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STERILE INSECT TECHNIQUE FOR CROP PROTECTION: ACCOUNTING FOR RESIDUAL FERTILITY

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The context of this work is the experimental introduction of sterile males to fight the Mediterranean fruit fly *Ceratitis capitata* in orchards in Corsica (France). It aims at optimizing the deployment of the Sterile Insect Technique (SIT) in an agricultural context. SIT is a biological control technique based on mass-rearing, radiation-based sterilization, and releases of the pest species targeted for population control. The sterilization process is subject to a trade-off: radiation doses should be high enough to effectively sterilize the males, but not too high to preserve their ability to attract females and mate.

To represent the pest dynamics when sterile males are released, we have built a mathematical model based on differential equations, consisting of three compartments: sterile males, wild males and wild females. With this model, we compared three cases: perfect male sterilisation, contrasted with two situations in which residual fertility is taken into account, associated either with or without a fitness cost. We varied the residual fertility level and the associated fitness cost and studied their influence on the population dynamics by means of analytical studies (equilibria, stability, bifurcations) illustrated with simulations of the model calibrated for *C. capitata*.

We showed that when residual fertility is below a threshold value, wild populations can be driven to extinction by flooding the landscape with sterile males. As expected, too high a level of residual fertility makes SIT less effective and hinders population control. Nevertheless, even if the residual fertility exceeds the aforementioned threshold value, substantial decreases in outbreak levels can be achieved. Indeed, SIT can still be effective for residual fertilities up to twice the threshold. Our results hence generalise the findings presented in [1]. Finally, the presence of an associated fitness cost, which is very likely, has an important impact on the acceptable residual fertility level and on control efficiency.

References

[1] Aronna M.S. and Dumont Y. (2020). On Nonlinear Pest/Vector Control via the Sterile Insect Technique: Impact of Residual Fertility, *Bulletin of Mathematical Biology* , 82(8):110.

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