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DYNAMICAL ANALYSIS AND OPTIMAL CONTROL OF A MATHEMATICAL MODEL FOR RED PALM WEEVIL INFESTATION

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ABSTRACT

In this study, we present a mathematical model to describe the population dy namics of the red palm weevil, a serious pest of palm trees. The most dangerous stage of this insect is the larval stage, which destroys the internal tissue of the palm. The mathematical model describes the different stages of the red palm weevil. The model integrates the main biological interactions and environmental factors that affect the insect's life cycle. We perform a comprehensive dynamic analysis of the model, identifying equilibrium points, evaluating their stability, and studying bi furcation. Overall stability is analyzed using the appropriate Lyapunov function and employing the geometric approach to investigate stability using the Lozinski measure. A sensitivity analysis is conducted to determine the influence of various factors on the system's behavior. Furthermore, we apply the Pontryagin princi ple of extreme values to formulate an optimal control problem aimed at reducing infestations through targeted interventions, such as pesticides and biological con trol. Numerical simulations are performed using the forward and backward sweep method. The results indicate the effectiveness of different control strategies and their impact on sustainable pest management in palm farms.

***K*eywords** Optimal Control · Red Palm Weevil · Lozinski Measure Mathematical Models

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