Perennial flower strips for pest control in organic apple orchards

F. Cahenzli[1], L. Sigsgaard[2] and L. Pfiffner[3]

Abstract

Orchards often have low diversity of plants, which limits the promotion of natural enemies to combat important pests. We trialed perennial flower strips in organic apple orchards in seven European countries. Flower strips increased the number of natural enemies in Dysaphis plantaginea *Passerini colonies. Likewise, trees in the flower strip plots recorded a slower* D. plantaginea *population increase than in control plots, resulting in reduced fruit damage after the second fruit drop. The number of preadult* Cydia pomonella *L decreased more from 2016 to 2017 in the flower strip plots as compared to the control plots, resulting in reduced fruit damage at harvest. We show that the implementation of perennial flower strips boosts natural enemies and reduces key apple pests and the associated fruit damage.*

Keywords: conservation biological control; *Dysaphis plantaginea*; flower strip; orchard

Introduction

Promoting natural enemies with a view to controlling pest insects is promising in orchards (Daniel et al., 2018). Since orchards are perennial and their complex multi-strata structure offers diverse niches, a certain stability and resilience enabling to build-up of natural enemy populations can be assumed. In addition, flower strips can increase nectar and pollen availability, enhance alternative prey in times of low pest abundance and offer shelter and overwintering sites in orchards. However, it is challenging to establish and maintain species-rich, perennial flower strips, which promote the correct species of natural enemy in sufficient abundance and in alignment with pest and crop development. In this pan-European study, we investigated whether sown perennial flower strips can (I) promote natural enemies, (II) decrease pest insects, and (III) reduce crop damage as compared to control plots without flower strips.

Material and Methods

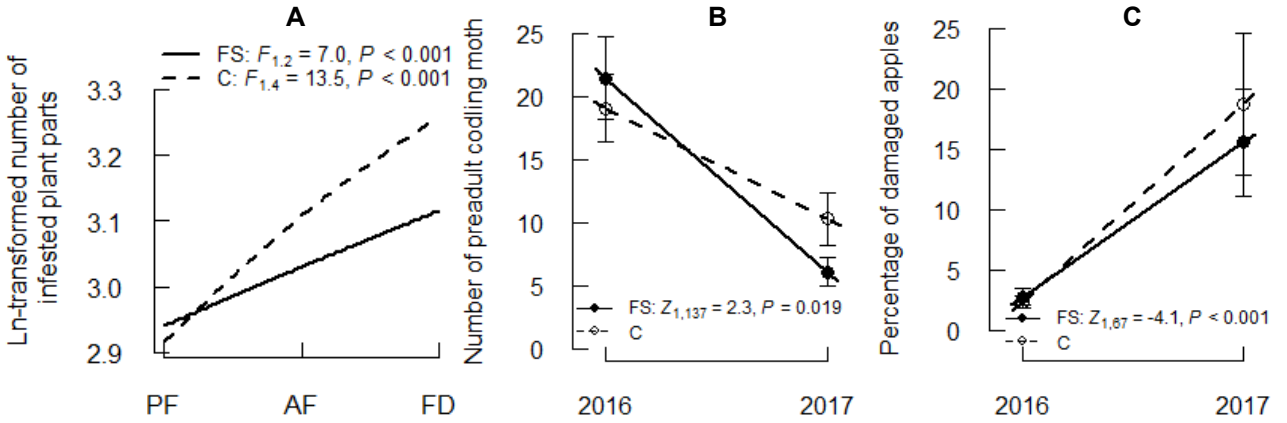
In 2015, 23 experimental blocks were established in nine organic apple orchards in Belgium, Denmark, Germany, Italy, Poland, Sweden and Switzerland. Each block consisted of 7-8 tree rows. Flower strips (21-25 native dicotyledon & 4-7 grass species) were sown in the alleyways of one part of the block. An assessment plot (30 trees) was placed in the central part of the block with flower strips (FS) and in the control part (C). The plots were separated by 41.46 ± 6.97 m (mean ± SE). In 2016 and 2017, plant diversity and ground cover were assessed in spring, summer and autumn. Natural enemies, pests and fruit damage were assessed during pre- and after flowering, after the second fruit drop, and at harvest.

Results and Discussion

Compared to the spontaneous orchard vegetation, species richness ($t_{1,569} = 34.6$, $P < 0.001$) and ground cover ($t_{1,569} = 9.6$, $P < 0.001$) by flowering plants was significantly increased in the flower strips by 63.6 % and 29.0 %, respectively. Flower strips significantly increased

[1] F. Cahenzli, Research Institute of Organic Agriculture (FiBL), CH-5070 Frick, Fabian.cahenzli@fibl.org
[2] L. Sigsgaard, University of Copenhagen (UCPH), DK-1871 Frederiksberg, les@plen.ku.dk
[3] L. Pfiffner, Research Institute of Organic Agriculture (FiBL), CH-5070 Frick, Lukas.pfiffner@fibl.org

the mean number of natural enemies (Syrphidae, Chrysopidae, Forficulidae, spiders, Anthocoridae, Miridae and Coccinellidae) per colony of *Dysaphis plantaginea* Passerini by 16.4 % (χ^2 = 7.9, P = 0.005). This suggests that the specifically designed flower mixtures boosted natural enemies. Likewise, the population increase of *D. plantaginea* was significantly slower on trees in the flower strip plots than in control plots (Fig. A) and the percentage of malformed apples after the second fruit drop was significantly reduced from 10.1 ± 2.4 % to 7.7 ± 1.9 % (χ^2 = -9.7, P < 0.001). From 2016 to 2017, the number of preadult *Cydia pomonella* L dropped more in the flower strip plots than the control plots (Fig. B), while the increase in relative fruit damage was lower in the flower strip plots (Fig. C). This indicates a positive control effect of the flower strips. Our study shows on a wide continental scale that the implementation of perennial flower strips in the alleyways between apple tree rows boosts natural enemies and reduces key apple pests and the associated fruit damage. The observed reduction in fruit damage may not support the use of this conservation biological control strategy as a stand-alone practice, but our study supports the role of functional agrobiodiversity as a way to potentially reduce insecticide use in orchards.



(A) *Dysaphis plantaginea* infestation on trees with (FS, solid lines) or without (C, dashed lines) flower strips at pre- (PF) and after flowering (AF) and after the second fruit drop (FD). Interaction plots of (B) preadult *Cydia pomonella* and (C) the associated fruit damage at harvest.

Acknowledgements

The project “EcoOrchard” was provided by FP7 ERAnet, CORE Organic Plus and cofinanced by the European Commission.

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Citation of the full publications

Cahenzli, F., Sigsgaard, L., Daniel, C., Her, A., Jamar, L., Kelderer, M., Kramer Jacobsen, S., Kruczyńska, D., Matray, S., Porcel, M., Sekrecka, M., Świergiel, W., Tasin, M., Telfser, J., Pfiffner, L. (2019). Perennial flower strips for pest control in organic apple orchards - A pan-European study. *Agric Ecosyst Environ* **278**: 43-53.

Pfiffner, L., Cahenzli, F., Steinemann, B., Jamar, L., Bjørn, M.C., Porcel, M., Tasin, M., Telfser, J., Kelderer, M., Lisek, J. & Sigsgaard, L. (2019). Design, implementation and management of perennial flower strips to promote functional agrobiodiversity in organic apple orchards: A pan-European study. *Agric Ecosyst Environ* **278**: 61-71.