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Advantages of ecological management of leafminers (Diptera: Agromyzidae) in commercial cultivation of crisphead lettuce in southern Brazil

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Abstract: The objective this work was to evaluate the potential interference of two types of management of leafminer populations and their parasitoids under commercial production conditions of lettuce in plastic tunnels in the state of Minas Gerais, southeast Brazil. The comparison between conventional management using calendar sprays of insecticides, and ecological management with *Bacillus thuringiensis*, sticky traps and pheromones, showed that ecological management has several advantages over chemical control. In the plastic tunnel with ecological management lower numbers of leafminers emerged, a greater number of parasitoids emerged, the control costs were lower and the commercial value was equivalent to the conventionally managed crop.

Key words: *Liriomyza* sp., *Opius* sp., biological control, chemical control, pheromone traps, crop quality

Introduction

Leafmining flies of the family Agromyzidae cause serious problems because of their habit to live inside the leaf, which results in direct and indirect consequences for the crop, in this case crisphead lettuce in the South of the state of Minas Gerais. There are, however, several species of parasitoids that are natural enemies of leafminers which can avoid the pest outbreaks. But the parasitoids are very sensitive to the insecticides used in tunnels where lettuce is grown. This experiment aimed to evaluate the interference of the two types of management used to control leafminer populations (conventional chemical and ecological) and the effect of the management method on the leafminer parasitoids, in commercial lettuce production.

Material and methods

The experiment was performed in Boa Esperança, Minas Gerais State, Brazil, in the area of commercial production of crisphead lettuce located at an altitude of 840 meters. The experimental units were two tunnels covered with white plastic, containing two beds of 1.0 x 50.0 meters and an average of 1,260 plants per tunnel. The tunnels were 150m apart from each other. In one of the tunnels, the conventional calender spray system was used (Table 1). The ecological management system was characterized by weekly applications of *Bacillus thuringiensis* (= Bt 5g in 5l of water for the two beds), use of a delta trap with the pheromone

of *Spodoptera frugiperda* and two yellow sticky cards for monitoring pests. In both tunnels Manzate® was used for disease control and Herbohort® as resistance inducer. Weekly, on an average 23 plants were collected in each tunnel throughout the crop cycle and taken into the laboratory of Biological Control, Department of Entomology, UFLA. Here, the leaves were inspected for the presence of mines and larvae of *Liriomyza* spp. The leaves with larvae were kept in Petri dishes inside a room at 25 ± 2°C until emergence of adult leafminers or parasitoids. At harvest of the crop in the tunnels, a sample of five plants was taken to assess the quality of the harvested lettuce, and data were compared by Tukey test at a significance level of 5%, by using the statistical software Sisvar® (version 5.1).

Table 1. Products used for pest and disease control in each week in crisphead lettuce crops, 13 March to 5 May 2009.

Week	Products sprayed
1	Abamectin[1], Mancozeb[2], Methamidophos[3]
2	Inductor resistance[4], Metomil[5], Ciromazine[6]
3	Abamectin, Mancozeb, Methamidophos, Acephato[7]
4	Inductor resistance, Metomil, Ciromazine
5	Abamectin, Mancozeb, Methamidophos
6	Inductor resistance, Metomil, Abamectin e Acephato
7	Harvest of lettuce

(1) Dose of product = 100ml/100l; (2) Dose of product = 300ml/100l; (3) Dose of product = 100ml/100l; (4) Dose of product = 240ml/100l; (5) Dose of product = 100ml/100l; (6) Dose of product = 15ml/100l; (7) Dose of product = 100ml/100l.

Results and discussion

Leafminers were found during almost the whole crop cycle and with both types of pest management (Table 2). The difference between the number of mines and larvae in the leaves of the crops with both types of pest management was often small (Table 2). However, there was an important difference in the number of emerged leafminers and parasitoids in the two tunnels (Figure 1A): more leafminers and fewer parasitoids emerged in the conventionally sprayed crop than in the ecologically managed crop.

The leafminer population increased throughout the crop cycle (Figure 1A) and calendar sprays with pesticides gave insufficient control. In addition, we observed negative effects of chemical products on the parasitoids: the parasitoid population in the chemical control tunnel was lower than that found with ecological management (Figure 1B).

In the tunnel with ecological management, the pest population did not grow dramatically during the crop cycle (Figure 1A) and the parasitoids occurred in greater numbers than in the chemical control tunnel (Figure 1B). We did not introduce leafminer parasitoids in the tunnels; they moved into the tunnels spontaneously and belonged to the genus *Opius*. It is interesting that this form of natural biological control alone was sufficient to keep the leafminer population at low numbers.

Table 2. Average number of mines per plant and percentage of mines with larvae in the crisphead lettuce leaves at the conventionally and ecologically managed crop.

	CONVENTIONAL MANAGEMENT			ECOLOGICAL MANAGEMENT		
DATE	**n**	**Average no. mines /plant**	**% of mines with larvae**	**n**	**Average no. mines /plant**	**% of mines with larvae**
23/03/09	25	0	0	21	0.19	0
01/04/09	23	1.70	43.59	25	1.28	65.63
08/04/09	26	2.00	51.92	25	0.88	40.91
15/04/09	25	4.28	54.21	25	1.64	43.90
22/04/09	20	4.05	46.91	14	5.36	36.00
05/05/09	21	4.62	27.84	22	4.05	20.23
TOTAL	**140**	**2.69**	**44.41**	**132**	**1.99**	**35.36**

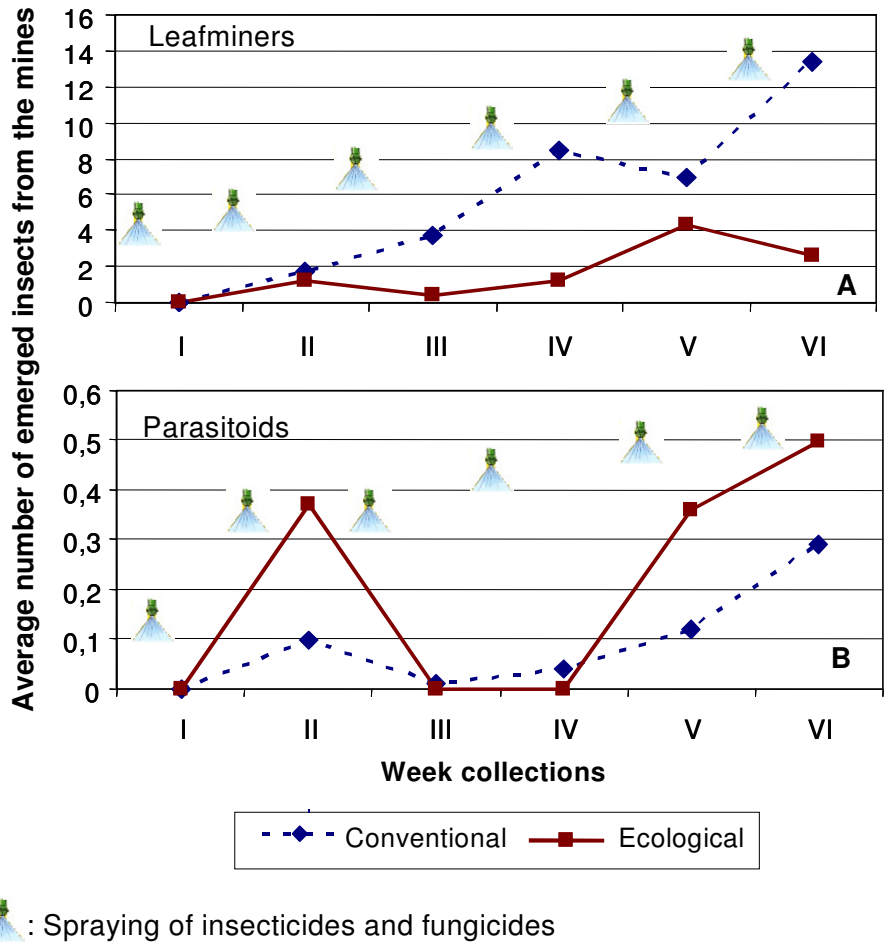

Figure 1. Average number of emerged adults of leafminers (A) and parasitoids (B) from crisphead lettuce leaves.

Fathipour *et al.* (2006) showed that natural parasitism of leafminers in cucumber crops was reduced by spraying insecticides. Chen *et al*. (2003) found 10-20% parasitism on vegetable crops treated with insecticides in China and 48.5 to 68.8% parasitism in untreated areas or with reduced pesticide applications. According to Parrella (1987), insecticide applications may be responsible for the resurgence of the leafminer pest because these products are usually more toxic to the complex of natural enemies than to the leafminers. Another cause for pest resurgence is that a sublethal dose of insecticides can physiologically stimulate development of the pest, resulting in more crop damage. Bolckmans & Tetteroo (2002) mention that, in the Netherlands, there are no pesticides compatible with biological control of leafminers (*Liriomyza trifolii* and *L. bryoniae*) when using the parasitoid *Diglyphus isaea* in eggplant crops.

Among the five pesticides currently used in calender sprays of pests in lettuce in Minas Gerais (Brazil), two are of toxicological Class I (highly toxic), two are Class III (moderately toxic) and one is Class IV (low toxicity). The fungicide and the four insecticides belong to the environmental classification III (harmful to the environment) and one is classified as II (very dangerous for the environment). This classification is according to the Brazilian Ministry of Agriculture. None of the insecticides are registered for use in lettuce crops by the Ministry of Agriculture (MAPA, 2009) still they are used because of lack of registered products. Thus, in addition to causing the death of natural enemies, these products are hazardous to the labourers in the tunnels and consumers. This stresses the necessity to seek for alternatives that might replace them or reducing their usage. This is not an isolated case, sadly enough it is common use in all the vegetable crops in the region which are mainly used in fast food.

The ecological pest management system we evaluated did not affect the parameters that determine the quality and marketability of the produced lettuce, since the post-harvest assessment showed that both crops had values statistically equal ($p > 0.05$) for quality parameters as commercial weight and head circumference (Table 3).

Table 3. Comparison between quality of crisphead lettuce produced with conventional and ecological pest management.

Type of Pest Management	**Total weighty (g)**	**Commercial weight (g)**	**Head circumference (cm)**	**Stem length (cm)**
Conventional	1015.0 a	744.0 a	47.6 a	5.8 a
Ecological	1024.4 a	777.4 a	47.6 a	6.2 a

Means followed by the same letter in the columns are not significantly different (Tukey test at 5% probability).

Conclusion

The results show the negative effects of calendar sprays with pesticides on leafminers parasitoid populations, resulting in poor leafminer control in the chemical control tunnels. They also show that simple strategies such as those adopted in ecological management are effective concerning pest control and important for conservation of natural enemies that provide natural pest control. Moreover, with the ecological control system the production of good quality crisphead lettuce appeared feasible.

Acknowledgements

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