LIÈGE université
Gembloux
Agro-Bio Tech

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

Monsieur XU Qingxuan,

Titulaire d'un diplôme de *master of Pesticide Science*,

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

DOCTEUR EN SCIENCES AGRONOMIQUES ET INGENIERIE BIOLOGIQUE,

le 14 septembre 2017, à 10 heures précises (personne ne sera admis après cette heure),

en l'auditorium Zl (Zoologie, bât. 9),

Passage des Déportés, 2, à 5030 GEMBLOUX.

Cette dissertation originale a pour titre :

« Push-Pull strategy to control aphids in Belgium and China ».

Le jury est composé comme suit :

Présidente : Prof. M.-L. FAUCONNIER, Présidente du Département AGROBIOCHEM,
Membres : Prof. F. FRANCIS (Promoteur), Prof. J. CHEN (Copromoteur - CAAS, Chine), Prof. B. BODSON, Prof. F. VERHEGGEN, Prof. G. LOGNAY, Prof. D. QIU (CAAS, Chine).

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Summary

Wheat (*Triticum aestivum* L.) is one of the most cultivated crops in temperate climates. As its pests are mainly controlled with insecticides which are harmful to the environment and human health, alternative practices such as intercropping have been studied for their potential to promote biological control. Fifty original research papers were obtained from a systematic search of the peer-reviewed literature. Results from a vote-counting analysis indicated that, in the majority of studies, pest abundance was significantly reduced in intercropping systems compared with pure stands. However, the occurrence of their natural enemies as well as predation and parasitism rates were not significantly increased. Nevertheless, other practices could be combined with intercropping to favour natural enemies and enhance pest control.

Dispersal of viruses is intimately tied to their vectors. Aphids are known to invest in costly antipredator behavior when perceiving cues of predators. Before presenting the results and the answers to the previous questions, a brief research was conducted in order to have an overview of the intercropping on the spread of aphids, to assess the potential impact of intercropping systems attracting natural enemies on the virus transmission. We studied aphid antipredator behavior in intercropping with wheat-broad bean (*Vicia faba* L.) as a model. The bird cherry-oat aphid, *Rhopalosiphum padi* Linnaeus, is an important vector of the barley yellow dwarf virus. The effects of two natural aphid enemies, adult and larvae of the seven-spot ladybeetle, *Coccinella septempunctata* Linneaus, on *R. padi* dispersion was studied under laboratory conditions. Results show that the total number of aphids was higher in intercropping than monoculture in treatments without ladybeetles, while the contrary was observed in the presence of ladybeetle larvae. These results might be explained by the non-host plant chemical cues and the physical barrier that was broad-bean plants confusing *R. padi* when searching for their host plants after being dropped from wheat by predators (i.e. associational resistance).

After make sure that the intercropping can reduce the dispersal of aphids in the presence of predators, *in fine* potentially limiting virus dispersal, especially shortly after aphids colonize plants. Next step will be to solve how to increase the number of natural enemies of intercropping in Belgium and China.
Semiochemical substances have been tested to enhance biological control, with inconsistent results. Combining semiochemical and intercropping can be an interesting way to maximize pest control. In Belgium, a two-year setup involving wheat–pea strip intercropping combined with the release of *E*-β-farnesene (EBF) or methyl salicylate (MeSA) was tested as a push–pull strategy to simultaneously repell aphids and attract beneficials. Two types of slow-release formulation (i.e., oil and alginate beads) containing EBF or MeSA were deployed with intercropping. The abundance of aphids was significantly decreased, hoverfly larvae and mummified aphids increased on both pea plants and wheat tillers by the release of oil-formulated EBF and MeSA. The proportion parasitism of aphids-parasitism rate was also increased by treating both crops in both years. Releasing EBF through oil rather than alginate beads proved significantly better for attracting natural enemies and reducing aphids. Aphids were negatively correlated with the density of hoverflies (both adults and larvae) and numbers of mummies. We also tested the combining in China and the experiments were set-up: wheat-pea strip intercropping solely, intercropping combined with the release of EBF, and intercropping combined with the release of MeSA, each treatment repeated three times. The total number of aphids throughout the growing season was significantly decreased in treatments with releases of semiochemicals compared to intercropping solely. The effect was stronger with MeSA than with EBF on the control of *R. padi*, and hoverflies and lacewings were twice more numerous in MeSA.

All these results showed that combining intercropping with the release of EBF or MeSA formulated in oil can significantly reduce aphid density and attract their natural enemies. Therefore, the combination of both strategies could help farmers reduce the use of insecticides.