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Parasitoids of horticultural pests associated to commercial developmental stages of cultivated Apiaceae

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Abstract

Mendes de Haro M, Santos Resende AL, da Silva VF, Souza B, Paterno Silveira LC. 2015.Parasitoids of horticultural pests associated to commercial developmental stages of cultivated Apiaceae. Entomotropica 30(17): 174-180.

The objective of this study was to evaluate the parasitoids of horticultural insect pests associated with Apiaceae plants: coriander, dill and fennel. The experiment was conducted in a randomized complete block design with four replications and three treatments. Collections were carried out weekly, beating the plants on white plastic trays. Parasitoids were aspirated and stored in 70 % alcohol for screening and identification. Important parasitoids of vegetables pests, such as aphids and caterpillars, were collected from all treatments. Coriander and dill had the highest richness of pest parasitoids, with 8 species, while fennel registered only 4 species. Abundance was higher in coriander, with 7.78 parasitoids/sample (including 1.73 pest parasitoid/sample) and dill, with 6.15 parasitoid/sample (including 2.15 pest parasitoid/sample). Despite the superiority shown by coriander and dill, fennel also showed attractiveness to parasitoids involved in regulation of important pests of horticulture, and their presence is beneficial to conservation of parasitoids in organic system.

Additional key words: Conservation of natural enemies, crop diversification, floral resources, Hymenoptera.

Resumen

Mendes de Haro M, Santos Resende AL, da Silva VF, Souza B, Paterno Silveira LC. 2015.Parasitoides de plagas hortícolas asociados a los estadios de desarrollo comercial de plantas de Apiaceae. Entomotropica 30(17): 174-180.

El objetivo de este estudio fue evaluar los parasitoides de plagas hortícolas asociados a las plantas Apiaceae: cilantro, eneldo e hinojo. El experimento se realizó en un diseño de bloques completamente aleatorizados con cuatro repeticiones y tres tratamientos. Las colectas se llevaron a cabo semanalmente, agitando las plantas sobre bandejas de plástico blancas. Los parasitoides fueron aspirados y almacenados en alcohol al 70 % para el posterior análisis e identificación. Importantes parasitoides de plagas de hortalizas, como pulgones y larvas fueron obtenidos en todos los tratamientos. El cilantro y el eneldo tuvieron la mayor riqueza de parasitoides de plagas, con 8 especies, mientras que el hinojo sólo presentó 4 especies. La abundancia fue mayor en el cilantro, con 7,78 parasitoides / muestra (incluyendo 1,73 plagas de parasitoide / muestra) y el eneldo, con 6,15 parasitoides / muestra (incluyendo 2,15 plagas de parasitoide / muestra). A pesar de la superioridad mostrada por el cilantro y el eneldo, el hinojo también se mostró atractivo para los parasitoides involucrados en la regulación de las plagas importantes de la horticultura, y su presencia es benéfica en la conservación de parasitoides en los sistemas orgánicos.

Palabras clave adicionales: Conservación de enemigos naturales, diversificación de cultivos, Hymenoptera, recursos florales.

Introduction

Provision and manipulation of plants features such as shelter, pollen, nectar and alternative prey/hosts, within the agroecosystem provides a strategy for enhancing the effectiveness of natural enemies for biological pest control (Griffiths et al. 2008). Plants with the desirable characteristics can be grown as companion plants around or within crops to increase the density and diversity of predators and parasitoids (Landis et al. 2000). There is evidence that the selective accumulation of natural enemies in habitats intensifies top-down effects and promotes herbivore suppression in agroecosystem (Finke and Denno 2004, Silveira et al. 2009).

Commercial spice plants, culinary herbs and medicinal plants can be grown as a companion plants enhancing biological control, optimizing the land usage and consequently increasing the profits of small farmers (Gonçalves and Sousa e Silva 2003).

In this context Apiaceae plants as coriander (*Coriandrum sativum* L.), dill herb (*Anethum graveolens* L.) and fennel (*Foeniculum vulgare* Mill.) stand out for being commercially cultivated for medicinal and culinary purposes and for its capacity to attract, conserve and increase efficacy of natural enemies (Baggen et al. 1999, Ramos 2008, Resende et al. 2012, Stefanello et al. 2008, Balzan et al. 2014).

This study aims to evaluate and compare abundance and diversity of parasitoid wasps, with emphasis in natural enemies of horticultural pests, associated to coriander, dill and fennel in organic cultivation.

Material and Methods

The study was developed at Department of Entomology in Federal University of Lavras (Lavras, MG, Brazil) from July to November 2012. The experimental area soil fertility characteristics were: P (44.9 mg dm^{-3}), K (136 mg dm^{-3}), Ca^{2+} (3.8 $cmol_c$ dm^{-3}), Mg^{2+} (2.0 $cmol_c$ dm^{-3}) e Al^{3+} (0.1 $cmol_c$ dm^{-3}). Apiaceae seedlings were prepared on trays with regular substrate and transplanted to the field 30 days after sowing.

A field experiment was established in a randomized complete block design with three treatments (coriander, dill and fennel) replicated on four blocks. Each block was composed of a bed with 21.6 m^2 (18 m x 1.2 m) with three treatments cultivated in three lines 4 m long separated by a clean area (3 m). Each bed received seedlings spaced at 0.3 m x 0.3 m. All blocks were separated by a clean area with 3 m length.

The insect sampling started in September, continuing for 6 weeks and coinciding with the commercial growing period of these plants. Samples weekly were obtained by direct beating of the plants on white trays and using a manual aspirator to collect the insects, which were preserved in 70 % alcohol and identified to family. Only parasitoids related to horticultural pests were identified to genus and species.

Species richness, abundance and similarity index (Lambshead et al. 1983) were determined using the software Biodiversity Pro (MCaleece et al. 1997). Diversity index (H') (Magurran 2004) and species accumulation curves (Gotelli and Colwell 2001) were calculated using the software EstimateS© (Colwell 2013) and subjected to non-linear regression analysis using the curve-fitting procedure of Table Curve 2D (Systat, San Jose, CA, USA). Data were submitted to analyses of variance and Tukey´s HSD, using R software® (R Development Core Team 2011).

Results and Discussion

A total of 202 parasitoids were collected during the sampling period, belonging to 14 families, 35 genus and species, including 11 natural enemies of horticultural pests (Table 1). With regards to sampling sufficiency (Figure 1), it was observed that the general accumulation curve for species

Table 1. Average number and abundance (%) of Hymenoptera parasitoids of horticultural pests per sample in coriander, dill and fennel. Lavras-MG, UFLA, Brazil, 2012.

Species	Coriander		Dill		Fennel	
	X[1]	%	X	%	X	%
Anastatus sp. (Eupelmidae)	0.08 ± 0.08	1.06	-	-	-	-
Aphidius colemani (Braconidae)	0.33 ± 0.18	4.26	-	-	-	-
Copidosoma koehleri (Encyrtidae)	0.42 ± 0.33	5.32	0.41 ± 0.19	7.04	-	-
Dendrocerus sp. (Megaspilidae)	-	-	0.08 ± 0.08	1.41	-	-
Diaeretiella rapae (Braconidae)	0.16 ± 0.11	2.13	0.25 ± 0.17	4.23	0.08 ± 0.08	2.93
Doryctes sp. (Braconidae)	-	-	1.00 ± 0.44	16.9	-	-
Elachertus charondas (Eulophidae)	0.16 ± 0.11	2.13	-	-	-	-
Lysiphlebus testaceipes (Braconidae)	-	-	0.25 ± 0.13	4.23	0.58 ± 0.22	29.92
Pediobius sp. (Eulophidae)	0.25 ± 0.17	3.19	0.08 ± 0.08	1.41	0.08 ± 0.08	5.84
Sympiesis sp. (Eulophidae)	0.25 ± 0.18	3.19	-	-	-	-
Trichogramma sp. (Trichogrammatidae)	0.08 ± 0.08	1.06	0.08 ± 0.08	1.41	-	-
Other taxa	6.25 ± 0.77	77.66	4.00 ± 0.84	63.37	1.66 ± 0.30	61.31
Total of parasitoids/sample	7.78	100	6.15	100	2.74	100
Parasitoids of horticultural pests	1.73	22.34	2.15	36.63	1.08	38.69
H' Index	88.57		74.77		41.67	

1 Mean ± SEM (Standard Error of the Mean).

assumes a strong positive slope until the 54th sample, and declines after this, tending to reach an asymptote at the end of sampling period, indicating that the sampling effort (72) was adequated for detecting most of the species that could potentially occur in all treatments.

All plants studied were able to attract and conserve important natural enemies of horticultural pests such as: a) *Aphidius colemani* Viereck, 1912; *Lysiphlebus testaceipes* (Cresson, 1880) and *Diaeretiella rapae* (M'Intosh, 1855) (Braconidae: Aphidiinae) all parasitoid of aphids; b) *Copidosoma koehleri* Blanchard, 1940 (Encyrtidae: Encyrtinae), parasitoid of potato tuber moth, *Phthorimaea operculella* (Zeller, 1873) (Lepidoptera: Gelechiidae); c) *Elachertus charondas* (Walker, 1839) and *Sympiesis* sp. (Eulophidae: Eulophini), which are, respectively, parasitoids of Noctuidae and lepidopteran leaf miners; d) *Trichogramma* sp. (Trichogrammatidae), egg parasitoid of Lepidoptera pests; *Anastatus* sp**.** (Hymenoptera: Eupelmidae) egg parasitoid of hemipterous pests as *Leptoglossus zonatus* (Dallas, 1852) (Hemiptera: Coreidae); *Pediobius* sp. (Eulophidae) parasitoid of eggs, larvae or pupae of Coleoptera, Diptera and Lepidoptera; *Doryctes* sp. (Braconidae), parasitoid of Coleoptera pests (Baggen et al. 1999, Gibson et al. 1997, Hanson and Gauld 2006). The aphid hyperparasitoid *Dendrocerus* sp. (Hymenoptera: Megaspilidae) was also collected in dill plants.

Coriander and dill showed significant higher median abundance (p = 0.002) (Figure 2), richness and diversity index (H' Index) than fennel (Table 1), but very low percentages of similarity were observed among treatments (coriander x dill = 38.29 %; coriander x fennel = 13.33 %; dill x fennel = 28.57 %).

Each Apiaceae plant demonstrated capacity to attract and conserve a particular fauna of parasitoids, since only two species were shared among all treatments. It can be explained by differences in plant volatiles, architectures,

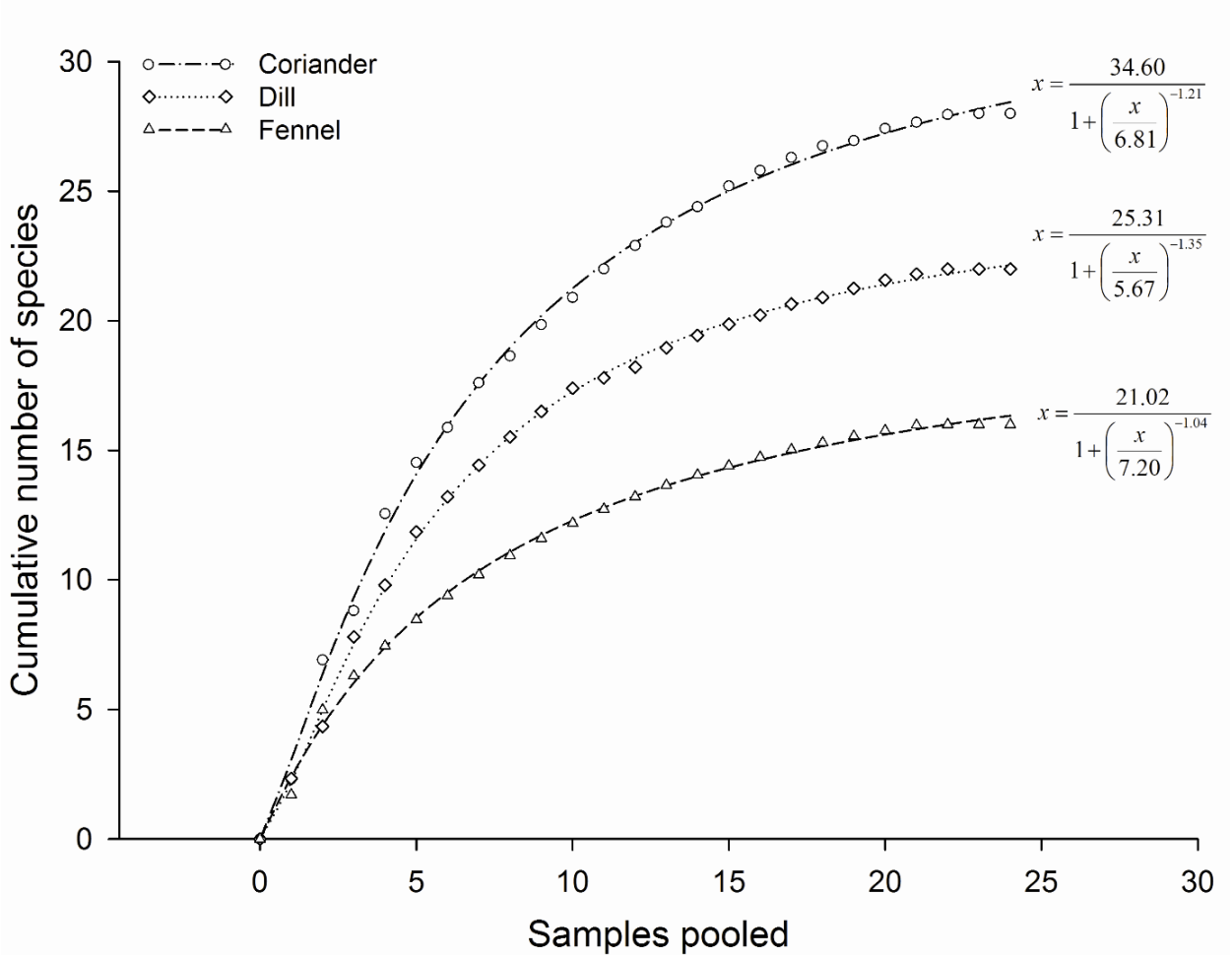

Figure 1. Cumulative number of species collected in all samples (72) for individual treatments (24 samples each). Lavras, MG, Brazil, 2012.

shelter and/or alternative hosts provided in each treatment (Griffiths et al. 2008, Irvin et al. 2006, Lavandero et al. 2006).

The regular abundance and richness of natural enemies reported in all plants tested can be useful to buffer ecosystem fluctuation in functioning (Yachi and Loreau 1999). This characteristic is especially important in agroecosystems where temporal fluctuations in resource availability, caused by sowing and harvesting processes, can drive fluxes of predatory arthropods between patches (Rand et al. 2006). Parasitoid populations in a horticultural crop require time to increase their population size, therefore, populations from companion plants may provide spatio-temporal complementarity, maintaining ecosystem functions such as biological control and preventing pest outbreaks (Bianchi et al. 2006).

Concerning the number of pests parasitoids collected weekly, all treatments demonstrated a regular abundance of parasitoids of horticultural pests. Coriander reached a peak during the third and fourth weeks, while dill and fennel increased their averages from the third sampling week onwards, probably in response to proximity of flowering stage (Figure 3). Plants were not sampled in totally flowering period due to the loss of their commercial value.

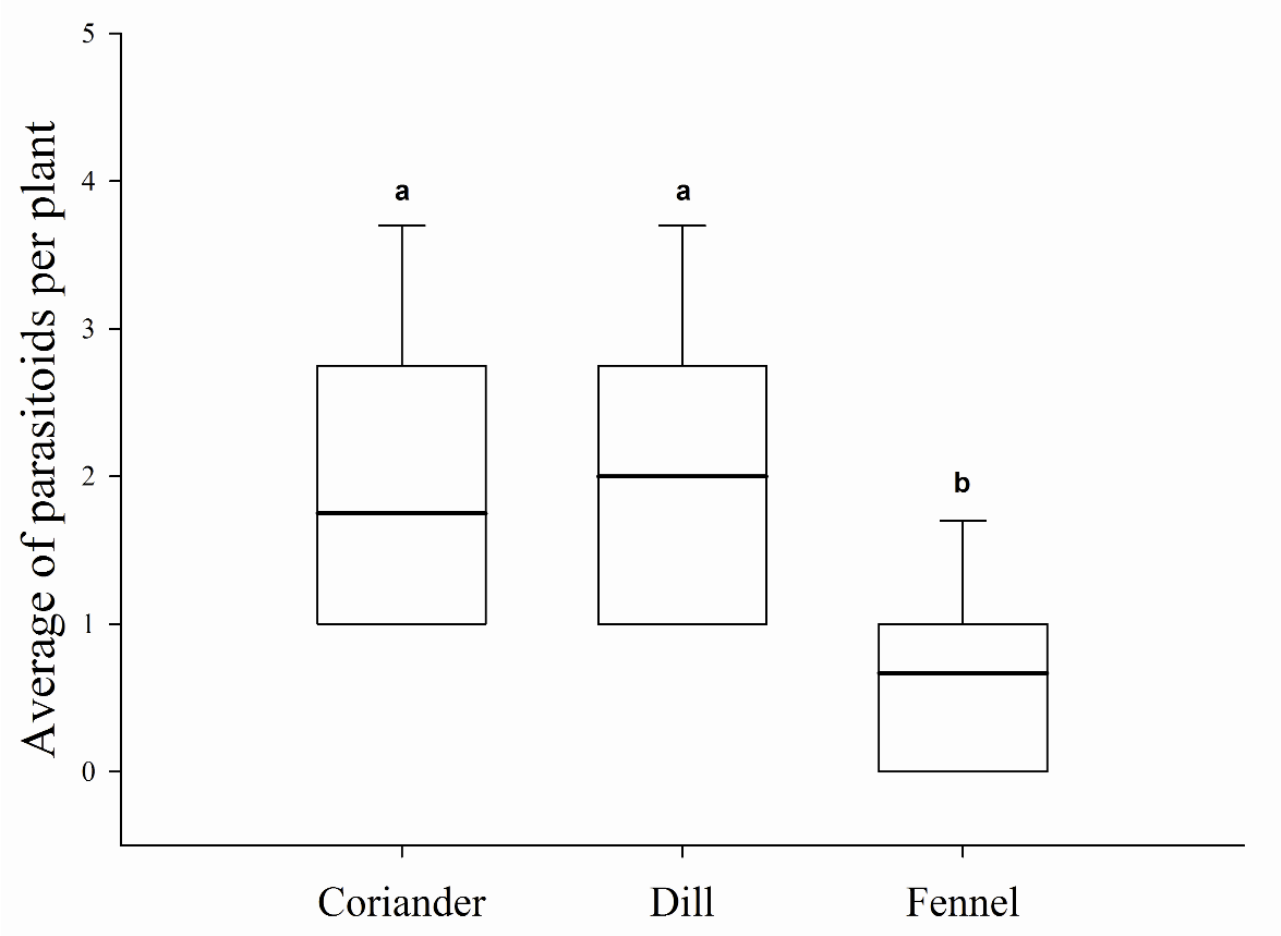

Figure 2. Boxplot showing median, range and interquartile of abundance of horticultural pests parasitoids per treatment during the experiment. Means followed by the same letter did not differ significantly from each other, Tukey, $p<0.05$. Lavras, MG, Brazil, 2012.

Based on the ecological information provided in this study, Apiaceae plants can be chosen for use in conservation biological control programs from specific horticultural pests and crops. The composition of the parasitoid community in relation to agroecosystem management and landscape structure is important for understanding how diversity may affect biological control, long-term stability and resilience (Öberg et al. 2007).

This study demonstrates the importance of Apiaceae plants, mainly dill and coriander, as an example of companion plants in enhancing habitat complexity. Additional studies are necessary to determine spatial arrangement of these resources in the agricultural system, dispersal of parasitoids and effective control of pests.

Conclusion

All Apiaceae plants were able to attract and conserve important natural enemies of horticultural pests and can be used as companion plants to enhance biological control in vegetable crops.

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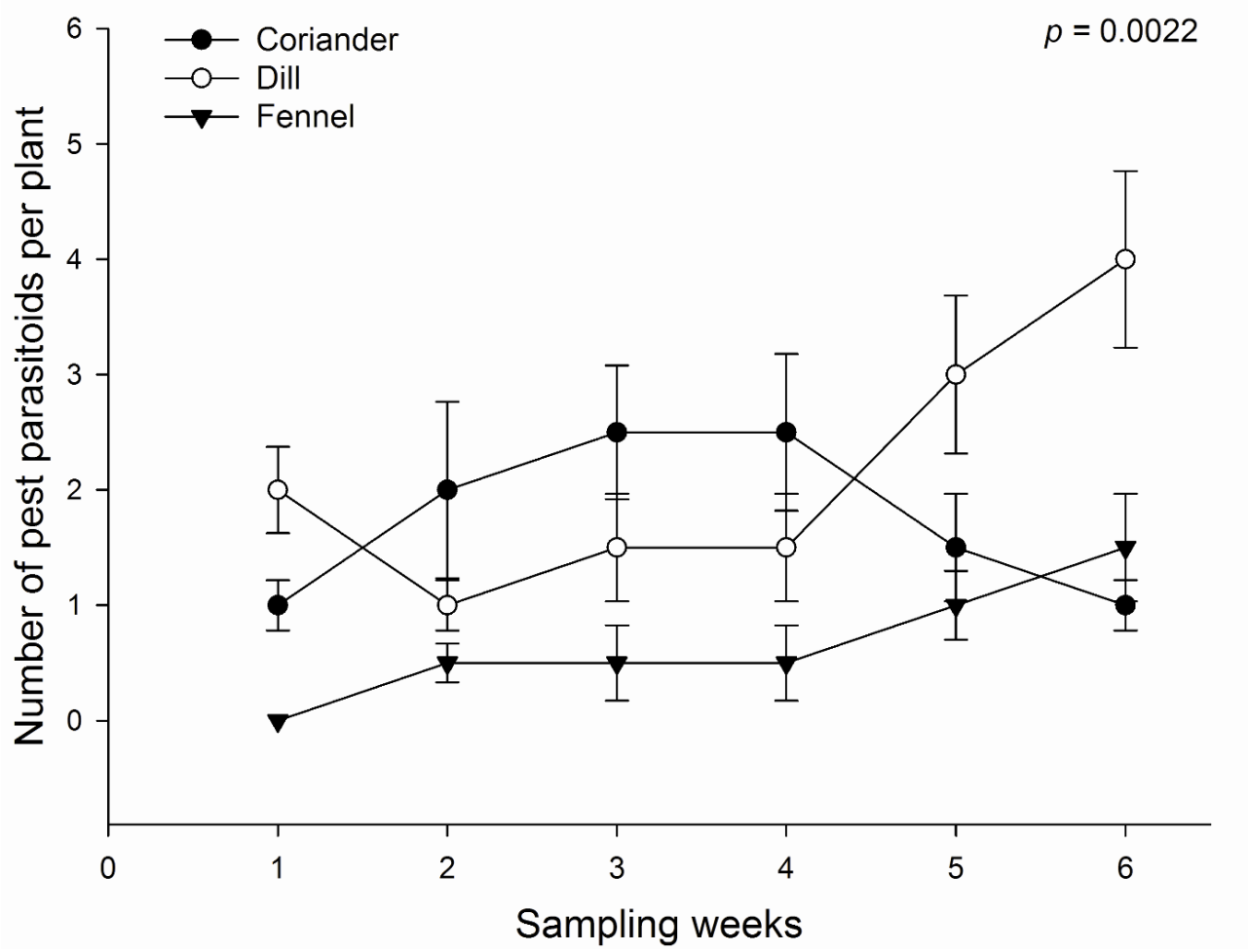

Figure 3. Total numbers of parasitoids of horticultural pests per week in coriander, dill and fennel. Lavras, MG, Brazil, 2012.

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