Regional spore dispersal as a factor in disease risk warnings for potato late blight

a proof of concept

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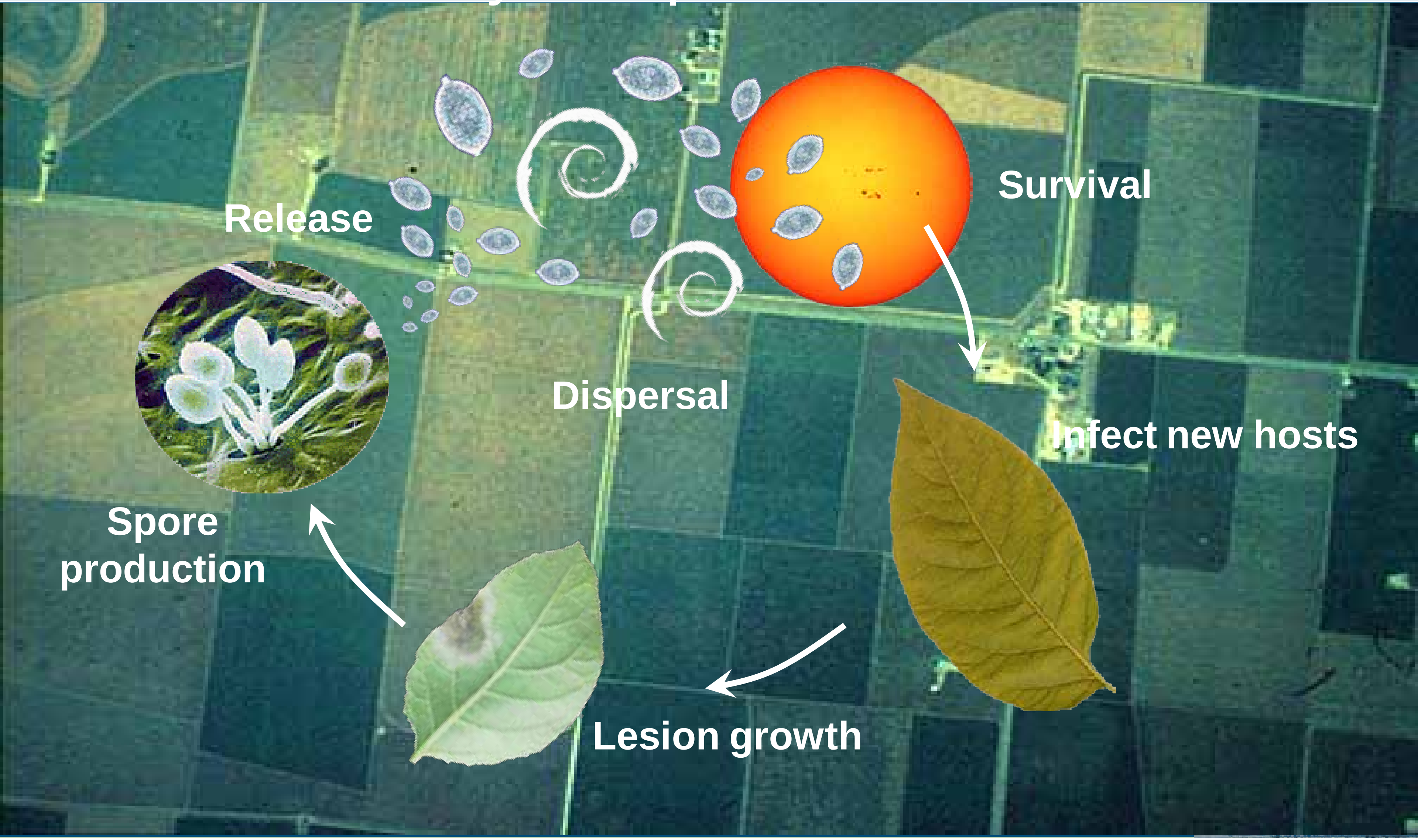
Outline

- Introduction
- Models
- Goals & applications
- Dispersal modeling & spray decisions
  - Components of spray decisions
  - Concepts
  - Perceptions
  - Implementation
- Field trials
- Results
- Conclusions

Introduction

- Research Objectives (PhD project Pete Skelsey)
  - Create tools to improve understanding of spatial PLB epidemiology
    - Field scale potato late blight model (spatial).
    - Models for release, and escape of sporangia.
    - Models for dispersal, survival & deposition of sporangia.
  - Explore management approaches that suppress potato late blight:
    - Reduce fungicide inputs (Umbrella plan)
      Good PLB control, as little fungicides as possible
    - Additional spatial strategies for PLB management (DuRPh)

PLB disease cycle: spatial model



Model application

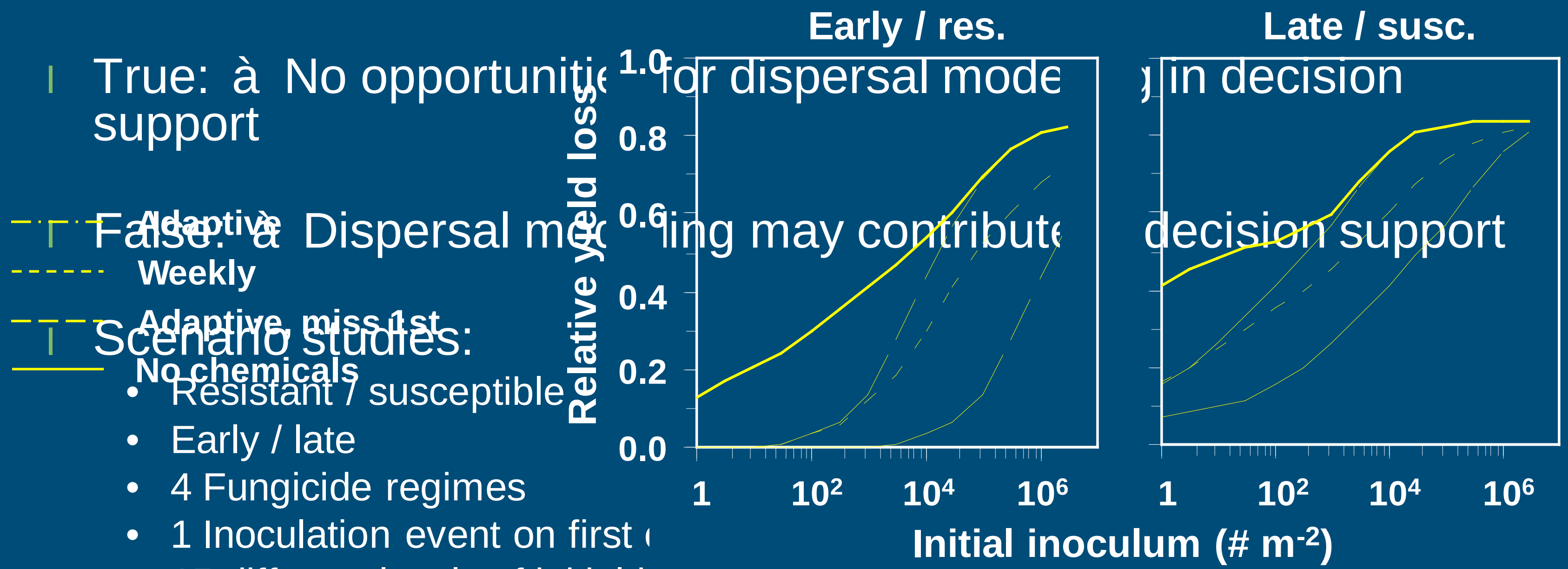
- ……
- R-gene deployment: PLB buffering landscapes (DuRPh)
- Decision support (Umbrella plan)
  - Umbrella plan:
    - Reduce environmental impact of fungicide use against PLB by 75%.
    - Short term: Improve Fungicide effectiveness:
      - Match operational requirements and fungicide characteristics
      - Reduced dose rates (protectants) on more resistant cultivars
      - Modified spray intervals on more resistant cultivars
    - Long-term: Host resistance
      - Classical breeding & GM techniques

Infection risks & Spray decisions

- Three components of spray decisions:
  - Crop
    - Remaining fungicide protection level
    - Resistance level
    - Maturation
  - Weather
    - Critical periods / Potential Infection events
  - Pathogen
    - Production & Influx of sporangia…….but
      - Sources (location & strength) unknown
      - Complex calculations
      - Lack of empirical dispersal data
  - Added value for dispersal models?

Perceptions (I)

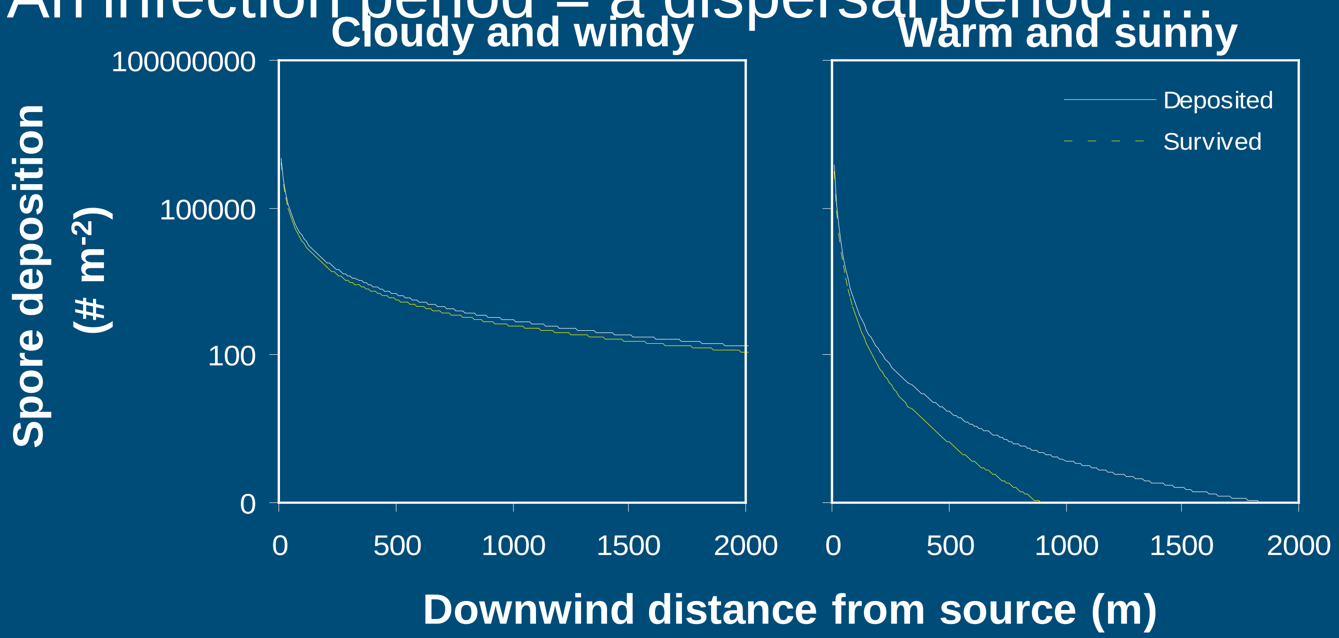
- A single spore is all you need…….
  - True: à No opportunitie for dispersal mode g in decision support
  - False: à Dispersal mo ling may contribute decision support
  - Scenario studies:
    - Resistant / susceptible
    - Early / late
    - 4 Fungicide regimes
    - 1 Inoculation event on first
    - 15 different levels of initial in
    - 10 seasons of weather data
    - Yield loss response
    - 5000 simulations



Perceptions (II)

- ‘If the weather is suitable for disease development then inoculum will arrive at your crop !’

An infection period = a dispersal period…..



Concept

- How to include dispersal (modelling) in decision making?

  - We don’t know where all the sources are !!

  - General appraisal of the suitability of the weather for long distance transport of viable sporangia:

    - Preventive control strategy

    - Spray is recommended by standard (aspatial) DSS
      →Crop is vulnerable
      →Weather is suitable for infection

    - Spatial ‘add-on’ component for existing DSS using dispersal models & hypothetical source
      - Dispersal day à do NOT modify spray recommendation
      - Non-dispersal day à Modify recommendation to NO spray

Field trial Valthermond 2007

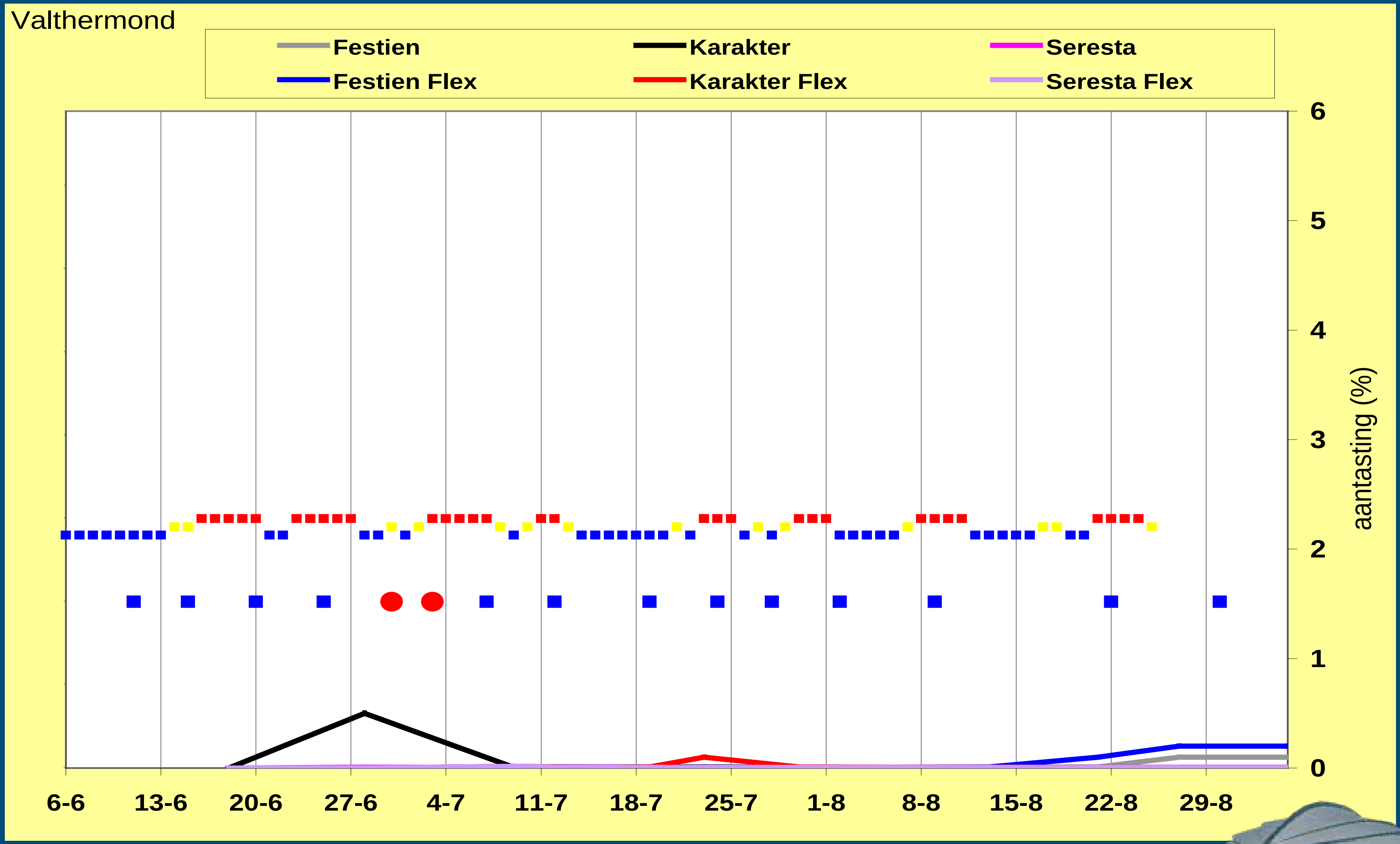
- 3 Cultivars
  - Karakter (susceptible): 0.4 l Shirlan /ha
  - Seresta (moderately resistant): 0.2 l Shirlan /ha
  - Festien (resistant): 0.1 l Shirlan/ha
  - Spray timing for susceptible cultivars!

- 2 Decision support systems:
  - Simcast (standard (non spatial)) DSS
    - 'Blight units' = f(T,RH), 'Fungicide units' = f(rain,T)
  - Simcast + spatial add on
    - 'Blight units' = f(T,RH), 'Fungicide units' = f(rain,T)
    - 'I_x' = f(T,u,R,LAI,IE)
    - Weather forecast: MM5

Field trial Valthermond 2007

- The weather:
  - 2007 Severe blight year
  - July wettest on record since 1901
  - Some fungicides were sold out (and not just in the Netherlands ….)

Field trial Valthermond 2007 (WUR-PRI)



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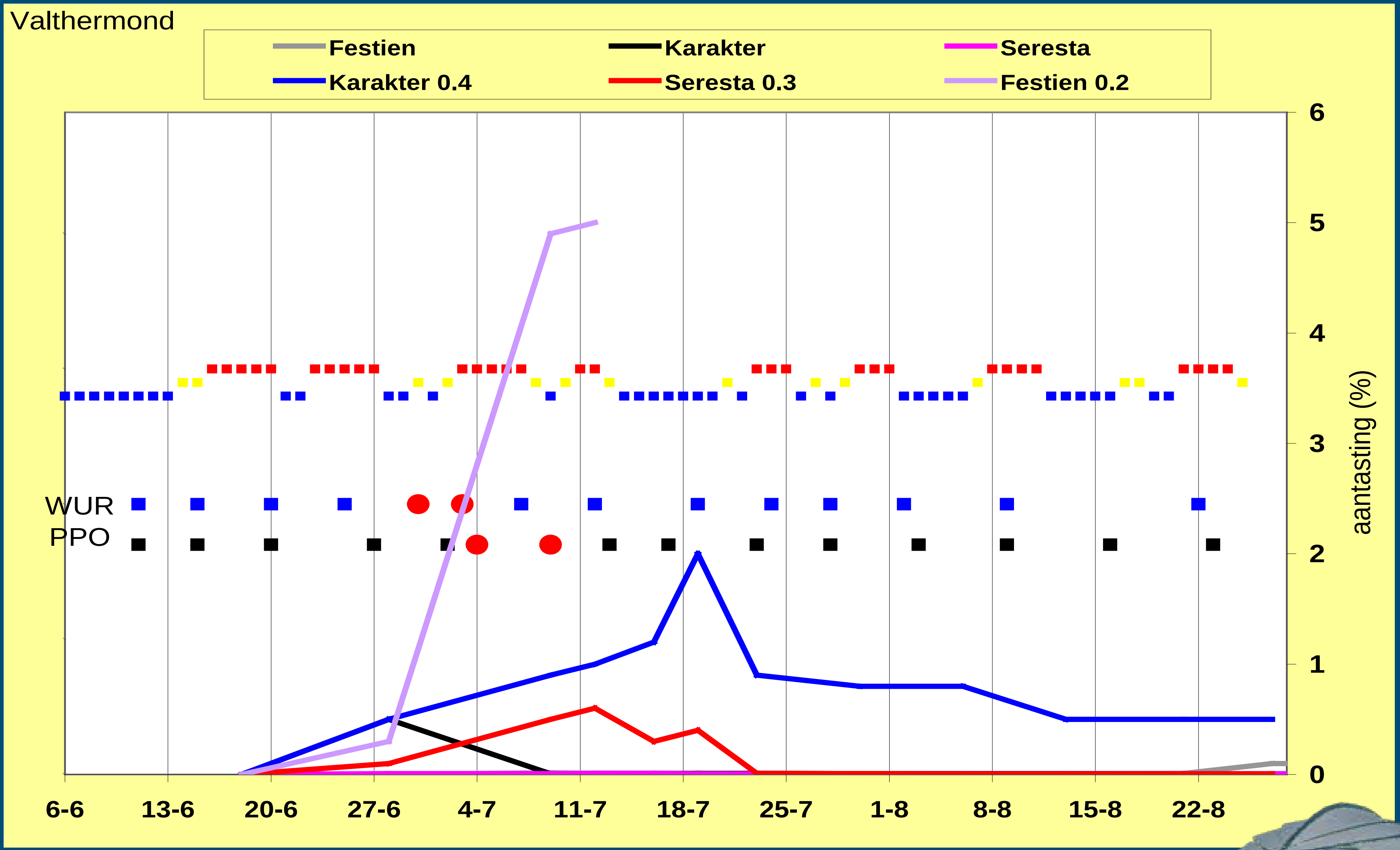
Field trial Valthermond 2007 (WUR-PPO)



Field trial Valthermond 2007

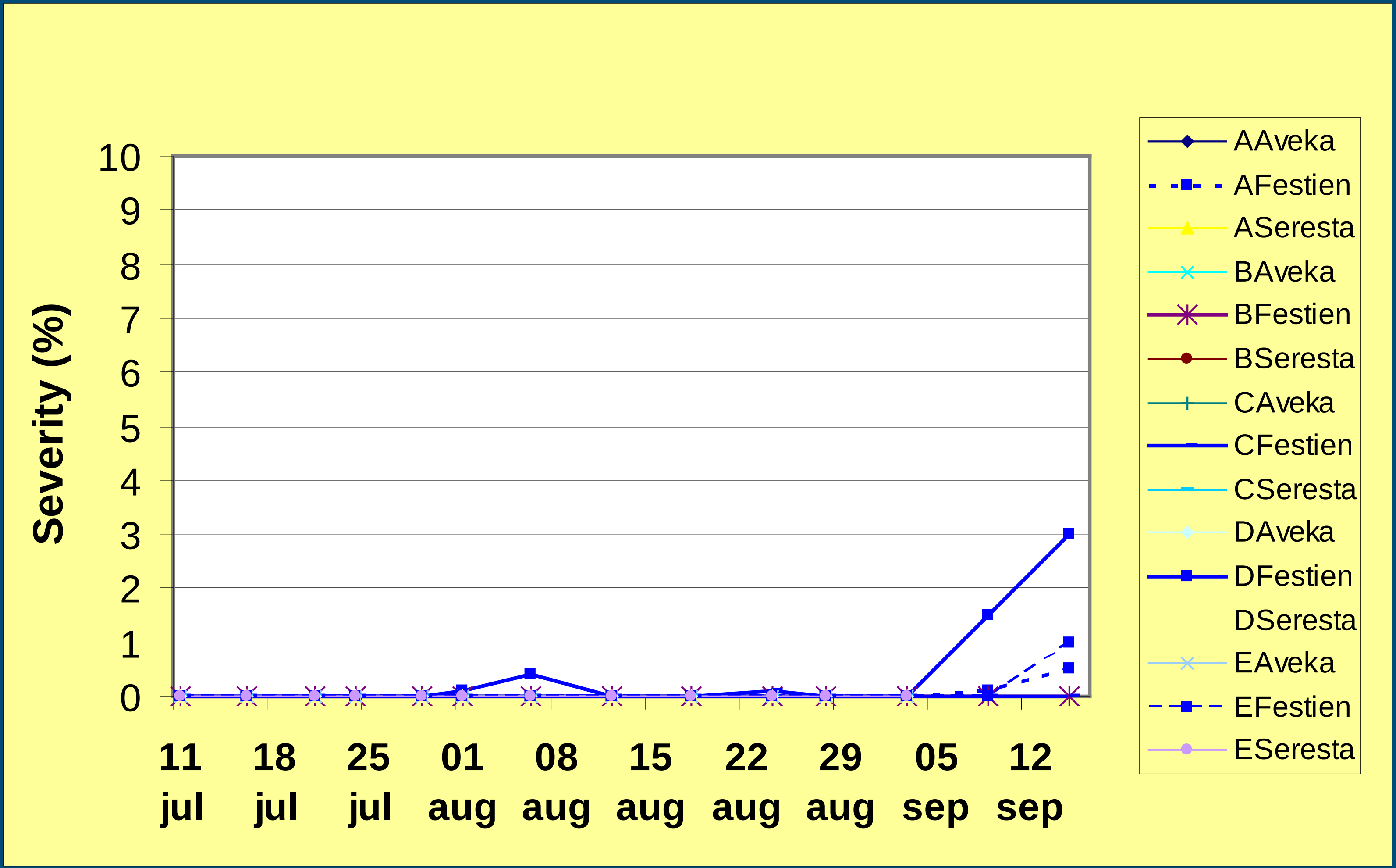
- Results:
  - Good PLB control for all systems (Despite extreme weather)
  - Significant reduction of fungicide input possible:
    - Reduced dose rates (cultivar dependent)
    - Modified spray intervals
  - Effect of spatial add on:
    - Simcast: 15 sprays (always FU based…)
    - Simcast – plus: 13 sprays + 1 modified spray interval for Festien (resistant) Max spray interval: 14 days
    - Full dose rate equivalents:
      - Karakter: 15 (15)
      - Seresta: 8.5 (8.5)
      - Festien: 5.25 (4.75)

Field trial Valthermond 2008

- The weather:
  - 2008 Moderate blight year
  - Wet period 2nd half of August
- 3 Cultivars
  - Karakter (susceptible): 0.4 l Shirlan /ha
  - Seresta (moderately resistant): 0.2 l Shirlan /ha
  - Festien (resistant): 0.1 l Shirlan/ha

  - Spray timing for susceptible cultivars!
- 5 Decision support “systems”:
  - Fungicide protection only (Simcast FU’s)
  - FU’s + Critical periods (blight days)
  - FU’s + Critical periods (blight days) + spatial add on 33% criterium
  - FU’s + Critical periods (blight days) + spatial add on 50% criterium
  - FU’s + Critical periods (blight days) + spatial add on 33% criterium + dose rate adaptation to length of predicted critical period (0.1 l/ha minimum)

Field trial Valthermond 2008



Field trial Valthermond 2008

# Sprays	Resistant	Moderately resistant	Susceptible
FU's only	16	16	16
FU's + Critical period	10 (7)	10	10
FU's + Critical period + Spatial 33%	10 (7)	9	9
FU's + Critical period + Spatial 50%	3	9	9
FU's + Critical period + Spatial 33% + length critical period	9	8	9
Full dose rate equivalents			
FU's only	4.75	8.50	16.00
FU's + Critical period	6.75 (3.75)	5.50	10.00
FU's + Critical period + Spatial 33%	7.5 (4.5)	5.00	9.00
FU's + Critical period + Spatial 50%	5.00	5.00	8.25
FU's + Critical period + Spatial 33% + length critical period	3.63	3.40	5.30

Field trial Valthermond 2008

- Conclusions 2007 & 2008
  - Fungicide degradation
    - Solid blight control
    - Too many sprays
  - Blightdays
    - Spray timing critical! (Inadequate definition blightdays in 2008)
    - Better timing of sprays
    - Reduction of # sprays
  - Spatial 33% criterium
    - Beneficial for resistant cultivars
    - Potential to reduce # sprays by 30%
  - Spatial 50% criterium
    - Beneficial for resistant cultivars but…
    - Too much risk (on resistant cultivars)
  - Length Critical period
    - Beneficial for less resistant – susceptible cultivars (3.5 – 5.5 full dose rate eq. / season!)

Thank you for your attention!

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