Functional traits can they be good indicators of agricultural practice impact on the agroecosystem functioning?

The case of weed management in citrus orchards.

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Martinique (05 au 08/06/2012)
DISCS*, based on prototyping method **

1. Diagnosis

2.1 New set of objectives

2.2 Design experimental prototypes

3. Research experiments and test

4. Layout and test on pilot farms

5. Dissemination and re-assessment

‘Public and professional stakeholders’

‘Professional Stakeholders’

New Cropping systems

Cropping systems prototypes

DISCS re-Design and assessment

Innovative

Sustainable

Cropping System


DISCS : a participatory method to redesign and assess innovative sustainable cropping systems

- Multicriteria assessment based on indicators

- To provide information on criteria difficult to access for complex systems => easy to understand by end users.

Functional traits can they be good indicators of agricultural practice impact on the agro ecosystem functioning?
The case of weed management in citrus orchards
Constraints framework determined by agricultural diagnostic

Objectives of citrus orchard weed management
- Quick and perennial soil coverage
- Reduce mechanised operations
- Enable control of parasites and weeds

Objectives of cropping system improvement
- Eliminate risks of erosion
- Limit pressure from weeds
- Reduce biocide inputs
- Avoid generating additional costs
- Maintaining employment
- Enable water input control according to demand
- Limit the uses of natural resources

Set up habitat zones for natural enemies

Difficulty in mechanising orchard weed control
Non-rational use of phytosanitary products
Production cost
Labor demand
Natural resources consumption
An effective way to increase natural pest regulation consists in allowing spontaneous and/or introduced species to grow and bloom in the field.

These habitats are vital for natural enemies because they can find there refuge, alternative food (nectar, pollen, honeydew..), and favorable conditions for reproduction.

The quality, quantity and stability of these habitats are important to attract, to host and to preserve natural enemies.

Integrated weed management would it be enough to host natural enemies?
**PV:** Inter-row ground cover with perennial resident vegetation

**GL:** Inter-row herbicide application (Glyphosate) on ground cover

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**Reference crop management**

**Current practice**
**PV**: Inter-row ground cover with perennial resident vegetation

**AV**: Alternative PV + one herbicide

**Perennial tactic**

**Annual tactic**

**GL**: Inter-row herbicide application (Glyphosate) on ground cover

**Control**

**PV and AV**
**AN:** Alternative PN + one herbicide

**PN:** Inter-row ground cover with perennial *Neonotonia wightii*

+ LM: Late mowed spontaneous vegetation

* Jannoyer et al., 2011. *Procedia Environmental Sciences*
<table>
<thead>
<tr>
<th>Treatments</th>
<th>Number of weeding practices (from January 2008 to January 2010)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Herbicide of the whole surface area</td>
</tr>
<tr>
<td>GL</td>
<td>6</td>
</tr>
<tr>
<td>AV</td>
<td>2</td>
</tr>
<tr>
<td>AN</td>
<td>2</td>
</tr>
<tr>
<td>PV</td>
<td>0</td>
</tr>
<tr>
<td>PN</td>
<td>0</td>
</tr>
<tr>
<td>LM</td>
<td>0</td>
</tr>
</tbody>
</table>
Field site (Guadeloupe, January 2008 to January 2010)

- Randomized experimental bloc: 6 treatments, 5 replicates (each plot: 105 m² with 3 citrus trees (valencia))

- Do the treatments have an influence on vegetation composition? If so, do plant functional traits allow to discriminate them?

- Do the treatments have an influence on bio-indicator populations? If so, which functional traits appear to be linked to?
Characterization of the plant community

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Interest</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomass</td>
<td>Quantity of the resource</td>
<td>Biomass (T ha(^{-1}))</td>
</tr>
<tr>
<td>Species richness</td>
<td>Diversity of pollen and nectar</td>
<td>Number of specie</td>
</tr>
<tr>
<td>Ground cover</td>
<td>Distribution of the resource</td>
<td>% of ground cover by specie</td>
</tr>
</tbody>
</table>
## Plant functional traits

<table>
<thead>
<tr>
<th>Plant functional traits</th>
<th>Interest</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dicotyledonous (DICOT)</td>
<td>Quality and quantity of pollen and nectar</td>
<td>Presence / absence of the trait</td>
</tr>
<tr>
<td>Open and/or capitate flower (OPEN)</td>
<td>Flower accessibility</td>
<td>Presence / absence of the trait</td>
</tr>
<tr>
<td>Moderate pubescence or glabrous leaves (GLAB)</td>
<td>Mobility</td>
<td>Presence / absence of the trait</td>
</tr>
<tr>
<td>Erected plant (ERECT)</td>
<td>Pollen interception</td>
<td>Presence / absence of the trait</td>
</tr>
</tbody>
</table>
Indirect evaluation based on 3 bio-indicators

- **Coccinellidae**
  - They are likely to increase natural pest regulation, especially in tropical orchard.

- **Parasitoids**
  - To increase their efficiency, these natural enemies need additional food resources (pollen, nectar, honeydew...).

- **Phytoseiidae**
  - They are very sensitive to the habitat disturbance.

Indirect measurement by the parasitism rate of *Coccus viridis* (green coffee scale)
Results: 1/ Characteristics of the plant communities

➢ The weed management treatments influenced the composition of ground cover

Date 10
Results: 1/ Characteristics of the plant communities
Species richness

- A total of 43 species were observed.
- Plant communities showed significant difference in species richness.
- Treatments with a limited number of weeding practices (PN and LM) lead to a loss in number of species.
Results:

- Treatments with *Neonotonia* (PN and AN) have the best ground cover rate.
- The biomass produced for LM treatment is extremely significantly higher than others.
Results: 2/ Impact of treatments on plant functional traits

- No correlation between plant functional traits
- Treatments influenced plants functional traits
Results: 3/ Impact of treatments on bio-indicators

- No impact on the parasitism rate of *Coccus viridis*
- Impact on Coccinellidae and Phytoseiidae populations
Letters are significantly different (P<0.05; Wilcoxon rank sum test)
Conclusion

➢ Weed management treatment had a significant effect on species diversity and composition of plant communities.

➢ Treatment had a significant effect on plant functional traits but relationships between functional traits and bio-indicators are not easy to understand.

➢ Ideal cover crop plant and/or ideal weed management treatment do not exist. However, in some cases, manipulations of habitat have increased the populations of natural enemies.

➢ Thus, in your case, we have to reconsider weed management in order to favor this habitat sustainably and to improve conservation biological control.
Conclusion

- Only a global approach will achieve this because any practice changes have positive and negative effects which need to be evaluated.

- An evaluation using functional traits seem to be relevant because it would provide simple and accessible indicators.

- The aggregation of these indicators into a global evaluation tool seems also relevant, but its validation must be achieved.
Thanks for your attention