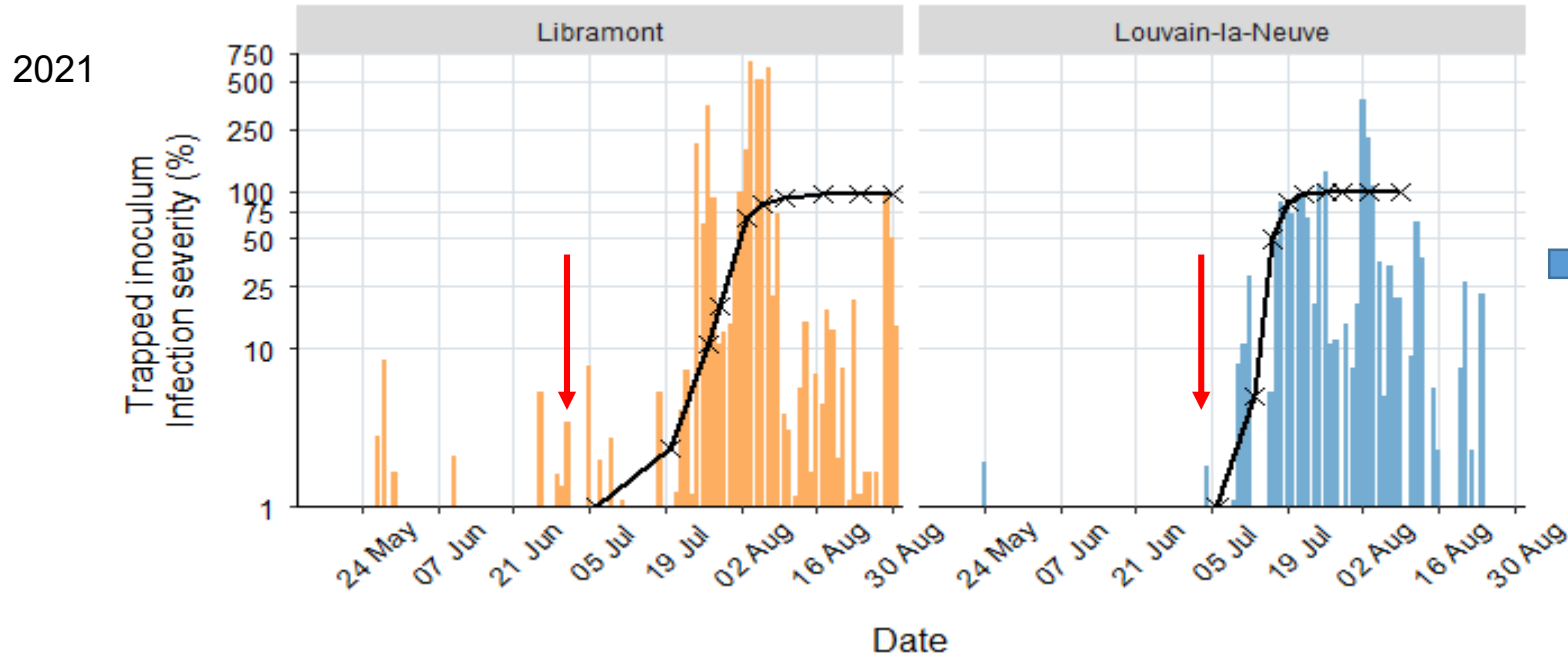
Presence of an alternate host ?

Airborne inoculum from nearby countries ?

Airborne inoculum monitoring on growing period in 2020 and 2021



- Poor conditions for late blight development
- Low airborne inoculum detection
- No symptom detected



- Ideal conditions for late blight development
- 10 times higher inoculum trapped compared to 2020
- Inoculum detection before symptom onset

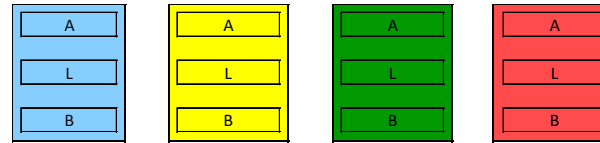


—x— Disease severity on Bintje

Can we reduce the treatment number using airborne inoculum monitoring ?

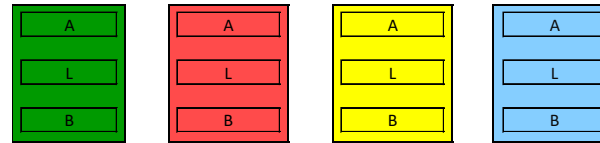
Control

Control: untreated



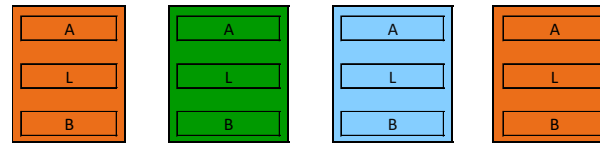
A

Treatments following DSS A



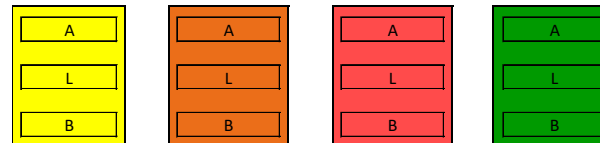
B

Treatments following DSS B



Vigimap

Treatments following Vigimap



Capteur

Delaying 1st spray until less than 10 sporangia are trapped
Then treatment according to Vigimap



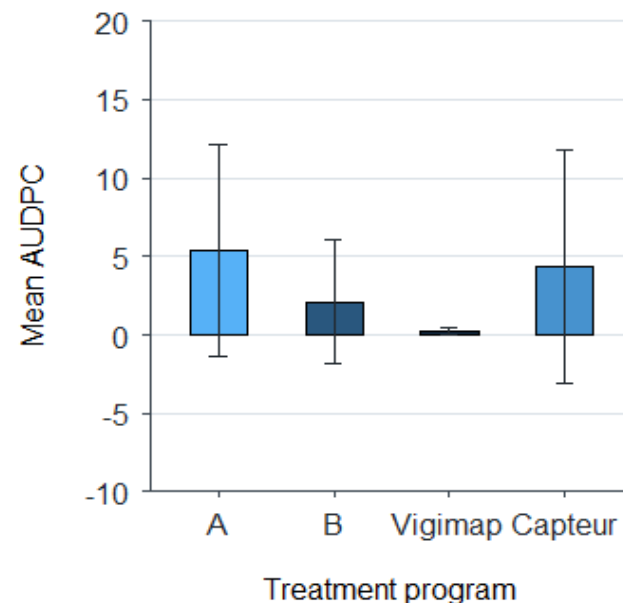
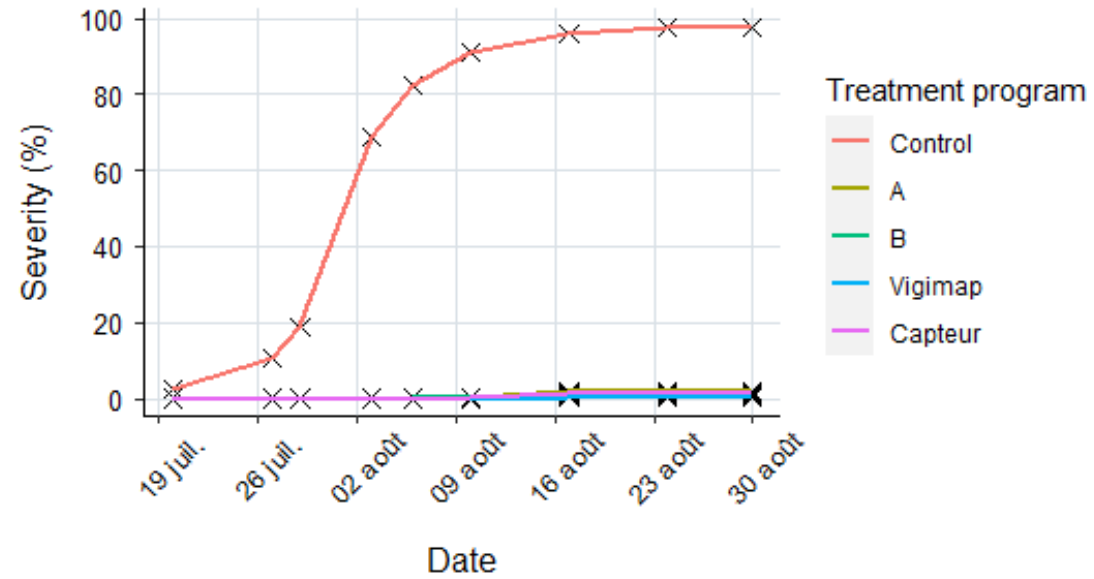
- Trapping tape harvest twice a week
- qPCR in the following 24 hours



- Split-plot experiment
- 3 potato varieties
- 4 blocs / condition

DSS improvement experiment

Date	Treatment	A	B	Vigimap	Capteur
16-june	Revus				x
23-june	Acrobat				x
24-june	Acrobat		x		
29-june	Infinito	x	x		x
05-july	Amphore	x	x	x	x
09-july	Orvegostar + Dash	x	x	x	x
16-july	Acrobat + Proxanil	x	x	x	x
23-july	Revus + Proxanil	x	x	x	x
28-july	Cabrio Duo + Dash + Cymbal				x
30-july	Cabrio Duo + Dash + Cymbal	X	x		
03-aug	Infinito				x
05-aug	Infinito	x	x		
09-aug	Valbon		x		x
17-aug	Amphore plus + Cymbal	x	x	x	x
23-aug	Infinito		x		x
25-aug	Infinito	x			
31-aug	Ranman		x		x
Total		9	12	13	10



Same protection level

3 treatments saved

Conclusions

- The profiles of airborne inoculum vary from year to year and from location to location
- Detection of an overwinter inoculum is surprising and raises the question of the origin of this inoculum
- Taking into account the quantification of this inoculum in the DSS could reduce the number of treatments

Perspectives

- Further field trials to confirm the interest of airborne inoculum quantification in potato late blight control strategy
- Modeling: can we predict airborne inoculum on the basis of meteorological data ?
- Develop a novel module to include airborne inoculum in current DSS
- Characterisation : can we identify *P. infestans* genotypes from airborne samples?

Thanks



Pr. Anne Legrève
Alain Decroës
Charlotte Liénard
Cyril Vansteenberge

Thank you for your attention

