



*Characterization of new resistance mechanisms for CAAs and OSBPIs in *Phytophthora infestans* and their impact on Late Blight control in potatoes*

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EuroBlight, May 2026





Change in sensitivity of **EU_43_A1** EuroBlight-type sub-population – *P. infestans* strains from 2021, 2022 and 2023 (partly from WU, NL)

EU_43 from 2021

EU_43 from 2022

EU_43 from 2023+

osbp-genotype:

wildtype

OSBPI

Oxathiapiprolin
(0.1ppm)



CAA

Mandipropamid
(10ppm)



Fluopicolide
(10ppm)
in Infinito[®]





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G770V

G770V+N837F

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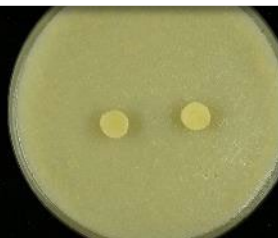
CAA

Mandipropamid
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- over time accumulation of multiple resistances to fungicides with CAA and OSBPI MoA

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EU_43 from 2022

EU_43 from 2023+

CAA (full dose rate)

OSBPI (full dose rate)



- over time accumulation of multiple resistances to fungicides with CAA and OSBPI MoA



Challenge the oversimplified explanation by recessive inheritance principle (two-alleles) for CAA-resistance

EU_46_A1 from 2023+



osbp-genotype:

G770V+N837F

OSBPI

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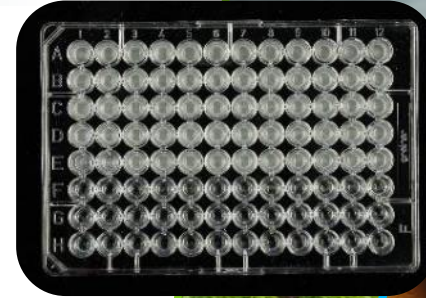
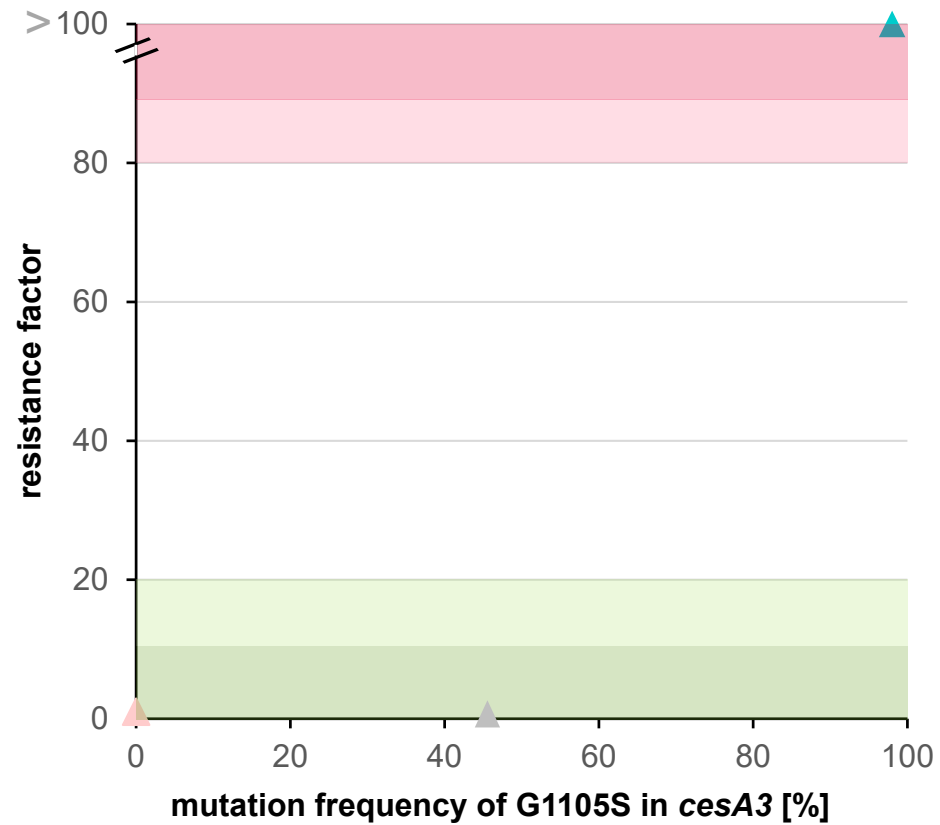
Challenge the oversimplified explanation by recessive inheritance principle (two-alleles) for CAA-resistance

EU_46_A1 from 2023+

CAA
(full dose rate)



Infinito
(full dose rate)





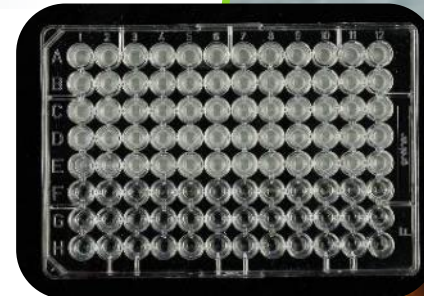
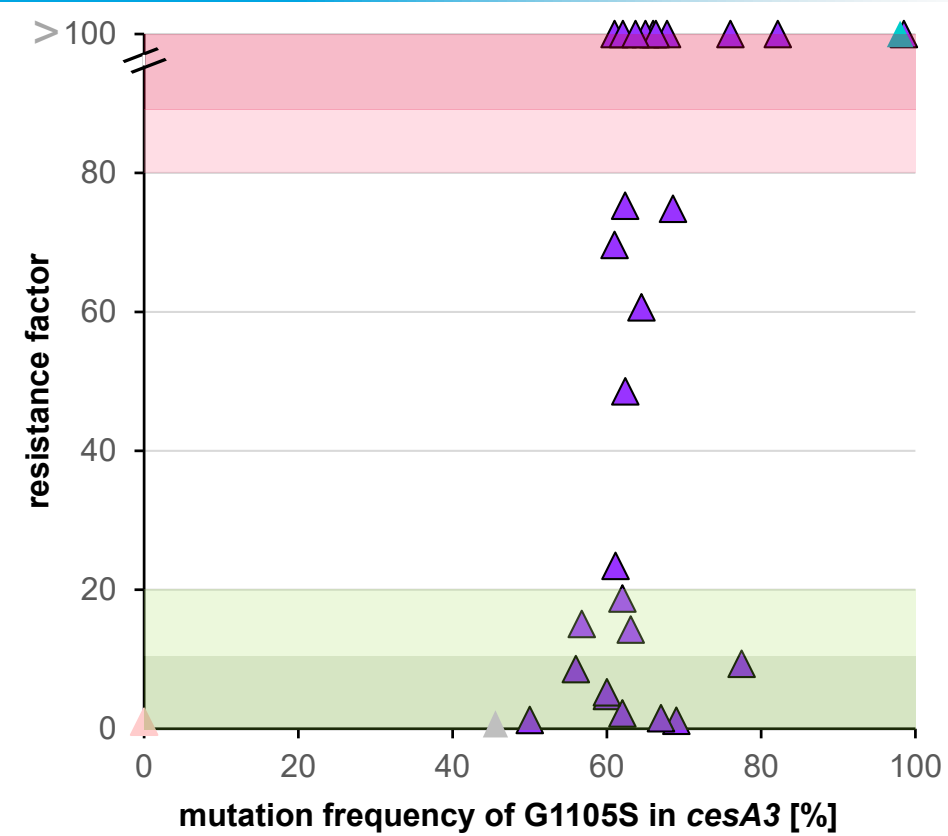
Challenge the oversimplified explanation by recessive inheritance principle (two-alleles) for CAA-resistance

EU_46_A1 from 2023+

CAA
(full dose rate)



Infinito
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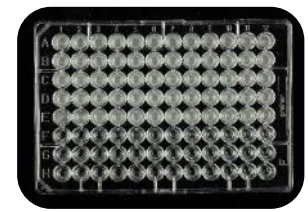


- intermediate mutation frequencies results in full sensitivity up to full resistance
- not fitting Mendelian modes of inheritance

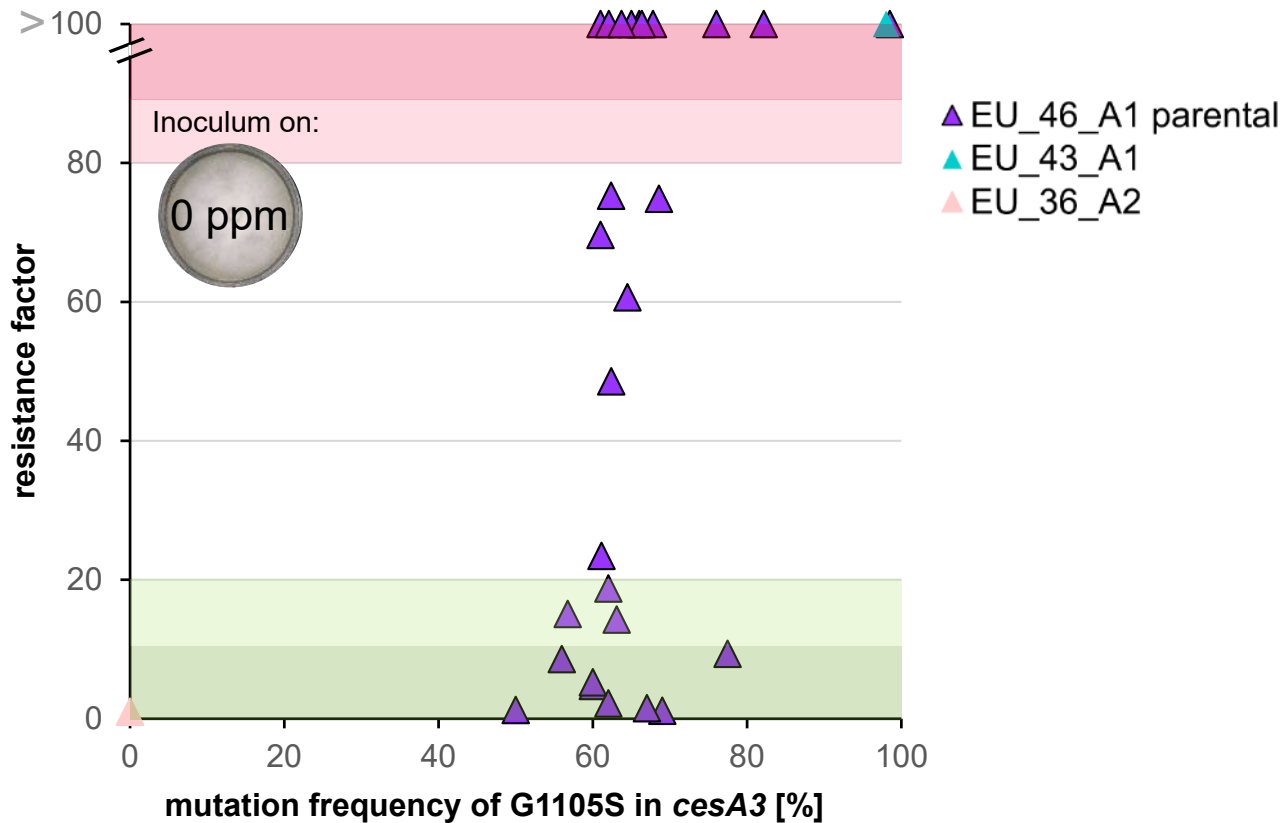




Explanation for variable resistance to CAAs: Difference in sensitivity of **parental** vs. **primed**



microtiter EC₅₀ test to determine the resistance factor (n= 31 EU_46 isolates)

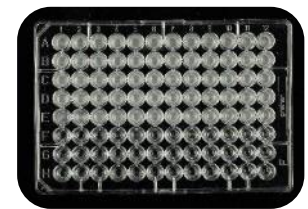


- field isolates from DE, NL and BE to map diversity within the sub-populations
→ variable resistance factors within the **parental EU_46_A1 isolates**

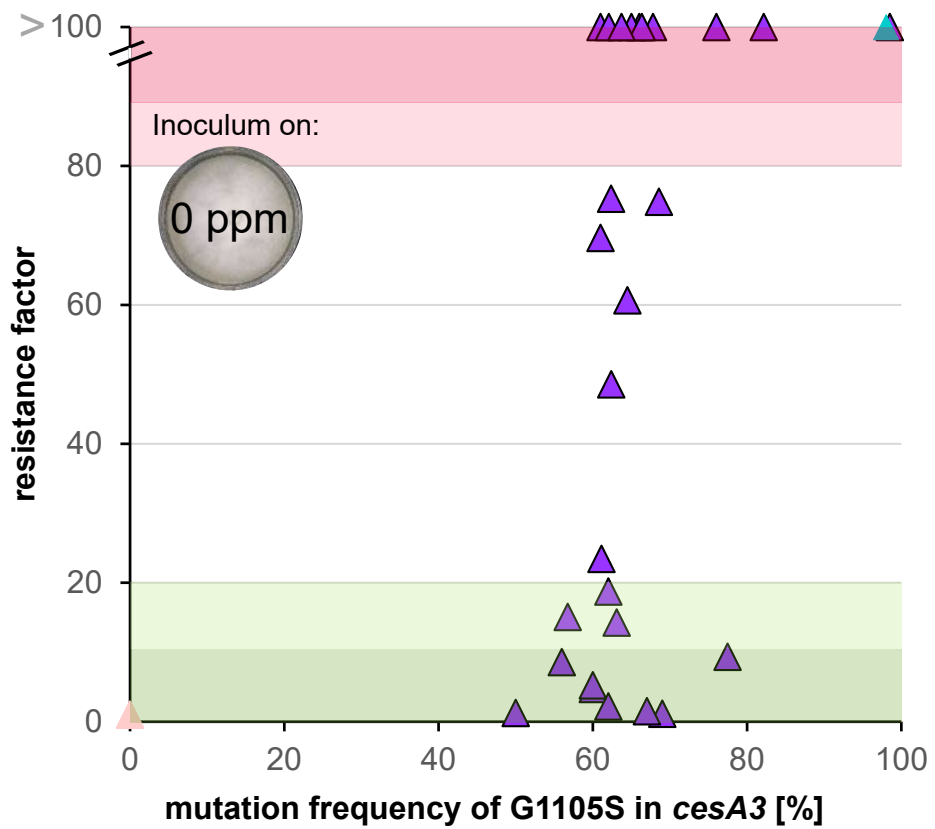




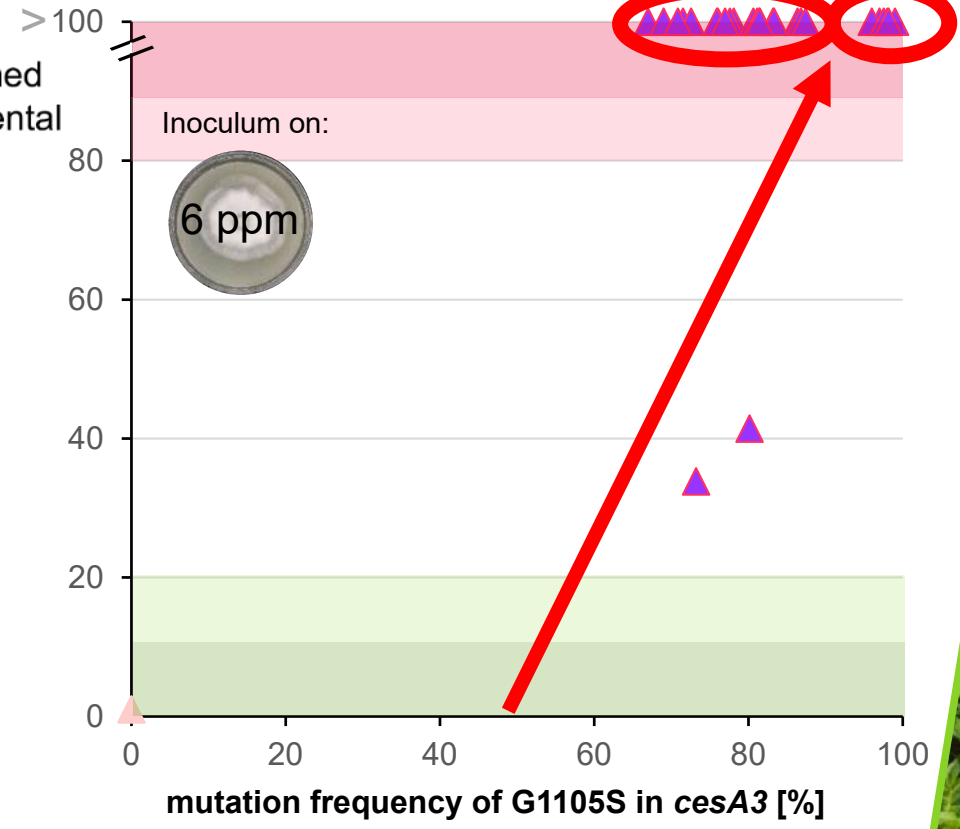
Explanation for variable resistance to CAAs: Difference in sensitivity of **parental** vs. **primed**



microtiter EC₅₀ test to determine the resistance factor (n= 31 EU_46 isolates) **two mechanisms**



▲ EU_46_A1 primed
▲ EU_46_A1 parental
▲ EU_43_A1
▲ EU_36_A2



- disruptive resistance phenotype after CAA exposure → **primed EU_46_A1**
- mutation frequency of **primed** isolates increased: none < 67%; some > 90%
- EuroBlight-typing: all **primed** isolates remain to be characterized as **EU_46_A1**



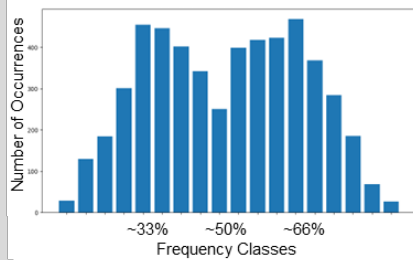


Explanation for variable resistance to CAAs: Difference in sensitivity of **parental** vs. **primed**

1. loss of heterozygosity:

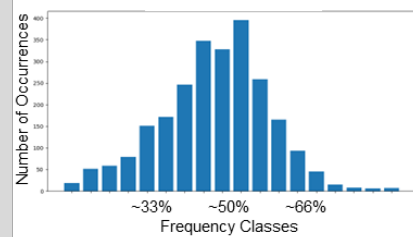
EU_46_A1
parent
60% G1105S
CAA-sensitive

target gene *cesA3* located
on pseudo-chromosome 14



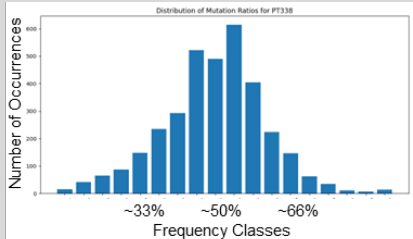
triploid

EU_46_A1
primed
100% G1105S



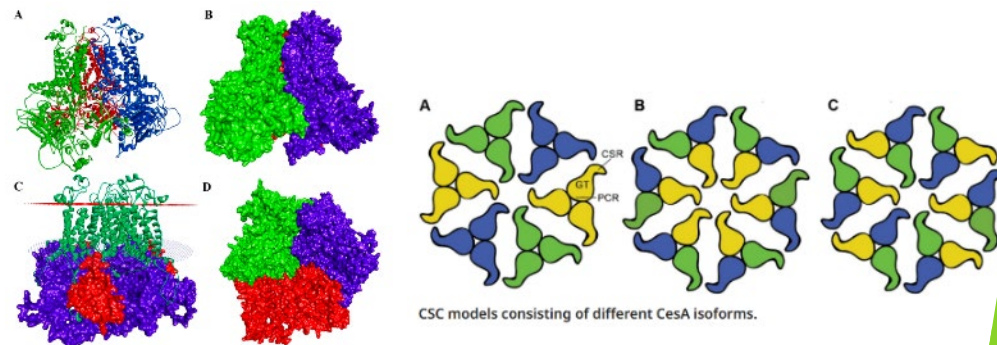
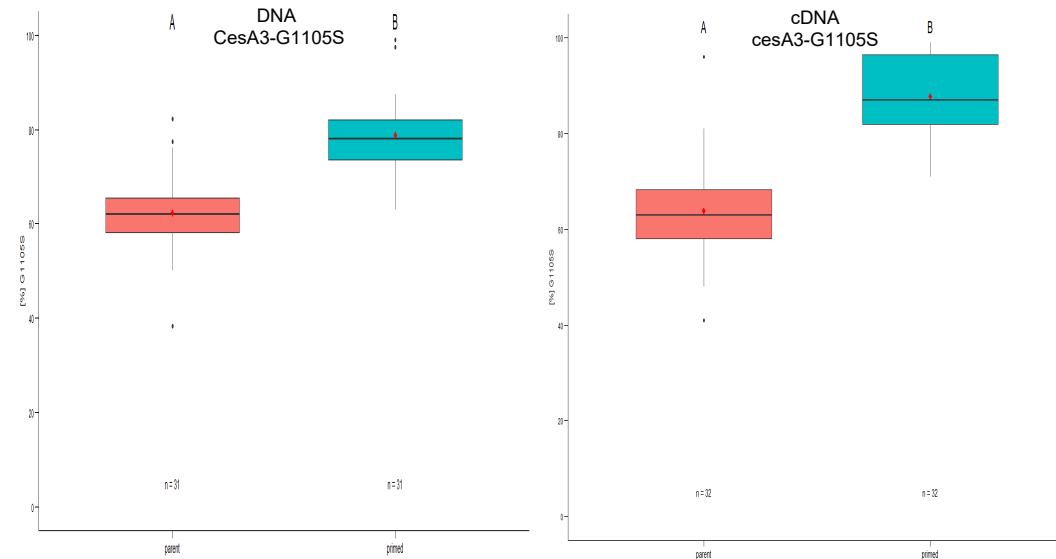
diploid

EU_43_A1
disruptive CAA
resistance
100% G1105S



diploid

2. mutation frequency - cDNA:



Chellappan et al. (2026)

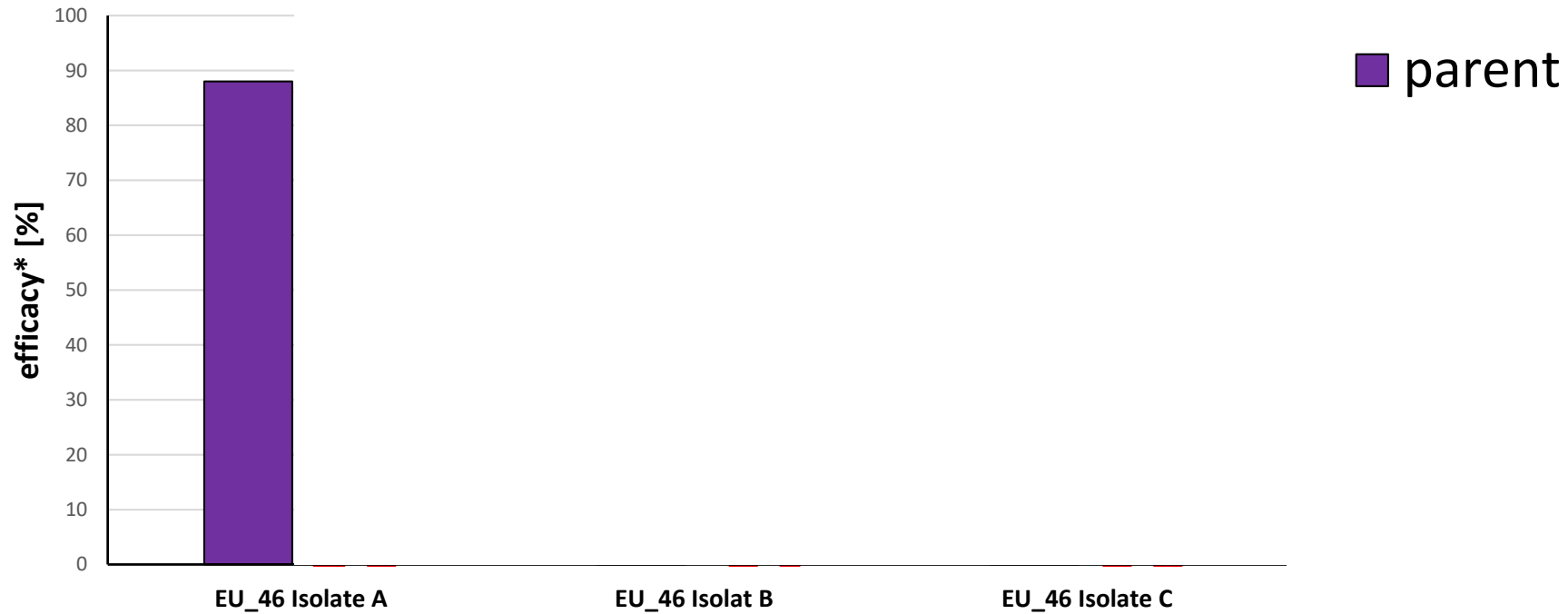
Ho et al. (pre-print)





Practical relevance confirmed by greenhouse trials

EU_46_A1: efficacy (10 DAI) on three **parental** and **primed** isolates at full CAA application rate

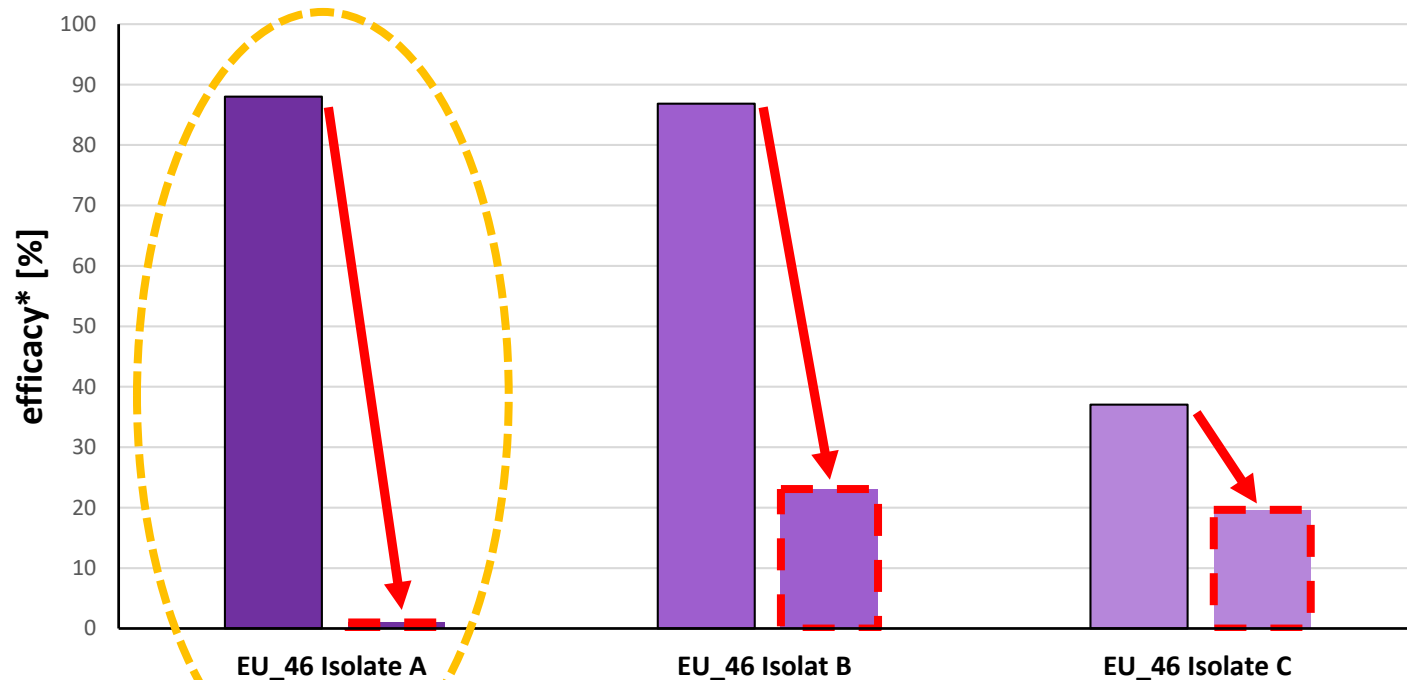


*at $\geq 80\%$ UTC infestation



Practical relevance confirmed by greenhouse trials

EU_46_A1: efficacy (10 DAI) on three **parental** and **primed** isolates at full CAA application rate



parent

primed

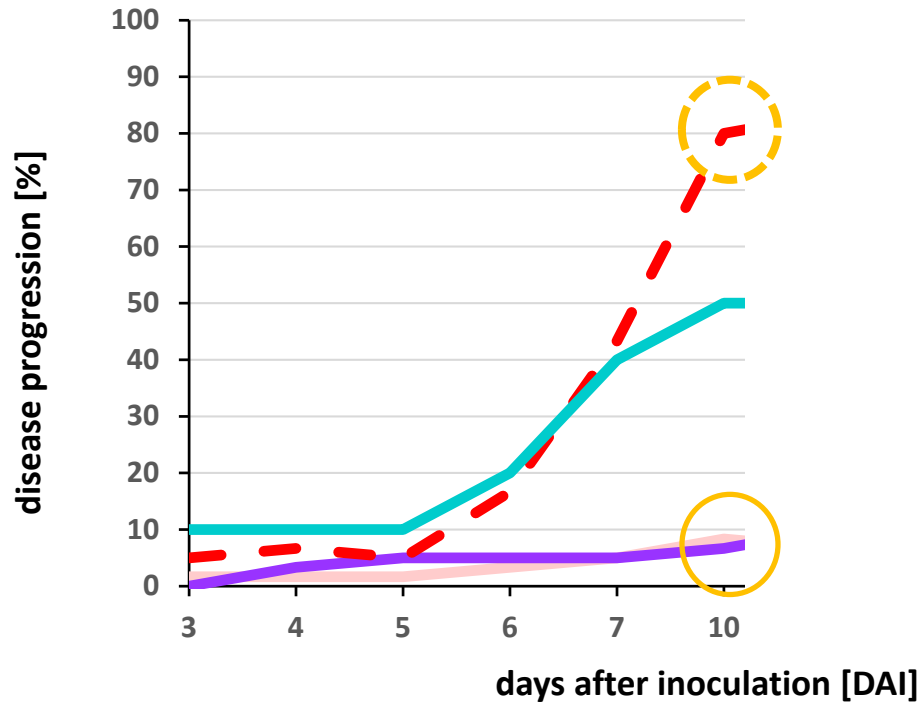


*at $\geq 80\%$ UTC infestation

- test indicates reduced efficacy against other **primed EU_46 isolates**
- practical relevance **of primed isolates** , e.g. by CAA application at beginning of season

Practical relevance confirmed by greenhouse trials

EU_46_A1: disease progression of **parental** and **primed** isolates at full CAA application rate



— EU_36_A2

— EU_46_A1
parental

— EU_46_A1
primed

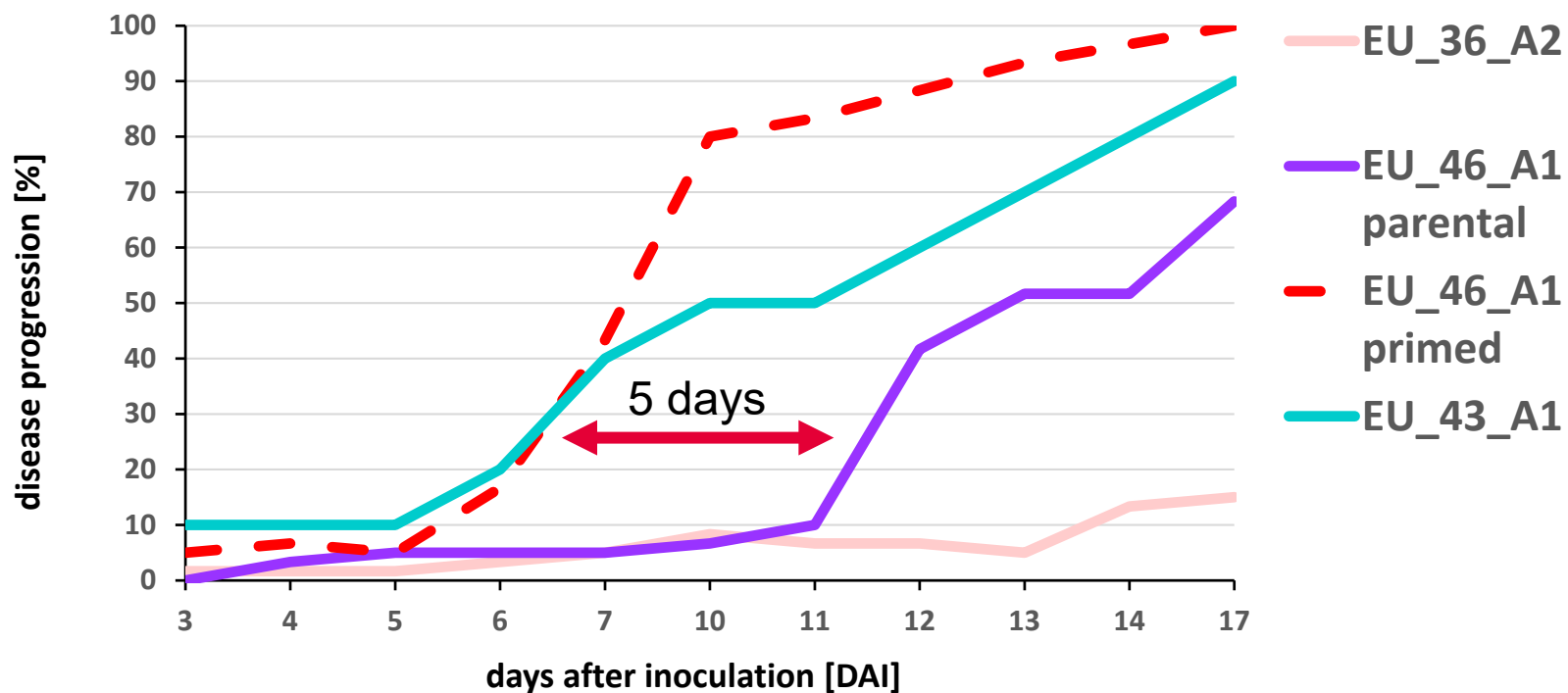
— EU_43_A1



- application of CAA only delays disease progression of **EU_46_A1 isolate (parent)**
- no protection by CAA application against **EU_46_A1 isolate (primed)** similar to **EU_43_A1**

Practical relevance confirmed by greenhouse trials

EU_46_A1: disease progression of **parental** and **primed** isolates at full CAA application rate






- application of CAA only delays disease progression of EU_46_A1 isolate (parent)
- no protection by CAA application against EU_46_A1 isolate (primed) similar to EU_43_A1
- adaptation by parent isolate also observed during the trial (after ~5 days)
- confirmation by detection of 100% G1105S in EU_46_A1 parent at the end of the test



Greenhouse efficacy on different OSBPI-resistant strains

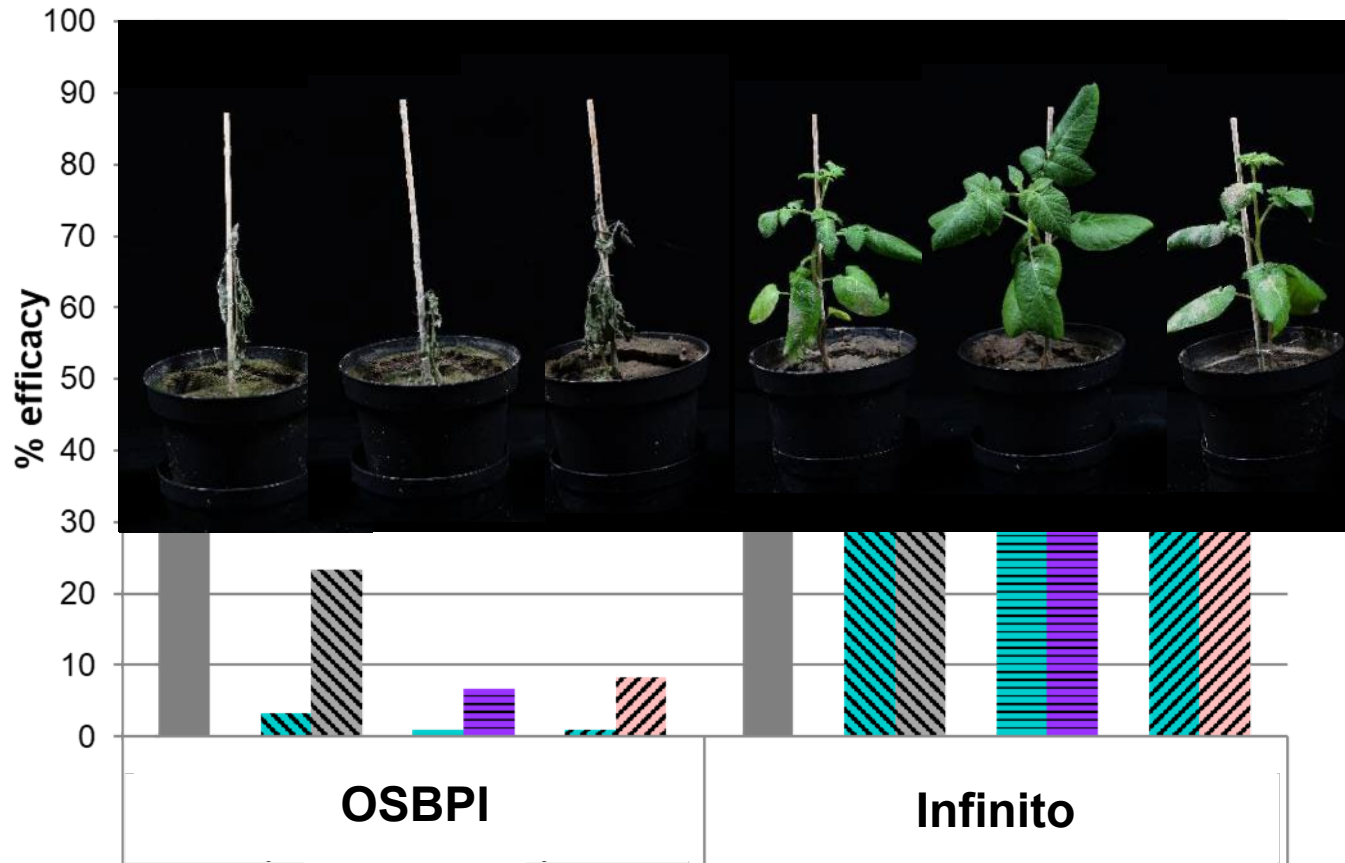
one day protective application, full dose-rate

OSBPI-resistance:

-  G770V
-  G770V+ N837F
-  N837F

EuroBlight-types:

-  Other
-  EU_36_A2
-  EU_43_A1
-  EU_46_A1



- detection of mutations in *osbp*-gene leads to complete loss of efficacy
- *osbp*-mutants occur in different *P. infestans* sub-populations





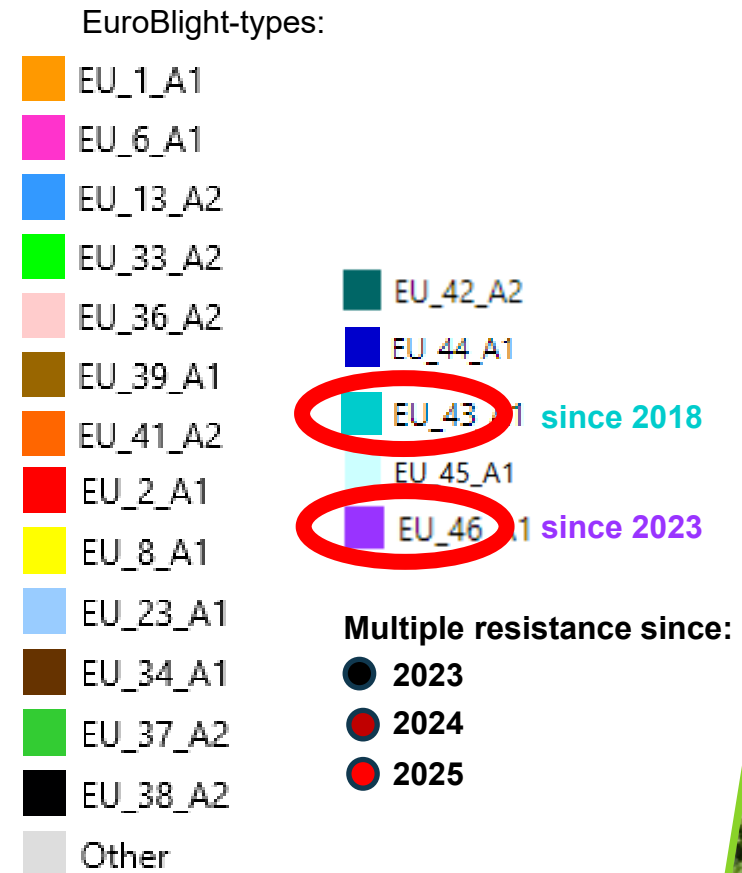
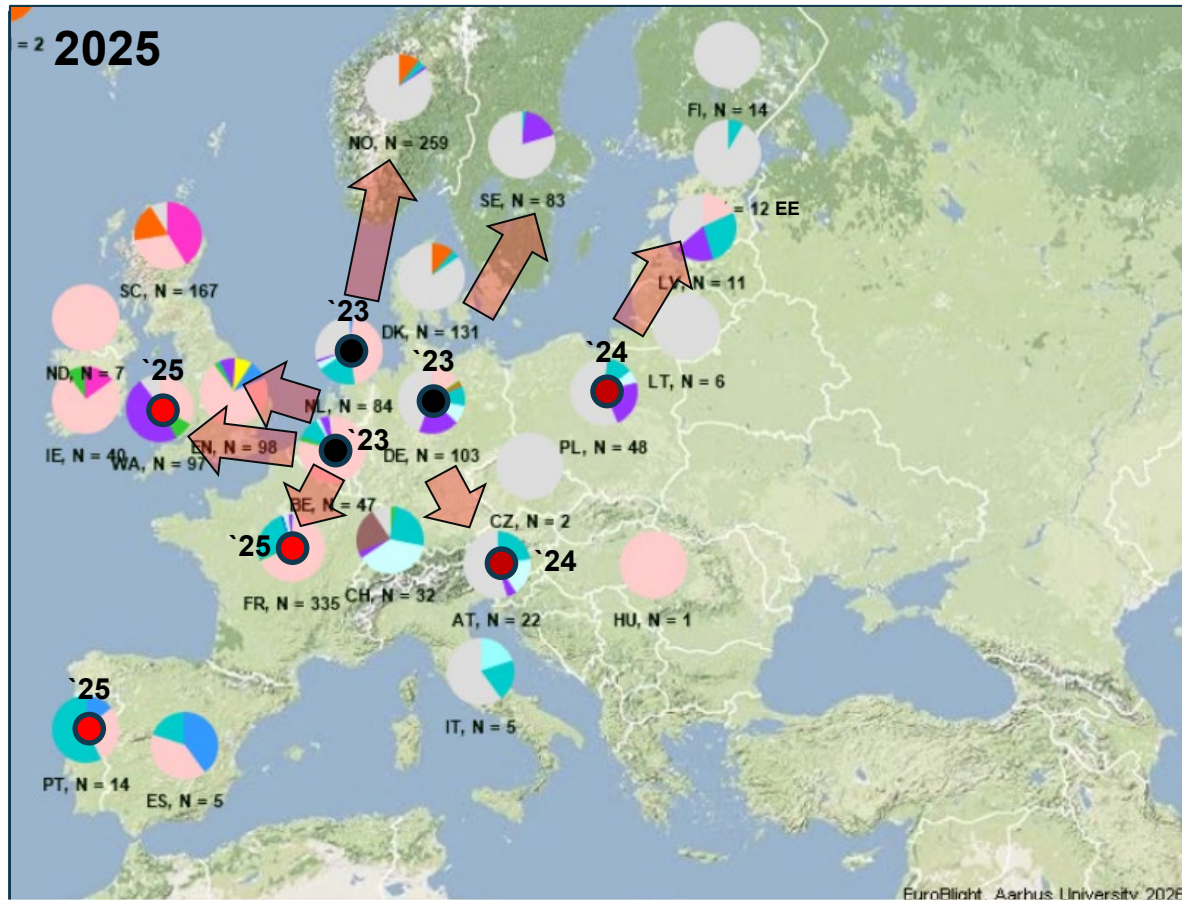
Spread of multiple resistance

from 2024 to 2025



Spatial spread of EU_43 and EU_46 EuroBlight-'types' as well as spread of multiple resistance

Frequency map (final, status May 2026)



- spread to new countries, despite lower disease => EU_46: UK, SE, NO, LV ; EU_43: CH, LV, EE
 - spread of multiple resistance from BE, DE, NL in 2023 to AT, PL in 2024 to FR, UK (PT) in 2025
 - beside resistance to OSBPis and CAAs, also 'intermediate' for metalaxyl in EU_43 and EU_46





Bayers' perspective on best practices in resistance management for strains with multiple resistance

due to the particularities in the biology of *P. infestans*

- // **always full alternation** with an effective partner with different mode of action (no block appl.)
- // **always in mixture** with an effective partner with different mode of action
- // **partner in mixture and its' dose rate should be sufficient** to control the disease on its own
=> e.g. mix of a *Phytophthora*-product with an *Alternaria*-product is not relevant mix for RM
- // **adapt spray schedule to best avoid selection of strains with multiple resistance** (e.g. **EU_43_A1**) as well as priming of EuroBlight-types (e.g. **EU_46_A1**)
- // **apply good agronomic practice**, e.g. primary inoculum control
- // **apply integrated disease management practices**, e.g. use of tolerant varieties



strategy: rational use of available `Modes of Action`, optimized by a high feedback from effective monitoring systems & embedded in a robust disease management concept





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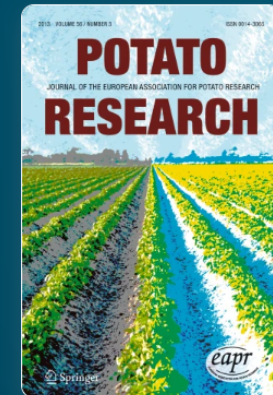
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