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Modelling the effects of spatially distributed cropping systems on the epidemics of potato late blight and on the durability of cultivar resistances

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COMITE NORD

BRETAGNE PLANTS

Background and objectives

- Potato late blight (*Solanum tuberosum*) caused by *Phytophthora infestans* is one of most damaging diseases of this culture
- Chemical control is the most widespread method used to contain this disease
- Use of resistant varieties can be the cornerstone of integrated late blight management, but resistance generally lacks durability
- It is therefore essential to preserve the efficacy of potato resistance against potato late blight

The aim of this work is to develop a model, spatially explicit, to represent

- **the effects of cropping systems on epidemics of potato late blight, the associated damage and the adaptation of pathogen populations to cultivar resistances**
- **the agronomic, environmental and economic performances of the simulated cropping systems**

Material and Methods

The IAM concept (Integrated Avirulence Management, Aubertot et al., 2006) was used to develop a generic model called SIPPOM (Simulator for Integrated Pathogen Population Management, Figure 1)

- *The work is based upon:*
  - *i)* Modelling
    - Development of a formalism to represent the durability of quantitative resistance
    - Translation of the conceptual framework (Figure 1) into a simulation model suited to potato late blight on the platform RECORD (Bergez et al, 2009) (Figure 2)
    - Evaluation of the predictive quality of the modules of SIPPOM-potato late blight
  - *ii)* Experimentation
    - Experiments to quantify the primary inoculum production of cull piles and potato volunteers
    - Experiments to analyse the effects of potato crop management on the epidemics of late blight

First results

- Selected models to adapt SIPPOM to potato late blight:
  - Crop model: Spudgro (Johnson et al., 1986)
  - Epidemiological model: Mileos ® (DGAL, Arvalis)
  - Dispersion model: the model developed by Scherm (1996)
  - Damage function: the model developed by Shtienberg et al. (1990)
- Evaluation of the predictive quality of the damage function proposed by Shtienberg et al. (Figure 3):
  - Ability to represent damages of various epidemics for a wide range of cultivars

Conclusion

- SIPPOM late blight will help in designing strategies for integrated, collective and durable management of potato late blight
- The created tool will help in identifying appropriate ideotypes to limit the risk of potato late blight and to enhance the epidemiological modelling of *Phytophthora infestans* life cycle

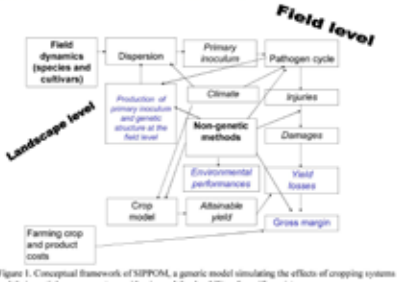

Figure 1. Conceptual framework of SIPPOM, a generic model simulating the effects of cropping systems and their spatial arrangement on epidemics and the durability of specific resistances.

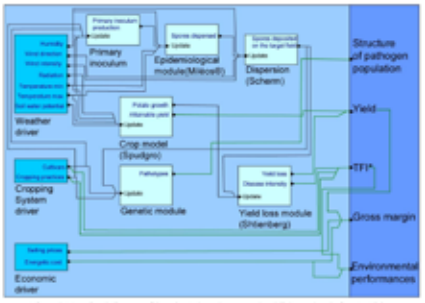

Figure 2. Functional diagram of SIPPOM adapted to potato late blight on the platform RECORD.

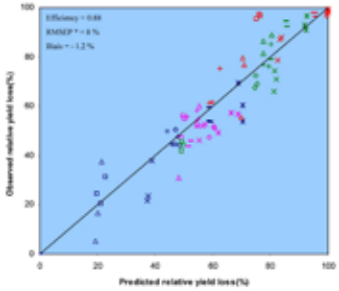

Figure 3. Evaluation of the predictive quality of the selected damage function (Shtienberg et al., 1990). Blue: 2006; red: 2007; green: 2008; pink: 2009 yield losses
○ : Arlac; * : Blanjac; - : Désirée; Δ : Eden; + : Inra 92T.114.76;
◊ : Inra 92T.120.16; • : Naturella; □ : Robijn.
* Root Mean Square Error of Prediction

References

• Aubertot JN, West JS, Bousset-Vaslin J, Salam MU, Barbetti MJ, Diggle AJ. 2006. Improved resistance management for durable disease control: A case study of phoma stem canker of oilseed rape (Brassica napus). European Journal of Plant Pathology, 114, 91-106.

• Bergez J.E., P. Chabrier, F. Garcia, C. Gary, D. Hilaire, G. Garsmeil, E. Ramat, H. Raynal, N. Rousse, D. Wallach, 2009, RECORD: a new software platform to model and simulate cropping systems, 5 SIMPAG SYSTEM DESIGN, Monterey CA

• Champeaux, C., 2006, Raisons à l'utilisation des pesticides en grandes cultures: évolution de l'indicateurs de fréquences de traitements au travers des enquêtes « pratiques culturales » du SCEE entre 1994 et 2001, Rapport INRA – Ministère de l'agriculture et de la pêche

• Johnson,K.B., S.B.Johnson, and P.S.Teng. 1986. Development of a simple potato growth model for use in crop-pest management. Agricultural Systems 19:189-205.

• Scherm,H. 1996. On the velocity of epidemic waves in model plant disease epidemics. Ecological Modelling, 87:217-222

• Shtienberg, D., S.N.Bergerson, A.G.Nikolaeva, W.E.Fry, and E.E. Ewing. 1990, Development and evaluation of general model for yield loss assessment in potatoes, Phytopathology, 80, 466-472