

Effect of management spontaneous cover crop on rosy apple aphid, green apple aphid and their natural enemies in an apple organic orchard

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Key words: rosy apple aphid, green apple aphid, natural enemies

Abstract

*Cover crops have been reported as shelters for pest but also for natural enemies. Nevertheless, there is not agreement about their influence on pest presence on apple trees. An experiment was conducted in 2004-2006 in an IRTA-Estació Experimental de Lleida organic apple orchard located in Les Borges Blanques (Lleida, Spain) in order to evaluate the influence of cover crops on the presence of pest and natural enemies on apple trees. Three cover crops were tested and compared to a bare soil: (1) spontaneous cover crop where *Plantago lanceolata* L. was the most abundant specie, (2) no-mowed spontaneous cover crop, (3) spontaneous cover crop mowed when weeds were 30 cm tall. Cover crops tested affected neither the presence the rosy apple aphid nor aphid natural enemies. Nevertheless, the green apple aphid was more abundant in bare soil trees than in cover crop trees.*

Introduction

Cover crops have been reported as a water, nutrient and light competitors. This competition can reduce crop growth and production (Weibel and Häseli 2003, Zimdahl 1993). On the other hand, cover crops can be a shelter for natural enemies. Trials carried out on apple tree orchards (*Malus domestica* Borkh.) have shown that cover crops and resident vegetation managed as a cover crop can attract natural enemies (Fitzgerald and Solomon 2004, Vogt and Weigel 1999, Wyss 1999, Haley and Hogue 1990, Bugg and Waddington 1994, Altieri and Schmidt 1986). However, there is not agreement on their effect on pest control.

The rosy apple aphid is one of the most important apple pests in Spain. It is a holocyclic insect that returns from *Plantago* sp. to apple trees in October (Blommers et al. 2004). Although species of *Plantago* are common weeds on fruit tree orchards (Marquès et al. 1983), their effect on the abundance of the rosy apple aphid on apple trees has not been studied. Thus, the objective of this work was to evaluate whether the presence of *Plantago* sp. affects the abundance of the rosy apple aphid on apple trees. In addition, the effect of cover crop management on the abundance of the rosy apple aphid, the green apple aphid and their natural enemies was also studied.

Materials and methods

The trial was conducted from 2004 to 2006 in a 1.5 ha organic apple orchard located at the IRTA-Lleida Experiment Station in Borges Blanques (Spain, UTM coordinates X: 320,794, Y: 4,597,395) planted in January 2003. It comprised 'Fuji' apple trees on

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M9 rootstock and 'Granny Smith' apple trees on Pajam 1[®] as pollinators. The apple trees were irrigated by dropping and the orchard was managed upon the rules of the European organic production (EEC, 1991).

Three cover crops were tested: (1) Plantago (PI): spontaneous cover crop where *Plantago lanceolata* L was the most abundant specie; this cover crop was mowed twice in 2004 and 4 times in 2006 to avoid weed competition. (2) No-mowed (NM): no-mowed spontaneous cover crop. (3) Mowed (M): spontaneous cover crop mowed when weeds were 30 cm tall (2, 1 and 4 times in 2004, 2005 and 2006 respectively). These cover crops were compared to a bare soil (BS) that was maintained free of weeds by hand. NM and M cover crops were composed by broad leaf species except in 2006 that grasses were more abundant.

The elementary plot was formed by 4 rows with 8 trees in each row, forming 3 alleyways taking up 134.4m². The treatment PI was assigned to the elementary plot where *P. lanceolata* was the most abundant specie. The rest of the treatments were randomly arranged. The trial was performed in a complete block design with 4 replicates. Samples were taken from the 8 central trees (4 trees for each 2 central rows). Data were analysed by lineal model ANOVA using SAS[®] Enterprise Guide (Version 2.0.0.417). Mean values of the treatments were compared by the Multiple Range Duncan's test (SAS Institute, 2000).

The presence of the rosy apple aphid, the green apple aphid and theirs naturals enemies were recorded by visual controls weekly on 10 shoot per tree on the 8 control trees. Rosy apple aphid was recorded from autumn 2004 to spring 2006. Green apple aphid and natural enemies were sampled from spring 2004 to winter 2005.

Results

Cover crops tested did not affect the presence of the rosy apple aphid in any season studied (Tab. 1). In contrast, the green apple aphid was more abundant in bare soil than in cover crops (Figure 1); these differences were significant in 2004.

Three aphid natural enemies were found on apple trees in 2004: parasitoides (Aphidiide), the 7-spotted lady beetle (*Coccinella septempunctata* L.) and the green lacewing (*Chrysoperla* sp.). One more natural enemy was found in 2005: *Allothrombium fuliginosum* Hermann. Anyway, neither in 2004 nor in 2005 there were differences among treatments (Tab. 2).

Tab. 1: Percentage of shoots with rosy apple aphid. PI: Plantago. NM: No-mowed. M: Mowed. BS: Bare soil. Each value is the mean percentage of shoots with rosy apple aphid during the sampling period.

| Cover crop | Autumn 2004 | Spring 2005 | Autumn 2005 | Spring 2006 |
|------------|-------------|-------------|-------------|-------------|
| PI | 1.49 | 4.17 | 1.81 | 2.52 |
| NM | 1.81 | 3.20 | 2.45 | 2.02 |
| M | 1.72 | 2.10 | 2.30 | 1.43 |
| BS | 2.36 | 4.14 | 3.36 | 3.61 |

No significant differences among cover crops for P<0.05.

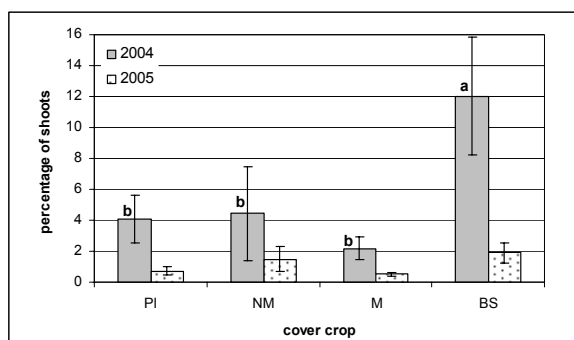


Figure 1: Percentage of shoots with green apple aphid. PI: Plantago. NM: No-mowed. M: Mowed. BS: Bare soil. Each value is the annual mean percentage of shoots with green apple aphid. Values followed by the same letter in each column are not significantly different ($P < 0.05$) by the Multiple Range Duncan's test.

Tab. 2: Percentage of trees with parasitized aphids, *Chrysoperla* sp., *C. septempunctata*, *A. fuliginosum*. PI: Plantago. NM: No-mowed. M: Mowed. BS: Bare soil. Each value is the annual mean percentage of shoots with natural enemies.

| Cover crop | Parasitized aphids | | <i>Chrysoperla</i> sp. | | <i>C. septempunctata</i> | | <i>A. fuliginosum</i> |
|------------|--------------------|------|------------------------|-------|--------------------------|------|-----------------------|
| | 2004 | 2005 | 2004 | 2005 | 2004 | 2005 | 2005 |
| PI | 8.08 | 0.41 | 8.02 | 17.36 | 1.51 | 0.19 | 2.38 |
| NM | 8.25 | 0.41 | 8.33 | 18.93 | 2.25 | 0.11 | 2.19 |
| M | 8.48 | 0.00 | 8.68 | 17.27 | 0.44 | 0.13 | 1.92 |
| BS | 5.89 | 0.46 | 9.74 | 20.26 | 1.49 | 0.00 | 2.41 |

No significant differences among cover crops for $P < 0.05$.

Discussion

The rosy apple aphid is a holocyclic aphid that migrates to *Plantago* sp. late May or June. It was expected that this aphid was more abundant in PI cover crop apple trees because *Plantago* sp. is its secondary host. Anyway, neither the presence of *P. lanceolata*, the mowing of the cover crop, nor the absence of a ground cover affected the presence of the rosy apple aphid.

In contrast, the absence of a ground cover promoted the presence of the green apple aphid. The development of aphids has been related to nitrogen content of the host plant (Klingauf, 1987). In fact, higher levels of nitrogen in the leaves were related to higher levels of green apple aphid infestation (Haley and Hogue 1990). The lack of weeds in the BS treatment avoided competition between the crop and the weed, so leaves of BS cover crop trees may have had more nitrogen content and became more attractive to green apple aphid.

As far as natural enemies are concerned, no differences were observed among treatments. Brown and Glenn (1999) neither found an effect of the ground cover on the tree presence of natural enemies. According to Bostanian et al. (2004) several years are required to increase natural enemy populations. Thus, more years will be needed to find out the effect of cover crop to attract natural enemies and control pests.

Conclusions

The conclusions of this trial are: (1) the presence of *P. lanceolata* did not affect the abundance of the rosy apple aphid on apple trees, (2) neither mowing nor the absence of a ground cover did not satisfactory help to control the rosy apple aphid, (3) any cover crop tested did not improve aphid natural enemy populations, (4) the green apple aphid was more abundant in the bare soil trees than in the cover crop trees, (5) more years will be needed in order to find out whether cover crops can attract enough natural enemies to control pests.

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