Landscape Management for Functional Biodiversity
IOBC wprs Bulletin Vol. 34, 2008
pp. 9-12

Insectary plants to enhance the biological control of *Nasonovia ribisnigri* and *Frankliniella occidentalis* in lettuce

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Abstract: Habitat management procedures are known to enhance the activity and abundance of natural enemies in field crops. From previous work on the relative attractiveness of plant species to predators, we short listed a preliminary mixture of plants to be annually planted in order to favour the presence of predators. The objective of this work was to evaluate the benefit of adding plant resources to a lettuce field in order to ensure the biological control of aphids (*Nasonovia ribisnigri*) and thrips (*Frankliniella occidentalis*). Providing plant resources in the field ensured the presence of key predators: adult hoverflies were attracted and aggregated on flower patches, and predatory bugs did establish on the insectary plants. Being highly mobile, both predators did disperse to plots without flower patches and established on lettuce plants unless limited by pesticide treatments. As a result of predator establishment, prey populations were reduced below the economic threshold.

Key words: predators, habitat management

Introduction

Heterogeneity in the landscape, typical in many vegetable cropping systems in the Mediterranean can exacerbate pest problems, but may also provide abundant refuges and sources for entomophagous thus favouring natural biological control in crops (Albajes & Alomar, 1999; Alomar et al., 2002; Gabarra et al., 2004; Castañe et al., 2004). However, natural control is not always fully predictable, and inoculative releases of beneficials are used in greenhouses (Avilla et al., 2004). Habitat management procedures are known to enhance the activity and abundance of natural enemies in field crops. From previous work on the relative attractiveness of plant species to predators, we short listed a preliminary mixture of plants to be annually planted in order to favour the presence of predators (Alomar et al., 2006). The objective of this work was to evaluate the utility of adding plant resources into a lettuce field to ensure the presence of hoverflies and the minute pirate bug (*Orius*), and the biological control of aphids (*Nasonovia ribisnigri*) and thrips (*Frankliniella occidentalis*), two of its major pests.

Material and methods

Lettuce seedlings were planted in a 3600 m^2 field in a complete randomized-block design with four replications of each of four treatments. Two insectary plant treatments were set-up in the middle of lettuce plots replacing 16 lettuce plants: (1) a simple arrangement of insectary plants with only *Lobularia maritima* (alyssum), and (2) a plant mixture with *L. maritima, Centaurea cyanus*, *Vicia sativa*, and *Lupinus hispanicus*. Two controls were included: (3) a pesticide control, with lettuces sprayed according to conventional practices; and (4) a natural control, without pesticides. The field was planted twice, both in spring (24^{th} April) and summer (4^{th} July). For the 2^{nd} crop, we kept the same lay-out of the treatments to keep the insectaries *in situ*, but replaced both legume plants with *Ocimum basilicum* and *Achillea millefolium* two weeks before transplanting the new crop.

Predator populations were non-destructively sampled in the insectary patches by shaking the plants over a white pan (33×23 cm) every week, and visually counting them. Visits to the plots by adult hoverflies were recorded by weekly visual observations (three minutes) of the centre of each plot. Lettuce sentinel plants infested with *N. ribisnigri* were left each week for two days in each plot, and taken to the laboratory to count the number of predators recovered. Finally, four lettuces were destructively sampled from each plot each week and taken to the laboratory in order to count the number of aphids and thrips, other major pests (e.g. Lepidoptera), and predators.

Results and discussion

Hoverfly establishment and aphid control

Fig. 1 shows the percentage distribution in each treatment of adult hoverflies active in the centre of the plots, and of eggs and larvae that were recorded from sentinel and field lettuces during both crops. The visual observation on insectary patches or equivalent central lettuce plants confirms that hoverflies were active in the field, being attracted by the flowers. No adults were seen in the no-insectary plots. However, hoverflies did locate and oviposit on sentinel plants across all four treatments, thus indicating that adults did disperse all over the field after visiting the flower resources.

In the 1st crop, hoverfly larvae and eggs were recovered from lettuces in both insectary treatments as well as from the natural control plots (average of 2.7±0.3 larvae and eggs/ plant). Neither larvae nor eggs were recovered from the pesticide control plots. As a result of hoverfly establishment in the no-pesticide plots, aphids were controlled from average peak levels of 184.9±33.4 aphids/plant down to 5±1 aphid/plant in two weeks, and to the same level as in the pesticide plots. A quality assessment at harvest showed that lettuce head weight was not affected by any treatment, nor were remains of hoverfly larvae present in marketable heads. In the 2nd crop, very few hoverflies established in the no-pesticide plots (0.1±0.05 eggs + larvae/plant), probably due to low aphid levels (0.75±0.5 aphids/plant).

Orius establishment and thrips control

Orius were first recovered from insectary plants from mid-may onwards, five weeks after transplant (up to 4.3±0.7 individuals/sample in the alyssum plots). Alyssum harboured higher *Orius* populations in the plant mixture, and did maintain *Orius* during the crop-free period. During the 2nd lettuce crop, *Orius* did build-up slowly in the insectary plants (up to 7.1±2.1 individuals/sample in the plant mixture, and 5.3±0.9 individuals/sample in the alyssum plots), but did specially increase in the newly transplanted basil that harboured almost three times as many *Orius* as alyssum.

In the 1st crop, *Orius* were found on lettuce plants in all treatments, but very few did establish (up to 0.56±0.2 individuals/plant in the alyssum plots). Thrips (*Frankliniella occidentalis*) populations maintained at low levels (up to 5.9±1.4 thrips/plant in the alyssum plots) without differences among treatments. In the 2nd lettuce crop, *Orius* nymphs were already established on lettuces by the 2nd week after transplant, without significant differences among the three no-pesticide treatments (peak populations of 3.8±0.3 adults + nymphs/plant). Thrips populations on lettuce were similar to the 1st crop (peak of 6.4±0.6 thrips/plant), and not significantly different among treatments. The same level of thrips control was obtained in the pesticide control than in the other treatments. *Orius* also preys *N. ribisnigri*, and its establishment in the lettuce may also have contributed to the control of aphids.

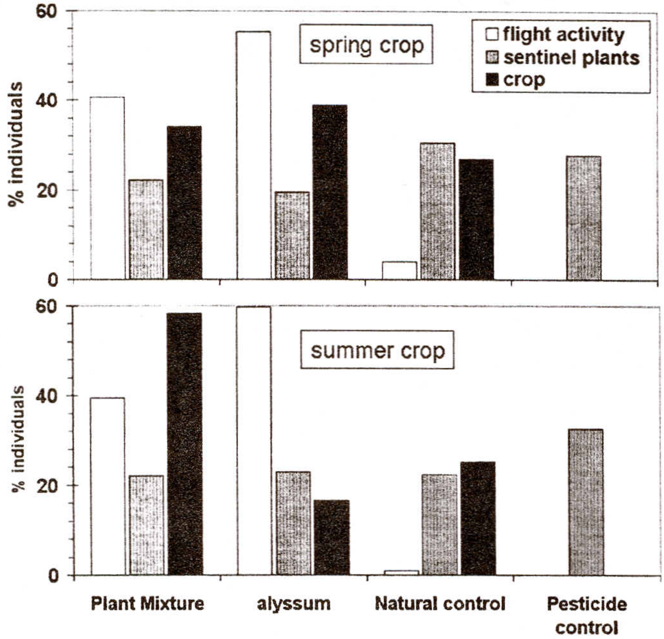

Figure 1. Relative percentage distribution of all recorded hoverflies in each of four treatments during the spring and summer lettuce crops: (a) flight activity in the centre of the plots (insectary plant patches or equivalent lettuce plants); (b) oviposition on sentinel plants; (c) eggs and larvae established in the crop.

Developing a plant mixture for vegetable crops

The results confirm that biological control shows great potential for aphid and thrips control in spring and summer lettuce, and that pesticide sprays against both pests may not always be necessary. Providing plant resources in the field ensured the presence of key predators: adult hoverflies were attracted and aggregated on flower patches, and predatory bugs did establish in the insectary plants. Being highly mobile, both predators did disperse to plots without flower patches and established on lettuce plants unless limited by pesticide treatments. As a result of predator establishment, prey populations were reduced below the economic threshold. Moreover, no other pests were recorded from the lettuce crops as a result of adding the insectary plants.

From the tested plants, *Orius* did established better in alyssum and basil, and did maintain in alyssum while the crop was harvested and the next was transplanted. The maintenance of on-farm refuges can help to bridge crop-free periods and contribute to reduce the effects of disturbances caused by crop harvest and transplant.

Mediterranean vegetable growing areas are complex landscapes characterised by the coexistence of several annual crops, grown on rather small farms (2-3 ha). The discontinuous nature of such ephemeral habitats makes the permanent establishment of natural enemies more difficult than in more stable crops, and natural enemies must re-colonize the fields each time. Under such circumstances, the establishment of predators in a crop should not only be seen as a net benefit for a given field, but also as a net contribution to the enhancement of predator populations that will benefit other neighbouring crops (e.g. cucurbits) within the agricultural mosaic. Moreover, many of those predators are polyphagous, and will contribute to control other pests (e.g. Arnó et al., 2008).

However, the abundance and diversity of natural enemies can vary according to the composition of the surrounding landscape, and it is necessary to confirm that the presence of insectary plant margins in simple landscapes is also sufficient to ensure biological control of major lettuce pests.

Acknowledgements

This research was supported by the Spanish Ministry of Education (AGL2006-08726/AGR), and by TRUEFOOD ("Traditional United Europe Food", Integrated Project financed by the European Commission, 6th Framework Programme for RTD; Contract FOOD-CT-2006-016264). The information in this document reflects only the author's views and the Community is not liable for any use that may be made of the information contained therein. Thanks to SELMAR for providing the necessary field.

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