Earwigs and aphids in apple orchards – influence of agri-environmental measures and landscape factors

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Abstract

Earwigs are important generalist predators in apple orchards, regulating key pests such as aphids. We investigated how local factors including forb species richness, woody habitats and apple cultivar, and landscape factors affect earwig and aphid populations in organic and integrated (IP) apple orchards in Germany and Spain. We expected positive and interacting effects of reduced management intensity, resource-rich adjacent habitats and complex landscapes on earwigs but not on aphid infestations, which should be regulated by orchard management. Our results indicate that orchard management altered the effect of woody habitats on earwigs and aphids. Earwig species and aphids responded differently to local and landscape factors in the two European countries.

Keywords: Generalist predator, organic management, apple cultivar, woody habitat

Introduction

Omnivorous predators such as *Forficula auricularia* L. contribute crucially to biological pest control in apple orchards (Cross *et al*., 2015). Living conditions for generalist predators are enhanced by agri-environmental structures and landscape complexity, but with research focusing on annual cropping systems (e.g. Chaplin-Kramer *et al.,* 2011, Dainese *et al.,* 2016; Tschumi *et al*., 2016), little is known about the interacting effects of agri-environmental measures and local management on generalist predators in perennial crop systems (Malagnoux *et al.*, 2015; Marliac *et al.*, 2016). Here, we investigated how local factors such as forbs, woody habitats and apple cultivar, and landscape factors affect earwigs and aphids in organic and integrated (IP) apple orchards in Germany and Spain.

Material and Methods

We sampled commercial apple orchards in SW Germany (29 organic including two cultivars, Braeburn and Topaz, and 15 IP, Braeburn only) between June 2015 and September 2016, and in NE Spain (14 organic and 14 IP) in 2015 (dwarf trees, 6-18 years old, M9 rootstocks). To sample earwigs, bamboo shelters (Germany) and cardboard shelters (Spain) were installed. Bamboo shelters remained in the orchard throughout the study and were sampled 4 times. In Spanish orchards, we sampled cardboard shelters in June 2015.

We calculated the proportion of trees infested with green apple aphid (GAA) *Aphis pomi* De Geer, rosy apple aphid (RAA) *Dysaphis plantaginea* Passerini, and woolly apple aphid (WAA) *Eriosoma lanigerum* Hausmann in all orchards.

Vegetation surveys were conducted within a radius of 20 m from the orchard edge. Landscape complexity was calculated based on cover of commercial fruit orchards in 1 km (with higher landscape complexity at lower orchard covers).

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Results and Discussion

The presence of adjacent woody habitats such as hedgerows decreased abundance of *F. auricularia* in IP but not in organic orchards in Germany. Hedgerows may serve as temporary habitats for earwigs if pest pressure is low but local earwig densities remain high. Comparing organic Braeburn and Topaz orchards in Germany, we did not detect any cultivar effects on earwig abundance. Organic management increased the abundance of the Mediterranean earwig species *Forficula pubescens* Gené (9% of the earwig community, not present in German orchards) in Spain. There was no strong effect of orchard cover but forb species richness marginally increased earwig abundance in Spain, where adjacent woody habitats were scarce.

Woody habitat presence temporarily increased GAA infestation in organic compared to IP orchards in Germany. In Spain, GAA infestation was low. RAA were most responsive to orchard management in both countries. We found lower RAA infestation in organic Topaz compared to organic Braeburn orchards in early summer 2016 in Germany. Infestation by WAA varied strongly between orchards and increased with orchard cover in the surrounding landscape in Germany. A lack of strong correlations between earwigs and aphids in the two countries indicates that responses of other predator and prey taxa should be considered.

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