Dynamics of Continuous, Discrete and Impulsive Systems
Series **B:** *Applications & Algorithms* **14 (2007)** 135-153

ANALYSIS OF A PREDATOR-PREY MODEL CONCERNING IMPULSIVE PERTURBATIONS[1]

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Abstract. According to biological and chemical control strategy for pest control, we investigate the dynamics of Ivlev's functional response predator-prey system with impulsive effect, periodic releasing natural enemies and spraying pesticide at different fixed times, by using impulsive differential equation. We show that there exists a stable pest-eradication periodic solution when the impulsive period T is less than some critical value T_{max}. If the period of pulses T is larger than T_{max}, the system can be permanent. The pest-eradication periodic solution becomes unstable and undergoes a transcritical bifurcation, and the pest and predator can coexist on a stable limit cycle when $T > T_{max}$ and is close to T_{max}. Under some conditions, the unforced continuous system (without impulses) only has a stable limit cycle, however, numerical simulations show that the system we consider can take on various kinds of periodic fluctuations and several types of attractor coexistence and is dominated by periodic and quasiperiodic solutions, which implies that the presence of impulses makes the dynamic behaviors more complex. Finally, we conclude that our impulsive control strategy is more effective than the classical one if we take chemical control efficiently.
Keywords. Ivlev's functional response; Biological and chemical control strategy; Pest-eradication periodic solution; Quasiperiodic solution.

1 Introduction

External forcing can profoundly affect the dynamics of a nonlinear system. For example, the Duffing's non-linear mechanical system has a very simple dynamical behavior in the constant parameter case, while under periodic forcing it displays rich dynamics including chaos [9]. Sabin and Summers [24] analyzed the classical Volterra predator-prey model incorporating periodic forcing. They showed that the addition of the forcing to the model