Designing ecologically intensive horticultural systems for pest control in the tropics

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INTRODUCTION

Fruit and vegetable growers in the tropics are faced with plant protection issues resulting in food insecurity and low-income in low-input traditional agrosystems. In intensive systems, pesticide-induced adverse impacts on human health and the environment may occur (e.g. in African periurban areas and French overseas islands). In order to provide more and better food to populations of both the southern and northern hemispheres, setting up an “ecologically intensive” horticulture by modifying agrosystems to mobilize natural regulation mechanisms taking ecological processes as a source of inspiration, has therefore become a major challenge. It became necessary to shift from a « tactical » curative approach with chemical treatments (agrochemistry) to a « strategic » prophylactic approach to pest/pathogens infestations/infections (agroecology)(Deguine et al., 2008). Horticultural cropping systems, which are basically multispecies-based, provide ideal frameworks for studying the effect, either positive or negative, of the planned introduction and management of plant species diversity (PSD), on pest & disease impact. The Cirad Omega3 project (Ratnadass et al., 2008) addresses such questions. It builds on case studies taken in various cropping systems, representing a range of PSD levels, scales and deployment modalities, according to an *a priori* typology of pest and diseases based on life-history traits the most amenable to manipulation by PSD. From the study of such a broad range of PSD situations, robust and generic results are expected, namely: i) knowledge on ecological pest & disease regulation processes that can be mobilized in agrosystems; ii) tools & methods for incepting & evaluating innovating cropping systems. We expose here the approach followed and some first results obtained within this framework, with a focus on horticultural case studies.

MATERIALS AND METHODS

An operational flow chart of the Omega3 project is provided in Fig.1.The case studies considered correspond to experimental testing of specific potential PSD effects.

To check the hypothesis that the introduction of service plants with sanitizing/allelopathic effect managed as green manures in market gardens results in a reduction of soil infectious potential by bacterial wilt (BW) *Ralstonia solanacearum*, the host/non-host status of 12 plant species was evaluated in the glasshouse in Martinique. BW symptoms were monitored on the candidate species, then *R. solanacearum* was detected/quantified in the soil and plants 45 days after inoculation. BW incidence was then assessed on susceptible tomato plants transplanted in pots with soils where candidate species had been grown.

To assess the potential of pigeon pea and sorghum as perimeter trap crops/barriers for reducing infestation and damage of Tomato fruitworm (TFW) *Helicoverpa armigera* and Cotton whitefly (CWF) *Bemisia tabaci* on okra, a field test was conducted in Niger in plots (resp. 2 with above-mentioned trap crops as borders, and 2 controls with no trap crop borders, resp. unsprayed and insecticide-sprayed). TFW and CWF populations were monitored resp. by visual inspection of plants and yellow sticky traps, and pest damage symptoms to fruits were recorded at harvest.

In order to select cultivars and/or adjusting sowing dates of both crops to optimize trap crop (attractive) and visual camouflage of maize vs TFW *H. zea* (plus barrier effect vs CWF) to protect the tomato crop, a comparative study of the phenological stages of maize (cvs Java, Challenger F1 & Sugar Jean) and tomato (cv HeatMaster) was conducted in Martinique.

RESULTS AND DISCUSSION

In the BW study, 6 service plants were found promising. The testing of the host/non-host status of 8 more candidate plants is underway, and the allelopathic potential of all 20 species will be tested. This will serve as a model process for selecting service plants which can be used for sanitizing soils in horticultural systems, following a scope statement.

In the study conducted in Niger, TFW infestation and damage on okra were significantly lower in the insecticide-sprayed and pigeon pea-bordered treatments, than in the other 2 treatments. The same study is repeated with more treatments (cotton being added as a potential trap crop) and studies of phenological stages of okra, pigeon pea and sorghum, and of the insect-repellent or insecticidal effect of plant extracts (Neem and Jatropha) in an assisted "push-pull" strategy, are underway.

In the study on trap crop in Martinique, maize cv. Java was found to have a potential as a barrier vs CWF, whereas none of the varieties of maize covered the attractive phenological stage of tomato. The test continues with new planting dates, and the emphasis is placed on the research of "dead-end" potential of maize, either thru bottom-up (antibiotic resistance) or top-down (predation) effects.

These results on case studies on a generalist disease and polyphagous pests with resp. low and high dispersal ability, will provide decision rules which will help set up mechanistic models to predict the impact of PSD deployment modes on disease/pests with similar life-history traits. Existing models can also be used if adequate parameter setting. For instance, Tixier et al. (2006) developed a model predicting nematode population dynamics with variations in PSD. As shown by Potting et al. (2005) modelling approaches can be used to show differences in trap crop population regulatory effect between species.

REFERENCES

Deguine, J.P., P. Ferron, and D. Russell. 2008. Protection des cultures: De l'agrochimie à l'agroécologie. Quae, Versailles, France.

Potting, R.P.J., J.N. Perry, and W. Powell. 2005. Insect behavioural ecology and other factors affecting the control efficacy of agro-ecosystem diversification strategies. Ecol. Modell. 182, 199–216.

Ratnadass, A., Sarah, J.L., Fernandes, P. Avelino, J., Letourmy, P., Habib, R. 2008. Omega3: Ecologically intensive approach for sustainable crop pest management in tropical agrosystems. *In* Proc. Endure International Conference, 13-15 Oct. 2008, Grande Motte, France.

Tixier, P., J.-M. Risède, M. Dorel, and E. Malézieux. 2006. Modelling population dynamics of banana plant-parasitic nematodes: A contribution to the design of sustainable cropping systems. Ecol. Modell. 198:321-331.

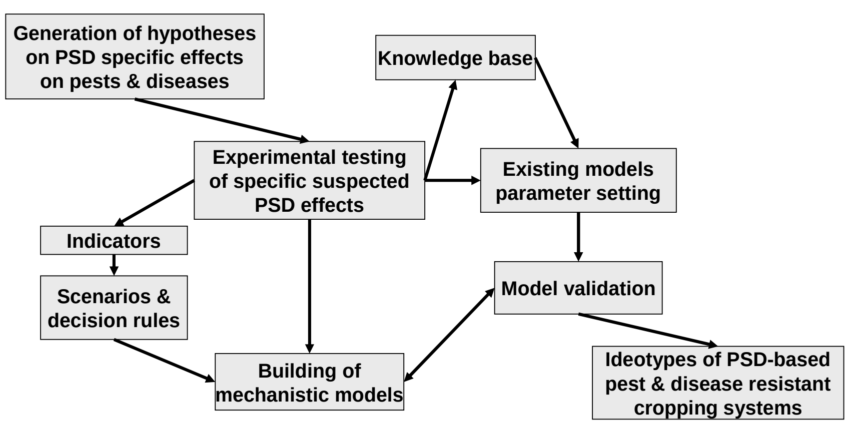

Figure 1. Operational flow chart showing the place of modelling in Omega3 project research process