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Simulation Model for Dengue Fever Transmission with Integrated Control

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Abstract

This paper formulates a simulation model for the integrated control of *Aedes aegypti* mosquito, transmitter of dengue fever, with non-linear ordinary differential equations. The infection caused by the *Wolbachia* Bacterium and adulticid traps are included for the vector control. It is also made simulations with values of the parameters from the literature for different control strategies.

Keywords: *Aedes aegypti*, *Wolbachia* Bacterium, integrated control, mosquito traps, simulation model

1 Introduction

Dengue fever is caused by a virus that is transmitted to humans, mainly in a vector way. In other words, it is transmitted when a healthy person is stung by a genre *Aedes*'s female mosquito, more frequently from the *aegypti* specie, which has gotten the virus previously by biting an infected human [9].

Although there are 5 serotypes for dengue virus (DENV 1, DENV 2, DENV3, DENV 4 y DENV 5) that are transmitted to humans, serotype 2 and serotype 3 are the ones that have caused more grave cases of dengue, and while the infection with one of the serotypes gives permanent homologue immunity, the heterologous immunity (against other serotypes) is only temporary [9]. In 2013, DENV 5 serotype was reported when there was confirmed the existence of a different phylogenetically serotype from the other 4 ones. This new virus was diagnosed to a farmer from Sarawak (Malaysia) in 2007, and it is thought it comes from primates. However, some reports have just created mild dengue in contagious patients [11].

Even though dengue virus is transmitted by female mosquitoes from genre *Aedes*, they are *Aedes aegypti* and *Aedes albopictus* the most frequent transmitters [15]. Specifically, for the American continent, *Aedes aegypti* is the one which most contagions are attributed [4]. *Aedes aegypti* is a highly anthropophilic mosquito (it lives close to humans) It comes from Africa [4] and survives under 2000 meters above sea level, but it has been observed in 2200 meters zones [13].

As a result of the not existence of a vaccine for the 5 serotypes of dengue, the control applied for decreasing the number of infected people is currently focused on the reduction of the vector population. In this way, there are three specific techniques for controlling the expansion of this mosquito population: mechanic control, chemical control, and biological control. In the last type of control, there is found the *Wolbachia* bacterium group which produces series of alterations in the reproduction of its hosts with the purpose of taking advantage and stay inside the population [17]. The already mentioned type of bacteria are not only found in the tissue cytoplasm of the ovaries and testicles in a great range of anthropods, but also in isopods and nematodes [17]. This bacterium is transmitted vertically from mother to son, and some of the strategies used for staying in the population is the cytoplasmic incompatibility