iCROPM2020 - 30/09/2019 - Modelling of the mango tree – blossom gall midge system: in silico assessment of its functioning.

- Oral communication
- 2. Crop modelling for ecological intensification

Modelling of the mango tree – blossom gall midge system: *in silico* assessment of its functioning.

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Introduction

Mango (Mangifera indica L.), a major fruit production in tropical and subtropical regions, is facing many production constraints. In particular, mango tree exhibits phenological asynchronisms that result in long periods of susceptibility to pests and diseases. Among them, the mango blossom gall midge (BGM, Procontarinia mangiferae Felt) (Amouroux, 2013) can cause significant yield losses by damaging mango inflorescences to lay eggs. The last instar larvae of BGM leave the inflorescences, drop to the ground and bury themselves into the soil to pupate. Then adults emerge from pupae in the soil. The life-cycle lasts less than one month (Prasad, 1971). Management solutions for the mango crop are required to control BGM. Currently, some pesticide-free levers are considered relying on soil mulching (Brustel, 2018). Mulching is used as a physical barrier to break the BGM life-cycle, by preventing BGM larvae from burying into or adults from emerging from the soil. BGM population being only estimated indirectly with larvae trapping, the objective of this study was to develop a quantitative modeling approach of the mango-BGM system that integrates knowledge on the BGM life cycle and assess the effect of mulching on it.

Materials and Methods

Data were collected in 2017 in a mango orchard (cv. 'Cogshall') located at Saint-Paul, Réunion Island. The orchard was split into three patches with different soil mulching treatments including low weed cover, high weed cover and synthetic mulching with plastic cover. BGM larval population was monitored twice a week from July to October with 60 traps positioned under inflorescences. Additionally, burst and death dates of sampled inflorescences were also monitored weekly.

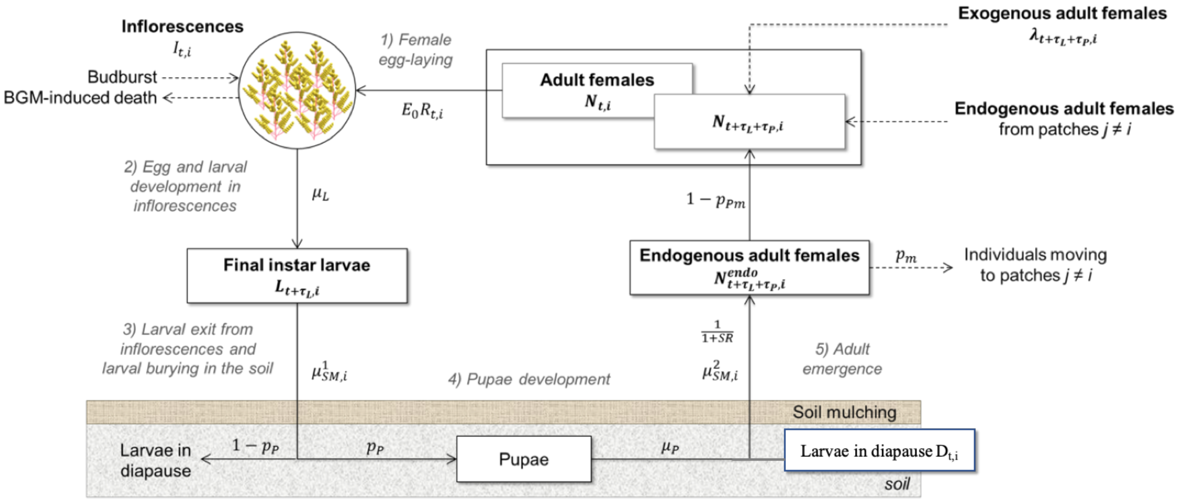
The mango-BGM model simulates the dynamics of BGM populations of an orchard at a daily time-step during the period of mango flowering. The model is defined at the patch scale and considers: i) age-structured inflorescence population dynamics, ii) stage-structured BGM population dynamics, iii) orchard colonization by exogenous BGM individuals and individuals emerging from diapause, and iv) movements of endogenous individuals between patches. Model inputs are the daily numbers of bursting inflorescences. A set of parameters are defined controlling for instance the survival probabilities of larvae for each soil mulching, etc. Calibration of these parameters was made using the multicriteria optimization algorithm NSGA-II (Deb et al., 2002) to minimize difference between simulated and observed BGM larval population dynamics.

Results and discussion

Model simulations makes it possible to investigate the responses of the mango-BGM system to mulching treatments. Different hypotheses were also tested to improve the model such as the effect of temperature on diapause. These hypotheses make it possible to capture increase of population according to inflorescence dynamics but failed to capture the rapid decrease of the BGM population at the end of the season. This seasonality modulation can still be modelled and quantified but open questions on the biological processes controlling this phenomenon.

Conclusion

This model allows to represent the main processes of BGM life cycle and test their impact of the population dynamic. Next step will be to test *in silico* alternative BGM management levers such as the manipulation of mango phenology to reduce the flowering period, which could be achieved using pruning (Persello et al., 2017).



Modelling of the BGM life cycle and its interaction with mango inflorescences and soil mulching.

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