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Functional agrobiodiversity – a novel approach to optimize pest control in fruit production

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Abstract: Fruit growers suffer great economic losses each year due to pest damage. The demand for organic produce is increasing along with the interest from growers to develop sustainable and more resilient production systems and over 20% of the apple production in Denmark is now organic. Available pest management options are limited and prevention is important for resilience. In the project PROTECFRUIT we test the use of functional agrobiodiversity, by promoting the abundance and diversity of natural enemies in ecological infrastructures using perennial, wild flower strips in organic orchards. Rosy apple aphid, *Dysaphis plantaginea*, infestation and damage, and predator abundance and diversity were assessed in organic orchards with flower strips and compared to organic orchards without flower strips. In orchards with flower strips these parameters were also assessed as a function of distance to flower strip. The methodology includes visual observations, beating samples and sentinel prey to estimate predation activity. Field trials were conducted in 2016 and will be repeated again in 2017. Preliminary results show that aphid infestation and fruit damage w ere less in orchards with flower strips than in control orchards.

Key words: apple, *Dysaphis plantaginea*, flower strip, natural enemies, organic agriculture

Introduction

Organic apple production has now exceeded 20 percent of the total area of apple production in Denmark. The increasing demand for organic produce and the interest from growers to develop more sustainable and resilient production systems has lead to this increase in organic production. The lack of pest control options has great economic consequences for apple growers each year and less than a fifth of the apples are sold as class A. It is hypothesised that functional biodiversity can promote natural control of pests and contribute to reduce crop losses in organic orchards.

Material and methods

Sampling sites and f lower strips

Field trials were conducted in five organic apple orchards with a flower strip and in three organic apple orchards with no flower strip, serving as control orchards. Three orchards have the flower strip replacing a row of apples, and two orchards have the flower strip in the edge of the field. All assessment methods described below were conducted in the first and third row from the flower strip (2 m and 10 m from the flower strip). The flower strips were established in 2015, replacing existing strips. The seed mixture was selected based on plant characteristics such as value for natural enemies, flowering time, plant size and tolerance to mulching. The mixture consists of 40 species of perennial native plants: 8 grass species and 32 flowering herbaceous plant species.

***Infestation level and damage of* D. plantaginea**

Infestation of *D. plantaginea* was assessed by visual observation, four times during the growing season, either as aphid presence in flower clusters or as visual symptoms on long shoots after aphid migration. Time of observation was based on the growth stages of apple trees (BBCH scale) and conducted at pre-flowering (59), at end of flowering (69), at June drop (73), and immediately before first harvest (89). Damage assessments were conducted twice during the season; immediately after June drop and before harvest. Fruit damage by *D. plantaginea* was assessed in ten trees per row, in ten randomly selected apples per tree.

Predation activity, predator abundance and diversity

Predators were visually observed four times during the season, at the same dates and on the same flower clusters or shoots as the observations of *D. plantaginea*. Beating samples were conducted three times during the season in order to assess predator abundance and diversity, at end of flowering, at June drop, and before harvest. Three beating samples were conducted per row. Each sample consisted of three beatings per branch on 33 trees. Only one branch per tree was beaten, so in case of shorter rows, fewer samples were possible. Predation activity in the orchards was assessed by sentinel prey. Eggs of *Ephestia kuehniella* were glued onto cards of 2 x 3 cm, using egg white. The predation cards were attached to the underside of apple leaves in the orchard, collected after 24 h and the numbers of eggs eaten were assessed under a stereomicroscope.

Results and discussion

The overall aphid infestation was low in 2016. Preliminary data show that the infestation was highest in the control orchard with about 6% infested clusters/shoots by June drop, whereas in orchards with flower strips the infestation was less than half of that. Likewise, the proportion of apples with damage from aphids was highest in the control orchards (6%), while the proportion of damaged fruits in orchards with flower strips was less than half of that. Figure 1 shows that the proportion of flower clusters/shoots with aphid natural enemies present increased from around 5% during pre- and post-flowering to about 20% later in the season, and was comparable between the control orchards and orchards with flower strips. In the orchards with flower strips the highest proportion was found in the tree row adjacent to the flower strip. Predation activity assessed on sentinel prey peaked by June drop and was highest in the first tree row (2 m from flower strip, almost 100% eggs predated) and less in the third row (10 m from flower strip, 90% eggs predated) and in the control orchard (ca. 80% eggs predated).

Though infestation was low, losses (smaller, misshapen apples) were above what is accepted in conventional production, especially in the control orchards, i.e. the results from the first year points to the contribution of flower strips to reduce the losses by increasing the functional biodiversity. This is corroborated by the higher density and activity of natural enemies near the flower strip. Results are also in agreement with previous findings on the effect of flower strips on codling moths and their natural enemies in apple (Sigsgaard, 2014), indicating that functional biodiversity can increase orchard robustness towards more pest species. The observed decrease in natural enemy activity with distance from flower strip suggest that a greater effectiveness of functional agrobiodiversity may be achieved with higher plant coverage and proximity of flower strips, as are currently being tested in the project EcoOrchard (Sigsgaard, 2016).

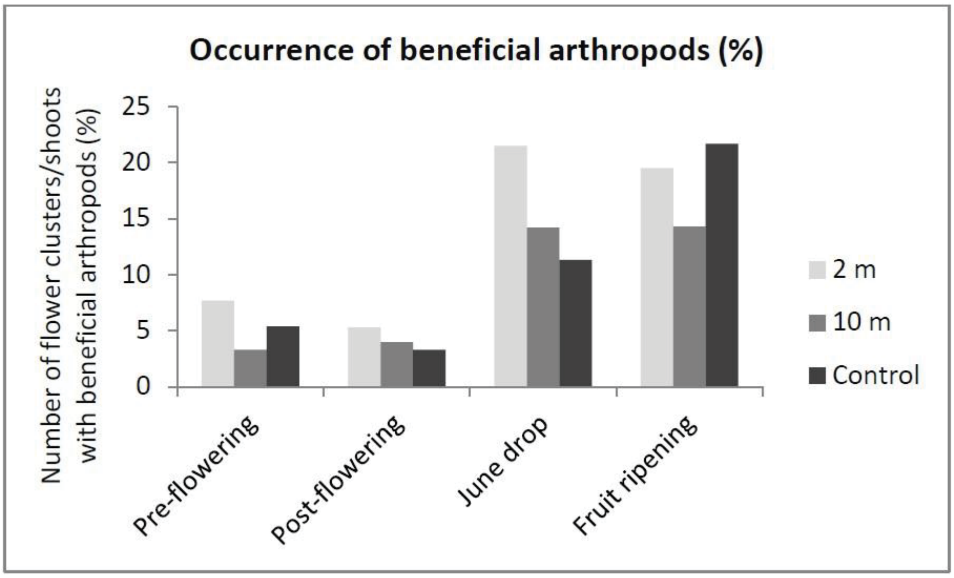

Figure 1. Number of flower clusters/shoots with beneficial arthropods in five organic orchards with flower strips assessed in tree row 2 m and 10 m from flower strip and in three organic orchards without flower strips in 2016.

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