Gembloux Agro-Bio Tech
Université de Liège

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 BOULLIS Antoine,

Titulaire d'un master en sciences, technologies et santé,

mention biologie intégrative et agrosciences,

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

DOCTEUR EN SCIENCES AGRONOMIQUES ET INGENIERIE BIOLOGIQUE,

le 27 avril 2017, à 16 heures précises (personne ne sera admis après cette heure),

en l'auditorium Zl (Zoologie, bâtiment 9),

Passage des Déportés, 2 à 5030 **GEMBLOUX**.

Cette dissertation originale a pour titre :

« Climate change and insect pests: impact of carbon dioxide increase on aphid behavior and semiochemistry ».

Le jury est composé comme suit :

Présidente : Prof. M.-L. FAUCONNIER : Présidente du Département AgroBioChem,
Membres : Prof. F. VERHEGGEN (Promoteur), Prof. G. LOGNAY, Prof. F. FRANCIS, Prof. C. DETRAIN (ULB), Prof. T. HANCE (UCL), Dr A. AMELINE (Université Picardie Jules Verne, Amiens, France).

Abstract

There is no longer any doubt on the incidence of rising carbon dioxide (CO_2) concentration on global change. The climate modifications are responsible of perturbations in interactions between living organisms. This research topic is in the light of scientists since several decades and is considered to be of major interest in the understanding of future ecosystems' functioning.

In this prospect, interactions between insect herbivores and their natural enemies have received little attention under a climate change scope, while they are of paramount importance in the proper equilibrium of agro-ecosystems. Insects are highly dependent on odor cues released into the environment to locate conspecifics or food sources. As the efficacy of natural enemies is governed largely by behavioral mechanisms, changes in the predators' behaviors but also in those related to prey defenses can change the dynamics of insect populations. As aphids are considered as one of the main crop pests in temperate regions, relative literature on impact of increases in atmospheric CO_2 concentrations on aphid population dynamic now exists. However, few publications about their chemical ecology are reported. Aphids are using many chemical signals to communicate with each other or in their interactions with higher trophic levels. **Here, I tempted to identify the impact of an increase in atmospheric CO_2 concentration on the interactions between aphids and their natural enemies mediated by semiochemicals. Aspects of phytovirus transmission by aphids were also covered**.

After being involved in three literature reviews, I was interested in the aphid alarm signaling which strongly supports aphid-predators interactions. In the pea aphid *Acyrthosiphon pisum* (Harris), this signaling is mediated by a pheromone, namely the (*E*)-β-farnesene. For my experiments, I took into consideration the importance of all the steps that this molecule has to pass by, from its production into the emitter individual to the induced behavioral response of the receivers. The results obtained during these experiments highlighted an imbalance in aphid chemical communication for populations grown under elevated CO_2 conditions, by modifications in several steps of the signal (decrease in pheromone production, emission and associated behavior). The results obtained here were supported by previous studies indicating that increases in CO_2 concentration reduce the aphid escape behavior, which makes them potentially more susceptible to predation.

We know that many plant pathogens are dependent on aphid dispersal to spread, so it is of major importance to predict how these insect vectors could be affected by forecasted climate. I thus carried my interest on the ability of aphids to transmit phytoviruses under changing atmosphere. Using another aphid model, the green peach aphid *Myzus persicae* (Sulzer), we have not observed any modifications in terms of virus and aphid spread in laboratory trials when tested under either actual or forecasted CO_2 concentration. However, the viral transmission efficiency via aphids is increased under CO_2-enriched atmosphere.

Finally, the host searching behavior of an aphid predator was studied. As explained above, the efficiency of natural enemies of insect pests is mainly driven by their ability to find food sources or oviposition sites in their environment. The conducted study highlighted the preference of the hoverfly *Episyrphus balteatus* De Geer towards aphid colonies grown under actual CO_2 levels, suggesting modifications in chemical cues guiding hoverflies to a suitable oviposition site, due to increase of CO_2.

The results and knowledge obtained during these studies will add novel information on how a major component of climate change may impact tritrophic interactions and thus the efficiency of natural enemies of insect herbivores in biological control scope.