Including regional spore dispersal into spray recommendations

proof of concept of a novel decision support tool

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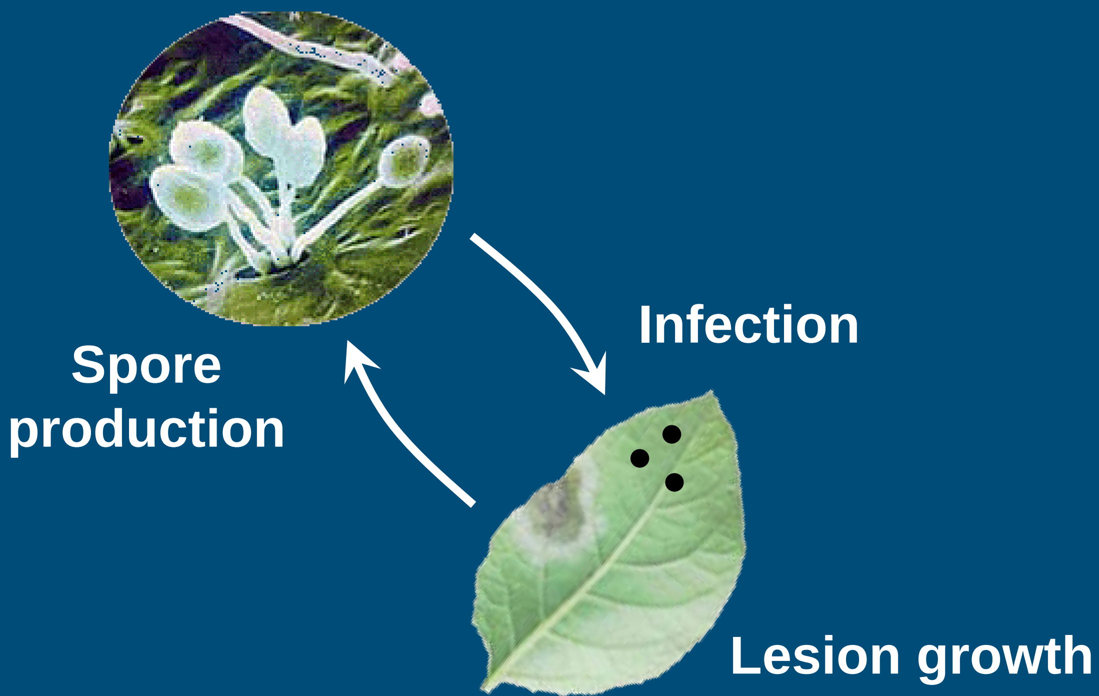
Outline

- Introduction
- Temporal & spatial models
- Research goals & model application
- Dispersal modeling & spray decisions
  - Components of spray decisions
  - Grower perceptions
  - Concepts
  - Implementation
- Field trial
- Results
- Conclusions

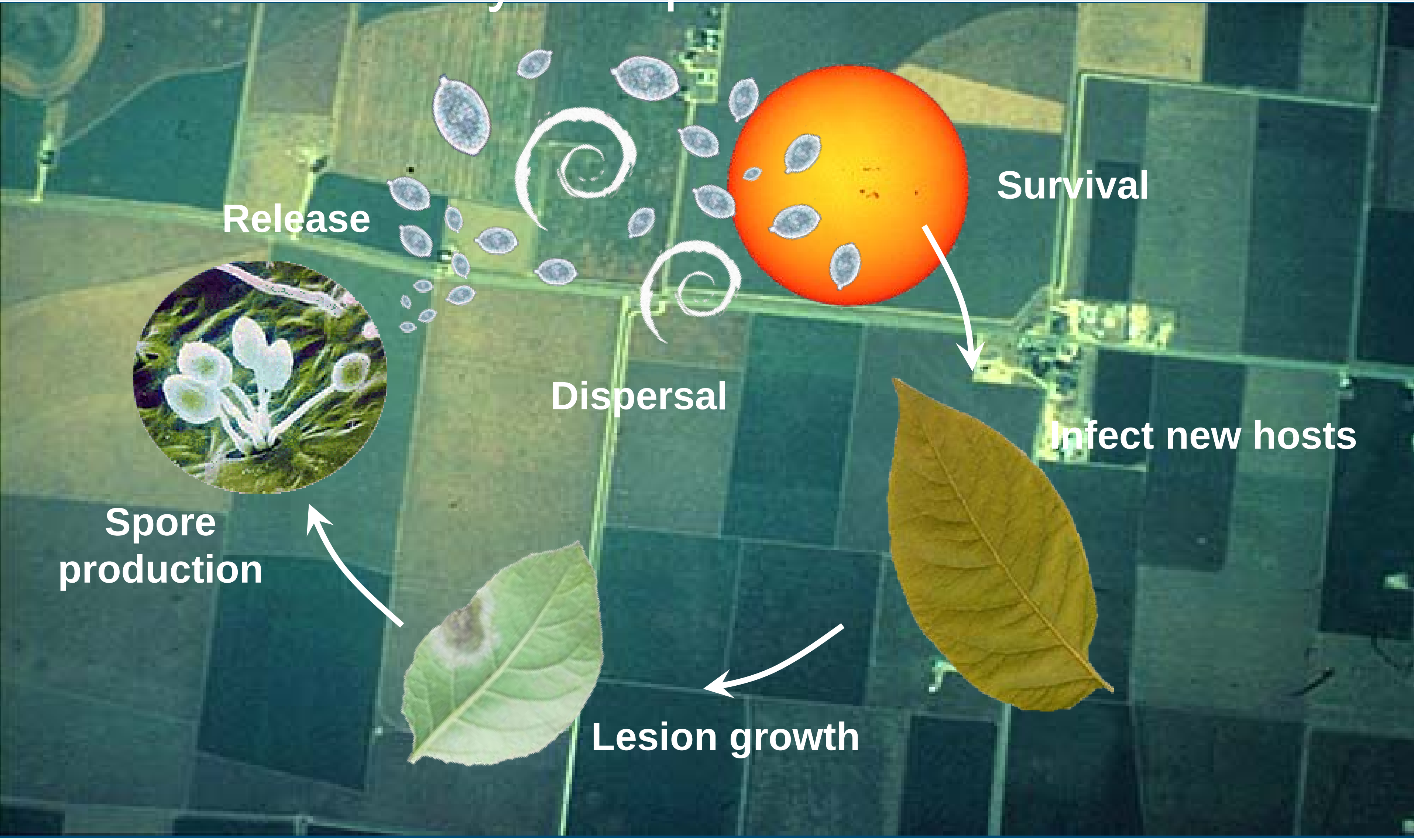
Research Milestones & Objectives

- 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: temporal model



PLB disease cycle: spatial model



Model application

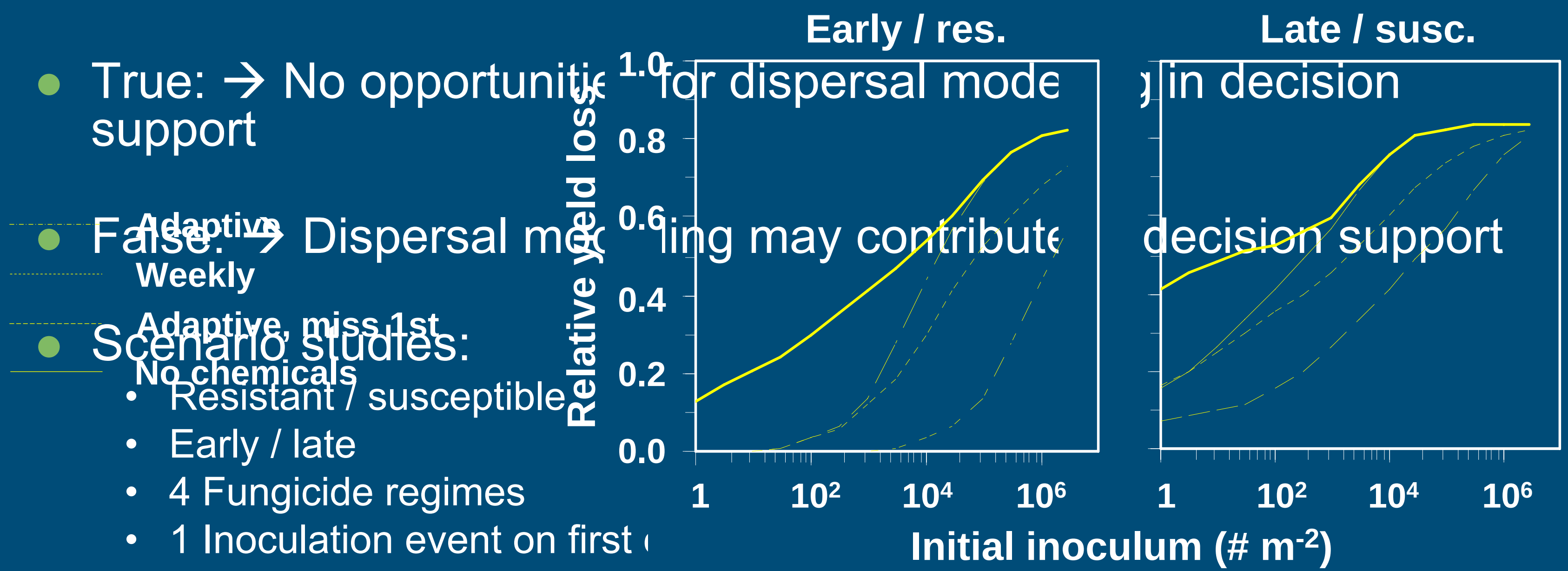
- ……
- Resistance management
  PLB buffering landscapes (DuRPh)
- Decision support (Umbrella plan)
  - Umbrella plan:
    - Reduce environmental impact of fungicide use against PLB by 75%.
    - Short term: Improve Fungicide effectiveness:
      - Match operational requirements and fungicide characteristics
      - 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
    - Resistance level
  - Weather
    - Critical periods / Potential Infection events
  - Pathogen
    - Influx of sporangia…….but
      - Sources unknown
      - Complex calculations
      - Lack of empirical dispersal data
  - Added value of dispersal models?

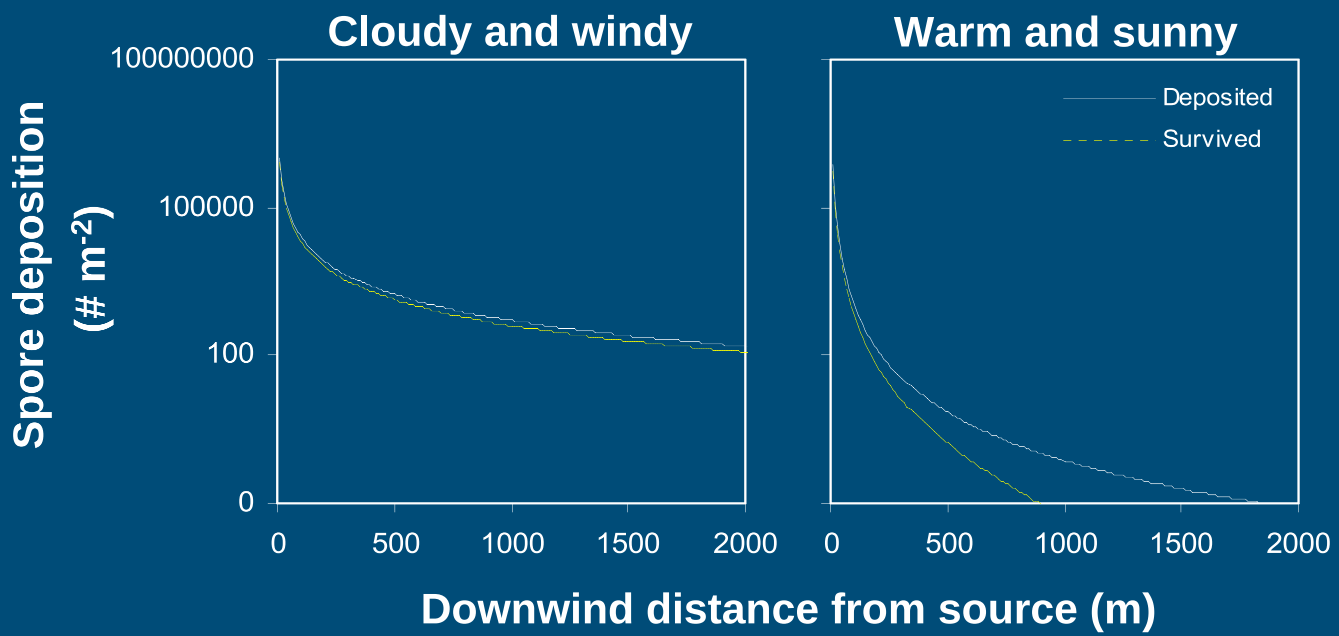
Grower perceptions (I)

- A single spore is all you need…….
  - True: → No opportuniti… for dispersal mode… in decision support
  - False: → Dispersal mo… ling may contribut… 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



Grower 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 !!
  (and we never will)

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

  - Preventive control strategy

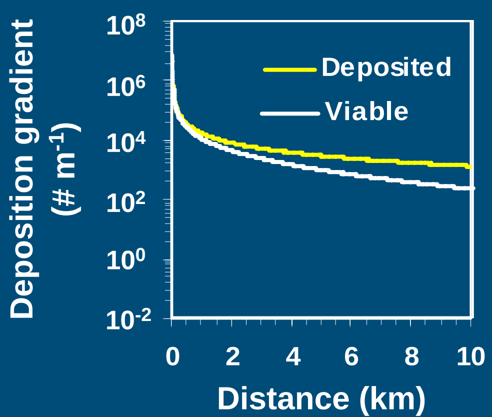
  - Spray is recommended by standard (aspatial) DSS
    → Crop is vulnerable
    → Weather is suitable for infection

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

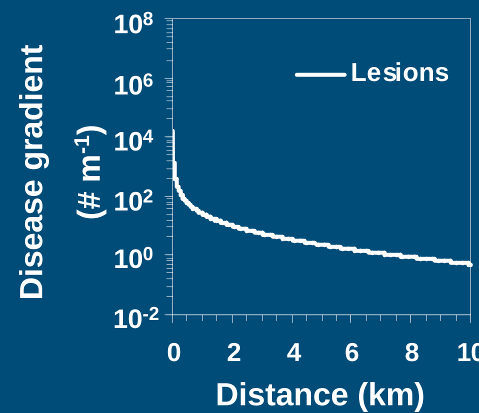
Making a decision

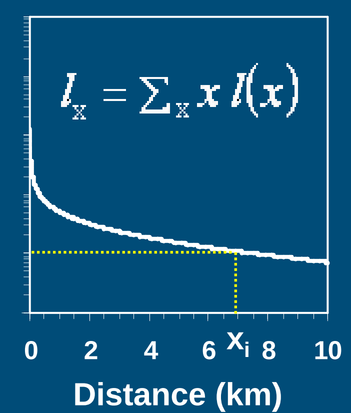
1. Predict deposition gradient.
2. Predict survival.
3. Predict disease gradient.
4. Summarize gradient:

   l_x (lesions) = single number.
5. Compare l_x to threshold.

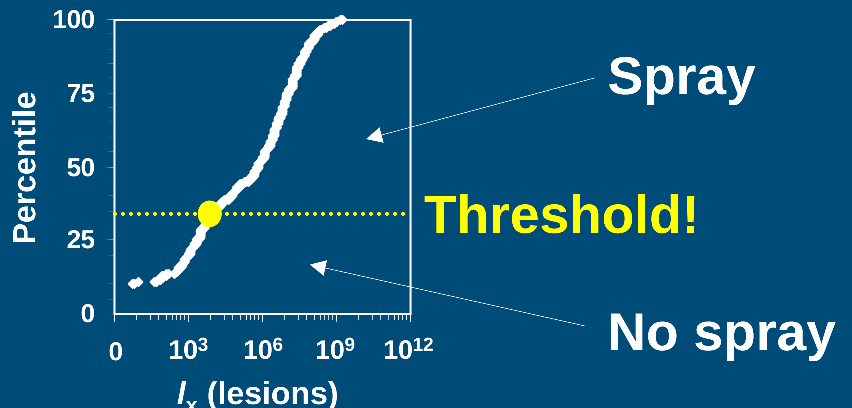


x IE for cultivar





Decision:



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!

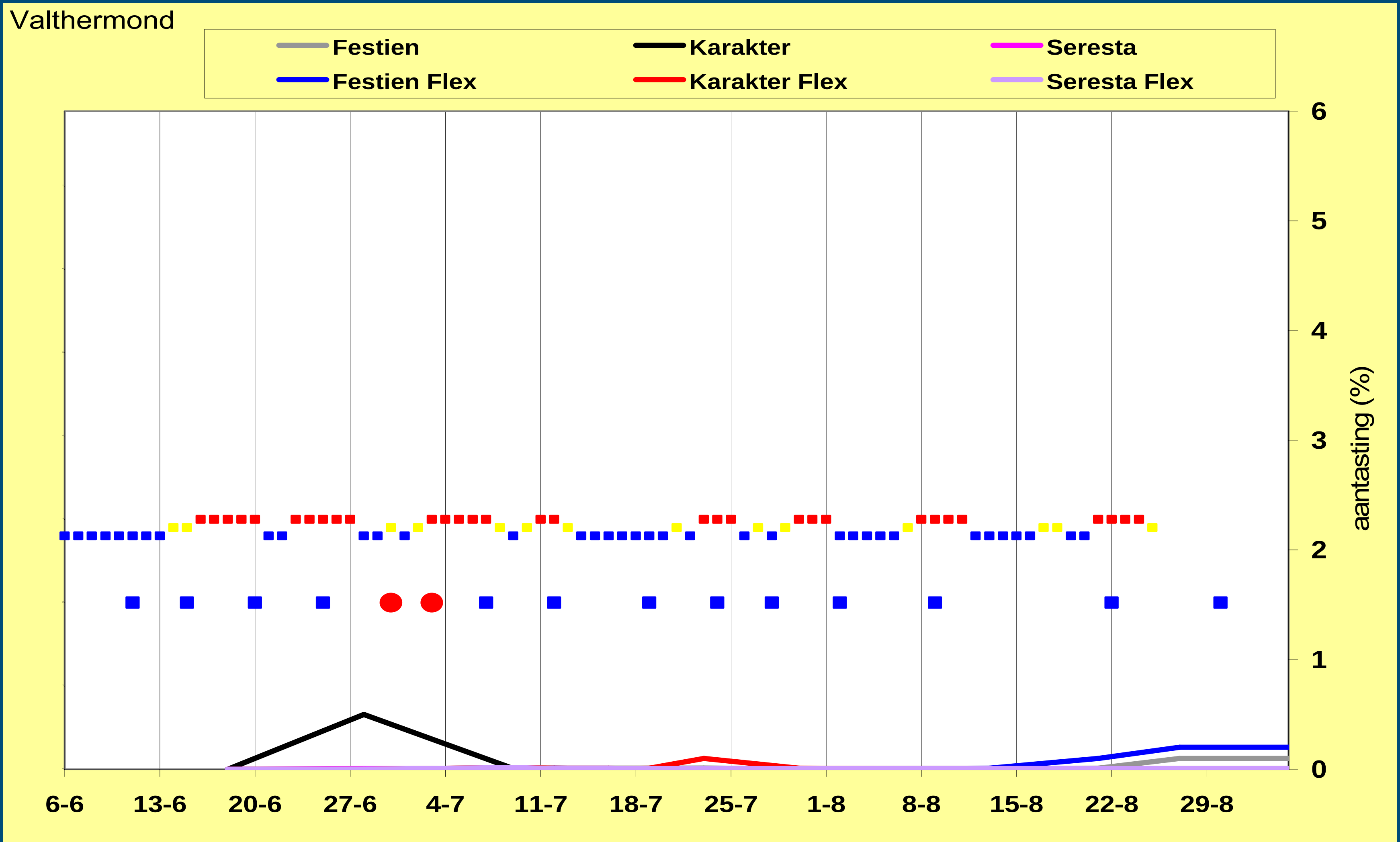
- 2 Decision support systems:
  - Simcast (standard (non spatial) DSS
    - ‘Blight units’ = f(T,RH), ‘Fungicide units’ = f(rain,T)

  - 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

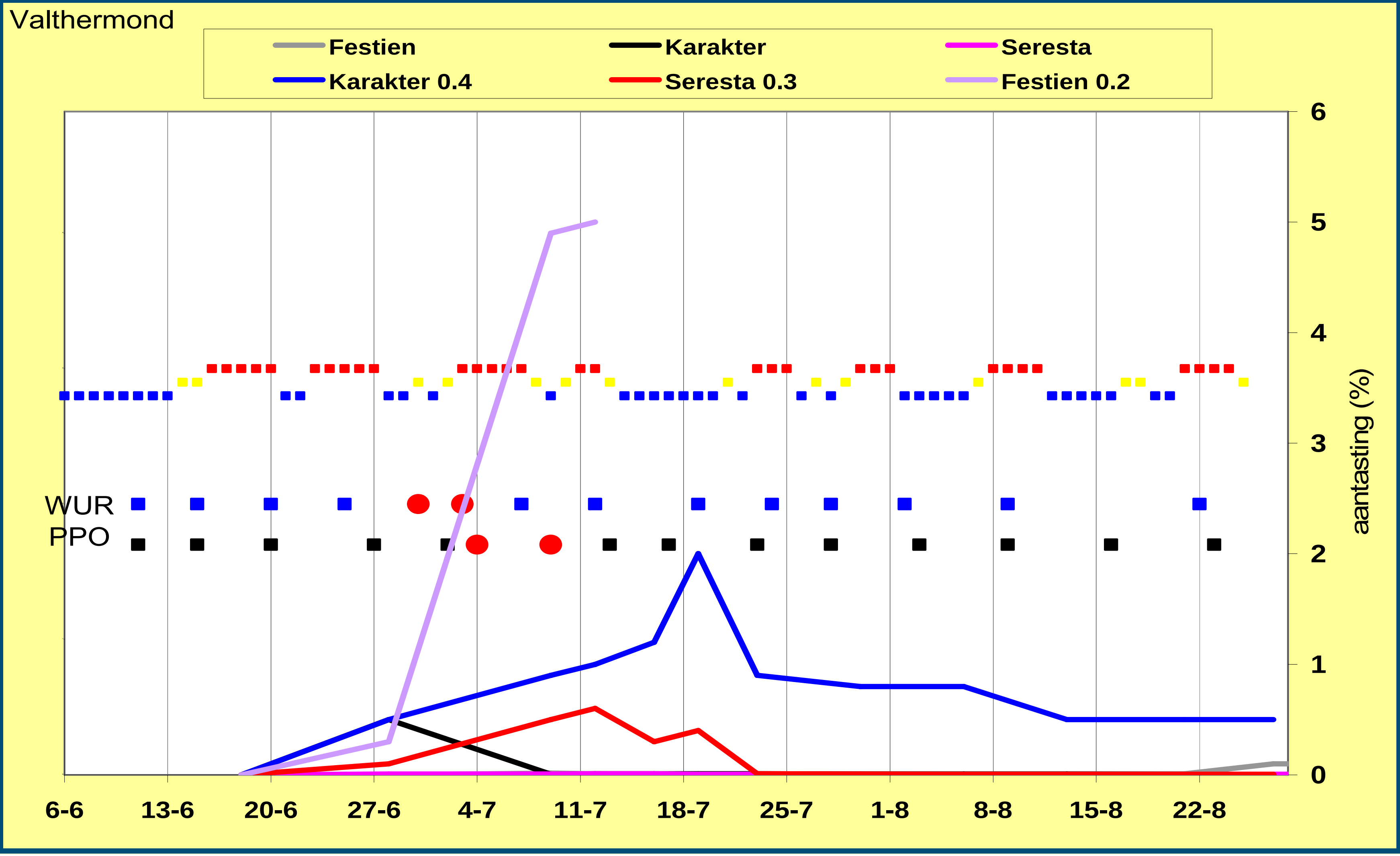
Field trial Valthermond 2007

- 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)



Field trial Valthermond 2007 (WUR-PPO)



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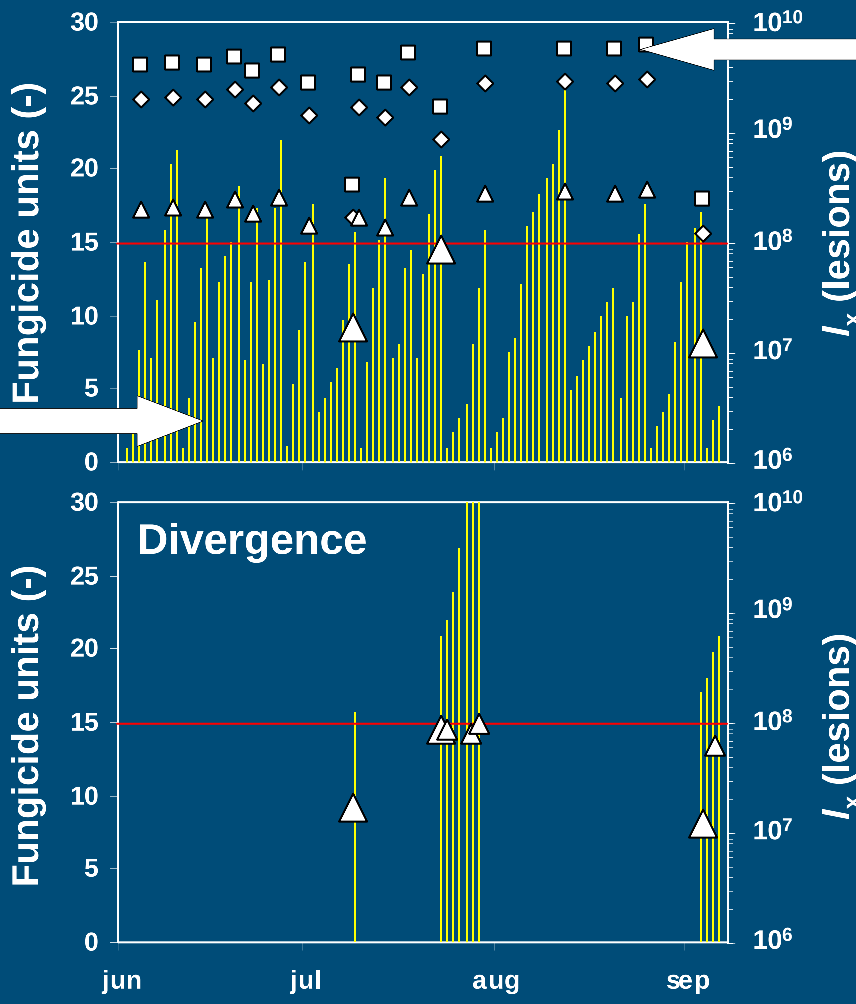
Field trial Valthermond 2007

TEMPORAL:

SIMCAST

= Fungicide units

= Threshold



SPATIAL:

SIMCAST+

■ = I_x, Karakter

◆ = I_x, Seresta

▲ = I_x, Festien

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)
  - First step towards next generation DSS?
- To be continued in 2008….
  - Higher threshold for Lx
  - No accumulating point systems

Conclusions

- Modeling framework (suite of models) to study spatial epidemiology (of PLB)
- Added value of dispersal models for decision making in more resistant cultivars
- General concept for including dispersal information in operational decisions
- Concept successfully tested once, more tests will follow

Thank you for your attention!

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