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Population Densities of *Liriomyza huidobrensis* (Blanchard, 1926) (Diptera: Agromyzidae) in Insecticide-Treated and Non-Treated Cucumber Producing Greenhouses in the İzmir Region*

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Abstract: *Liriomyza huidobrensis* (Blanchard) (Diptera: Agromyzidae) is an important pest in cucumber greenhouses in Çamönü (Menderes, İzmir), Turkey. This study was carried out during the spring and autumn production seasons in 1999 and 2000 in two greenhouses belonging to a local farmer, each of them 1000 m² in size. The infested leaves from insecticide-treated and non-treated greenhouses were sampled weekly. The leaves were sampled weekly from both greenhouses and kept in our laboratory under observation to compare the number of emerging leafminer adults. Despite the applications, during three of the four seasons examined, pest density in the insecticide-treated greenhouse was not maintained below the economical threshold by insecticide applications. The overall differences between the number of adults in insecticide-treated and non-treated greenhouses were in fact minimal. During the first year there were significant differences in the density of leafminer populations, but during the second year there were no significant differences. The results of this study led us to the conclusion that non-chemical methods should be used instead of insecticides to control *L. huidobrensis* in cucumber greenhouses in the Menderes region.

Key Words: *Liriomyza huidobrensis*, population density, insecticide-treated and non-treated, cucumber, Turkey.

İzmir'de İnsektisit Kullanılan ve Kullanılmayan Hıyar Üretim Seralarında *Liriomyza huidobrensis* (Blanchard, 1926) (Diptera: Agromyzidae)'in Populasyon Yoğunluğu

Özet: *Liriomyza huidobrensis* (Blanchard) (Diptera: Agromyzidae), Çamönü (Menderes, İzmir) hıyar yetiştirme seralarının önemli bir zararlısıdır. Bu çalışma 1999-2000 yıllarında, ilkbahar ve sonbahar üretim dönemlerinde her biri 1000 m² büyüklüğünde, üreticiye ait iki serada gerçekleştirilmiştir. Zararlı ile bulaşık olan yapraklar insektisit uygulanan ve uygulanmayan parsellerden haftalık olarak toplanmıştır. Yapraklar gözlemler için laboratuvara getirilmiş ve çıkan erginlerin sayısı karşılaştırılmıştır. İlaçlamalara rağmen, dört üretim sezonunun üçünde ilaçlı parseldeki populasyon yoğunluğu ekonomik zarar eşliğinin altına düşmemiştir. İnsektisit kullanılan ve kullanılmayan parsellerde ergin populasyonları arasındaki farklılıklar çok düşük bulunmuştur. İnsektisit uygulanan ve uygulanmayan seralarda populasyon yoğunlukları arasındaki fark 1. yılda önemli 2. yılda ise önemsiz bulunmuştur. Bu çalışmanın sonuçları, Menderes yöresinde hıyar seralarında *L. huidobrensis* kontrolünde insektisitler yerine bazı kültürel yöntemlerin kullanılması gerektiğini ortaya koymuştur.

Anahtar Sözcükler: *Liriomyza huidobrensis*, populasyon yoğunluğu, insektisit kullanılan ve kullanılmayan, hıyar, Türkiye.

Introduction

Liriomyza leafminers have become important pests in vegetables and ornamental crops. Damage is inflicted by punctures in the leaves made by females for either oviposition or apparent feeding, and by mines in the leaf

mesophyll. Photosynthetic activity can also be reduced by leafmining (Zoebisch and Schuster, 1987). One of the most important leafminer species in greenhouses is *Liriomyza huidobrensis*, which is a polyphagous pest that feeds on plants belonging to as many as 14 different

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families. Heinz and Chaney (1995) found that *L. huidobrensis* larvae were unlike the larvae of *L. trifolii* and *L. sativae* species, which both feed on the upper mesophyll, as the former feed within the lower mesophyll layer and hence have a greater impact on leaf photosynthesis. For this reason, *L. huidobrensis* must be considered a species directly responsible for heavy yield loss. If damage occurs at an early stage, replanting is possible; however, at a later stage, such damage results in significant losses. In the greenhouse production of cucumbers, *L. huidobrensis* can cause a significant reduction of yield and delay fruit ripening several days if populations are not controlled on young seedlings. Shepard et al. (1998) reported that when a potato crop in Indonesia was attacked, the damage caused by *L. huidobrensis* resulted in almost 100% yield reduction. Spencer (1973) reported yield losses of 50% in a spinach crop and 54% in a lettuce crop. Torres et al. (1995) reported a *Gypsophila panincolata* yield loss due to a significant increase in *L. huidobrensis* population from 0.7 adults/leaf in the 5th week after planting to 1.3 adults/leaf in the 9th week after planting. In celery crops, up to 50% losses have also been reported due to *L. huidobrensis* (Shepard et al., 1998).

Generally, producers apply insecticides more frequently and in large quantities to avoid the rapid increase in pest population in their greenhouses. Insecticides applied to counter pests, especially those with systemic and translaminar properties, have a negative impact on beneficial fauna (such as *Diglyphus isaea*) feeding on the leafminer (Heinz and Chaney, 1995; Weintraub and Horowitz, 1996). The objective of this study was to compare the population densities of adult *L. huidobrensis* which emerged from cucumber leaves collected from insecticide-treated and non-treated greenhouses. The aim of this study, based upon the obtained results, was to support more environmentally friendly cucumber production by reducing the use of insecticides to combat this pest.

Materials and methods

Study site

This study was carried out during 1999 and 2000 in Menderes (İzmir, Turkey) on cucumber plants grown under commercial greenhouse conditions. The species examined was *L. huidobrensis* adults.

Greenhouse

The study was carried out in two greenhouses belonging to a local farmer, each was 1000 m² in size and built of an iron framework covered with polyethylene. In order to prevent contamination from the outside, all ventilation openings of the non-treated greenhouse were closed off with fly-nets (hole size: 0.5 mm) and no insecticide treatment was applied throughout the production period. During the study, the fly-nets of the non-treated greenhouse were replaced annually. The other greenhouse had no fly-nets and was treated with insecticides commonly used in the area. The grower recorded the use of insecticides. Favourable climatic conditions in the Menderes region allow two cucumber-growing seasons each year, (April to August and August to November). In this study, cucumber plants (cultivars: Gordion F₁) were planted simultaneously on 10 April and 12 August during 1999, and on 8 April and 2 August, during 2000.

Chemical control

The following commercial insecticides were used at recommended rates in the insecticide-treated greenhouse: abamectin (25 cc/100 l water, Agrimec-Novartis), chlorfenapyr (25 cc/100 l water, Pirate-Cyanamid), chlorfluazuron (100 cc/100 l water, Atabron-Zeneca), cyromazine (25 cc/100 l water, Trigard-Novartis), methadimophos + imidacloprid (100 cc/100 l water, Taifun-Bayer), oxamyl (250 cc/100 l water, Vydate-Du Pont) and thiocyclam hydrogen oxalate (25 cc/100 l water, Evisect'S-Aventis). In the spring 1999 and 2000 seasons each of the seven insecticides was used once. During the autumn 1999 season all but oxamyl were used once. During the autumn 2000 season only abamectin, chlorfenapyr, methadimophos + imidacloprid, thiocyclam hydrogen oxalate and imidacloprid were used one time each. The weeks corresponding to insecticide application throughout the production periods can be seen in Table 1.

Sampling

The greenhouses were checked weekly during the entire production period starting with the planting of the seedlings. From the very first appearance of *L. huidobrensis* larval mines on the leaves, 10 infested cucumber leaves were picked from each greenhouse, put in ice boxes and brought to the laboratory. The decision to collect only 10 leaves was taken because the plants

Table 1. Insecticide application weeks during all periods in the insecticide-treated greenhouse.

Insecticides	Application weeks			
	Week No. 1999		Week No. 2000	
	Spring	Autumn	Spring	Autumn
Abamectin	1	1	1	1
chlorfluazuron	3	6	6	-
thiocyclam				
hydrogen oxalate	11	3	4	9
chlorfenapyr	9	11	7	7
Methadimophos + imidacloprid	13	12	9	13
cyromazine	7	8	2	-
Oxamyl	1	-	1	-

were immature and during the flowering and early fruiting period, leaves are necessary to protect the ripening cucumbers from the sun. Another reason was to keep the study uniform at every stage. The cucumber leaves were kept in plastic culture containers (30 x 20 cm) in laboratory conditions of 25 °C and a relative humidity of 65%. A sheet of absorbant paper was put between each leaf in the container to prevent contact and the possibility of mould growing in the humid conditions. As the immature stage of the leafminers cycle lasts 10–17 days the infested leaves were kept in the containers for 3 weeks. The emerging adults were counted and recorded according to their collection dates.

Data analysis

The data were evaluated by the SPSS software program. Data were analysed with a one-way ANOVA test and means were analysed by the t-test. All analyses were conducted at $p = 0.05$.

Results

The results of the study are shown in the Figure and Table 2.

These data were compiled from the weekly counts of adult *L. huidobrensis* which had emerged from the cultivated cucumber leaf samples taken from the non-treated and insecticide-treated greenhouses during 1999 and 2000.

In spring 1999, the production period lasted for 16 weeks. These figures were compiled from the weekly counts of adult *L. huidobrensis* which had emerged from the cultivated cucumber leaf samples taken from the non-

treated and insecticide-treated greenhouses. The number of adult *L. huidobrensis* which had emerged from the leaves collected from the non-treated greenhouse totaled 695, whereas those of the insecticide-treated greenhouse totaled 284. Initially, despite the insecticide treatments, the number of *L. huidobrensis* in both greenhouses was similar. The atabron treatment in the 3rd week post-planting caused a reduction in leafminer numbers, and subsequent insecticide applications kept leafminer populations low. Leafminer populations peaked twice in the non-treated greenhouse, in the 2nd and 7th weeks after planting. The results of the analysis according to the t-test ($P < 0.05$) showed significant statistical differences between the population in the non-treated greenhouse and that of the insecticide-treated greenhouse. It is important to note that the economic threshold (E.T.) for *Liriomyza* spp. is 4-5 larvae/leaf (Tarım ve Köy İşleri Bakanlığı, 1996). For this first spring season in the non-treated greenhouse, leafminer levels were above the threshold during the first 9 weeks after planting, except for in the 5th week. Natural parasitism kept populations below the E.T. until the end of the growing season. In contrast, in the insecticide-treated greenhouse, leafminer levels were above the E.T. for three weeks at the beginning of the growing season.

The autumn season lasted for 13 weeks during 1999. For the first 4 weeks after planting, no leafminers were found in either greenhouse. Similarly, in spite of insecticide treatments, the E.T. was exceeded in both greenhouses during the 8th week post-planting. The total number of adult *L. huidobrensis* which had emerged from the leaves collected in the non-treated greenhouse during the 13-week production period was 772, and 455 from

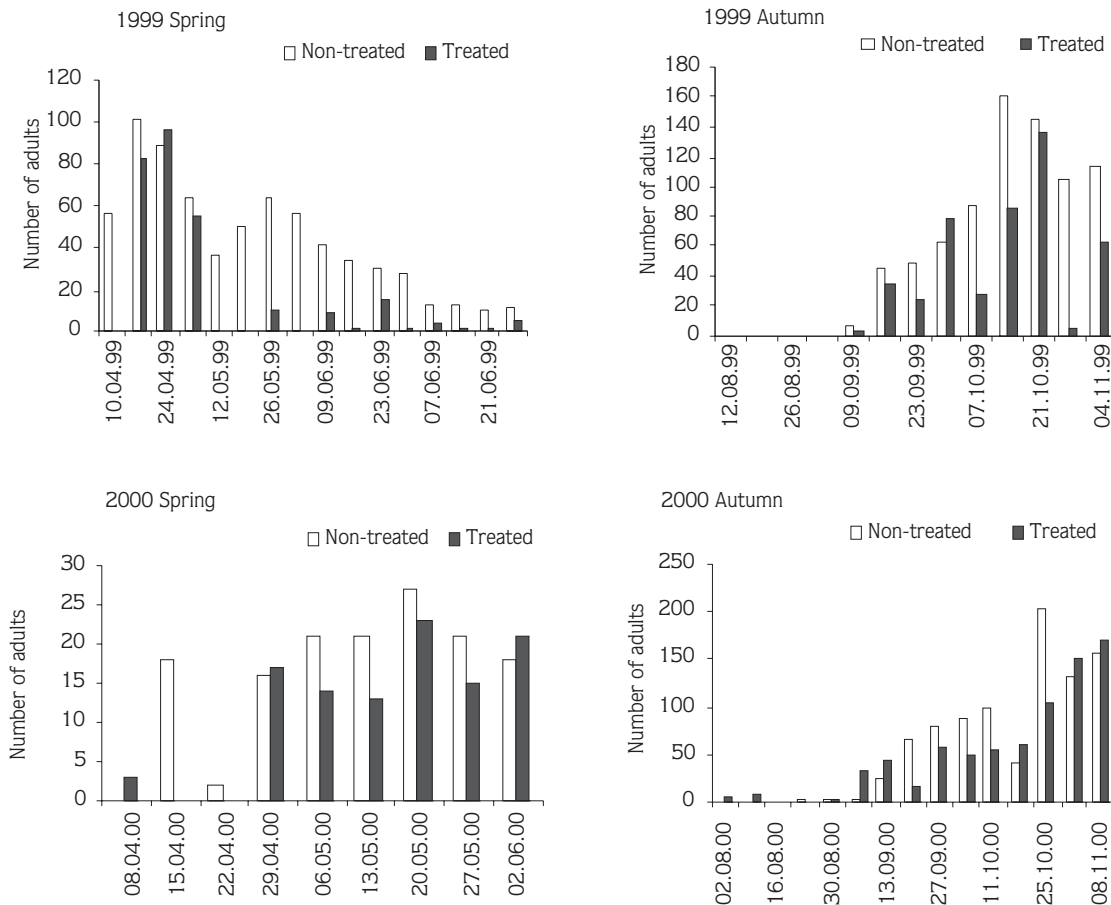


Figure. Occurrence of *Liriomyza huidobrensis* adults from infested cucumber leaves during 1999-2000 in each greenhouse

Table 2. The mean (\pm SE) of the adults of *Liriomyza huidobrensis* from infested leaves in each greenhouse during 1999 and 2000.

	1999		2000	
	Spring	Autumn	Spring	Autumn
Non-treated	45.6 \pm 7.2 a	59.3 \pm 10.5 a	15.9 \pm 4.8 a	59.6 \pm 25.9 a
Insecticide-treated	18.5 \pm 3.0 b	34.9 \pm 4.6 b	11.8 \pm 3.8 a	49.9 \pm 6.2 a

Means followed by different lower case letters are significantly different within a column by t-test ($P < 0.05$).

the insecticide-treated greenhouse. The results of the analysis according to the t-test ($P < 0.05$) showed significant statistical differences between the population in the non-treated greenhouse and that of the insecticide-treated greenhouse.

It took 9 weeks to complete the spring season during 2000. Unfortunately, there was a severe outbreak of

Verticillium sp. which, despite all efforts, resulted in all the plants dying, so this period was curtailed to 9 weeks. The total number of adult *L. huidobrensis* in both greenhouses for this shortened period was 144 individuals in the non-treated greenhouse and 106 individuals from the insecticide-treated greenhouse. The population density of adult *L. huidobrensis* was 1-2 per leaf – well below the E.T. for both greenhouses. There is

no significant statistical differences between the populations in both greenhouses ($P > 0.05$).

During the autumn season of 2000, which was completed in 15 weeks, the number of adult leafminers which had emerged from leaves in the non-treated greenhouse was 882, whereas the number of adults which emerged from leaves in the insecticide-treated greenhouse was 749. It was during this production period the highest pest density of the entire study was experienced. Despite all insecticide applications, leafminer populations surpassed the E.T. during the 9th week post-planting and remained high until the end of production. The results of the analysis according to the t-test showed that there was no statistical difference between the population in the non-treated greenhouse and that of the insecticide-treated greenhouse ($P > 0.05$).

Discussion

In this study we wanted to compare the population densities of adult *L. huidobrensis* from insecticide-treated and non-treated greenhouses. Based on our knowledge of local grower practices (the use of many different insecticides, often on a weekly basis), we wanted to introduce more economical and environmentally friendly cucumber production by reducing the use of insecticides against this pest.

During three of the four seasons examined, pest density in the insecticide-treated greenhouse was not maintained below the E.T. by insecticide applications. These facts show that the use of insecticide to combat *L. huidobrensis* infestation was not cost effective.

From these studies we see that the insecticides the growers are using are not appropriate for controlling leafminer pests. Weintraub and Horowitz (1998) applied translaminar insecticides (abamectin and cyromazine) and conventional insecticides to counter *L. huidobrensis* on celery. In conventional insecticide-treated plots they found a reduced parasitoid density and, parallel to that, a large adult leafminer population. In the translaminar insecticide plots, however, there was excellent leafminer

control. Oatman and Kennedy (1976) and Johnson et al. (1980) also showed that conventional insecticides, such as methomyl, disrupt parasitoids of *Liriomyza* spp. and induce pest population increases. Cucumber growers in Turkey use Pirate (chlorfenapyr), Evisect (thiocyclam hydrogen oxalate) and Taifun (methadimophos + imidacloprid) when *L. huidobrensis* populations are high, thus effectively killing parasitoids while at the same time having little to no impact on reducing leafminer populations. The overall differences between insecticide-treated and non-treated plants were in fact minimal. Chandler and Thomas (1982) reported that populations of *L. sativae* had the same densities in treated plots as non-treated plots. They reported that larger *L. sativae* populations as well as increased damage and mine numbers occurred in the spring; during all seasons lower mines/leaf or reduced damage were not noted. The results of this study are also supported by Yaşarakıncı and Hıncal (1996), who performed a similar study on leafminers in tomato greenhouses in the same region as our study. They reported that the insecticides used to counter leafminers caused resistance.

The results of this study lead to the conclusion that the use of insecticides to control *L. huidobrensis* in cucumber greenhouses in the Menderes region must be questioned. The overall differences between insecticide-treated and non-treated greenhouses were in fact minimal. Instead of using costly insecticides to combat *L. huidobrensis*, the problem should be approached by developing alternative methods to protect and increase the parasitoid population (possibly through parasitoid release programs) as this would result in more economical and environmentally friendly cucumber production.

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