AN INDIVIDUAL-BASED MODELING APPROACH TO ASSESS TRAP CROPPING IN PEST MANAGEMENT
- *HELICOVERPA ZEA* MANAGEMENT IN TOMATO FIELD -

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INTRODUCTION

- Setting up an ecologically intensive approach to the sustainable management of pests and diseases in tropical agrosystems is a challenge taken up by the Cirad Omega3 project (http://omega3.cirad.fr) that aims at studying the effects of the planned introduction of plant species diversity (PSD) in agrosystems, as a potential alternative to conventional practices based on pesticide use [1].
- One case-study focuses on the management of tomato fruit worm (TFW) *Helicoverpa zea* at the field scale using a stimulant pest diversion PSD-based process: trap cropping with sweet corn.
- Individual-based models (IBMs) are suitable tools to determine how the deployment modalities of traps and crops affect trap cropping efficacy [2,3]. An IBM is under development on the TFW case-study. The modeling approach is presented.

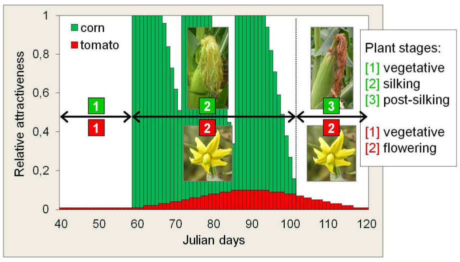

Fig.2. *Dynamic of the maximum relative attractiveness for TFW of tomato and corn plants. Simulation example with three sequential dates of corn sowing and $\alpha_{T:C}$ = 0.10. [2] attractive plant stages.*

THE MODELING APPROACH

❖ MODEL DESCRIPTION

A dynamic and spatially explicit IBM made of three interacting modules (Fig.1).

It runs at the field scale (<1 ha), over one tomato cropping cycle, at a spatial resolution of 1 m² and a daily time-step. Adult TFW females can however move and lay eggs several times during one time-step (Fig.4).

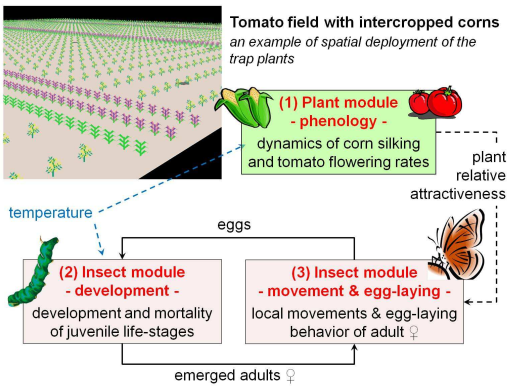

Fig.1. *Schematic representation of the model: interacting modules and spatial representation of the system. The model is developed on NetLogo environment.*

Plant phenology is based on physiological time. **Relative attractiveness for TFW of plants** (Fig.2) is computed from their flowering/ silking rates, assuming that plants attractiveness of corn >> tomato (ratio $\alpha_{T:C}$).

Dynamic of juvenile TFW life-stages (Fig.3) is shaped by their stage-dependent development (based on physiological time) and mortality rates.

Movement and egg-laying of adult TFW females (Fig.4) are driven by variables and parameters relative to their life-history and behavioral traits (host-plant selection patterns, perception distance, fecundity rate) and the state of plants (relative attractiveness, infestation level).

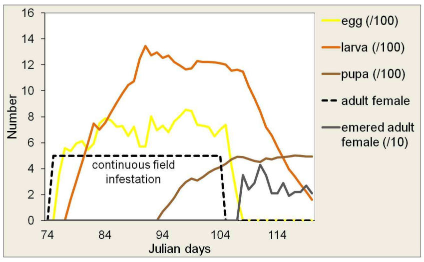

Fig.3. *Dynamic of the TFW life-stages in a field. Simulation example for a 30-day field infestation with 5 adult females per day.*

❖ MODEL PARAMETERIZATION

From experimental data (plant phenology) and existing knowledge and data (insect development, insect movement and egg-laying). There is however a knowledge gap on host-plant selection behavior of adult TFW female and additional dispersal and behavioral measurements are required.

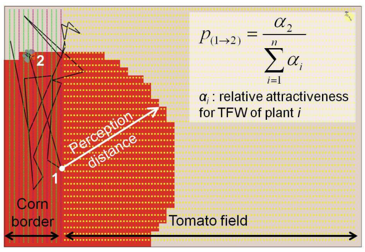

Fig.4. *Trajectory example (line) of an adult TFW female in a field, simulated at a daily time-step. Under an attractiveness-based host-plant selection hypothesis, female in position (1) move to one of the n plants located within its perception area (red area), with the probability $p_{(1\rightarrow 2)}$ of moving to (2).*

❖ MODEL VALIDATION AND SIMULATIONS

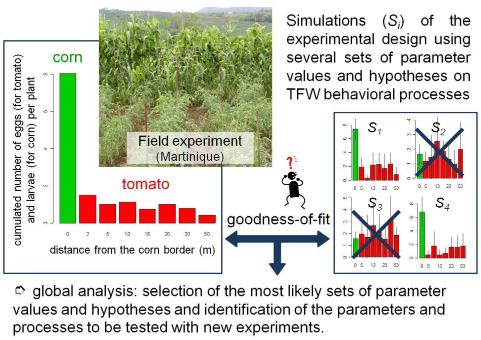

Fig.5. *Interplay between experiments and model simulations to improve the understanding of system functioning.*

Qualitative validation using experimental data (Fig.5).

Evaluation of trap cropping systems based on simulations results that:

- identify new potential period(s) of field infestation with emerged adult females (Fig.3: from 105JD),
- show if the attractive stages of corns and tomatoes are synchronized (Fig.2: not synchronized),
- quantify the infestation level of tomatoes under different spatial configurations (e.g., border (Fig.4, 5), perimeter, patches, strips, etc) of trap plants deployment.

References

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DISCUSSION AND CONCLUSION

- The IBM constitutes a research tool to better understand how the system changes; it can be used to define pattern responses of pest infestations to trap cropping systems by studying the interplay between their design (i.e., attractiveness characteristics and modalities of spatio-temporal deployment of the trap plants) and life-history and behavioral traits of pests.
- The IBM is a generic model to evaluate and optimize the design of trap cropping systems for the management of TFW *H. zea*, and for other pests if adequate parameter setting.

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