Le Corps professoral de
Gembloux Agro-Bio Tech - Université de Liège vous prie
de lui faire l'honneur d'assister à la défense publique de la dissertation originale que

Madame SUN Changjiao,

Titulaire d’un diplôme de master of biophysics,

présentera en vue de l’obtention du grade et du diplôme de

DOCTEUR EN SCIENCES AGRONOMIQUES ET INGENIERIE BIOLOGIQUE,

le 25 novembre 2019, à 10h00 précises (personne ne sera admis après cette heure),

en l'auditorium de Sylviculture (Bât. 9),
Passage des Déportés, 2, à 5030 GEMBLoux.

Cette dissertation originale a pour titre :

« Development and efficacy evaluation of novel adhesive pesticide
nano-delivery systems ».

Le jury est composé comme suit :

Président : Prof. H. JIJAKLI, Professeur ordinaire,
Membres : Prof. F. VERHEGGEN (Promoteur), Prof. H. CUI (Copromoteur - CAAS, Chine), Prof. F. FRANCIS, Prof. G. LOGNAY, Prof. Z. ZENG (CAAS, Chine).
Summary

Pesticide is the foundation for preventing major biological disasters and the safeguard of food security. However, it has been estimated that 70% to 90% of the applied pesticides are either lost in the air or run-off, which has caused many adverse effects, such as pest resistance, risk to humans and non-target organisms and environmental contamination. In the recent decade, the development of nanopesticide formulations has the great potential to improve the performance of pesticides by constructing nano-delivery systems. Moreover, in terms of the crop foliage microstructure, the surface of nanoparticles can be easily modified by affinity groups to improve adhesion and decrease the loss from crop foliage.

In this PhD thesis, an environment-sensitive pesticide, avermectin (Av) was selected as object. In order to decrease the organic solvent pollution and prevent premature degradation of avermectin, stable and controlled release of pesticide formulations with high affinity for crop foliage and long retention time on crop foliage were constructed to increase the effective utilization rate of pesticides and minimize loss to the environment. And the efficacy of the nanoformulations was evaluated as well.

First of all, surfactant-modified mesoporous activated carbon (MAC) was employed to absorb Av in order to improve its photo-stability and allow for sustained release of avermectin. Results suggest that sodium dodecyl sulfate (SDS) modified MAC had excellent absorption of avermectin, and the absorption could be represented by the Langmuir isotherm model. The Av-MAC-SDS delivery system significantly improved sustained release of avermectin and also effectively inhibited the photo-degradation of avermectin.

Then, biocompatibility and biodegradable polylactic acid (PLA) was employed as the carrier material. Tannic acid (TA), a bioadhesive natural molecule, was applied to modify abamectin nano-delivery systems. The nanoparticles showed excellent continuous sustained release and photo-stability. Compared with unmodified nanopesticides, the retention rate of modified nanoparticles on the foliage was remarkably enhanced by more than 50% and indoor toxicity with dipping method against *Myzus persicae* L. was also increased.

Finally, insecticidal activity of PLA-based nano-formulated abamectin was examined on the pea aphid, *Acrthosiphon pisum* (Hemiptera: Aphididae), and the aphid predator *Adalia bipunctata* (Coleoptera: Coccinellidae). A Potter Precision Laboratory Spray Tower was used to conduct direct spray laboratory bioassays. A comparable insecticidal effect of TA modified nanoformulation was observed compared to commercial emulsifiable concentrate (EC) against the aphid. And the nanoformulations had lower stomach toxicity on non-target lady beetles.

These results are expected to be beneficial to develop novel leaf-adhesive nanopesticides with high retention time and bioavailability.