

Peach-Rot Ideotype Modelling (PRIMo)

A tool for designing sustainable production systems - the case of the peach/brown food pair Modeling of Peach-Monilia ideotypes

ABSTRACT

The peach-brown rot couple is a complex system under the triple influence of the genotype (fungus and host), the environment and cultural practices. Studying this system could lead to a reduction of fungicide use and thus to ecological, economical and health benefits.

With the support of Agropolis Fondation, an interdisciplinary team of scientists from INRA conducted a study to illustrate how a model-based design approach could be used as decision making tool in handling such a complex system.

The objective of the team was to conceive innovative management strategies that optimize genotype x environment x practices interactions to limit peach fruit contamination by brown rot in the orchard. The challenge was to optimize the trade-off between antagonistic criteria of major importance for both fruit quality (increasing fruit mass and sweetness) and sensitivity to brown rot (decreasing skin density of cracks) in four different cultural scenarios, i.e., irrigation regimes and thinning intensities. For this, the team worked to improve a process-based model ('Virtual Fruit') which describes growth and quality elaboration of peach fruits. The improved model was used to conceive and evaluate production systems combining innovative practices and cultivars according to their cuticular and qualitative characteristics. This was realized using efficient multi-objective optimization algorithms and reliable evaluation methods. The team identified the genotypic dependant parameters that have the highest significant impact on the model outputs (fruit fresh mass, sweetness, crack density) for each of the processes (fruit growth, sugar metabolism, etc.). Simulations using optimization methods were then carried out in order to identify the combinations of genotypes for each cultural scenario (irrigation, thinning) and for a given environment. Researchers identified solutions corresponding to current breeding scheme and evaluated production systems using various criteria, e.g., feasibility (working time), economic profitability (yield, fruit size, turnover), environmental impact (period relative to harvest, water consumption) and production quality (gustative and conservation potential).

"The funding support from Agropolis Fondation allowed us to have a post-doctoral scientist in this project. It has been a very good opportunity for us to work on the approach, communicate on it through papers and conferences, and position our team in the scientific community developing the use of optimization approaches to contribute to addressing agronomic problems," says Project Leader Bénédicte Quilot-Turion.

Keywords : Plant, Ecophysio/architecture/phenotyping, Operation, Fruit quality, Interaction, Modelling, root

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Project leader : Benedicte Quilot -Turion Mohamed Mahmoud Ould Sidi Nadine Hilgert

Project leader's institution : INRA-INRAE

Project leader's RU : GAFL PSH MISTEA

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PERSPECTIVES

In the present version of the model, the genetic parameters are linear combinations of genetic coefficients (QTL effects). In the future, alleles at loci of interests may be directly taken into account. In addition, different climate scenarios (more locations, long reference series, predictions) should be further tested in order to evaluate the impact of global change on the ideotypes proposed by our algorithms. These prospects will already be engaged within two ongoing projects: FruitBreedomics (Large Collaborative Project EU FP7 KBBE-2010-4 _ 2011-2015) and CAQ40 (INRA ACCAF metaprogram 2012-2015).