Model-based design of integrated horticultural systems: contributions using multiobjective optimization methods

MM. Ould Sidi, F. Lescourret
PSH INRA Avignon
I. Grechi
Hortsys CIRAD Montpellier
Plan

- Introduction
- The developed model
- The optimization problem
- The proposed approach
- Results
- Conclusion and prospects
Introduction

The Integrated Fruit Production:

- **economical** requirements
- Organoleptic and health **quality** of fruits
- **environment** preservation:
  - Reduce the use of **pesticides**

Adaptation of production processes to improve crop quality and environment safety:

- Rational chemical control
- Integration of **alternative methods**
The developed model

Stem
- Rosettes growth
- Growing Shoots growth

Nº shoots
- % growing shoots
- max growth of shoots

Leaf area of the tree

Fruit growth
- Nº fruits

Quality (RI)

Pruning

N Fertilization

Aphids’ growth
- Intrinsic rate of pop increase
- Intra-specific competition coef
- Fall and damages
- predation

emigration
- mortality

insecticides

Thinning

Ladybird release

The developed model
The optimization problem

**Decision variables**
- ✓ Pruning
- ✓ Nitrogen supply
- ✓ Pesticides characteristics
- ✓ Winter oil characteristics
- ✓ Released ladybirds number

**Criteria**
- ✓ Fresh mass
- ✓ Yield
- ✓ Refractometric index
- ✓ Selling price
- ✓ Total quantity of ladybird instars released
- ✓ Number of insecticide applications
- ✓ Total number of aphids
- ✓ Number of growing shoots per tree
- ✓ Proportion of growing shoots > 30cm
The proposed approach
The proposed approach

- **Winter**
  - first « No treatment »
  - second « Conventional »
  - third « Organic* »
  - fourth « Integrated »

- **Full bloom**
  - first « No treatment »
  - second « Conventional »
  - third « Organic* »
  - fourth « Integrated »

<table>
<thead>
<tr>
<th>Season</th>
<th>Mfr</th>
<th>Yield</th>
<th>SP</th>
<th>RI</th>
<th>nGS</th>
<th>pGS30</th>
<th>INS</th>
<th>TotN_LA</th>
<th>TotN_APH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter</td>
<td>PR_ECO</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>PR_DR</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>ENV_ECO</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>
Results

Productive-Economic

ANYT
CONV
BIOL
INTG
Results

Productive-Economic

- ANYT
- CONV
- BIOL
- INTG
Results
Results
Results
Results
Conclusion & perspectives

• An evolutionary algorithm to design technical scenarios for integrated fruit production
• Exploring a wide search space and identifying potentially interesting and feasible solutions

• Reformulate the optimization problem
• Design and test new protection strategies
• Develop a non-aggregative approach based on the concept of Pareto dominance.
• Compare theses two approaches
Thank you for your attention!