The Sterile Insect Technique. On the usefulness of Mathematical Modelling

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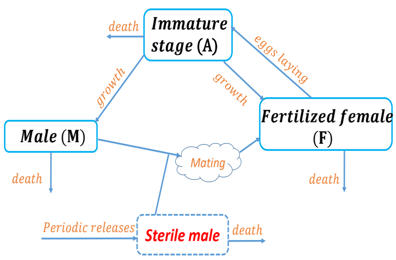
1. Introduction

- The development of sustainable vector/pest control methods is of utmost importance to reduce the risk of human vector-borne diseases, like Chikungunya, Dengue or Malaria, and also pest damages on crops. Among them, the **Sterile Insect Technique (SIT)** is a very promising one.
- The classical SIT relies on the mass releases of males sterilized by ionizing radiations. The released sterile males transfer their sterile sperms to wild females, which results in a progressive reduction of the target population.
- **Several questions** : When ? How many ? Where ? Duration, thanks to the fact that massive releases are only possible for a short period of time.

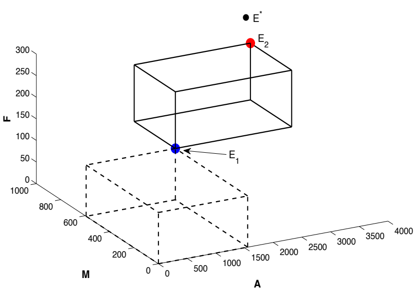
2. Entomological model diagram



- **Immature** stage: eggs, larvae, and nymphs/pupae stages.
- Sterile males are released periodically.
- A qualitative analysis gives an estimate of the minimum number of sterile males, M_{T_1}, to release to drive an established pest population to **elimination**.
- However, **when the population is small**, elimination is possible even with (very) small releases (below M_{T_1}).

3. The "trap" box strategy

From the previous results, we derive a control strategy: first, release many sterile insects to start from E^* to enter the dashed box; then, continue to release few sterile males to maintain the wild population in the "trap" box.



4. New control strategy – SIT size and minimal time estimations

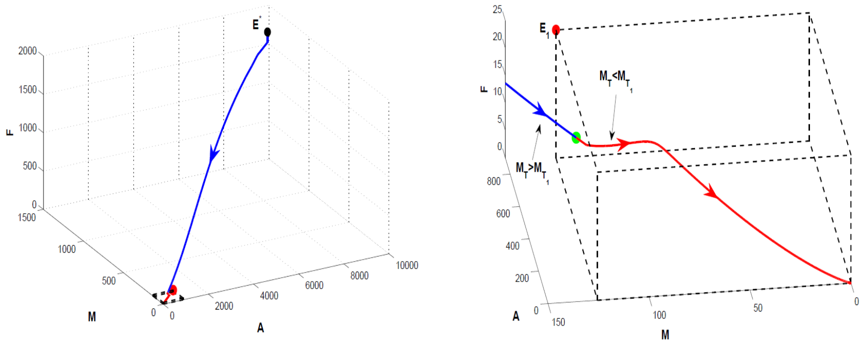
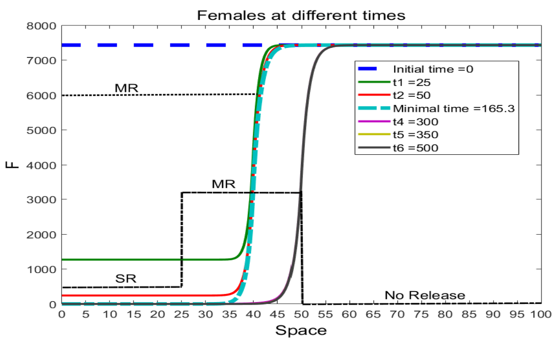


Illustration of the SIT strategy:

1. Massive releases, $5 \times M_{T_1}$, of sterile males (blue trajectory) during a finite time, t^*, to enter the "trap" box. Its shape is defined according to the size of the small releases, here 100.
2. When $t > t^*$, small SIT releases are done. They are sufficient to ensure that the wild population stay in the trap box, and also converges slowly to **0**.

- SIT only: simulations show that $t^* = 162$ days are necessary to enter the "trap" box .
- If adulticide is used before SIT starts, then t^* reduces to 113 days, [2].

5. Toward a spatial-"localized" SIT strategy



- Recovering and maintaining a vector/pest-free sub-domain, $[0, 25]$, with MR=$5\times M_{T_1}$=18725 for massive releases, and SR=100 for small releases. The minimal time for MR is 166 days. This strategy can also become "dynamic" and can push back an invasive vector/pest.

7. Acknowledgments

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6. Conclusions

Modeling, analysis, and simulations provide several useful information about the most important parameters to be estimated, the size of the releases to control the wild population, and also possible control strategies to be used in the field... before any field experiments!

8. References

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