Influence of perennial interrow flower strips on the insect population in organic apple orchards in South Tyrol

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Abstract

As part of the COREorganic project EcoOrchard, flower strips were sown in 2015 at the Research Center Laimburg, in two organically managed orchards. No insecticides were deliberately applied in the orchards. The aim of the project was to investigate the effectiveness of measures to promote Functional Agrobiodiversity (FAB). For a bachelor thesis, samples of the flower strips and the control (regular grass vegetation) treatments were taken. A field aspirator of the type "InsectaZooka" (BioQuip Products Inc., California, USA) was used for sampling. 16 samples were aspirated for one minute on an area of 1.2 m² per treatment. The subsequent determination of the insect populations was performed visually. For the evaluation, the insects were divided into four groups: beneficial insects, generally beneficial insects, pests and indifferent species. The subsequent statistical evaluation showed significantly more beneficial insects and a significantly lower number of pests in the flower strips. Furthermore, there was a general tendency for a higher number of generally beneficial insects and indifferent species within flower strips.

Keywords: interrow flower strips, functional agrobiodiversity, field aspirator, organic apple production, EcoOrchard

Introduction

Available plant protection methods for organic apple production are not always very effective. Consequently, organic apple growers suffer high economic losses due to insect damages. The project EcoOrchard developed low impact and sustainable strategies for ecological pest management to reduce pest losses for producers and promote clean and environmentally friendly products for consumers. In this context, Functional Agrobiodiversity (FAB) is a promising approach to preserve or increase biodiversity in agroecosystems in order to optimize ecosystem services.

Perennial interrow flower strips are an interesting measure to implement FAB by which the non-crop vegetation is diversified and the faunistic biodiversity is increased and therefore boosting the orchard's natural resilience. Through the goal-oriented choice of flower and grass species for the EcoOrchard seed mixture, flower strips provide food, shelter and winter quarters for natural enemies and contribute to biological plant protection.

As the installation and management of flower strips cause various costs for the producer it is important to evaluate if they are an effective and feasible tool to support biological plant protection. The insects within the tree canopy have been evaluated by the EcoOrchard project partners. The insect population within the flower strips might differ from the insect population within the canopy, not only because of the distance between tramline and treeline.

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The aim of this study is to use standardized monitoring methods to determine and evaluate the insect population within perennial interrow flower strips compared to the regular grass vegetation found in apple orchards. The study deals with the question if the insect populations within flower strips contribute to the orchard's resilience and biological plant protection according to FAB.

Material and Methods

16 samples were taken from the treatments "flower strip" and "control" (regular tramline vegetation) by use of the battery-operated field aspirator InsectaZooka (BioQuip Products Inc., California, USA) at the Research Center Laimburg in South Tyrol, Italy. The two organically managed orchards were not sprayed with insecticides. The flower strips were sown at of width of 28 x 0,5 m. For each sample, the suction time was limited to one minute and a wooden frame (1,2 m²) was used to limit the suction space. The collected samples were frozen and visually determined by entomological identification keys. For evaluation, insects were divided into four groups: natural enemies, generally beneficial insects, pest species and indifferent species.

A general linear model was used to determine significant differences between flower strips and control for the five insect groups. A principal component analysis was applied to identify a smaller amount of not correlating variables in order to make interpretation easier. The α-level was 5% for all statistical analyses and the program Minitab for Windows version 17 (Minitab LLC, Pennsylvania, USA) was used.

Results

The number of natural enemies was significantly increased in flower strips while the number of pest species was significantly decreased (Fig. 1 (A), (B)). Moreover, there is a trend towards a higher population of generally beneficial insects and indifferent species in flower strips (Fig.1 (C), (D)). In line with this, an almost complete (except for sample K2/3.2) spatial separation in the four-dimensional space of the variants is possible through a principal component analysis (Fig. 2). The first two principal components explain 79% of the variation. The biplot and table 1 show, that the first principal component differentiates samples with a high number of natural enemies (e.g. B3/3.1) as well as samples with a high number of indifferent species (e.g. B1/3.1). The second primary component differentiates samples with a high number of pests (e.g. K1/2.1) and samples with a high number of generally beneficial insects (e.g. K1/2.1).

Table 1: Eigenvectors, results of the principal component analysis for the variables natural enemies, generally beneficial insects, pests and indifferent species (PC = principal component)

Variable	PC1	PC2	PC3	PC4
Pests	-0,354	-0,661	0,007	0,662
Natural enemies	0,672	0,039	0,627	0,392
indifferent species	0,622	-0,197	-0,744	0,143
generally beneficial insects	0,190	-0,723	0,231	-0,623

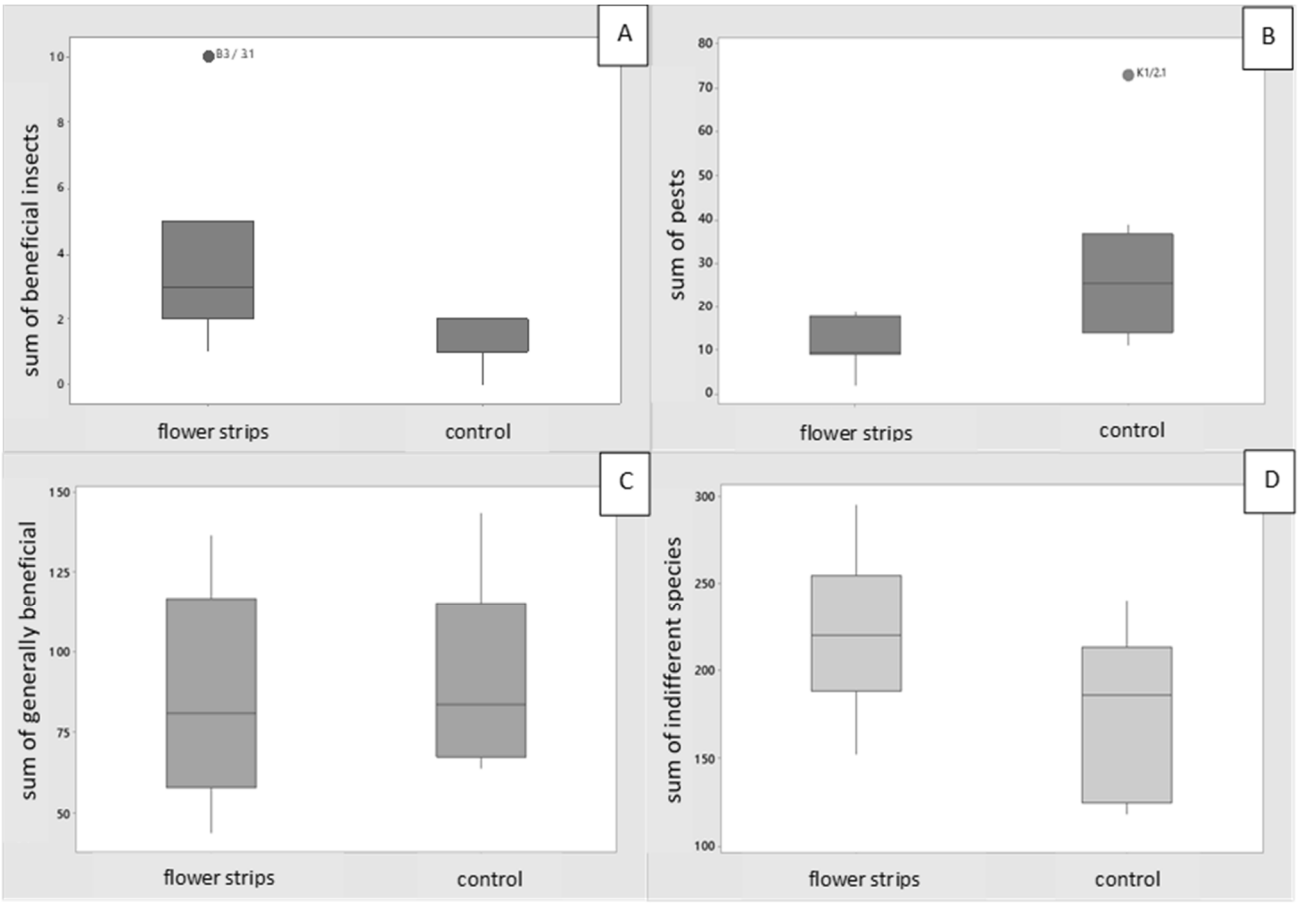

Figure 1: Insect population within flower strips and control (A) Significant effect of flower strips on sum of beneficial insects (p= 0,039) (B) Significant effect of flower strip on sum of pests (p= 0,037) (C) No significant difference for sum of generally beneficial insects (p= 0,725) (D) No significant difference for sum of indifferent species (p= 0,093).

Discussion

On the basis of previous studies, it was assumed that there would be a difference between the insect population within flower strips and within regular grass vegetation (Markó et al., 2012; Dib et al, 2012; Kienzle et al., 2014; Campbell et al., 2017). In line with this, the results showed a significant difference between the insect population within flower strips compared to regular grass vegetation. This was particularly confirmed by the principal component analysis. Due to the significant differences, especially for beneficial insects and pests, it can be assumed that perennial, interrow flower stirps have a positive effect on the orchard's resilience. The results of this trial expand and complete the results of the EcoOrchard project and can contribute to a more detailed statement whether flower strips can be usefully implemented into pest management strategies and thus plant protection sprayings could be reduced. To improve the efficiency of flower strips as a FAB measure furthermore, there is still a need for action. For prospective trials the sampling of the insect population should take place throughout the vegetation period so that population fluctuations can be taken into account. It became clear that the InsectaZooka is less appropriate for sampling herbaceous plants than comparable motorized devices for different reasons. First, the collecting vessel was of limited space and collected insects were not separated into an additional vessel during aspiration. Therefore, already collected insects could have fallen out of the collecting vessel during aspiration. Second, the suction power was limited due to the use of a battery-operated aspirator, whereby bigger insects might not be sucked in.

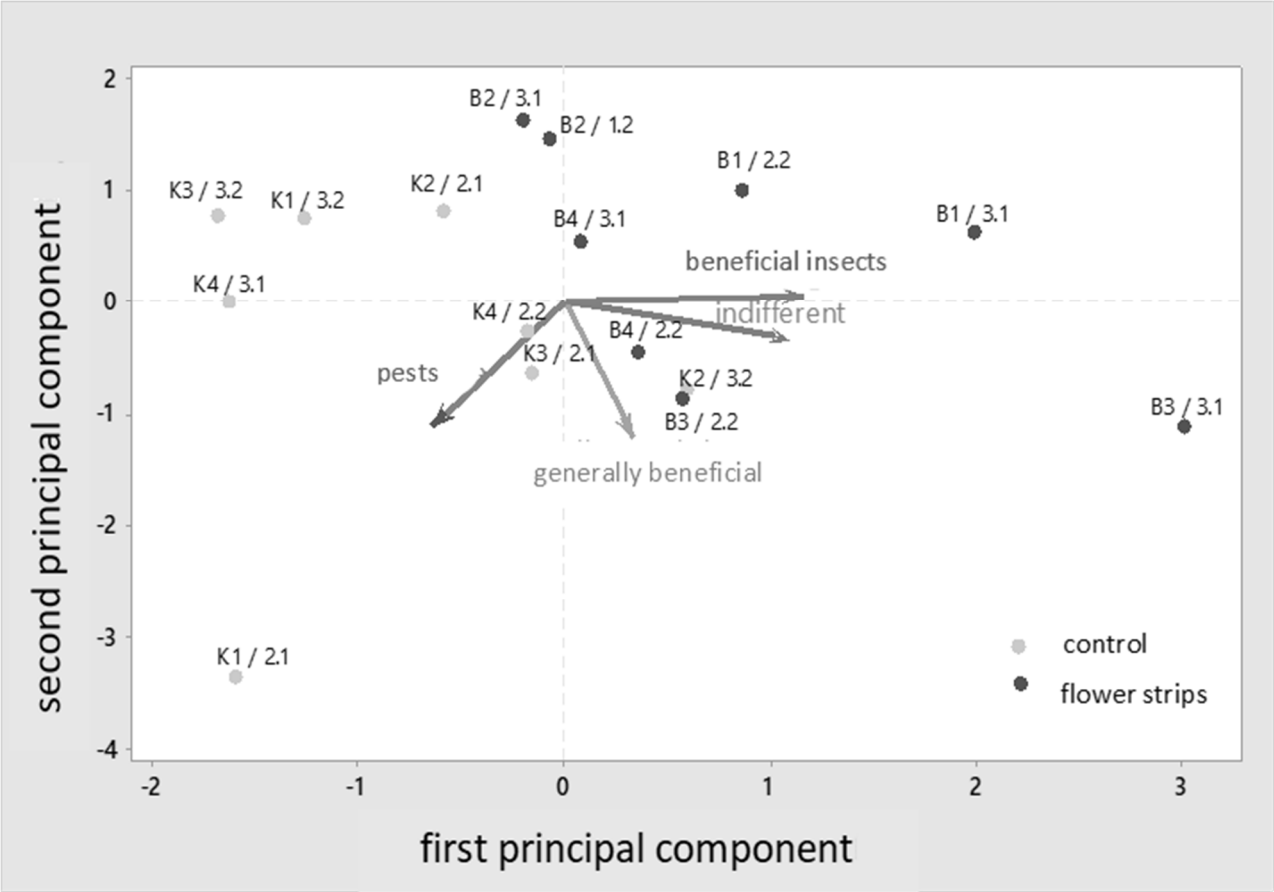

Figure 2: Biplot (overlaying score plot and loading plot) of the first two principal components for the treatments flower strips and control

Third, the vegetation was already quite high at the sampling date which limits suction efficiency further. For these reasons, a combined application of methods should be used for the recording of the overall insect fauna. For the complete assessment of flower strips according to more detailed determination of insect groups, e.g. DNA-methods, should be carried out to explore biodiversity on the level of genetic diversity.

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