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On residual fertility and remating in the Sterile Insect Technique against fruit flies

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The fruit fly ceratitis capitata, also called the medfly, is a very destructive pest all around the world against a wide range of hosts, including stone fruits and citrus. Several operational control programs have been launched against the medfly in California, Central America, in Southern-Europe (Spain, Croatia) and in South Africa, using the sterile insect technique (SIT). SIT is an environmentally-friendly insect pest control method involving the mass-rearing and sterilization, using radiation, of males that are repeatedly released to mate with wild females resulting in no viable offspring. A new SIT project against medfly is now ongoing in Corsica (a French island in the Mediterranean Sea), CeraTIS-Corse. A new and very destructive pest, the oriental fruit fly, bactrocera dorsalis, has appeared in Réunion island (a French overseas department in the Indian Ocean) in 2017. Since then, it has invaded the whole island, infesting most of the crops from the sea level till 500 m. The damages are important, in particular in Mango orchards where crop yields have been reduced by 50% to 80%. A feasibility SIT project, GEMDOTIS, is ongoing in La Réunion.

While conceptually very simple, in practice, SIT is very complex. In particular, it requires a very good knowledge of the targeted pest ecology and biology. It is also crucial to ensure that the released sterile males are of very good quality to disperse and compete against wild males. However, release strategies often seek for a balance between the quality of the males and the minimum level of sterility acceptable. In [1], using a generic model we studied the impact of residual fertility (RF), i.e. irradiated males are not fully sterilized, that is, a proportion, say ?, of sperms is always fertile. At the population level, this means that a proportion, ?, of sterile males is able to have progeny. In [1], we show that RF is strongly linked to the basic Offspring/Reproduction Number of the pest, N, i.e. the average number of female offspring produced by one female during her entire life. In other words, we showed that SIT is effective if and only if $\varepsilon N < 1$ [1].

In this talk we consider a more complex model, where remating, i.e. the ability of female to be inseminated multiple times, after a so-called "refractory" period, can occur. We also consider that the frequency of remating is higher for females previously mated with sterile males. We study the impact of remating coupled to RF to explain SIT failures or mitigated results obtained in some countries. Our results highlight the importance of a very good knowledge of the targeted species reproduction biology. We illustrate our results on Ceratitis capitata and Bactrocera dorsalis and the consequences in terms of efficiency [2].

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References:

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[2] Y. Dumont and C. Oliva, Impact of residual fertility and remating in the Sterile Insect Technique against fruit flies. To be submitted.
