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Short contribution

Aphid regulation in covered organic apricot production by open rearing and releasing of beneficial insects

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Abstract

Aphids are the main pests in organic low stem stone fruit orchards with weather protection and lateral nettings. Under the favourable microclimatic conditions and the limited access of beneficial insects, large aphid colonies can develop from a few fundatrices. As part of a series of experiments in 2022, beneficial insects (hoverflies, parasitic wasps, lacewings and ladybirds) were used in their capacity as natural predators of aphids. Specifically, in one of the trials, hoverflies, ladybirds and lacewings were actively introduced into an enclosed apricot tunnel. In the other trial, the beneficial insects were attracted by stripes of barley infested with cereal aphids when the aphids on the apricot trees were not yet in the mass reproduction phase. In both trials, the aphids were successfully reduced with the help of beneficial insects alone, so that no damage was caused to the crop. Furthermore, the different types of beneficial species have been released to find the most promising species for biocontrol in organic apricot production. As for the beneficial species, hoverflies have been found to be the most promising, while lacewings disappeared after their release and were no longer detectable. However, further trials at other locations and with adaptations such as the creation of flowering strips for the adult insects are needed to verify the findings and further develop the system.

Keywords: beneficial insects, aphid control, organic apricot production, plant protection

Introduction

Aphids are one of the most important pests in covered organic stone fruit production. To prevent fungal diseases and prevent the fruits from cracking, the crops are covered with weather protections. However, this measure changes the microclimate in such a way that it favours aphid reproduction on the trees. Aphids suck on the leaves and buds in spring and early summer, whereby the shoot tips in particular are attacked. This leads to severe curling and deformation of the leaves, which impairs their photosynthesis performance and growth. The damage is particularly severe in young trees as, unlike trees in the yield phase, they still have little leaf mass. In addition to leaf damage, a high level of aphid infestation also leads to contamination of the fruit with sooty mold, which grows on the honeydew excreted by the aphids (Cahenzli & Boutry 2022).

Various aphid species exist in apricot production that can cause considerable damage. These include the green peach aphid (*Myzus persicae*), the mealy plum aphid (*Hyalopterus pruni*), the elderberry aphid (*Aphis sambuci*) and the green apple aphid (*Aphis pomi*). In organic stone fruit production, where the use of synthetic chemical insecticides is prohibited, only a few plant protection products are available for the direct control of aphids. The products that can be used include mineral oil (paraffin oil), pyrethrum and neem oil (azadirachtin). In nature, aphids are controlled by their antagonists or beneficial insects. It therefore makes sense to utilise this mechanism as a further measure for aphid control. As beneficial insects often appear too late in nature to prevent major damage to crops, they need to be encouraged at an early stage. This is the aim of open rearing of beneficial insects, which attempts to break the life cycle of aphids before parthenogenetic mass reproduction

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by installing a large number of beneficial insects in the crops before it begins. Two options are available for this. Either the beneficial insects are attracted before the mass reproduction of aphids by offering them food in the form of cereal aphids or they are released and tied to the site with the help of a large food supply or a crop protection net. Messelink et al. (2013) already showed that the establishment of predators before the invasion of pests can massively reduce them.

Material and Methods

In 2020 and 2021, FiBL conducted preliminary trials with various host plants (barley, oat, field bean, pea), aphids (*Sitobion avenae*, *Rhopalosiphum padi*, *Aphis fabae*) and beneficial insects (hoverflies, lacewings, ladybirds, gall midges). It showed that barley is the most suitable host plant for aphids, as it is easy to grow and maintain. The large cereal aphid (*Sitobion avenae*) was chosen for this trial because, unlike the other two aphid species mentioned, it develops quickly on barley and tolerates lower temperatures.

Hoverflies (*Episyrphus balteatus*), lacewings (*Chrysoperla carnea*), two-spotted ladybirds (*Adalia bipunctata*) and a parasitic wasps mixture called "FresaProtect" (17% *Praon volucre*, 17% *Aphidius ervi*, 17% *Aphidius colemani*, 17% *Aphidius matricariae*, 16% *Aphelinus abdominalis*, 16% *Ephedrus cerasicola*) from Andermatt Biocontrol were used as natural antagonists of aphids. The trial was conducted in an organically managed apricot tunnel The tunnel (70 m length, 8.5 m width, 4.2 m height, Hortuna AG) of FiBL in Frick (Switzerland) with 15 different varieties (ACW 4353 (Elsa), ACW 4477 (Mia), ACW 4527, Bergeron, Early Blush, Flopria, Goldrich, Harogem, Lady Cot, Lily Cot, Orangerubis, Précoce de Millet, Samouraï, Valla Must, Vertige) planted in three rows with two replicates with three trees each (planted 2018, row spacing of 2.5 m, and tree spacing of 2.2 m).

For the present trial, one half of the tunnel was enclosed all around with a crop protection net (1.2 x 1.2 mm mesh size) at the end of March 2022 and thus closed "insect-proof" (netted treatment). In this part of the tunnel, beneficial insects (hoverflies, lacewings, and ladybirds) were actively released. The second part of the apricot tunnel was left open (open treatment) no beneficial insects were actively applied. In both treatments, the large cereal aphid (*S. avenae*) was released on the barley host plant as a food source for beneficial insects. The aim was to test whether the release of beneficial insects is worthwhile or whether it is sufficient to attract naturally occurring beneficial insects by placing cereal aphids on cereals.

Assessments in the entire apricot tunnel were carried out weekly from 20 May 2022 to 30 June 2022. On the apricot trees assessments were conducted on 29 April 2022 and 6 May 2022. Ten shoots per tree were checked for aphids and beneficial insects (number and stage, i.e. larvae, pupae, adults). In addition, the barley blocks were also checked for beneficials for an observation time of five minutes at a time. For the parasitic wasps, as the adults are too small and mobile to determine their numbers precisely, only the parasitized aphids were counted here. Where the following section refers to parasitic wasps, the statements and data therefore relate to the parasitized aphids. The different-looking parasitized aphids were identified by species using molecular identification (Figure 1).

a)  b)  c) 

Figure 1: Colour and shape changes of aphids due to parasitization by parasitic wasps. a) white colour with base (*Praon volucre*), b) golden colour (*Aphidius spp.*), c) black colour (*Ephedrus spp.*).

Results

The aphids were controlled with the help of the beneficial insects in both the netted treatment (Figure 2, left) and the open treatment (Figure 2, right). This raises the question of how essential it is to completely net the tunnel. On the one hand, it could be shown that the exposed beneficial insects accumulated more in the netted treatment (Figure 2, left). On the other hand, the aphids also multiplied more in the netted treatment due to the slightly different microclimate. In addition, the temporal course of the beneficial insect and aphid occurrence showed that the ladybirds, in contrast to the hoverflies, only appeared in significant numbers at a late stage. Lacewings could not be found more than five individuals over the entire period in either treatment, which is why they are not shown in the graph.

Only aphids of the species green peach aphid (*M. persicae*) and black elderberry aphid (*A. sambuci*) were found in the trial. While the mealy plum aphid (*H. pruni*) multiplied strongly outside the trial (in the immediate neighbourhood) from mid/late June, only one infested leaf was found inside the apricot tunnel. The beneficial insects appear to have developed their full potential at this time.

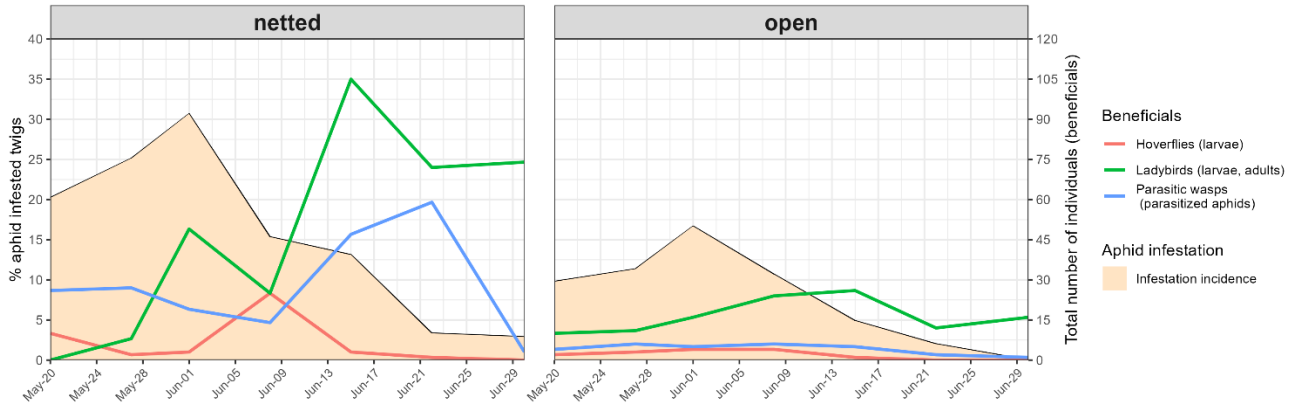

Figure 2: Aphid infestation incidence of the trees (left axis) and total number of individuals per beneficial insect type (right axis) in the netted treatment (left) and open treatment (right) of the apricot tunnel. On 12 May 2022, 30 hoverfly pupae and 10 ladybird larvae per barley block (12 blocks) were released in the netted treatment; parasitic wasps were not actively released. No beneficial insects were released in the open treatment. The sum of the aphid-feeding stages (hoverflies: larvae, ladybirds: larvae, adults) or the sum of individuals from different species (parasitic wasps) on all trees is shown for each beneficial insect type. To determine the aphid infestation level, 10 shoots per tree were checked for aphids for all 45 trees per treatment.

Discussion

Population formation and aphid reduction by ladybirds, parasitic wasps and hoverflies appear promising. Even at their maximum spread, the pressure exerted by the aphids was never so great that the trees were damaged. Due to their sensitivity to abiotic and biotic factors, as described in the literature (Dhandapani et al. 2016), lacewings are less suitable for controlling aphids. The present trial showed that a combination of various beneficial insects is more effective than using them individually. This confirms the description by Wyss et al. (1999), according to which *E. balteatus* and *A. bipunctata* together have a positive effect on the aphid population. The approach of open rearing of beneficial insects should therefore be pursued as a control method against aphids. It may be possible to test other beneficial insects as a control method, such as the gall midge *Aphidoletes aphidimyza*, which is already being used successfully in greenhouses (Boulanger et al. 2019).

It should be noted, that these findings are based on the results from a single trial, which is why results should be treated with caution for the time being and should not be generalised.

In particular, it remains to be examined whether the results can be reproduced in larger orchards, with other fruit species and/or in other geographical conditions. The apricot tunnel itself also needs to be examined, i.e. whether and what influence it has on its microclimate if the tunnel does not have side ventilation, front flaps and a ridge opening, and how this changes the aphid beneficial insect dynamics. It has to be determined whether open rearing of beneficial insects will establish itself as an exclusive method or, if necessary, in combination with other biological control methods. Further trials are planned on various farms over the next years. The focus here should be on a semi-closed system with ant control and flower strips or reservoirs. The naturally occurring beneficial insects can be supported by spreading parasitic wasps and hoverflies. In the case of ladybirds, a simpler application method (e.g. application of adults or pupae) must be examined. In addition, special attention will have to be paid to the differences between varieties. This was not possible within the scope of this trial, but it appears to be a promising approach (data not shown). The evaluation clearly showed that certain apricot varieties had significantly less aphid infestation than others.

In addition to the actual control of aphids, the question must always be asked for what reason aphid pressure in covered orchards is a problem at all. The microclimate is often a decisive factor, because the higher the temperature and humidity (Xu and Feng 2002), the faster aphids multiply. It is therefore not only important to ensure that the tunnel is well ventilated, but also that seasonal coverings, such as in cherry orchards, are closed as late as possible and reopened early. It would also be useful to avoid excessive fertilisation, as fertilisation produces many fresh shoots, which in turn attract and encourage aphids. So, there is still a lot to consider when it comes to preventing aphids.

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