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Natural parasitism of *Liriomyza sativae* (Diptera: Agromyzidae) on cucumber under field and greenhouse conditions

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Abstract: *Liriomyza sativae* is one of the most important pests affecting cucumber in Iran and is mainly controlled by applying chemical products. The main purpose of this study was to determine the rate of natural parasitism of *L. sativae* in the Tehran region, Iran. From September to December 2004 surveys were carried out on cucumbers in sprayed fields and also in sprayed and non-sprayed greenhouses in Varamin and Pishva, near Tehran. A sampling program was designed to estimate the population density and parasitism rate of *L. sativae* larvae on cucumber leaves. In this study we determined the average percentage and trend of parasitism associated with each parasitoid species. The results showed that in the study area *L. sativae* larvae were parasitized by three eulophid parasitoid species including *Diglyphus isaea*, *Hemiptarsenus zilahisebessi* and *Closterocerus formosus*. *D. isaea* was the most frequent species at all three sampling sites, followed by *C. formosus* and *H. zilahisebessi*. The overall percentages of parasitism on cucumber caused by these three parasitoids in the field and in sprayed and non-sprayed greenhouses were 21.36 (8.44-39.32), 10.26 (8.01-15.66) and 39.31 (29.45-54.51), respectively. These results indicated that sequential application of insecticides on cucumber led to a significant reduction in the rate of natural parasitism in the field and in sprayed greenhouses. The highest rate of parasitism was observed in non-sprayed greenhouses. It was finally concluded that illogical and inappropriate use of insecticides for controlling pests affecting field and greenhouse crops can reduce the population density and efficacy of natural enemies.

Keywords: *Liriomyza sativae*, parasitism, greenhouse cucumber, Tehran, Iran

Introduction

Cucumber is the main greenhouse vegetable in Iran and this crop is attacked by various pests including leafminers. The vegetable leafminer, *Liriomyza sativae* Blanchard, is a major pest of a wide variety of vegetables and ornamental crops throughout the world (Parrella, 1983; Reitz & Trumble, 2002). This fly thrives in suitable warm temperature habitats and especially in temperature-controlled greenhouses where reproduction is almost uninterrupted (Spencer, 1986). For many years, chemical insecticides have been used to control leafminers in Iran and they are still the main tool employed in this and many other countries. However, applications of broad spectrum insecticides have led to a decline in vectors of natural pest control such as parasitism (van Lenteren, 2000). Alternative strategies such as biological control within a framework of Integrated Pest Management (IPM) programs are essential for effectively reducing leafminer populations (Minkenberg & van Lenteren, 1986; Minkenberg, 1989; Heinz & Parrella, 1990).

Agromyzid leafminers are found almost everywhere in the world and are economically important pests of many agricultural crops (Spencer, 1986; Nicoli & Pitrelli, 1994). The main damage caused by agromyzids is due to larval feeding, although leaf punctures caused by

females of the species can also be significant (Johnson *et al.*, 1980; Parrella *et al.*, 1981, 1983; Minkenberg & van Lenteren, 1986; Spencer, 1986).

Biological control as part of IPM programs is a reliable and economically viable crop protection strategy for growers of greenhouse crops (van Lenteren & Woets, 1988; Jervis & Copland, 1996). The introduction and support of a number of natural enemies in situations where chemical control is insufficient, impossible or undesired, is also a powerful pest control option (van Lenteren, 1995). *Liriomyza* species have many natural enemies, particularly in their native area. Forty-one species of parasitoids belonging to four different families have been found in Asia (Murphy & LaSalle, 1999). However, under natural conditions, the parasitism rate is usually low in early crop development and gradually increases as the crop matures (Parrella, 1987). At least 23 species of parasitoids have been used in biological control programs against *L. trifolii* and *L. sativae* in Senegal, California, Hawaii, Barbados, Marianas, Tonga, Taiwan and Guam (Johnson, 1993). Using biological pest control on greenhouse crops it should be possible to produce the same crops without the need to use conventional pesticides. This would also imply a cleaner environment and satisfy consumer demands for pesticide-free food and sustainable crop protection (van Lenteren, 2000).

Our study was conducted to demonstrate the natural parasitism and seasonal activity of native parasitoids of *L. sativae* in field and vinyl greenhouse cucumber production at Varamin and Pishva (near Tehran, Iran).

Materials and methods

From September to December 2004 surveys were carried out on cucumber grown in the field and also in sprayed and non-sprayed greenhouses. Numerous insecticides were applied in the fields and sprayed greenhouses of the study region. A sampling program was designed to estimate the population density and parasitism rate of *L. sativae* larvae on cucumber leaves. Field and greenhouses were monitored 4-5 times per month throughout the growing season by randomly collecting cucumber leaves. First, we counted the number of larvae on each leaf and then the leaves were placed in separate transparent plastic containers (15×10 cm) covered with a fine mesh screen for ventilation. These leaves, containing leafminer larvae and their parasitoid, were kept in a growth chamber at 25±1°C, 65 ± 5% RH, with a photoperiod of 16:8 (L: D) h. for two or three weeks. We then recorded the number of emerged parasitoids. All parasitoids were isolated in small vials with 75% ethanol for identification.

Statistical analysis

Statistical analysis was carried out using one-way ANOVA to determine differences between mean numbers of parasitoid species per leaf at each site. The percentage of parasitism was calculated for each parasitoid and also for all parasitoid species.

Results and Discussion

In the province of Tehran, cucumber is produced in open fields and greenhouses, where it is often attacked by *L. sativae*. A total of three hymenoptera parasitoid species were collected from the study region as natural enemies of *L. sativae*. These included *Diglyphus isaea* (Walker), *Hemiptarsenus zilahisebessi* (Erdos) and *Closterocerus formosus* (Westwood). All three species are larval parasitoids belonging to the Eulophidae family and attack many of the hosts that live in confined places (Gauld & Bolton, 1988). No egg or pupal parasitoids were collected during the sampling period. The previously mentioned parasitoids play an important role in controlling the population of *L. sativae* in non-sprayed and less-sprayed areas. The

parasitoid complex of leafminers often depends on the predominant *Liriomyza* species, the host crop and the particular region (Palumbo *et al.*, 1994).

Table 1.Mean (±SE) number and percentage of parasitism (emerged adults per leaves) of *L. sativae* larvae reared on cucumber leaves collected from three different sites at Varamin and Pishva during the period September-December, 2004.

Sampling site	Parasitoid species			Total
	D. isaea	*H. zilahisebessi*	*C. formosus*	
Field				
Mean	0.60±0.08 a	0.41±0.05 ab	0.23±0.03 b	1.24±0.15 B
Percentage	10.45	7.02	3.93	21.36
Range	(3.80-20.87)	(2.77-12.14)	(1.69-6.31)	(8.44-39.32)
Sprayed greenhouse				
Mean	0.30±0.04 a	0.24±0.04 a	0.22±0.02 a	0.76±0.09 C
Percentage	4.04	3.16	3.06	10.26
Range	(3.20-6.33)	(2.11-5.36)	(2.50-4.22)	(8.01-15.66)
Non-sprayed greenhouse				
Mean	2.23±0.36 a	1.21±0.21 a	1.79±0.24 a	5.23±0.68 A
Percentage	17.10	8.98	13.23	39.31
Range	(10.47-25.86)	(4.83-14.91)	(3.88-21.02)	(29.45-54.51)

Means in the same row followed by the same small letters are not significantly different. Means in the last column followed by the same capital letter are not significantly different. All significant differences identified by the LSD test are at the 0.05 level.

The average percentage and trend of parasitism caused by *D. isaea*, *C. formosus* and *H. zilahisebessi* are shown in Table 1 and Figure1. Analysis of variance (ANOVA) showed a significant difference between parasitism rate of the three parasitoid species under field conditions (F=10.77; df=2, 30; P<0.001) and non-significant difference under greenhouse conditions (in sprayed greenhouses: F=1.46; df=2, 24; P=0.252, in non-sprayed greenhouses: F=3.33; df=2, 24; P=0.053). ANOVA also revealed a significant difference between total parasitism rate in the three sampling sites (F=39.12; df=2, 26; P<0.001) (Table 1). Overall rates of parasitism in the cucumber field, and in sprayed and non-sprayed cucumber greenhouses were 21.36% (8.44-39.32), 10.26% (8.01-15.66) and 39.31% (29.45-54.51), respectively. These results indicated that sequential application of insecticides on cucumber led to a significant reduction in the rate of natural parasitism in field and sprayed greenhouses. The highest rate of parasitism was observed in non-sprayed greenhouses.

D. isaea was the most frequently found species at all three sampling sites, followed by *C. formosus* and *H. zilahisebessi*. *D. isaea* has already been reported parasitizing *L. cicerina* Rondani in Iran (Adldoost, 1995). This is a primary ectoparasitoid of various Agromycidae (Diptera). It has also been reported on other hosts, including Lyonetidae (Lepidoptera) and Tephritidae (Diptera) (LaSalle & Parrella, 1991; Zhu *et al.*, 2000). *H. zilahisebessi* has been collected on *L. sativae*, *L. bryoniae* Kaltenbach, *L. congesta* (Becker), and *L. trifolii* (Diptera: Agromyzidae). The host range of *C. formosus* is not restricted to Diptera; other host species include Coleoptera, Hymenoptera, and Lepidoptera. (Noyes, 2004; Talebi *et al.*, 2005).

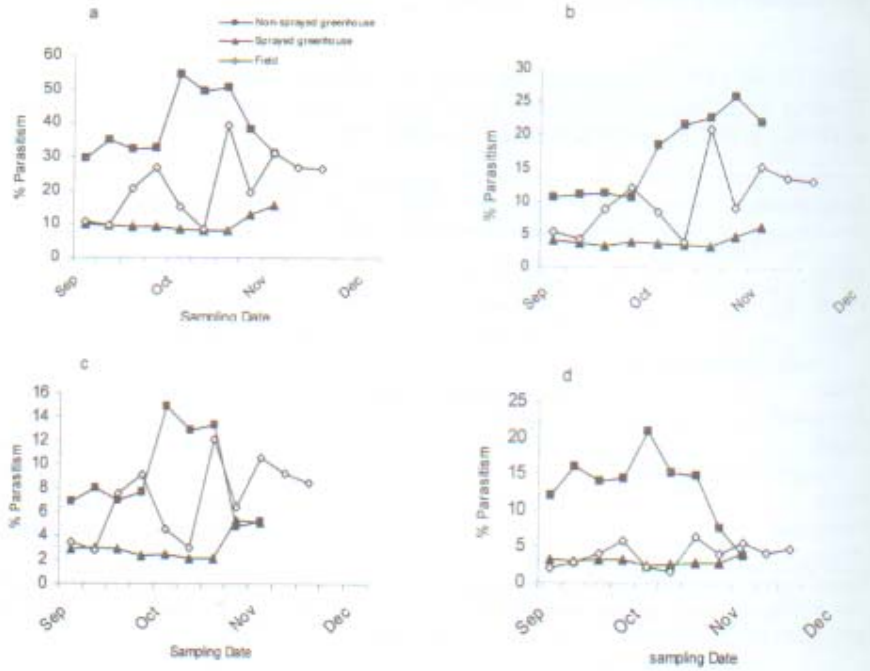

Figure.1. Percentage of parasitism of *L. sativae* populations on cucumber leaves in the field and in sprayed and non-sprayed greenhouses. a) overall parasitism; b) by *D .isaea*; c) by *H. zilahisebess*; d) by *C. formosus*.

Our results showed that chemical insecticides are lethal to leafminer parasitoids and that these compounds can reduce the efficiency and population density of parasitoids on cucumber. The population density and parasitism rate of parasitoids of *L. sativae* larvae in non-sprayed greenhouses were significantly higher than those found in sprayed fields and greenhouses.

It was finally concluded that illogical and inappropriate use of insecticides for controlling pests affecting field and greenhouse crops can reduce the population density and efficacy of natural enemies. There are various indigenous natural enemy communities of *Liriomyza* spp., particularly parasitoids in their native ranges and there is evidence that in pesticide-free areas these can regulate leafminers (Benuzzi & Nicoli, 1988; Benuzzi & Raboni, 1992). They may also vary in type and number in their adventive ranges in continental areas, as invading *Liriomyza* spp. quickly attract local parasitoids and polyphagous arthropod predators (Heinz & Parrella, 1990). The main reason for the use of biological controls in the 1960s was the presence of resistance to pesticides amongst several key pests in greenhouses (van Roermund *et al.*, 1997).

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