

IPM 2.0 in potato -

Know your enemy to chose the right weapon

Jens G. Hansen & Bent J. Nielsen, AU, Agroecology & Geert Kessel, WUR, NL



The enemy



Primary attack Foulum, 1988

>1997



Oospores 2014
Foulum



Milder winters -
Volunteer plant
2015, Foulum



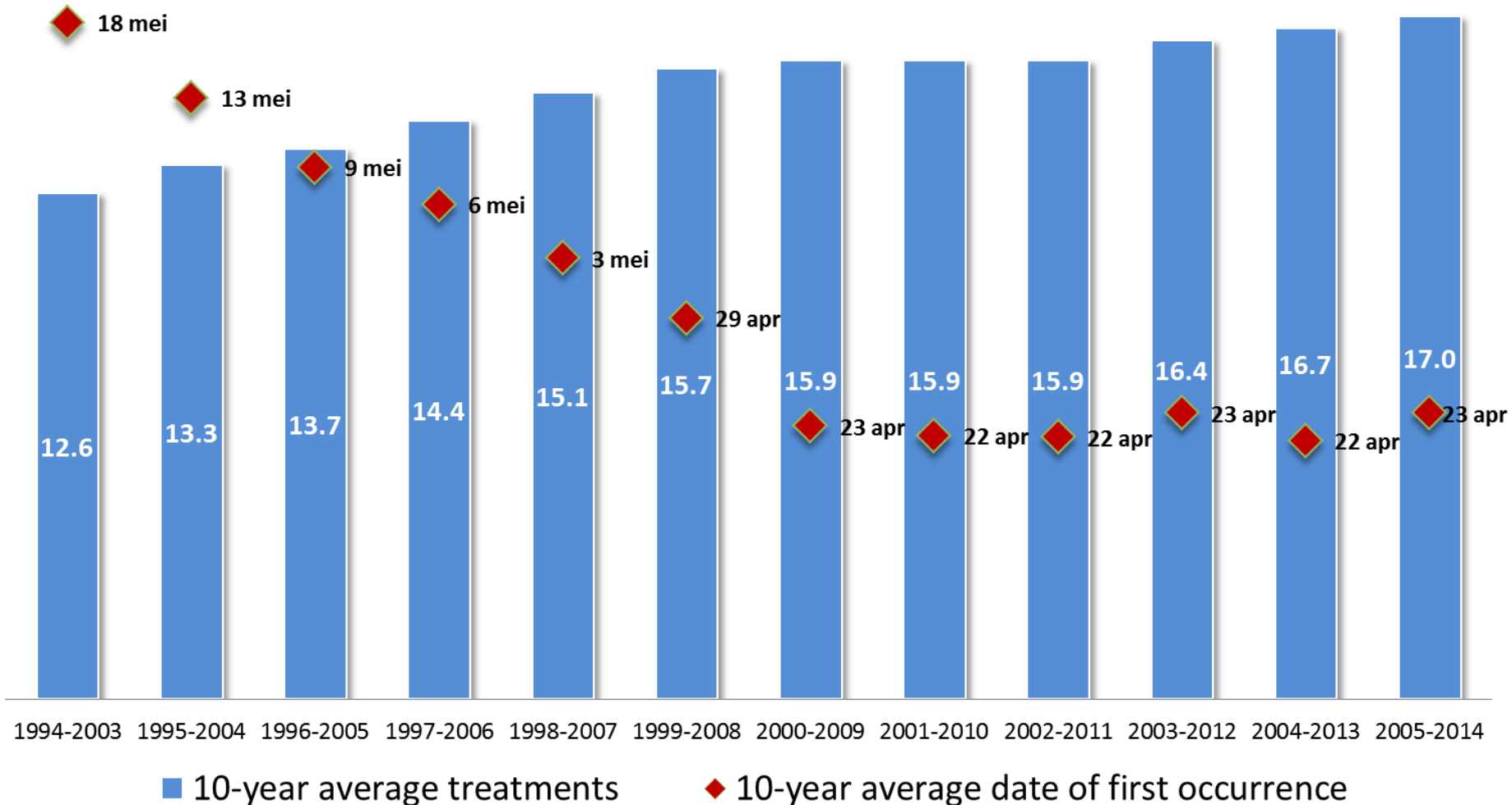
Sexual recombination = high diversity / adaptation + oospores
Earlier attacks, most likely from oospores
Early attacks on resistant starch potatoes (e.g. Kuras)
More aggressive isolates (Blu-13), fungicide resistans
"False crop rotations" due to volunteers survival during winter
Structural changes in agriculture (less farmers with more fields)



Increased fungicide use, from 5 i 1990th to 10 in 2010-15

Development in fungicide use, Belgium

Date of first occurrence | Number of advised treatments in Bintje
10-year averages - PCA late blight warning service, seasons 1994 to 2014





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News



AsiaBlight strengthens ties in India

2015.09.20 | EUROBLIGHT

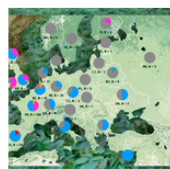
India is now the third largest producer of potato in the world and at a recent meeting researchers expressed enthusiasm for links into a global collaborative network on potato late blight management.



AsiaBlight meeting at the Potato World Congress

2015.09.11 | EUROBLIGHT

The establishment of an Asian late blight network is part of a global trend of greater collaboration and knowledge sharing to improve the management of potato late blight.



First step towards global attack on potato blight

2015.06.08 | EUROBLIGHT

European researchers and companies concerned with the potato disease phytophthora will work more closely with parties in other parts of the world. The first move was made during the biennial meeting of the European network EuroBlight, held in Romania earlier this month. Colleagues from North-America, South-America and Asia were also invited.

COMMENTS ON CONTENT: [JENS GRØNBECH HANSEN](#)
REVISED 2015.07.28

After the workshop in Brasov, Romania 13- 15 May, 2015

- > [Scientific program and participants list](#)
- > [All presentations and posters](#)
- > [The EuroBlight statement from Brasov](#)

EuroBlight Fungicide Table

EuroBlight evaluate the effectiveness of fungicide products/co-formulations for the control of *P. infestans* based on the **highest** rate registered in Europe. These ratings are the opinion of the Fungicides Sub-Group, and are based on field experiments and experience of the products performance when used in commercial conditions.

[Go to table](#)



Publications



Fungicide evaluation to rate efficacy to control leaf late blight for the EuroBlight table. Results 2006 - 2013 [here](#) NEW 22 April 2014

Fungicide evaluation to rate efficacy to control tuber blight for the EuroBlight table. Results 2009-2011. [here](#)

Find the proceedings from the Limassol workshop in 2013 and previous workshops since 1996 [here](#)

EuroBlight statement, Limassol, 2013 [here](#)

POTATO LATE BLIGHT TOOLBOX

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[Partners](#)
[Administration](#)

Welcome Jens Grønbech Hansen [logout](#)

ISOLATE MAPS

Survey map

Genotype map

Genotype frequency map

US lineages map

US lineages frequency map

Year

☒ 2014
 ☐ 2013

Continent

☒ Europe
 ☐ Africa & West/Central Asia

Genotype

☐ All
 ☒ EU_1_A1
 ☐ Other

ISOLATE MAPS

Survey map

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Show

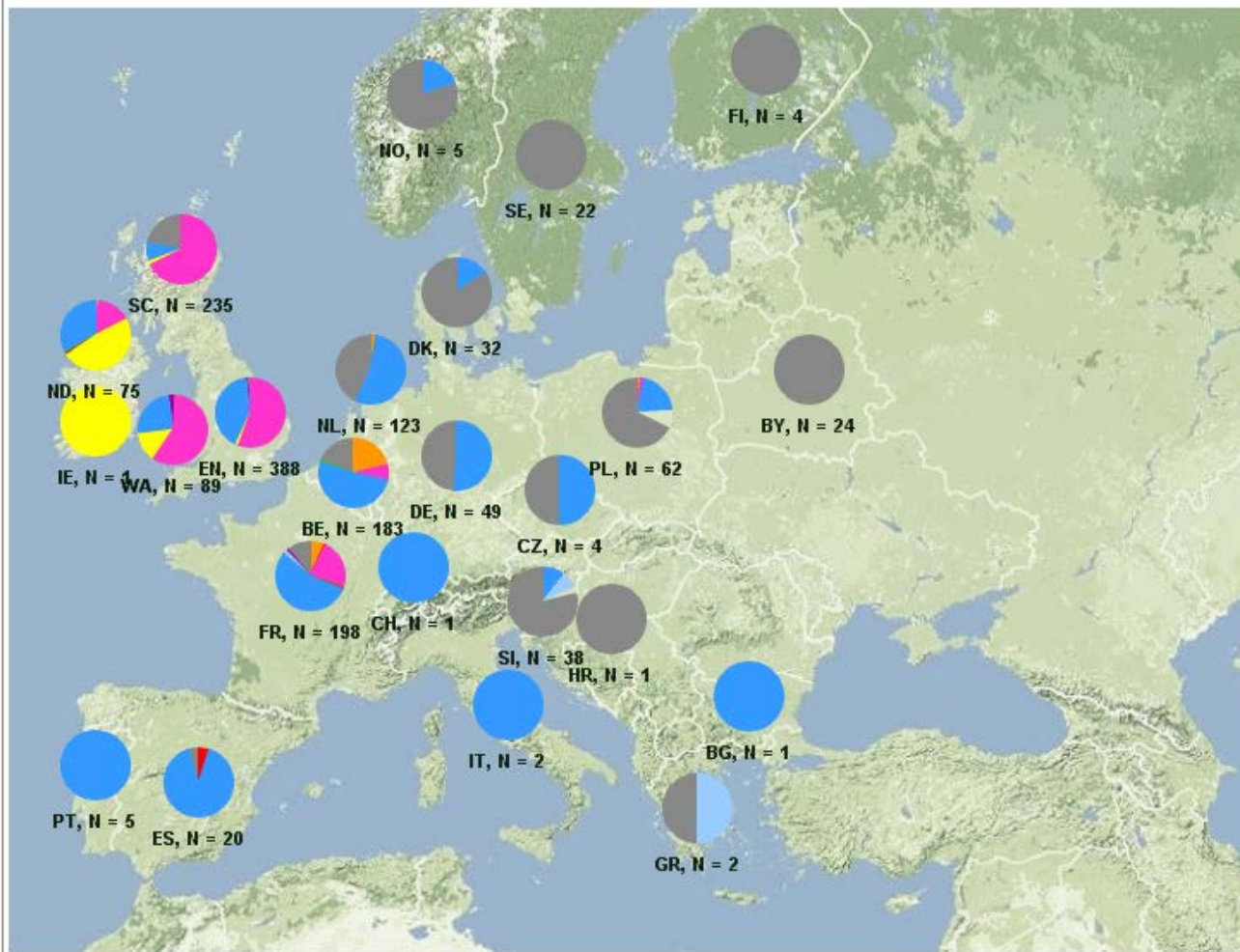
Continent

☒ Europe
 ☐ Africa & West/Central Asia
 ☐ East Asia
 ☐ South America

Year

☐ All

☒ 2014
 ☐ 2013
 ☐ 2012
 ☐ 2010
 ☐ 2009
 ☐ 2008
 ☐ 2007
 ☐ 2006
 ☐ 2005
 ☐ 2004
 ☐ 2002



Legend

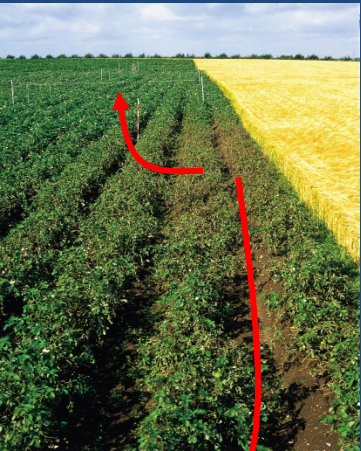
- EU_1_A1
- EU_2_A1
- EU_5_A1
- EU_6_A1
- EU_8_A1
- EU_12_A1
- EU_13_A2
- EU_23_A1
- EU_33_A2
- EU_34_A1
- EU_35_A2
- Other



Cooke DEL, Cano LM, Raffaele S, Bain RA, et al. (2012) Genome Analyses of an Aggressive and Invasive Lineage of the Irish Potato Famine Pathogen. *PLoS Pathog* 8(10): e1002940. doi:10.1371/journal.ppat.1002940
<http://www.plospathogens.org/article/info:doi/10.1371/journal.ppat.1002940>

Defence weapons

Primary attack



Volunteers



Dumps



Oospores



- Healthy seed and crop rotation
- Breeding & inclusion of new resistance genes
- DSS and control strategies (Fungicides: timing, type og dosis)
- Mapping of the pathogen on population level. Link between genotype and phenotype
- Surveillance (Scouts: when and where is the disease, how much, disease activity etc.)
- Strategic, tactical and operational planning and missions



Integreret plantebeskyttelse IPM RIMER PÅ



3. BRUG VARSLINGER, PROGNOSE OG SKADETÆRSKLER

- Brug varslingerne på LandbrugsInfo.dk/regnet. Her kan du uge for uge se, hvad planteavlskonsulenter over hele landet finder af svampe og skadedyr.
- Begynd at føre tilsyn i dine egne marker, når de første angreb viser sig i registreringsnettet, eller der varsles.
- Sæt gule fangbakker i rapsmarken og feromonfælder i hvedemarkerne. Det giver det mest præcise billede af risikoen for rapsjordlopper henholdsvis hvedegalmyg i dine marker.
- Brug bekæmpelsestærskler til at afgøre, om der for eksempel er behov for at bekæmpe glimmerbøsser i vinterraps.
- Brug Skimmelstyring, hvis du dyrker kartofler.
- Justér indsatsen i forhold til klimaforholdene.



FOTO: BODIL PEDERSEN, SEGES
Skimmelstyringapp'en er et godt værktøj til at beslutte, hvordan der skal behandles for kartoffelskimmel.

HVORDAN TACKLER DU KARTOFFELSKIMMEL?



Jeg bruger programmet Skimmelstyring til at understøtte mit valg af midler og dosering.

Jeg sprøjter efter den plan, der står i nyhedsbrevet fra min rådgiver.

Jeg sprøjter mod skimmel efter et fastlagt program.

DANSKE KARTOFLER

7. maj 2015/
MAGASINET

Velkommen
til nye læsere

TEMA: Skimmelstyring

Overskæring af læggekartofler
vinder frem i Danmark

LÆS SIDE 24

GODE
RÅD

/ Udsyn/ Nyheder/ Information/ Forskning/ Branchen/ Annoncer/

TEMA: SKIMMELSTYRING



AF BENT J. NIELSEN
OG JENS GRØNBECH HANSEN
AARHUS UNIVERSITET
OG LARS BØDKER
LANDBRUGSULLEN, SEGES

Værktøjs- kasse med skimmel- styring

Selvom kartoffelskimmel er en meget aggressiv plantesygdom, har vi heldigvis gode midler til rådighed, som kan begrænse opformering og spredning af svampen.

På www.landbrugsinfo.dk og www.skimmelstyring.dk er der forskellige modeller og information om vejrforhold, som kan bruges, når der skal tages beslutning om bekæmpelse.

De forskellige komponenter udgør en slags værktøjskasse, som vi samlet kalder Skimmelstyring. Her kan avlerne få et grundlag for at beslutte, hvornår skimmelen skal bekæmpes, med hvilket fungicid og hvilken dosis.

I det følgende gennemgås de forskellige komponenter i Skimmelstyring og hvordan de anvendes:

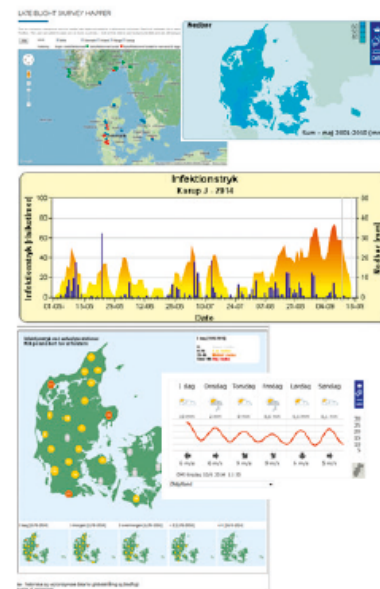
Registreringsnet for kartoffelskimmel

Registreringsnettet viser fund af kartoffelskimmel i Danmark indberettet af rådgivere, som færdes jævnligt i kartoffelmarkerne (fig. 1). Registreringsnettet er omtalt på side 6-7 i dette temanummer.

Systemet fortæller hvor der er fundet skimmel, hvornår, i hvilke sorter og på hvilket vækststadium. Denne information anvendes til at vurdere hvornår og hvordan man skal starte bekæmpelse. Informationerne fra Registreringsnettet bruges også som input til dosismodellen – se artikel her på siderne.

Infektionstryk af kartoffelskimmel

De daglige risikotal viser antal timer pr. dag, hvor luftfugtigheden i mindst 10 sammenhængende timer er over 88 procent, og hvor temperaturen i denne periode er over 10 °C (fig. 2).



Figur 1. Beslutningsstøttekomponenter i Skimmelstyring. Øverst: Registreringsnettet og den regionale nedbørfordeling (mm) for Danmark. Midt: Infektionstrykket (kurve) samt nedbør (søjler). Nederst: Infektionstrykket ved udvalgte stationer (stort kort) og de næste 5 dage (små kort).

Det daglige risikotal er et udtryk for, hvor stor risiko der er pågældende dag for sporedannelse, spredning samt betingelser for infektion.

Der er større risiko for skimmeludvikling, hvis der er flere sammenhængende dage med skimmelrisiko. Derfor udregnes et infektionstryk (fig. 3) som er en løbende sum af fem daglige risikoværdier (to dage tilbage, dags dato, to dage frem).

Infektionstryk over 40 er højt, mens niveau 20-40 betegnes som medium og mindre end 20 som lavt. Forud for perioder med højt infektionstryk anvendes et effektivt middel og helst med en vis kurativ egenskab. Værdien af infektionstrykket indgår i beregningen af Dosismodellen (se nedenfor).

Vejledning om start af bekæmpelse sker ved en samlet vurdering af nedbør under fremspring (risiko for angreb fra jordsmitte i lanstrengte sædsifter), fund af skimmel i registreringsnettet og det aktuelle regionale infektionstryk. I eksemplet fra Karup i figur 3 ses et højt infektionstryk og samtidig megen nedbør 6.-14. maj. Det var nøjagtigt i mange marker i området ved fremspring.

Der blev udsendt varsel om risiko for tidlige angreb den 22. maj, og de første angreb blev indrapporteret til registreringsnettet den 25. maj. Allerede den 2. juni var der fundet

JENS GRØNBECH HANSEN,
AARHUS UNIVERSITET

Se skimmelfund og infektionstryk på ny app

Grundlaget for den nye app til at se skimmelfund er et fællesnordisk registreringsnet for kartoffelskimmel. En kombination af registreringer af skimmel og beregninger af den vejrbetingede risiko for skimmeludvikling har vist sig som en god vejledning om, hvornår man skal starte en rettidig forebyggende bekæmpelse af kartoffelskimmel.

I Danmark kan der mellem årene være 1½ måneds forskel på, hvornår skimmelen etablerer sig i konventionelle marker (Figur 3). Dermed er der også en økonomisk og en miljømæssig gevinst ved at starte bekæmpelse efter behov.

På baggrund af viden om fremspiring og beregninger af infektionstrykket kan vi i dag sige, hvornår man skal starte med at kigge efter tidlig skimmel. Den information kommer ud via konsulenterne.

Det er vigtigt, at avlerne selv hjælper med til at kigge efter meget tidlige angreb. Hvis du finder skimmel, skal du kontakte din konsulent, som vil foretage en indrapportering. For de allerførste fund indsendes en prøve til Seges i Skøjby til verifikation. Efterfølgende fund sendes via en mail fra konsulenterne til Seges. Fra 2015 vil det være muligt at indrapportere fund via en app (Blight-Tracker) som findes både til Android og Apple telefoner og tablets.

Man skal dog være registreret som deltager i registreringsnettet for at kunne indrapportere, men alle kan downloade app'en og se kortet med skimmelfund samt infektionstryk per postnummer uden login.

Seges har ansvaret for at organisere indrapporteringen samt at verificere de fund, som indrapporteres. Systemet er udviklet af Aarhus Universitet i samarbejde med nordiske partnere.

Hvad viser resultaterne. 2000-2014

I 2014 blev der fundet meget tidlig skimmel i både Danmark og Sverige sidst i maj. Observationerne tyder på, at smitekilden i mange marker var oosporer. Den 18. juni var der udbredte angreb specielt i det midt-sydjyske samt i det sydlige Sverige (Figur 2).

For at vurdere tidligheden af skimmel i den nordiske region har vi analyseret data fra registreringsnettet 2000-2014. I tabel 1 er vist den gennemsnitlige dato (medianen) for det absolut tidligste fund samt hvornår der er fundet skimmel i fem eller flere konventionelle marker. For hver af disse indikatorer er der angivet den tidligste og seneste observation for de 15 år.

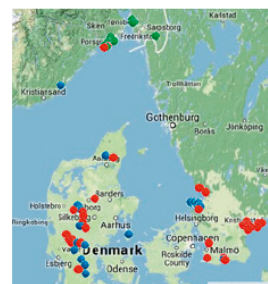
Resultaterne viser, at meget tidlig skimmel i gennemsnit findes i Danmark 13. juni, og at fund af skimmel i fem eller flere konventionelle marker i gennemsnit af årene er 24. juni i Danmark. Ser man på de enkelte år blev det tidligste skimmel fundet 25. maj i 2014 (Tabel 1 og Figur 3).

Den seneste dato for første fund er 2. juli, i 2008 (Figur 3). Den tidligste etablering af skimmel i fem eller flere konventionelle marker var 2. juni i 2014. Den tilsvarende seneste etablering var 17. juli i 2008.

Jo tidligere skimmelen etableres udbredt, jo mere bekæmpelse skal der også



Figur 1. Registreringsnet på mobiltelefon.

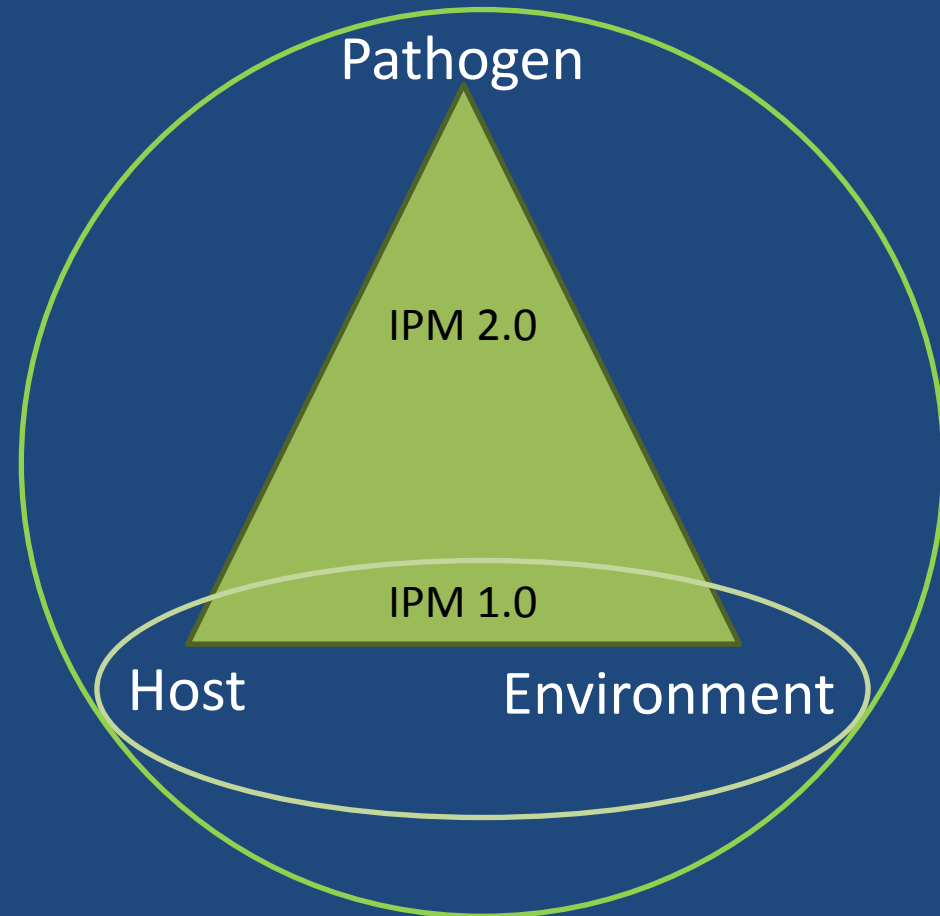


Figur 2. Skimmelsituationen 18. juni, 2014. Grøn prik betyder, at der er observeret men ikke fundet skimmel (kun Norge bruger denne metode). Blå prik betyder at der er fundet skimmel, men at fundet er gjort for mere end 10 dage siden. Rød prik betyder, at der er fundet skimmel inden for de seneste 10 dage.

IPM2.0 – Geert Kessel & colleagues, PRI, WUR

More and better with less

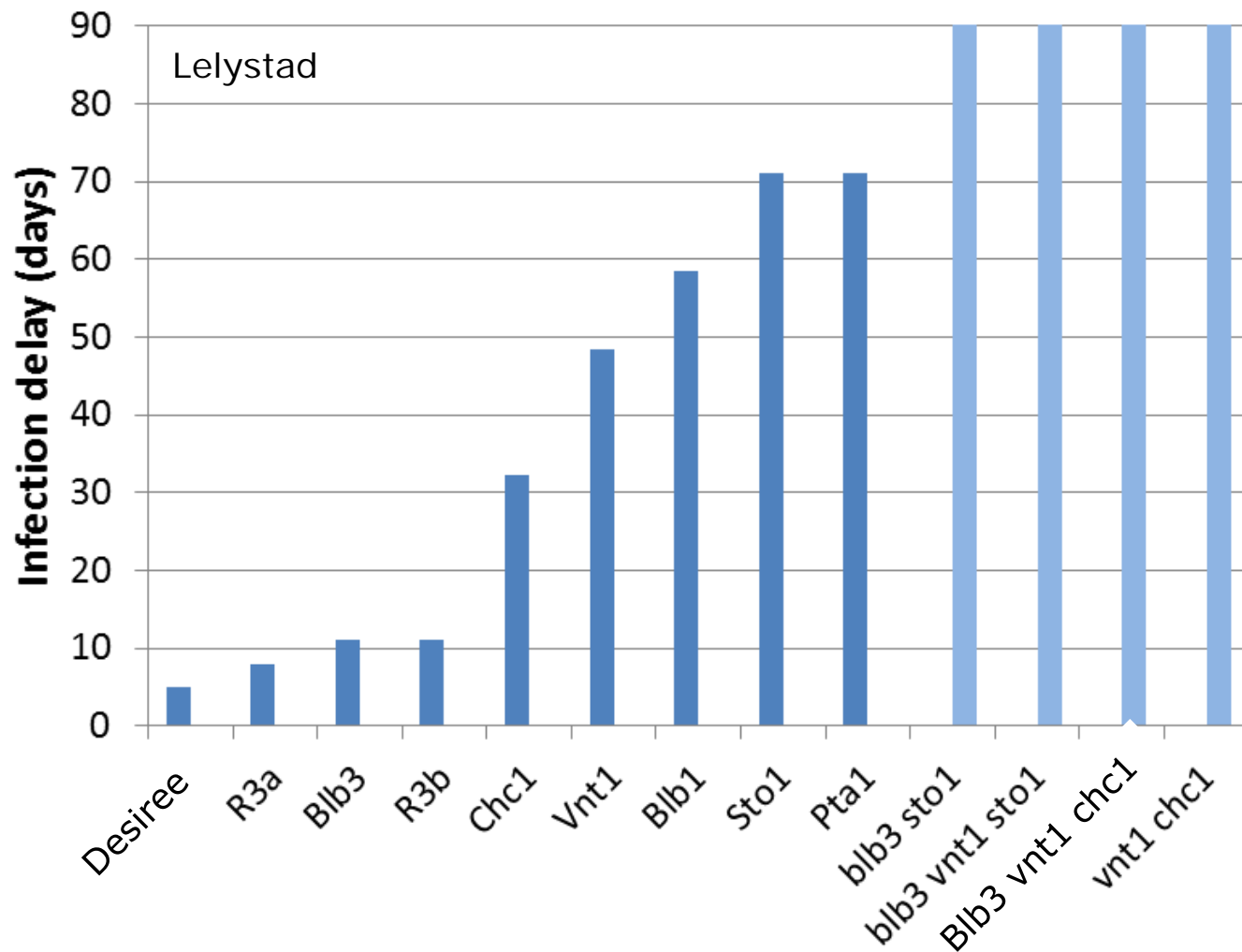
- IPM 2.0
 - Host is present
 - Susceptible
 - Resistant? **Which R-genes?**
 - Weather suitable for infection
 - When? For how long?
 - Do spores survive atm transport
 - Pathogen is present
 - How much? Disease pressure
 - **Specific genotypes**
 - **Specific virulences**
 - **Fungicide resistance**



Proof of concept for the IPM 2.0 control strategy / Geert Kessel, PRI, WUR



Bait field 2011; delay of infection



R-genes versus NL *P. infestans* population

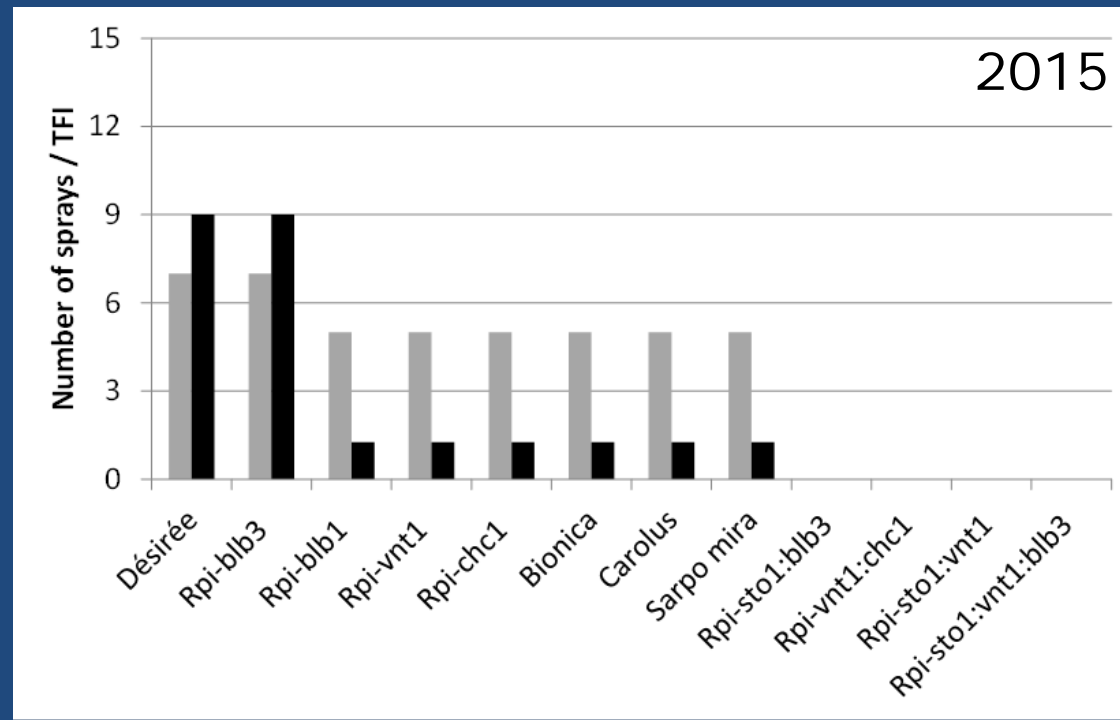
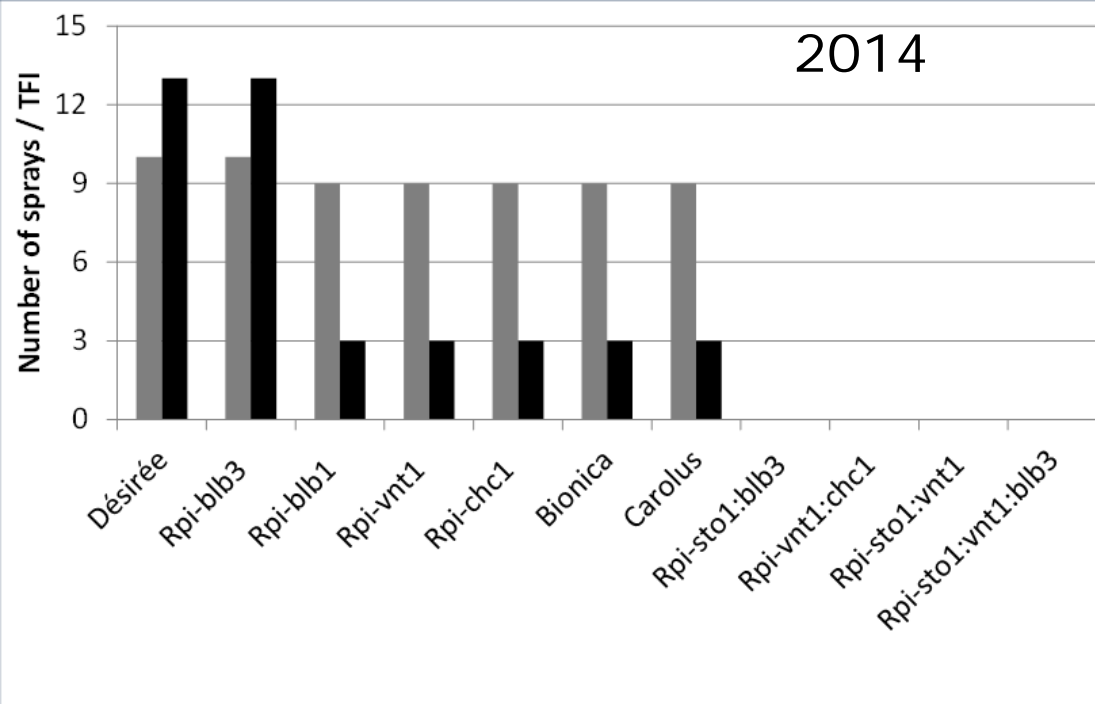
- We need to support host resistance for enhanced durability
- Use (low amount of) fungicide to protect new resistance genes

DuRPh 2014 and 2015

Durable Resistance against Phytophthora through cisgenic marker-free modification



Fungicide Input using a DSS





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News



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2015.09.20 | EUROBLIGHT

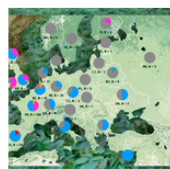
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2015.06.08 | EUROBLIGHT

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Publications



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Fungicide evaluation to rate efficacy to control tuber blight for the EuroBlight table. Results 2009-2011. [here](#)

Find the proceedings from the Limassol workshop in 2013 and previous workshops since 1996 [here](#)

EuroBlight statement, Limassol, 2013 [here](#)

EuroBlight Statement - 2015

Recommendations:

*Monitoring of the meta population of *P. infestans* in Europe and beyond*

Linking genotypes to phenotypes

EuroBlight engages in the development and improvement of DSS adapted to IPM2.0

Fostering international collaboration



15th EuroBlight Workshop - Statement

Brasov, Romania 10-13 May 2015

'Designing sustainable management strategies of early and late blight in potato'

Coordinators: Jens G. Hansen, Alison Lees and Huub Schepers

25 June 2015



What is EuroBlight?

Potato late blight (*Phytophthora infestans*) and Early blight (*Alternaria* spp.) continue to severely damage both the foliage and tubers of potato crops, and also to cause severe losses in other important food crops, such as tomato.

Despite active research and recent breakthroughs, further investigations are still needed to fully achieve integrated pest management (IPM) strategies. Remaining questions include: what are the genotypic (DNA) and phenotypic (behavioural) diversity and the mechanisms of evolution of the European meta-population of *P. infestans*? how can we use this information to develop new innovative and more effective IPM strategies (IPM2.0)? why are these diseases so difficult to control sustainably? how can we sustain the use of both efficient fungicide active ingredients and host resistance genes whilst simultaneously minimising the risk that the pathogen overcomes the efficacy of these important control measures? These, and other, questions were the rationale for establishing 'EuroBlight', a network of European scientists, with initial funding by the European Union.

EuroBlight is a very active consortium of scientists and industry representatives, which has met regularly since 2006 with a simple overall objective: to identify, evaluate and combine the best possible tools to predict, manage and control blight diseases in the field. EuroBlight is a unique collaborative platform to tackle the challenges that early and late blights pose in Europe and worldwide. Its biennial workshops allow key research and extension priorities to be identified and formulated into collective Statements that can serve as the core principles of joint actions and international collaborations to improve IPM strategies.

The 15th EuroBlight Workshop, held in Brasov, Romania in May 2015, brought together over 100 participants from all parts of Europe, South America, USA, Israel and China to achieve this aim.

The European-wide monitoring initiative of *P. infestans* populations carried out by EuroBlight partners in 2013 and 2014 (> 2200 isolates collected and genotyped using SSR markers) confirmed that the populations are constantly evolving and that some of them are subject to repeated biological invasions by novel genotypes ([read news story about this](#)). Such genetic changes may jeopardize the ability to develop durably resistant cultivars and the sustainability of other control measures. It is thus essential to understand the mechanisms behind the changes and also to their relation to human intervention (e.g. pathogen transportation with plant material or cropping practice) and to the changing climate.

Together with the comprehensive web-based resource developed within EuroBlight i.e. hosting harmonized research protocols and extensive databases allowing the compilation and sharing of data on pathogen populations, host resistance and fungicide characteristics, the research and extension efforts carried out within the network pave the way for the set-up and adoption of 'smart control', IPM strategies for early and late blight in Europe.

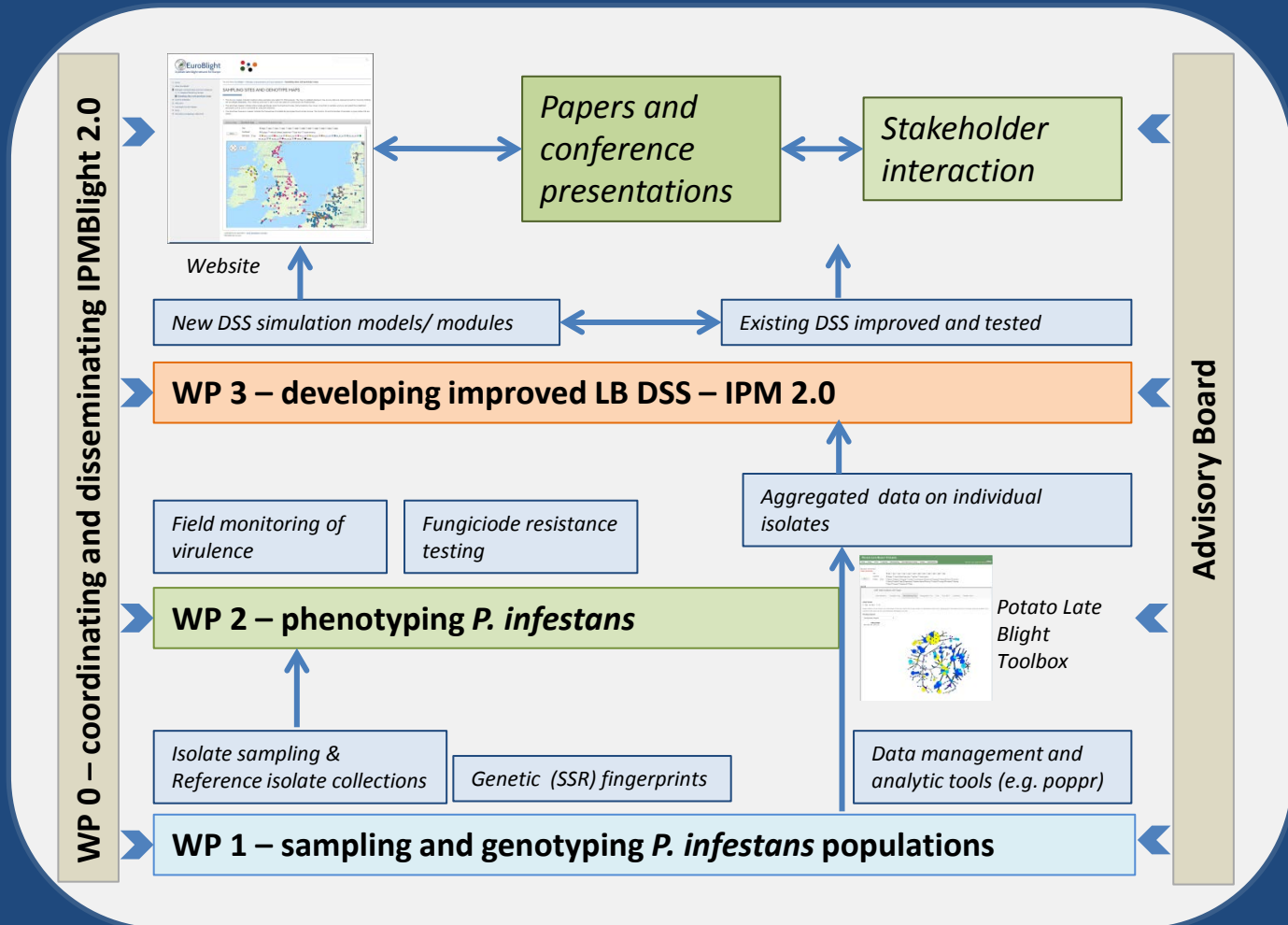
The recent Europe-wide late blight monitoring initiative demonstrated the value and necessity of constant monitoring of populations and characterization of invasive genotypes in order to understand and predict changes. It directly influences the development and deployment of resistant cultivars, the performance of disease warning systems and the efficacy of plant protection products. A coordinated and continuous monitoring effort would be best supported through National Action Plans relating to IPM implementation in EU member states.

Major achievements and breakthroughs on past EuroBlight statements

Major issues of relevance to policy making in Europe

IPMBlight2.0

IPM2.0 for sustainable control of potato late blight - exploiting pathogen population data for optimized Decisions Support Systems

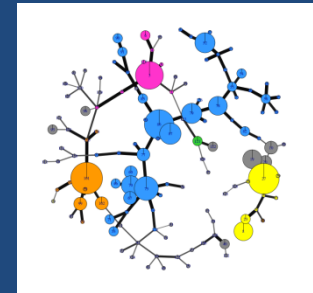


Desiree^{plus} GM differential set

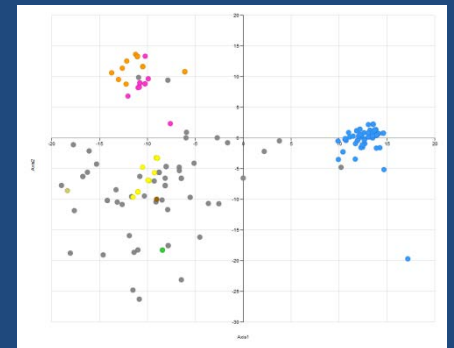


DuRPh – *Cisgenesis*
Stacking of R-genes

Potato Late Blight Toolbox



Min Spanning tree



Principle Com Anal.

Conclusions – IPM2.0

- IPM2.0 – more with less/ the potential is high
- More host resistance is needed
- *P. infestans* is highly adaptable
 - Resistance gene stewardship and a.i. stewardship
 - New resistance genes must be protected with fungicide
 - Monitoring of *P. infestans* population via EuroBlight
 - Link phenotype to genotype
- Close collaboration between government, research, industry, extension and farmers is needed

Thank you!

