Beneficial and pest insects associated with ten flowering plant species grown in Québec, Canada

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Abstract

The attractiveness of ten flowering plant species (Achillea millefolium, Coriandrum sativum, Cosmos bipinnatus, Lobularia maritima, Medicago sativa, Petunia grandiflora, Phacelia tanacetifolia, Sinapis alba, Tagetes patula and Tropaeolum majus) to beneficial natural enemies, such as ladybeetles (Coccinellidae) was assessed. Observations were also recorded for the economically important insect pests Lygus lineolaris and flea beetles (Chrysomelidae: Alticinae). Coccinellids captures were highest in T. patula, T. majus, C. bipinnatus and A. millefolium plots. Numerous captures of insect pests, such as L. lineolaris in P. tanacetifolia and flea beetles in L. maritima, S. alba and T. majus, indicate that rigorous selection of flowering plant species has to be used in pest management strategies to reduce insect pest problems.

Introduction

Curative strategies to control insect pests are quite limited in organic production. Therefore, preventative approaches, such as cultural and conservation biological control, are of highest priority in organic cropping systems (Zehnder et al. 2007). Conservation biological control involves managing the agroecosystem to provide ecological resources for natural enemies of insect pests. The use of flowering strips which may provide food source (pollen and nectar) and shelter for beneficial insects may contribute to increase predator or parasitoids' fitness and make them more effective biological control agents (Gurr et al. 2004).

This 3-year study looked at the attractiveness of ten flowering plant species to natural enemies, focusing on beneficial predatory Coccinellids, as well as insect pests that could be harmful to adjacent crops.

Material and methods

This study was conducted at the Organic Agriculture Innovation Platform managed by the Research and Development Institute for the Agri-Environment (IRDA). The site is located in Saint-Bruno-de-Montarville, Québec, Canada. The experimental design consisted of a randomized complete block design with ten flowering plant species (*Achillea millefolium, Coriandrum sativum, Cosmos bipinnatus, Lobularia maritima, Medicago sativa, Petunia grandiflora, Phacelia tanacetifolia, Sinapis alba, Tagetes patula* and *Tropaeolum majus*) and 4 replicates. Plots were 2.4 m x 3 m, with 3 m between plots within a block and 10 m alley between blocks. In 2012, a vegetation- free treatment was added. Plots were regularly manually weeded. In 2011 and 2012, one replicate out of four was not sampled due to lack of plant uniformity for some species. Plant growth stages* were recorded weekly to determine the annual flowering period for each plant species.

Beneficial insects and their abundance were monitored weekly with sweep nets and yellow sticky traps. Counts included predatory insects such as Coccinellidae, Syrphidae*, and *Orius* spp.*, and other beneficial insects (Syrphidae and Hymenoptera)*. Insect pests were also recorded: tarnished plant bug (*Lygus lineolaris*), flea beetles (Chrysomelidae: Alticinae), aphids (Aphididae)*, leafhoppers (Cicadellidae)* and thrips (Thysanoptera)*.

The GLIMMIX procedure of SAS was used to fit a generalized Poisson mixed model for overdispersed count data. Treatment fixed effect and random effects of year and blocks were accounted for in the model. Tests of treatment effect were carried out using Wald tests.

* Data not presented

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Results

Yellow sticky traps captured a higher number of coccinellids than the sweep net as has been previously reported (Schmidt et al. 2008). In our study, for all treatments combined, the average number of ladybeetles per yellow sticky trap per week was 2.64, 2.53 and 2.89, whereas captures by sweep net were 0.13, 0.62 and 0.18 in 2010, 2011 and 2012 respectively.

The following six species constitute nearly 100 % of the Coccinellidae assemblage detected by the sampling techniques used: *Coleomegilla maculata*, *Coccinella septempunctata*, *Harmonia axyridis*, *Hippodamia variegata*, *H. convergens* and *Propylea quatuordecimpunctata*. The three dominant species on the experimental site were: *C. maculata, H. axyridis* and *P. quatuordecimpunctata*. Treatment effect was significant (F=15.16, p<0.0001). There were twice as many Coccinellidae captured in *T. patula, T. majus, C. bipinnatus* or *A. millefolium* compared to *S. alba* (for all contrasts, p<0.0001), and there were twice as many insects trapped in *T. patula* compared to *L. maritima* (p<0.0001) (Figure 1). As nectar is an important food source for many Coccinellidae (Hagen 1962), this likely reflects the high nectar loads and secretion rates associated with *T. patula* and *T. majus* as reported by Comba et al. (1999). Ambrosino et al. (2006) also observed higher number of Coccinellidae visits in *C. sativum* and *Fagopyrum esculentum* compared to *L. maritima* and *P. tanacetifolia*.

Coccinellid larvae were occasionally caught with the sweep net. Captures varied between years, in terms of number, date and associated plant species. Plant species in which larvae were consistently found were *C. sativum, M. sativa, T. patula* and *A. millefolium*. These larvae were also found in *S. alba, P. tanacetifolia* and *C. bipinnatus* plots. The presence of larvae indicates that adult coccinellid females oviposited in these plant species. Coccinellid larvae feed on aphids and adult females lay their eggs near aphid colonies. However, in this study, there is no apparent link between the number and timing of aphids captured with the sweep net or the yellow sticky traps and the occurrence of coccinellid larvae.

For insect pest species, use of the sweep net showed significant captures of *L. lineolaris* (F=51.42, p<0.0001) and flea beetles (F=23.56, p<0.0001). *L. lineolaris* had a clear preference for *P. tanacetifolia* (Figure 2). After this, the presence of this economically important pest species was highest on *S. alba, C. sativum. A. millefolium* and *C. bipinnatus* compared to *L. maritima, P. grandiflora, T. majus* and *T. patula* (for all contrasts, p<0.0001). Flea beetle captures were highest on *S. alba, T. majus* and *L. maritima*, two of these being Brassicaceae species which is an economically important family of flowering plants.

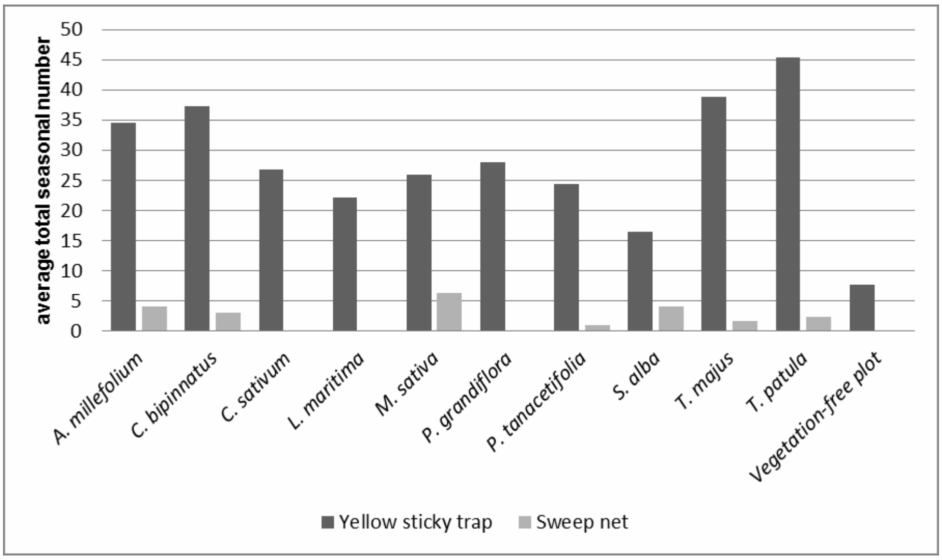

Figure 1. Average seasonal number of Coccinellidae captured with yellow sticky traps in ten plant species, 2010, 2011 and 2012 and in vegetation-free plots in 2012.[a,b,c]

[a] Captures in the vegetation-free plots with sweep net were negligible.
[b] For yellow sticky trap data, the relative standard errors of estimated means are 18 %, except for the vegetation-free plot treatment (28 %).
[c] For sweep net data, the relative standard errors of estimated means vary between 25 % and 30 %, except for *P. grandiflora* and *L. maritima*, for which abundance was negligible.

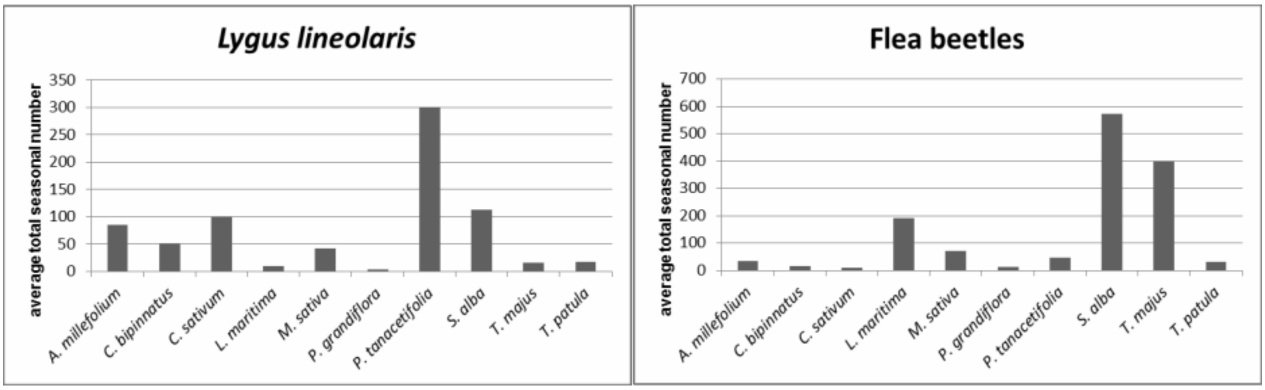

Figure 2. Average seasonal number of pest insects captured with sweep net in ten plant species in 2010, 2011 and 2012 and in vegetation-free plots in 2012.[a,b,c]

[a] Captures in the vegetation-free plots with sweep net were negligible.
[b] For *L. lineolaris*, the relative standard errors of estimated means are 30 %.
[c] For flea beetles, the relative standard errors of estimated means are 30%.

Discussion

These results show that Coccinellids are attracted to some flowering plant species and these plants could be used to provide a food source/habitat for these beneficial insects. This knowledge can be implemented in conservation biological control strategies. Further studies are needed to understand the resources that these plants provide to these beneficial insects as non-prey foods (floral nectar, pollen, honeydew, etc) are critical to the success of conservation biological programs (Lundgren 2009). As habitat manipulation is an important component of insect pest management in organic cropping systems, these results emphasize the importance of rigorous selection of plant species as suggested by Winkler (2005). It is essential to consider not only the attractiveness of a flowering species to beneficial insects but its potential to act as a reservoir for pest insects that can contribute to pest problems. Flowering strips, therefore, can serve to support beneficial insect populations and also serve as trap plants for insect pests and by both means contribute to crop pest control.

Suggestions to tackle with the future challenges of insect pest management in organic cropping systems

Future studies conducted at different spatial scales are necessary to fully understand the potential use of plant diversity around crops to achieve effective conservation biological control in organic cropping systems. Better understanding of landscape spatial scale effects will contribute to better integrate conservation biological control approach. Increased knowledge of specific natural enemies' requirements (floral and extra floral nectar, pollen, shelter, alternate hosts and preys, etc.) would greatly contribute to improve conservation biological control.

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