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Dynamics complexity of generalist predatory mite and the pest leafhopper in tea plantation

The tea green leafhopper *Empoasca onukii* Matsuda (Hemiptera: Cicadellidae) is one of the most important insect pests threatening the tea production in China, Vietnam, Japan, Indonesia and other countries in Asia. Both nymph and adult of *E.onukii* suck the tea buds, leaves, and shoots and make wounds in tea plants which finally leads to the symptom from blade curling, bronzing, shriveling, necrosis to stand loss, even severe hopperbum, affecting the quality and yield of the tea. The pesticides were the commonly applied which caused the pest resistance, pest resurgence and the undesirable pesticide residues on brewed tea. Therefore, the biological control methods have received widespread attention in recent years. A potential biological control agent, the mite *Anystis baccarum*(L.) is an important predator of the leafhopper in various agricultural systems. A good understanding of generalist predatory mite and the pest leafhopper population dynamics is crucial for tea pest suppression. We propose a predator prey model with generalist predator and aim to understand the dynamics of leafhopper pest *E. onukii* and predatory mite *A. baccarum*, and to make some endeavor to present a plausible control mechanism. The dynamics of the model are very complicated, with saddle-node bifurcation, Hopf bifurcation, Bogdanov-Takens bifurcation and nilpotent singularities of codimension 3, even nilpotent singularities of codimension 4. We also present the bifurcation diagram near the nilpotent singularities of codimension 3.