Sterile Insect Technique for crop protection: accounting for residual fertility

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Sterile Insect Technique (SIT) for crop protection: accounting for Residual Fertility (RF)

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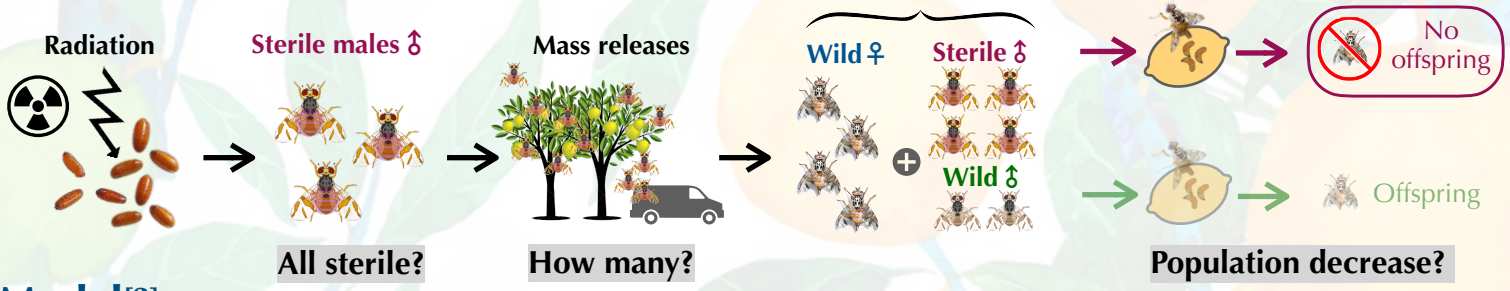
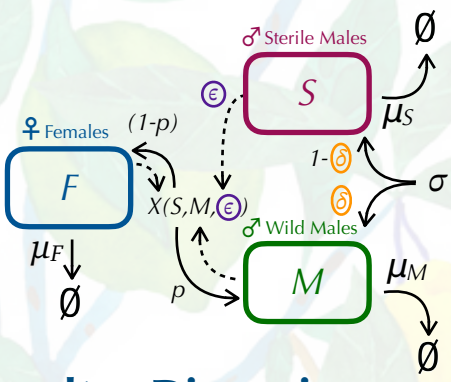
Introduction: SIT[1]



Model[2]



$$\begin{cases} \dot{S} = -\mu_S S + (1-\delta)\sigma \\ \dot{F} = -\mu_F F + r(1-p)X(S,M,\epsilon)C(F)F \\ \dot{M} = -\mu_M M + rpX(S,M,\epsilon)C(F)F + \delta\sigma \end{cases}$$

Residual fertility

δ, ϵ : proportion of non-sterile males among the releases

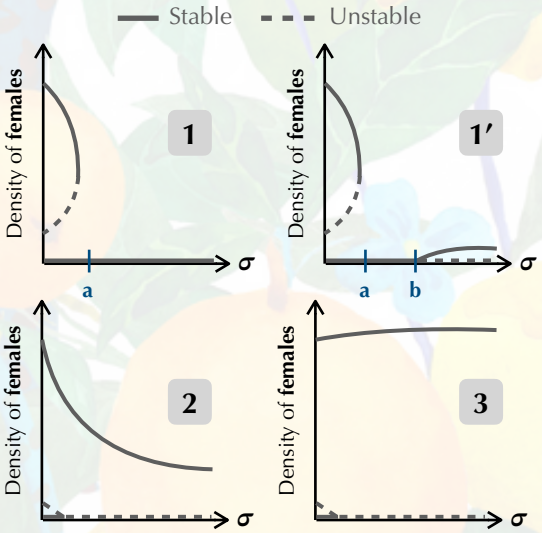
- (0) No ~~Residual fertility~~ $\delta = 0, \epsilon = 0$
- (1) Cost-free fertility model $\delta \neq 0, \epsilon = 0$
- (2) Costly fertility model $\delta = 0, \epsilon \neq 0$

μ: mortality rate
r: emergence rate
p: proportion of males
$C(F)$: female competition
σ: sterile male release rate
η: relative sterile males fitness
$X(S,M,\epsilon)$: mating probability

$$X(S,M,\epsilon) = \frac{M+\epsilon\eta S}{k+M+\eta S}$$

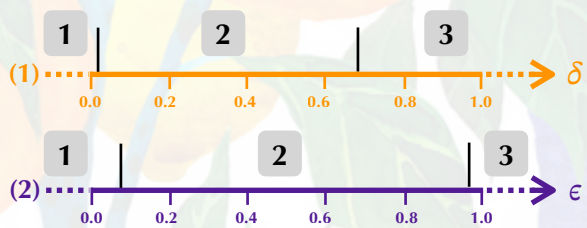
Results - Discussion

General shapes of σ bifurcation diagrams

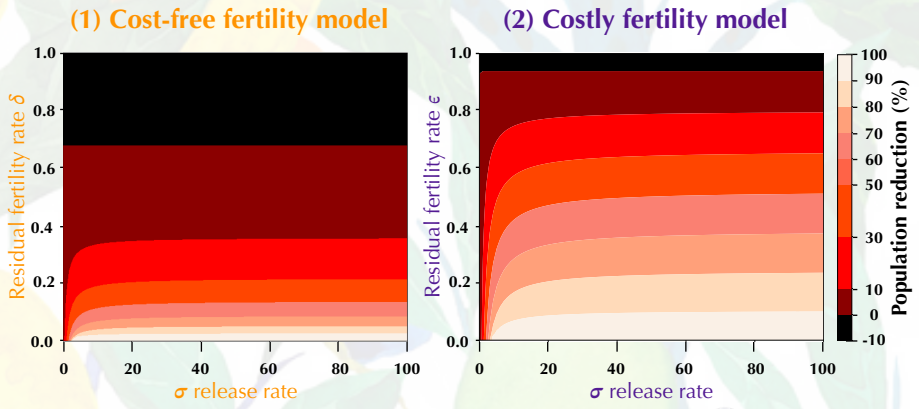


- **Bifurcation diagram shapes** as function of **RF rate**

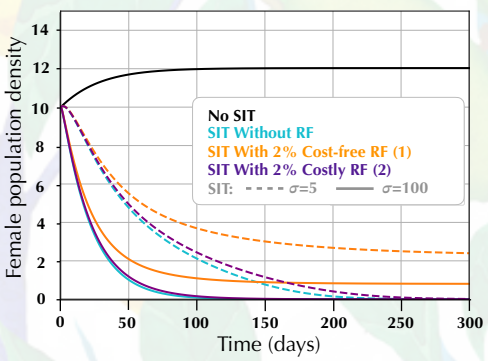
$\sigma = 5$



Pest population control capacities at equilibrium



Temporal dynamics



- Strong impact of RF on SIT efficiency
- For costly RF, SIT is effective at higher release rates
- For SIT effectiveness with 2% of RF: releases of at least 500 sterile males per day per ha ($\sigma = 5$)

Conclusion

References

[1] V.A. Dyck, J. Hendrichs, A.S. Robinson, Sterile insect technique: principles and practice in area-wide integrated pest management, Springer, 2005.
[2] M.S. Aronna and Y. Dumont, On Nonlinear Pest/Vector Control via the Sterile Insect Technique: Impact of Residual Fertility, Bull Math Biol, 82(110), 2020.