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 ZHANG Yong,

Titulaire d'un *master of agricultural entomology and pest control*,

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

DOCTEUR EN SCIENCES AGRONOMIQUES ET INGENIERIE BIOLOGIQUE,

le 29 mai 2018, à 9 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 :

« Investigations of aphid saliva composition and role in plant – insect: focused on *Sitobion avenae* and *Myzus persicae* ».

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. M. ONGENA, Prof. F. VERHEGGEN, Prof. Y. LIU (Shandong Agricultural University, Chine).

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Summary

Aphid is one of the most important and destructive agricultural group of pests in the world. Currently, aphid is mainly controlled by chemical pesticides, resulting in serious impacts on human health and environmental safety. Cultivating and using insect-resistant host plant varieties is an important approach for the sustainable control of wheat aphids, but due to few understanding of the interaction mechanisms between aphids and hosts, it still lacks aphid resistance varieties. Aphid saliva play important roles in the interactions with plant. Some studies have identified several salivary effectors from *Acyrthosiphon pisum* pea aphid and *Myzus persicae* peach aphid inducing plant defense responses. However, few studies have been reported on the roles of *Sitobion avenae* grain aphid saliva, which is one of the most important cereal pests.

In our studies, the role of *S. avenae* watery saliva in host plant resistance induction was firstly examined by infiltrating aphid saliva into wheat leaves. Strong SA-dependent and moderated JA defensive responses were observed. The fecundity and the intrinsic increase rate of the *S. avenae* population significantly decreased after feeding on wheat leaves infiltrated with aphid saliva. In a choice test, saliva-infiltrated wheat had obvious repellent effects on aphids. The feeding behavior of *S. avenae* on saliva-treated wheat was also negatively affected, including shorter feeding time on phloem and longer penetration activity. These findings directly demonstrated the invovlment of *S. avenae* salivary components in the induction of wheat resistance against aphids and the important roles of watery saliva in aphid-plant interactions.

To investigate the aphid saliva composition, the transcriptome of the whole salivary glands of *S. avenae* was sequenced. Among the 33,079 identified unigenes, 526 unigenes were predicted to encode secretory proteins, and some of their orthologs have been proved to play important roles in aphid-host interactions. Gene expression analysis showed that the 15 most highly expressed putative secretory proteins and glutathione-S-transferase 1 are specifically expressed in salivary glands. These findings firstly provide insight into the identification of potential effector molecules in *S. avenae* saliva and further understanding of the saliva impact in aphid-wheat interactions.

In the next step, the species and function of salivary effectors in *S.avenae* were identified by RNA interference (RNAi) via oral delivery. The knockdown of *laccase 1* (*Lac1*) was performed to demonstrate that the genes in aphid salivary gland can be successfully silenced by feeding dsRNA directly. *Lac 1* from *S. avenae* (*SaLac 1*) was highly expressed in the salivary gland. After feeding on aphid-resistant wheat with a high total phenol content, the expression level of *SaLac 1* increased significantly. RNAi by oral feeding successfully inhibited the transcript levels of *SaLac 1*, and the knockdown of *Lac* 1 significantly decreased the survival rate of *S. avenae* on aphid-resistant wheat. Our study demonstrated that *S. avenae Lac1* was essential for the aphid to adapt to resistant plant and oral delivery of gene-specific dsRNA successfully silenced the target gene in salivary gland of *S. avenae*. Beside the cereal aphid, further investigations were performed to the *M. persicae* and plant interactions. Direct effects of SA and JA exposure on the green peach aphid, *Myzus persicae* physiology were investigated developing a proteomic approach. SA and JA treatments induced variation in several regulated proteins that were mainly associated with stress responses, protein synthesis, energy metabolism and cytoskeleton. This study was the first to demonstrated that beside the fundamental roles in the regulation of plant developmental processes and stress responses, plant signal molecules SA and JA can also modulate physiological status of aphid as a second target, providing new insight into aphid-plant interactions.