



HAL
open science

Impact of agro-ecological infrastructures on the control of insect pests in apple orchards

Pierre Franck, Luan Odorizzi dos Santos, Marlice Botelho Costa, Claire Lavigne, Odair Aparecido Fernandes, Armin Bischoff

► To cite this version:

Pierre Franck, Luan Odorizzi dos Santos, Marlice Botelho Costa, Claire Lavigne, Odair Aparecido Fernandes, et al. Impact of agro-ecological infrastructures on the control of insect pests in apple orchards. 7. meeting of the IOBC-WPRS Working Group Landscape management for functional biodiversity, International Organisation for Biological Control (IOBC). Organisation Internationale de Lutte Biologique (OILB), FRA., Mar 2017, Dundee, United Kingdom. 178 p. hal-01605409

HAL Id: hal-01605409

<https://hal.science/hal-01605409>

Submitted on 14 May 2018

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution - ShareAlike 4.0 International License

Impact of agro-ecological infrastructures on the control of insect pests in apple orchards

Pierre Franck¹, Luan Alberto Odorizzi², Marlice Botelho Costa³, Claire Lavigne¹,
Odair Aparecido Fernandes², Armin Bischoff⁴

¹INRA, Plantes & Système de cultures Horticoles, 228 route de l'Aérodrome, Agroparc, CS40509, 84914 Avignon Cedex 9, France; ²São Paulo State University, Rod. Prof. Paulo Donato Castellane km 5, SP-14884-000, Jaboticabal, Brazil; ³Federal University of Lavras, Entomology Department, MG-37200-000, Lavras, Brazil; ⁴Mediterranean Institute of Biodiversity and Ecology (Univ. Aix-Marseille, Univ. Avignon, CNRS, IRD), University of Avignon, Agroparc, BP61207, 84911 Avignon Cedex 9, France

Abstract: The rosy apple aphid, *Dysaphis plantaginea*, and the codling moth, *Cydia pomonella*, are major insect pests in apple orchards causing high economic losses. A conservation biological control approach using plant species that provide resources for natural enemies may improve natural regulation and reduce insecticide use. In this study, we compared the influence of wildflower strips, grass strips and spontaneous vegetation on the biological control of aphids and moths by their natural enemies (parasitoids, hoverflies, and ladybirds) in three untreated apple orchards in 2014 and 2015. The sown wildflower strip mixture was successful in increasing floral resource provisioning in both years. Among the major natural enemy groups observed in the margin strips only hoverflies responded positively to the increase of floral resources. Within the orchards, the number of aphid colonies per tree was higher close to the margins, but the number of codling moth larvae smaller. The number of natural enemies observed in aphid colonies was largely driven by aphid number. None of the natural enemy groups observed in *D. plantaginea* colonies responded to the adjacent strip treatments. This dynamic response may explain the reduction in aphid numbers close to wildflower strips without finding higher overall natural enemy numbers. Similarly, codling moth parasitism was higher close to the margins. These results suggest a positive influence of floral resource provisioning by wildflower strips on aphid predation and codling moth parasitism but they also demonstrate that effect size may be small if species-rich spontaneous vegetation does already occur in margins or inside orchards.

Key words: conservation biological control, predation, parasitism, codling moth, rosy apple aphid, floral resources

Introduction

Flowering strips significantly increase the local abundance and biodiversity of flying predators and parasitoids in the agroecosystem (Marshall & Moonen, 2002). However, only few studies have demonstrated their role in pest control and their impact on the dynamic of arthropod populations and on trophic interaction within the crop (Lavandero *et al.*, 2006; Géneau *et al.*, 2012).

The objective of this work was to test the effect of biodiversity in flowering strips on the biological control of two major insect pests in apple orchard, the codling moth (CM) and the rosy apple aphid (RAA).

Material and methods

Orchard experimental design

The experiment was carried out in 2014 and 2015 in three untreated apple orchards (480 to 1200 m²) at INRA Montfavet, France (43°54'51.57 "N, 4°52'56.15" E). Three strip treatments (30 to 70 m²) were established along the longer edge of each orchard (Figure 1): (a) a wildflower strip mixture comprising 30 vascular plant species (WS) optimized for high and long lasting productions of floral resources, (b) a grass strip mixture (GS) including *Lolium perenne* (28%) and *Festuca arundinacea* (72%), (c) an unsown strip allowing the natural development of spontaneous vegetation (SV). Grass and wildflower strips were sown in orchard edge in March 2014.

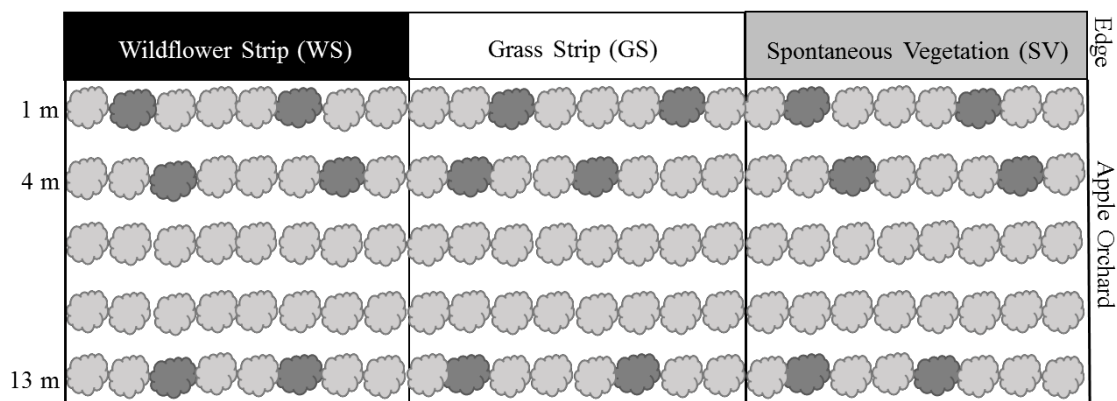


Figure 1. Schema of the experimental design. Shaded symbols indicate the selected trees to monitor apple pests and their enemies in each apple orchard.

Entomological observations

The arthropod communities involved in RAA and CM control were monitored at 18 or 27 apple trees per orchard (Figure 1). These observation trees were selected at three distances from the margin strips (1 m, 4 m and 13 m). The same trees were selected in 2014 and 2015. The number of RAA colonies per apple tree was counted at the end of the RAA growing period (19/05/14 and 03/06/15). The occurrence of predators and aphid mummies were recorded in up to six RAA colonies per tree (Table 1; Dib *et al.*, 2016).

Table 1. Mean number of RAA colonies per apple tree and mean proportions of RAA with an observed predator (hoverflies, ladybirds and earwigs) or a mummy (parasitoids) in 2014 and in 2015. Minimum and maximum values per orchard are indicated in brackets.

	2014	2015
RAA colonies	41.9 [31.8-56.0]	22.3 [11.3-27.4]
Hoverflies	0.1 [0.0-0.4]	0.7 [0.4-0.9]
Ladybirds	0.6 [0.5-0.9]	0.5 [0.2-0.7]
Earwigs	0.6 [0.5-0.9]	0.2 [0.0-0.8]
Parasitoids	0.7 [0.5-1.0]	0.6 [0.3-0.7]

CM larvae were collected weekly from May to October in cardboard band traps wrapped around the tree trunks. The number of CM larvae and adult emergences were recorded to infer the parasitism of diapausing and non diapausing larvae (Table 2; Maalouly *et al.*, 2015).

Table 2. Mean number of CM larvae per apple tree, parasitism rates and proportion of parasitoids (*Ascogaster quadridentata*, *Pristomerus vulnerator* and *Perilampus tristis*) in 2014. A total of 2673 CM larvae were collected (including 927 diapausing). The diapausing samples correspond to the emergences that occurred in 2015. Minimum and maximum values per orchard are indicated in brackets.

	Non-diapausing	Diapausing
CM larvae	27.7 [18.4-33.4]	14.7 [6.9-19.8]
Parasitism rate	0.27 [0.15-0.36]	0.32 [0.15-0.38]
<i>A. quadridentata</i>	0.59 [0.33-0.63]	0.43 [0.21-0.69]
<i>P. vulnerator</i>	0.13 [0.10-0.26]	0.17 [0.00-0.23]
<i>P. tristis</i>	0.27 [0.26-0.40]	0.38 [0.31-0.51]

Furthermore, the percentages of flowering entomophilous plants and the number of predators and parasitoids in each strip treatment were recorded in May of each year to shed light on their respective impact on the control of the apple pests.

Statistical analysis

The occurrence of predators in RAA colonies and CM parasitism were analyzed using generalized linear models assuming a binomial distribution (*glmer* function, lme4 package, R version 3.2.4). The strip treatment, the distance to the orchard margin and their interaction were factors tested. All models also included the observation date as an additional fixed factor to account for temporal variation and a random ‘orchard’ effect to account for a block factor.

Results and discussion

The percentages of flowering entomophilous plants in the margin strips were significantly higher in WS than in SV and in GS both year (Figure 2). We mainly observed hoverflies and ladybirds in the margin strips. The number the hoverflies was higher in WS than SV and GS in 2015 (Figure 2). However, we did not detect significant differences in the number of ladybirds and hymenopteran parasitoids among the margin strips.

The abundances of RAA colonies and CM larvae per apple tree were not homogenously distributed within the orchards. RAA infestations were significantly higher at the closest distances from the margin, but infestations were lower close to WS than close to GS and SV strips. Inversely, the number of CM larvae were significantly lower at the lowest distances from margin strips.

The occurrence of predators and parasitoids in RAA colonies and codling moth parasitism within the orchards were not significantly different among the classes of distances to the margin and among the margin strip treatments. However, the arthropod communities involved in RAA and CM control significantly changed within and between years (Tables 1 & 2).

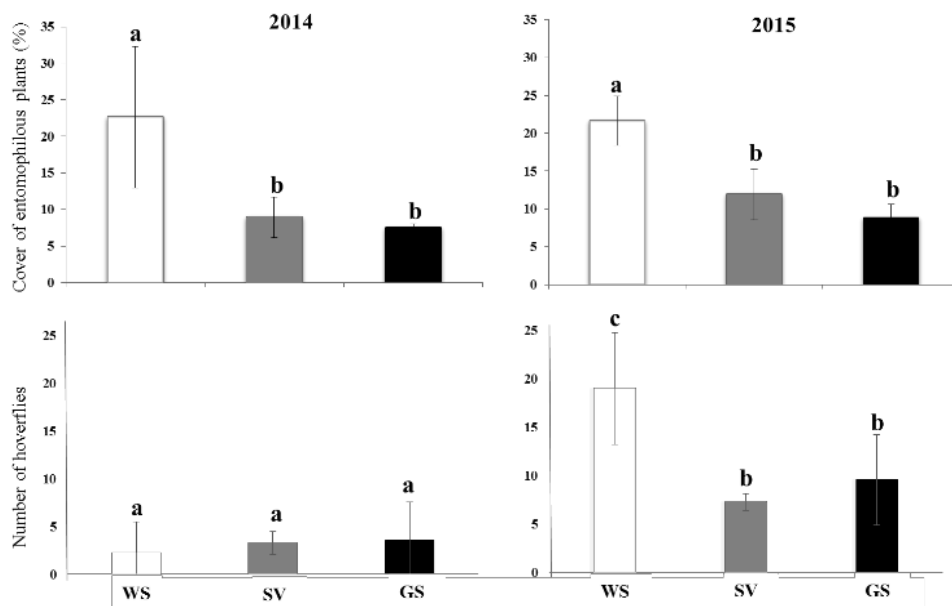


Figure 2. Percentage of entomophilous plants in flower (upper panels) and number of overflies (lower panels) in WS (white), SV (grey) and GS (black) margin strips in May 2014 (left panels) and 2015 (right panels).

These results suggest that provisioning of additional flower resources in orchard margins had a limited impact on the abundance of pest natural enemies both within the orchards and their edges if floral resources are already present in the environment. Selection of entomophilous plants according to temporal natural enemy's requirement could additionally enhance RAA and CM controls in the apple orchards.

Acknowledgements

This work was supported by the Agropolis Fondation (ANR-10-LABX-0001) and by the PEERLESS project (ANR-12-AGRO-0006).

References

- Dib, H., Sauphanor, B. & Capowiez, Y. 2016: Effect of management strategies on arthropod communities in the colonies of rosy apple aphid, *Dysaphis plantaginea* Passerini (Hemiptera: Aphididae) in south-eastern France. *Agric. Ecosyst. and Environ.* 216: 203-206.
- Géneau, C., Wäckers, F. L., Lukaa, H., Daniela, C. & Balmer, O. 2012: Selective flowers to enhance biological control of cabbage pests by parasitoids. *Basic Appl. Ecology* 13: 85-93.
- Lavandero, B., Wratten, S. D., Didham, R. K. & Gurr, G. 2006: Increasing floral diversity for selective enhancement of biological control agents: A double-edged sword? *Basic Appl. Ecol.* 7: 236-243.
- Maalouly, M., Franck, P. & Lavigne, C. 2015: Temporal dynamics of parasitoid assemblages parasitizing the codling moth. *Biol. Control* 82: 31-39.
- Marshall, E. J. P. & Moonen, A. C. 2002: Field margins in northern Europe: their functions and interactions with agriculture. *Agric. Ecosyst. and Environ.* 89: 5-21.