分类号：_____ 单位代码：10335

密 级：_____ 学 号：11616119

浙江大学

博士学位论文

用于扶桑绵粉蚧防治的几种纳米新农药的研发

Development of Some Novel Nanopesticides for the Control of Cotton Mealybug, *Phenacoccus solenopsis* Tinsley

作者姓名	**Asem Saad Saad Elabasy**
指导教师	**Mingxing Jiang and Zuhua Shi**
学科(专业)	**Agricultural Entomology and Pest Control**
研究方向	**Insect-Pest Ecology and Integrated Control**
所在学院	**College of Agriculture and Biotechnology**
论文提交日期	**2020 年08月10日**

用于扶桑绵粉蚧防治的几种纳米新农药的研发

Development of Some Novel Nanopesticides for the Control of Cotton Mealybug, *Phenacoccus solenopsis* Tinsley

A DISSERTATION FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

IN

Agricultural Entomology and Pest Control

(Entomology)

By

Asem Saad Saad Elabasy

Supervised by

Prof. Mingxing Jiang and Prof. Zuhua Shi

Institute of Insect Sciences, College of Agriculture and Biotechnology, Zhejiang University, Hangzhou, P.R. China

August 10th, 2020

Contents

List of Figures

List of Tables

Abstract

Chemical pesticides play an indispensable role in modern agriculture. They are needed for crop protection against insect pests, weeds, and plant pathogens in order to achieve high crop productivity and adequate food supplies. However, it is estimated that more than 90% of the traditional pesticide formulations are lost or decomposed owing to degradation, evaporation, leaching, and runoff during field application. In addition, repeated and indiscriminate use of pesticides has led to numerous issues, such as pest resistance and negative effects on human health, environment, and non-target organisms. In recent years, the considerable advancement of nanotechnology and nanomaterials has paved the way for the creation of new pesticide formulations through constructing a nano-delivery system and using nanomaterials as carriers. Furthermore, using smart nanopesticide formulations based on nanomaterials can offer promising potential applications for decreasing pesticide residues and their effects on human health and the environment.

In this PhD thesis, we carried out different experiments to develop new formulations of emamectin benzoate (EMB) and thiamethoxam (TMX) by utilizing cellulose nanocrystals (CNCs) and silicon dioxide nanoparticles (SNPs) as carriers. In order to improve photostability and prevent premature degradation of EMB, stable and controlled release of TMX, and insecticidal activity, we created novel formulations to increase the effective utilization rate of pesticides, reduce the number of application times, and minimize pesticide residues and their effects on human health and the environment. The efficacy of the nanoformulations against *Phenacoccus solenopsis* was evaluated as well. We obtained the results as following.

In chapter 3, two novel nanoformulations (NFs) were successfully prepared based on nano-delivery systems for EMB by loading it on CNCs and SNPs as carriers through a freeze-drying method. The synthesized nanoformulations were examined using field emission scanning electron microscopy (FE-SEM), transmission electron microscopy (TEM), X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), thermogravimetric analysis (TGA), and dynamic light scattering (DLS). The results showed that SNPs and CNCs had a loading efficiency of 43.31% and 15.04% (w/w) for EMB, respectively, and could effectively protect EMB from photolysis under UV radiation. The biological activity results showed that EMB+NFs were highly effective against *P. solenopsis* than commercial EMB EC formulation, suggesting that SNPs and CNCs as carriers can considerably improve the insecticidal activity of EMB.

In chapter 4, a novel nanoformulation of TMX was fabricated using the solvent evaporation method through loading TMX on CNCs. The synthesized TMX-CNCs was investigated through different techniques. The results revealed that the loading efficiency and entrapment efficiency were 18.7% and 83.7 ± 1.8% for TMX, respectively. The prepared nanoformulation (TMX-CNCs) had a width of 7–14 nm and a length of 85–214 nm with a zeta potential of −23.6 ± 0.3 mV. The drug release behavior study exhibited that the release of TMX from TMX-loaded CNCs was good and sustained. Furthermore, bioassay results showed that the insecticidal activity of TMX-CNCs against *P. solenopsis* was significantly superior to that of the technical and commercial formulation, as indicated by lower LC_{50} value. The results indicate that the TMX nanoformulation has a great potential application in agriculture for pest control.

Overall, the results in this dissertation will provide valuable information for further study on the development of new nano-formulations for EMB and TMX, which has promising potentials to be used for control of insect pests such as cotton mealybug. These findings are anticipated to be useful in developing novel nanocarriers for potential applications of pesticides in plant protection, indicating improved anti-photolysis, controlled release, and insecticidal activity as compared to conventional formulations.

Keywords: Emamectin benzoate, Thiamethoxam, Cellulose nanocrystals, Silicon dioxide nanoparticles, Insecticidal activity, *Phenacoccus solenopsis*