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.

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).

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 αc,t).

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).

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.

MODEL VALIDATION AND SIMULATIONS

Simulations (S) of the experimental design using several sets of parameter values and hypotheses on TFW behavioral processes

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.

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.

References


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