Monitoring of predation activity in apple orchards

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Abstract

Utilization of insect predators as a pest control agent is a very valuable tool in plant protection. Predation cards (sentinel prey) with aphids and codling moth eggs were used to evaluate a predation activity in 3 apple orchards (1, 2, 3a) in the Czech Republic in years 2016 and 2017. In 2017 one more site was added (orchard 3b). Monitoring took place from the end of May till the turn of September and October. The average predation rate was 67, 18 and 43 % for aphids and 15, 5 and 7 % for codling moth eggs in orchard 1, 2 and 3 respectively in 2016. The average predation rate was 75 %, 31 %, 60 % and 48 % for aphids and 12 %, 7 %, 10 % and 11 % for the codling moth eggs in orchard 1, 2 3a and 3b respectively in 2017. The highest predation activity was reported from the end of June to August. In the orchard 1 there was 100% predation rate at this time due to high abundance of earwigs in 2016 and 99,33% predation rate in 2017.

Keywords: Aphids, biological control, ecological fruit production, predation, sentinel prey

Introduction

Food production is often seen as an industrial process. However, natural principles does exist in orchards and fields. One option how to bring natural principles and thus more sustainability into food production process, is biological crop protection. It uses natural relationships between organisms to work in favour of pest regulation. Such organisms appear naturally in ecosystems. We can promote their occurrence in orchards in several ways. Placing birdhouses, nesting places, insect hotels, establishing hedgerows, flowering strips, water areas and so on will enhance their abundance in orchards. Well-designed agro-ecological measures can serve other functions as well, it is known as functional agrobiodiversity (FAB).

One of the important agro-ecological measures is sowing of flowering strips/mixtures. Beneficial insects (predators, parasitoids) need nectar and pollen for their survival (Wäckers et al. 2007). On the other hand not all the flowers are suitable for them (Olson & Wäckers 2007). Plants considered as supportive for beneficial insects belong generally to family Apiaceae (carrot, coriander, fennel, parsnip). Other suitable plants belong to family Asteraceae (marigold, yarrow, chicory, cornflower) and leguminous plants (vetch and common bird's-foot). Good overview was published by Wäckers & Van Rijn (2012) in a book “Biodiversity and Insect Pests: Key Issues for Sustainable Management”.

Some rivalry can occur among insects foraging nectar and pollen. Bumblebees can scare off hoverflies, which in turn expel butterflies (Kikuchi 1963). Even different species of hoverflies can compete with each other (Ambrosino et al. 2006). The ability of predators and parasitoids to suppress populations of pests can be used in orchards especially in case of aphids. Zoophagous hoverflies are quite abundant in landscapes and so play an important role in aphid’s control (Wäckers & Van Rijn 2012). The other important predators are larvae of lacewings, bugs belonging to genus *Orius* and *Anthocoris*, ladybeetles, earwigs and spiders.

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Sentinel prey/predation cards method provides a direct qualitative predation rate in field (Lövei & Ferrante 2016). In the Czech Republic this method is not used in practise yet, while it is a simple and useful tool for measuring the predation activity in orchards.

Material and Methods

Predation cards were made of sandpaper strips (approx. 2 x 8.5 cm), coarseness 80. Live *Aphis fabae* individuals were stocked on sandpaper strips using a Bison Spray Adhesive glue. Excess glue was removed by cotton pads and aphids were glued carefully by soft tweezers one-by-one. The aphids were bred in Crop Research Institute facilities. It is possible to use other aphid species especially those, which can be found outdoors. Finished strips with aphids were placed in a fridge. Fresh baits were prepared on the same day as they were placed in orchards. Strips were wrapped around a branch by stapler. Using of shimmering colours of the sandpaper is recommended, because of its visibility on the tree.

Survey was done from May to October 2016 and 2017 in 3 orchards in different regions of the Czech Republic. In orchard 3 there were 2 sites monitored in 2017 (IPM x BIO) to see if there are differences between 2 managements within one orchard. Orchards **1** and **3a** had biological management whilst orchards **2** and **3b** were integrated.

In every site 30 predation cards, each with 5 aphids, were used for the monitoring. The cards were placed in 3 rows (10 cards per row). Experimental site with cards was situated in the middle of the plantations to avoid marginal effect. The cards were hanged on every 3. tree in the row. Every tree with the card was marked. Results were evaluated after 48 hours directly in the orchards with a magnifying glass. Cards with *Cydia pomonella* eggs were used together with aphid's cards and they were hanged in close proximity of the cards with aphids. Eggs of the codling moth were obtained in CRI breeding facilities. Butterflies laid eggs on a waxy paper from which small pieces with 5 eggs were cut. These were stapled to the underside of the leaves. Eggs were always less than a week old.

Results and discussion

Overall predation activity was at the highest level from June to August. The activity then dropped in September. Big differences between the used baits were observed. In orchards 1 and 3a with biological management there was a significant difference between predation on aphids and predation on the codling moth eggs in 2016. The highest predation rate was 100 % on aphids and 33 % on the codling moth eggs.

An average predation rate for the whole period on aphids in 2016 was 67 %, 18 % and 43 % in the orchard 1, 2 and 3a respectively and 15 %, 5 % and 7 % on the codling moth eggs. In 2017 it was a bit higher. Monteiro et al. (2013) recorded predation of 12 % in July and 48 % in August on the codling moth eggs in France. Predation rate in the same period (turn of July and August) in the orchards 1, 2, and 3a was 33 %, 4 % and 13 % respectively, which is relatively low in comparison with predation rate on aphids (100 %, 14 %, 55 %).

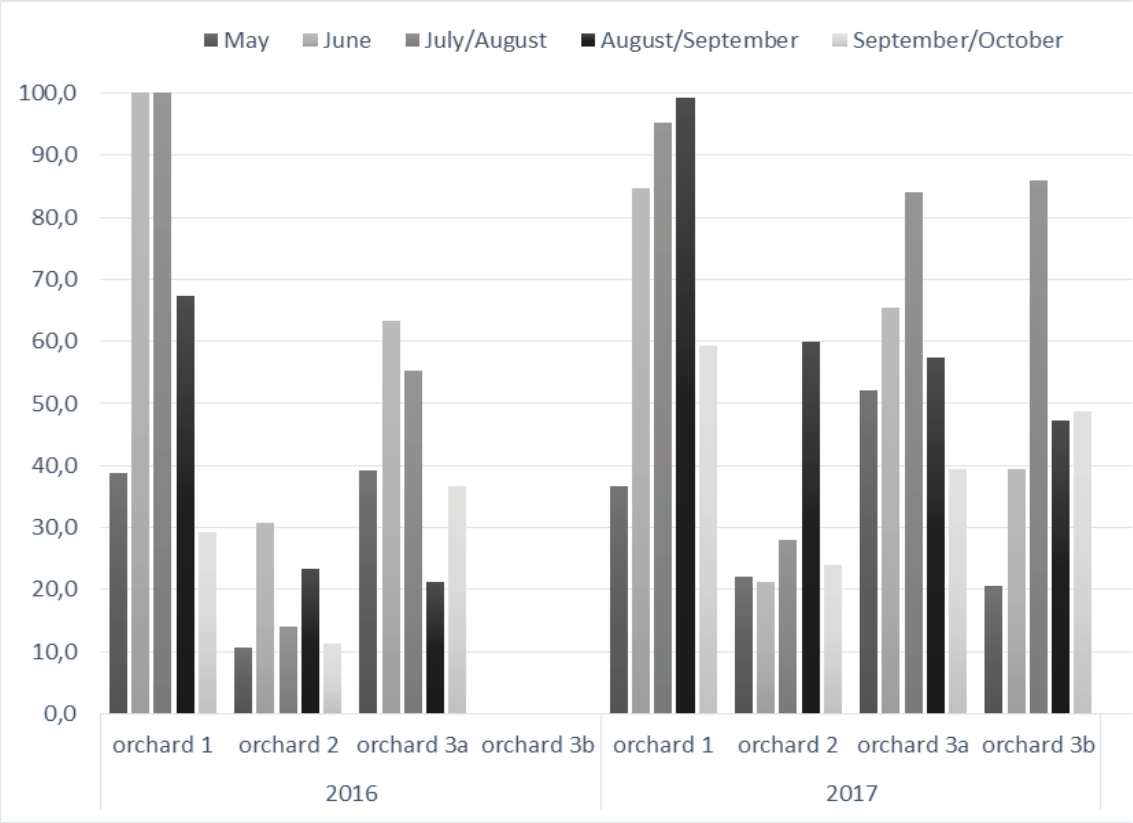

Figure 4: Predation rate on aphids in 2016 and 2017 in orchards with different pest management (BIO: 1, 3a; IPM: 2, 3b). There are no data for orchard 3b in 2016.

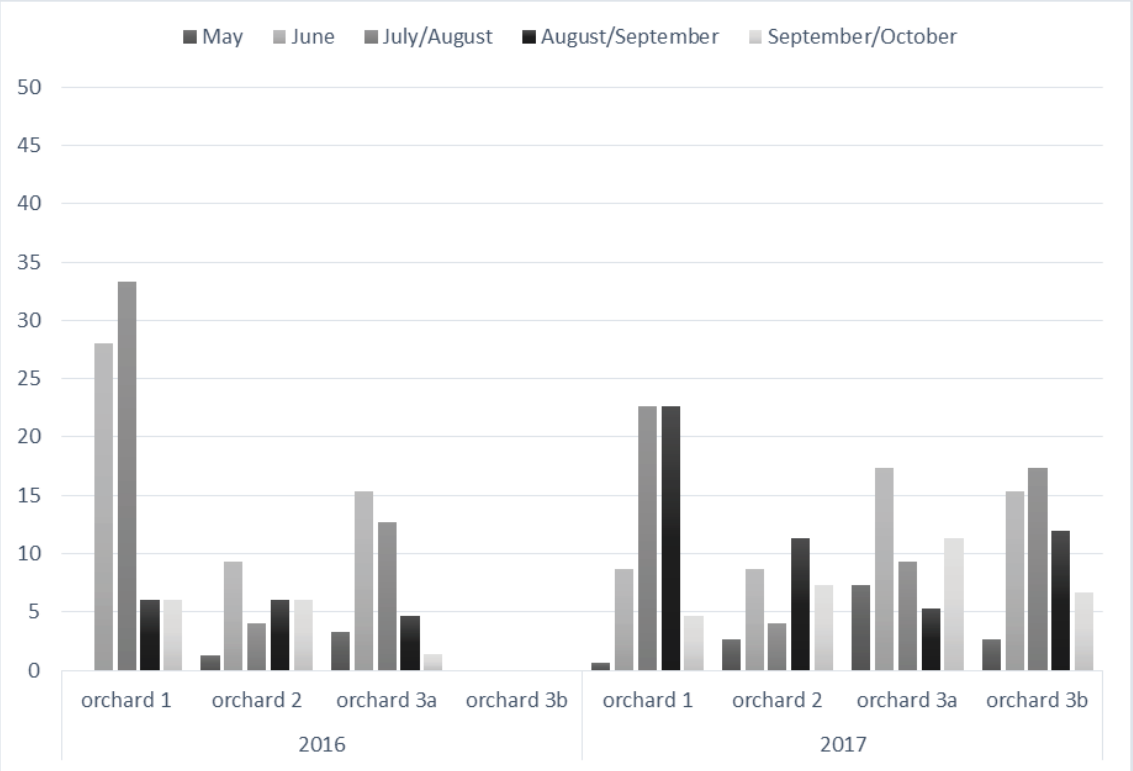

Figure 5: Predation rate on codling moth eggs in 2016 and 2017 in orchards with different pest management (BIO: 1, 3a; IPM: 2, 3b). There are no data for orchard 3b in 2016.

Very important factor, which is tricky to calculate, is the orchard itself and its surroundings and all interactions within (way in which protection is managed, abundance of beneficials, natural conditions…). Monteiro et al. (2013) observed that the highest impact on the predation activity was 1) toxicity of used pesticides and 2) the surroundings of orchards (diversity of a landscape). Such a statement seems to be in line with our results, because the predation rate in the orchard 2 (integrated) was the lowest one. On the other hand this orchard (2) was strongly attacked by woolly apple aphids and due to beating samples we know, that abundance of predators was sufficient. It is highly probable that the predators were feeding on this natural prey instead of the predation cards.

In the orchard 1 there was an interesting phenomenon of 100% predation rate in 2016. It means 2 terms with absolute predation rate when all the aphids on the cards were consumed. There was a high abundance of earwigs exactly at this time. Dozens of earwigs were found in corrugated cardboard shelters and some were found also by beating. Earwigs were not present in the rest of the orchards, thus predation rate in these orchards did not reach such high levels. It can be assumed that the earwigs are very important predators in this period. In 2017 predation rate was lower than 100 % in this orchard. Nevertheless, it was very high again (99,3333 %) due to the abundance of earwigs.

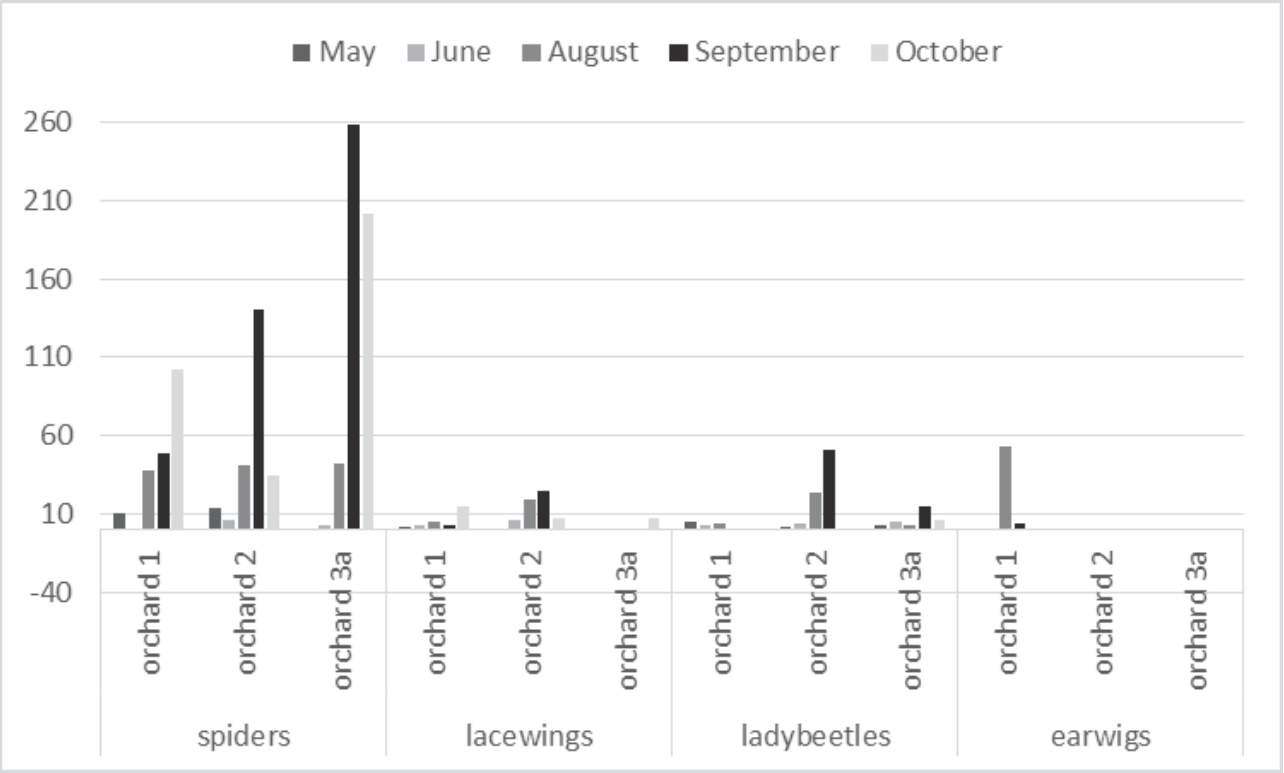

Figure 6: Abundance of predators in beating samples in 2016 (BIO: 1, 3a; IPM: 2).

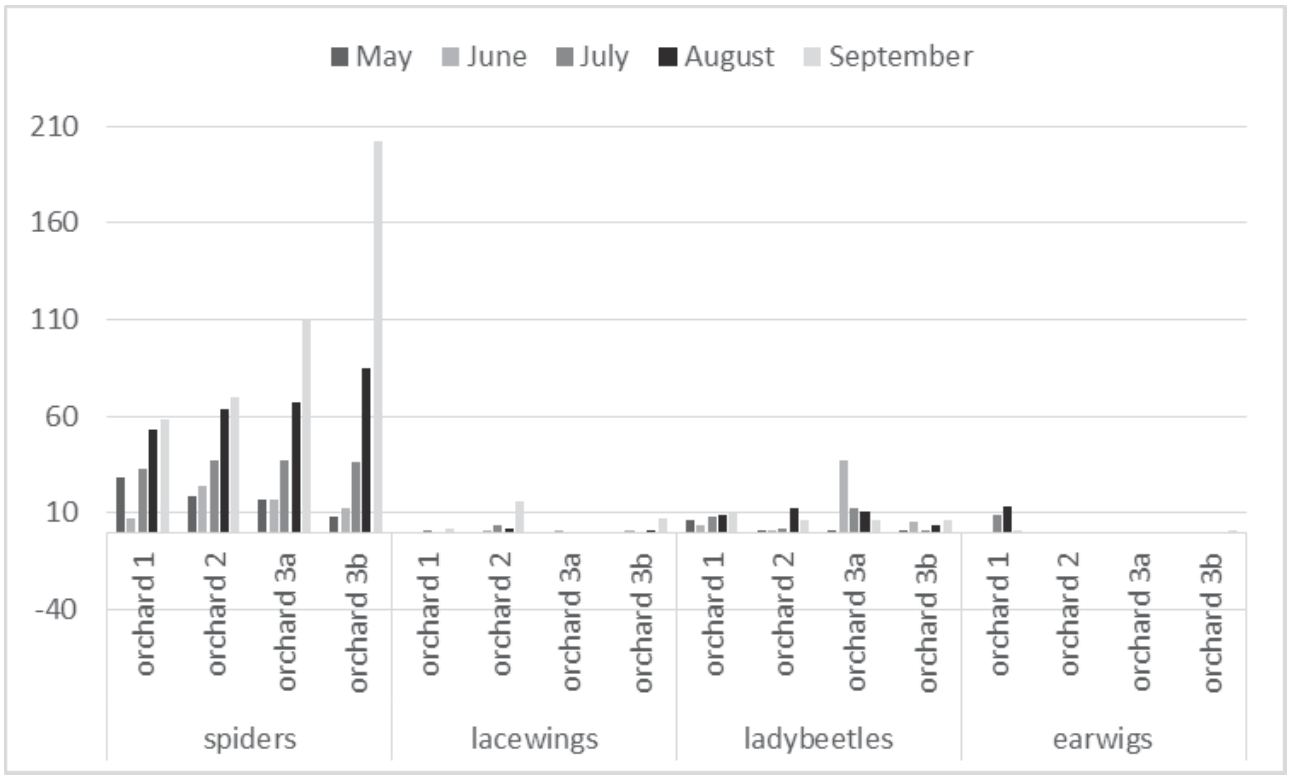

Figure 7: Abundance of predators in beating samples in 2017 (BIO: 1, 3a; IPM: 2, 3b).

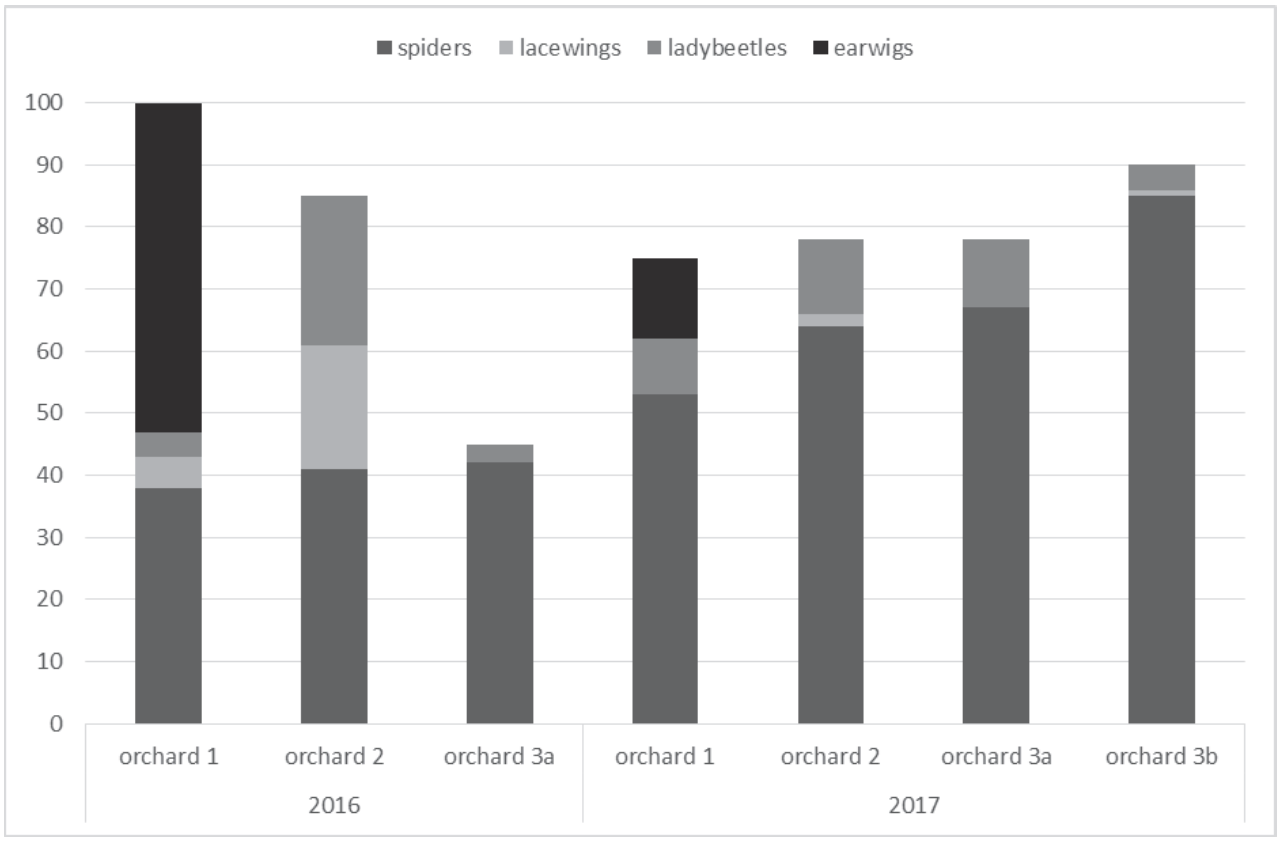

Figure 8: Abundance of predators in beating samples in August 2016 and 2017 (BIO: 1, 3a; IPM: 2, 3b).

Conclusion

The predation cards method is suitable for measuring the predation activity directly in the orchard. It is very easy to use and so it can be performed by farmers themselves. The situation on the cards reflects relative predatory activity. The orchard 2 is a good example. We had enough of active predators, but the pests were so many that the predators did not manage to destroy them, and so we had more intact aphids on the predation cards in this orchard. Such an information about predatory activity can be useful for farmers in the decision-making process, which intervention to use.

Due to our results aphids seem to be better bait to use on the predation cards. Their advantage is a great accessibility outdoors. *Aphis fabae*, which is usually present in undergrowth, is very attractive for ladybeetles. It is possible to use various aphid species, thus the best option might be to collect those which are present in the orchard. The codling moth eggs are attractive for less predator species and are difficult to obtain.

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References

Ambrosino, M.D., Luna, J.M., Jepson, P.C., Wratten, S.D. (2006). Relative Frequencies of Visits to Selected Insectary Plants by Predatory Hoverflies (Diptera: Syrphidae), Other Beneficial Insects, and Herbivores. *Environ. Entomol*. 2006. 35(2): 394–400

Kikuchi, T. (1963). Studies on the coaction among insects visiting flowers IV. Preferring behavior of some Syrphid flies, *Eristalis tenax*, *Eristalis cerealis*, and *Sphaerophoria cylindrica*, in relation to the age of the flower of Chrysanthemum leucanthemum. Sci. Rep. Tohoku Univ. Ser. IV 1963. 29:9–14.

Lövei, G.L., Ferrante, M. (2016). A review of the sentinel prey method as a way of quantifying invertebrate predation under field conditions. Accepted Article.

Monteiro, L.B., Lavigneb, C., Ricci, B., Franck, P., Toubonb, F., Sauphanorb, B. (2013). Predation of codling moth eggs is affected by pest management practices at orchard and landscape levels. Agriculture, Ecosystems and Environment 166: 86– 93

Olson, D.M., Wäckers, F.L. (2007). Management of field margins to maximize multiple ecological services. *Journal of Applied Ecology* 2007. 44: 13–21

Wäckers, F.L., van Rijn, P. (2012). Pick and mix: selecting flowering plants to meet the requirements of target biological control insects. In:Gurr. G.M., Wratten, S.D., Snyder, W.E. (2012). Biodiversity and Insect Pests: Key Issues for Sustainable Management, First Edition