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AN IMPULSIVE STAGE-STRUCTURED PEST CONTROL MODEL USING PESTICIDE SPRAY SYNCHRONIZED WITH BIRTH PULSE

Sunita Gakkhar and Anju Goel

Department of Mathematics
Indian Institute of Technology Roorkee, Uttrakhand,247667, India
Corresponding author email:goelanju23@gmail.com

Abstract. In this paper, an impulsive system of differential equations is proposed to model a pest control system. The stage-structured system consists of mature and immature pest population. Birth pulses occur at regular intervals to release immature pest population. The pest population is controlled by spraying chemical pesticides affecting mature as well as immature population. The discrete dynamical system determined by stroboscopic map is analyzed. The threshold condition for the stability of pest-free state is obtained and existence of period-1 solution is established. Finally, numerical simulation depicts the complex dynamics of the model. There exists a characteristic sequence of bifurcations above the threshold value of birth rate leading to chaos. Periodic halving bifurcation are also observed in some cases.

Keywords. Stage-structured; Birth pulse; Ricker Function; Impulsive pest management strategy; Stroboscopic map; Periodic solution; Chaos; Flip bifurcation.

1 Introduction

Frequent pest outbreaks have become a serious problem in agricultural fields. To control the pest, the pesticides are used to kill the pest population quickly. Although this chemical control reduces the economic loss, it pollutes the environment affecting the biological species as well as human beings. Biological control is another effective way to reduce the pest load. Accordingly, the natural enemy of pest is released and pest population is either eradicated or reduced below the threshold economic injury level. The non-chemical control also incorporates the microbial control with pathogen causing natural epidemics in pest population. Integrated Pest Management (IPM) strategies are the combination of one or more such controls so that the economic loss to the grower is minimized with least impact on the environment . The success of any pest management regime depends on the control methods, their timings and the dynamics of biological species. Many mathematical models are