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Chapter XI

Simulation Model for the Control of Olive Fly *Bactrocera Oleae* Using Artificial Life Technique

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ABSTRACT

In this chapter we present a novel method for modelling of the development of olive fly—Bactrocera oleae (Gmelin)—based on artificial life technique. The fly's artificial life model consists of a set of distinct agents, each representing one phase in the insect's lifecycle. Each agent is defined mainly by two internal state variables: health and development. Simulation results have provided development times and mortality rates that closely resemble those observations in biological experiment. The model presented has proven to offer good results in replicating the insect's behaviour under monitored climatic conditions. The model's potential uses are discussed.

INTRODUCTION

Pest management and control, as it is readily understood, are vital to a sustained agricultural production since, without it, long-term reliable income cannot

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be ensured. Nowadays chemical protection is the most widely used method for pest control. However, control methods relying on the use of chemical products pose a health risk for man and animals, unnecessary treatments increase production costs, cause more environmental pollution and can lead to the development of resistance to pesticide. Therefore, it becomes more and more important and necessary to know or estimate the state of pest population, because if the control action is applied at the correct moment, a reduced number of pesticide treatments can achieve the same level of pest control.

Olive growing is an important activity for the economic, social and ecological well-being of the Mediterranean region. It represents a relatively cheap source of high quality vegetable fat, and its importance spans the areas of agriculture and food industry. In Portugal this crop represents a significant proportion of the total agricultural production. The olive fly, *Bactrocera oleae*, is generally considered the most damaging of the insect pests that attack the olive trees. Its attacks may potentially account for 50-60% of the total insect pest damage, causing a reduction in the number and/or size of the fruits, with a subsequent reduction in yield and quality of the fruit and oil (Michelakis, 1986; Bento, 1999).

Simulation models have been introduced as a way to assess its current state of pest population and estimate the risk based on climatic data, especially in some cases, the ideal timing for treating a crop is a certain stage of the infestation's lifecycle that is not easily detectable in the field. The quality of a decision support tool concerning the timing and kind of crop-protection actions are highly dependent on the effectiveness of the simulation model used to assess and forecast the development of crop pests.

BACKGROUND

Traditional mathematical and statistical population dynamics analysis methods may satisfactorily reproduce the observed behavior. Most of these models aim at describing the evolution of the parasite population as a whole, using statistical interpolation or differential equations methods, in order to find a set of equations and parameters that correctly fit the available test data. The main problems of this approach are the lack of biological significance of the resulting systems and the difficulty in testing the resulting models, requiring extensive periods of climatic and biological data to increase the confidence in the system. Most of the time, it always fails to establish a correspondence between its low-level causes and the macroscopic parameters involved in the model (Pitzalis, 1984; Crovetti, 1982; Dicola & Crovetti, 1984).

Furthermore, using a single simulation model as the sole indicator for crop control decision should be avoided; combination of both traditional assessment

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