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Original article (Orijinal araştırma)

The effect of different pruning methods on *Lasioptera* sp. (Diptera: Cecidomyiidae)[1,2]

Lasioptera sp. (Diptera: Cecidomyiidae)'ye farklı budama yöntemlerinin etkisi

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Abstract

In this study, effect of cutting axial shoot in different ways and lengths on the egg-laying preferences of the females of *Lasioptera* sp. on tomatoes was determined. The study was conducted on naturally infected tomato plants in Antalya province in 2017. The experiment consisted of 5 characters (pruning at 5 and 8 cm long by scissors or manually and untreated control) with 100 replications. As a result, more pupae were counted in the scissors pruning groups than in the manual pruning axial shoots and the difference between two treatment was statistically significant (P<0.05). In the axial shoot pruning with scissors at 5 cm length 418 pupae and at 8 cm length 215 pupae were counted. No pupae were found to untreated control axial shoots that did not have any treatment, pruning or manual pruning, during the study. As a result, as reported in previous studies, overall the results showed that manual pruning the axial shoots at 5-8 cm lengths could reduce the damage of this insect by approximately 87%, and suggest that this method can be effective in controlling this harmful species by reducing its egg-laying activity.

Keywords: *Lasioptera*, tomato, pruning, control

Öz

Bu çalışmada domatesteki koltuk sürgünlerinin farklı yöntem ve uzunluklarda kesilmesinin *Lasioptera* sp. dişilerinin yumurta bırakma tercihlerini nasıl etkilediği saptanmaya çalışılmıştır. Çalışma 2017 yılında Antalya ilindeki bir domates serasında yürütülmüştür. Deneme 5 karakterden oluşmuştur (Makasla 5 ve 8 cm uzunluğunda kesim; elle 5 ve 8 cm uzunluğunda kırma, hiç koltuk alma yapılmamış (muamelesiz kontrol). Tüm karakterler 100 tekerrürlü olarak denenmiştir. Çalışmadan elde edilen sonuçlar makasla kesilen sürgünlere, elle kırılan sürgünlerden daha fazla yumurta bırakıldığını ve aralarındaki fark istatistiki olarak önemli olduğunu göstermiştir (P<0.05). Makasla 5 cm uzunlukta kesilen sürgünlerde toplam 418 adet yumurta bırakılmasına karşılık, 8 cm uzunluğunda kesilenler 215 adet yumurtaya sahipti. Elle kırılan sürgünlerde 53-55 adet yumurta bırakılmıştır. Çalışma süresince hiçbir işlem (kesme ya da kırma) yapılmadan bırakılan muamelesiz kontrol sürgünlerine ise hiç yumurta bırakılmamıştır. Sonuç olarak, daha önce yapılan çalışmalarda da bildirildiği gibi domates bitkisinden salgılanan semiokimyasallardan olan terpen maddesinin elle kırılan sürgünlerde daha fazla olması ve böceklere repellent etki yapmasından dolayı bu sürgünleri daha az tercih ettiğini düşündürmektedir. Tüm sonuçlar, elle 5-8 cm uzunlukta sürgün kırmanın zararlının zararını yaklaşık %87 kadar azaltabildiğini göstermiş olup, bu metodun yumurta bırakma aktivitesini azaltarak zararlı ile mücadelede etkili olabileceğini öğütlemektedir.

Anahtar sözcükler: *Lasioptera*, domates, budama, mücadele

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Introduction

Lasioptera sp. (Diptera: Cecidomyiidae) has been reported to feed on plants, especially those belonging to the families, Solanaceae, Cucurbitaceae, Poaceae and Apiaceae (Skuhravá & Skuhravy, 2009). It is generally reported that each *Lasioptera* species feeds on a single host plant species (Skuhravá & Skuhravy, 1981). In Turkey, it is known that there are 8 species of the genus *Lasioptera*. These are *Lasioptera oleicola Skuhravá, L. cerris Kollar, L. populnea Wachtl, L. berlesiana Paoli, L. carophila Loew, L. eryngii (Vallot), L. rubi* (Schrank) and *L. turcica* Möhm (Skuhrava et al., 2005, Unal & Akkuzu, 2009). The hosts of these species that were identified in Turkey were definitely not tomatoes. The pest has been reported on tomatoes in Turkey. However, although *Lasioptera* sp. causing significant damage in tomato cultivation was reported, it was not identified at species level yet (Büyüköztürk, 2014). Perdikis et al. (2011) reported that *Lasioptera* sp. is harmful on tomatoes and cucumber plants in Greece.

Females lay eggs in damaged tissue on tomato plants. The larvae emerged from the eggs feed by opening galleries in the main body and fruits and cause weakening of plants. Galleries generally occur in places where axial shoots are taken. It was reported that the symbiotic fungus colonies coexisting with the larvae were seen in the gallery; transmission of water and nutrients was blocked and eventually cause plant death (Büyüköztürk, 2016). Gültekin and Erler (2016) reported that 26 of 34 greenhouses in Antalya were infested with this insect pest.

Over the past 35 years, many studies were conducted for identification of systemic wound healing and systemic wound signals of plants, and their production, transport, and perception mechanisms (Ryan, 2000). Many structurally diverse molecules were involved in the production of oligosaccharides released from the damaged cell wall (Bishop et al., 1981). In addition molecules with hormonal activity such as jasmonic acid (Farmer & Ryan, 1990), ethylene (O'Donnell et al., 1996) and abscisic acid (Peña-Cortés et al., 1989) play regulatory roles in wound signaling.

Since chemical control of *Lasioptera* sp. observed on tomatoes with pesticides is very difficult, alternative control methods need to be developped. In this study we tried to clarify the effect of pruning methods and lengths of the cut part of the axial shoots on the egg-laying preferences of the females of *Lasioptera* sp. As a result pruning the axial shoot with different methods and at certain lengths were proposed as an alternative control method.

Material and Methods

The main materials of this study were Torry tomato cultivar and the pest *Lasioptera* sp. and the experiment was carried out in a greenhouse in Topallı village (Antalya-Aksu district). In April, the tomato seedlings were planted in the greenhouse with 50 cm intervals. During the experiment, no chemical insecticides were applied. The study was replicated on 100 plants. Five treatments were applied to each of these plants. The treatments included pruning manually or with sterile scissors leaving axial shoot length of 5 cm or 8 cm., Control group did not have any treatments. The experiments were carried out by randomly selecting five axial shoots on each of the 100 plants selected on the same row and labeled in different colors. Each treatment was applied for all plants. The methods and abbreviations used in the study were given in Table 1.

Table 1. Methods and abbreviations used in the study

Pruning methods (Characters)	Leaving axial shoot length (cm)	Abbreviations
Pruning with scissors	5	M_5-1, M_5-2, M_5-3...M_5-100
	8	M_8-1, M_8-2, M_8-3...M_8-100
Manual pruning	5	E_5-1, E_5-2, E_5-3…...E_5-100
	8	E_8-1, E_8-2, E_8-3…...E_8-100
Control	All	P_{-1}, P_{-2}, P_{-3}……..P-100

The study was conducted between May and July. This work was started in 25 May of 2017 because the adults of *Lasioptera* sp. began to be seen in spring. Five axial shoots on 100 plants marked for each treatment were observed 3 times a week. Since the pest is very small and it is very difficult to see its eggs, the exact times of egg laying could not be determined. However, as the larvae that had emerged from the eggs became mature by feeding, axial shoots turning yellow were used as an indicator of larvae emergence on axial shoots. When these signs were observed, axial shoots were considered as damaged by the pest. It was observed that the damaged and yellow colored axial shoots were an indication of presence of the pest at larval stage. Then, conversion of axial shoots color from yellow to brown was considered as the sign of the damage. This kind of axial shoots generally contained pupae of the pest. Later, when the damaged axial shoots were completely turn brown (3-4 cm long, fed during larval period), the adults emerged from the pupae as the axial shoots started to dry. In this study, however, 22 days after pruning and 3-4 days after yellow-brown axial shoots were observed before the emergences of adult individuals, the axial shoots with the pupae inside were carefully cut, in order to determine how many individuals were present in the damaged axial shoots before the adults instar. The axial shoots of other plants not included in the experiment in the greenhouse were cut longitudinally in order to detect color changes during larval and pupa periods of this insect.

First, square root transformation ($\sqrt{(x + 3/8)}$) was applied to the data obtained in the experiment and then evaluated by the ANOVA method. Tukey multiple comparison test was used for comparing the differences between the means (P = 0.05). Statistical analysis was performed by SPSS 22.0 package program (SPSS, 2014).

Results and Discussion

In this study, it was attempted to determine the damage rates of *Lasioptera* sp. larvae on axial shoots cut at different lengths and methods. Damage resulted from infestation was evaluated every 3-4 days and the results are given in Table 2 and Figure 1. The square root transformation ($\sqrt{(x + 3/8)}$) was applied to the obtained data and the statistics analysis of the results are summarized in Table 2.

Table 2. Statistical analysis of injured axial shoots numbers obtained by square root transformation (Mean ± SE)

Applications	Number of damaged axial shoots*	
Pruning at 5 cm by scissors (M5)	1.52±0.69	a
Pruning at 8 cm by scissors (M8)	1.21±0.28	ab
Manual pruning at 5 cm (E5)	0.75±0.15	bc
Manual pruning at 8 cm (E8)	0.84±0.13	bc
Control	0.61±0.00	c

*Means within a column followed by a different letter are significantly different (Square root transformation; P<0.05).

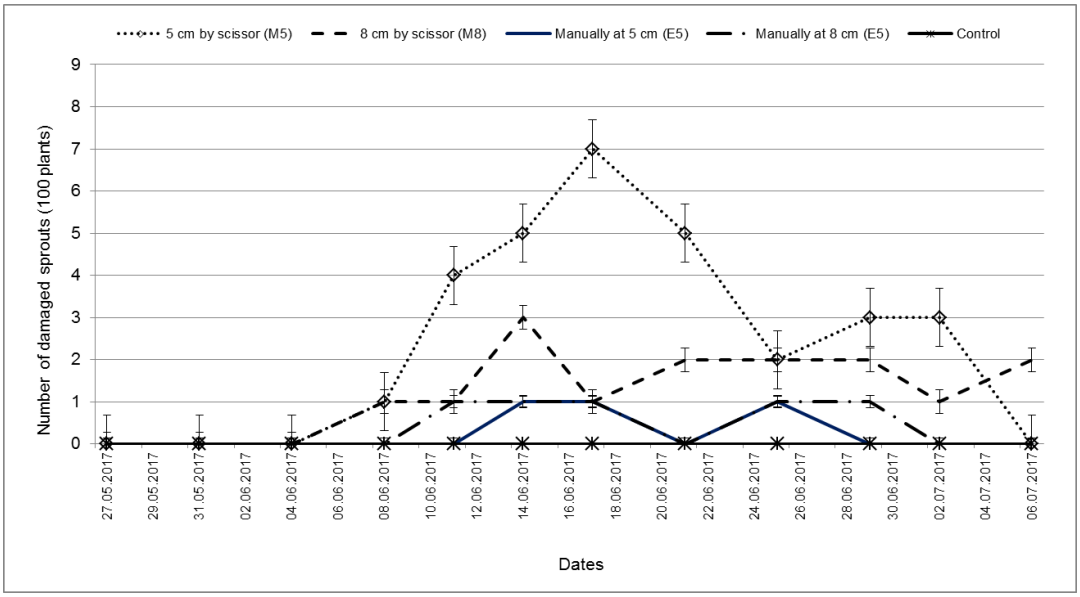

Figure 1. Number of damaged axial shoots in different cut and lengths.

As a result of the statistical analyzes the damage caused by this pests in axial shoots cut at different lengths and applications; ($p<0.05$), the difference between the cutttings with scissors at 5 cm length and the ones at 8 cm length was statistically significant ($p<0.05$). However, the difference between the cut with 5 cm and 8 cm lengths with scissors was statistically insignificant ($p<0.05$). The difference between control axial shoots was statistically significant ($p<0.05$), while the difference between axial shoots pruning at 8 cm length and manual pruning at 5 and 8 cm lengths were not statistically significant ($p<0.05$). The difference between control group and axial shoots applied manual pruning both at 5 and 8 cm lengths were not significant ($p<0.05$).

Since the larvae were expected to be pupae within the damaged axial shoots, the number of pupae was counted after cutting longitudinally. The number of pupae was calculated in the galleries of plants for all treatments.

It was observed in all counting results that *Lasioptera* has an important difference in the number of pupae in axial shoots injured in different lengths and different forms. These counting results are shown in Table 3 and shown in Figure 2. The square root transformation ($\sqrt{(x + 3/8)}$) was applied to the obtained data and the statistics analysis of these results were summarized in Table 3.

Table 3. Number of pupae in axial shoots damaged according to applied square root transformation

Applications	**(Means ± SE)/ axial shoot /pupae***	
Pruning at 5 cm (M5)	7.15±12.9	a
Pruning at 8 cm (M8)	4.77±6.13	b
Manual pruning at 5 cm (E5)	2.41±2.95	bc
Manual pruning at 8 cm (E8)	2.36±2.81	bc
Control	0.61±0.00	c

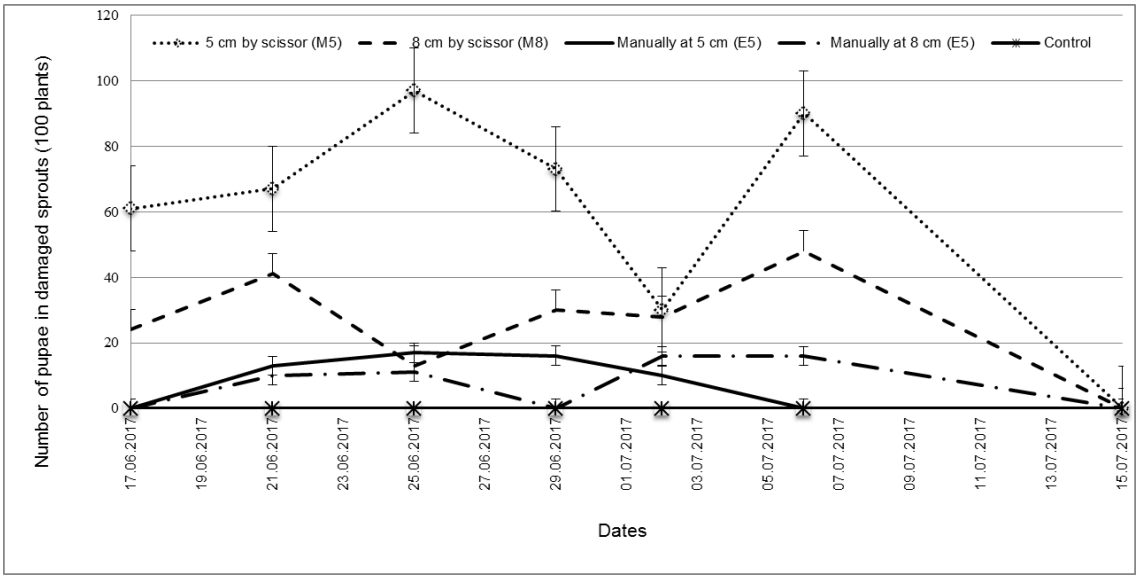

Figure 2.Graphical presentation of the number of pupae in damaged axial shoots with different pruning and lengths.

As a result of the statistical analysis, the difference between the numbers of pupae in the axial shoot cut at 5 cm length and all the other treatments was found to be significant ($p<0.05$). The difference between the number of pupae in the axial shoot pruning at 8 cm and manually pruning at 5 and 8 cm was statistically insignificant ($p<0.05$). The difference between the number of pupae in all other treatments and control axial shoot without any treatment was statistically significant ($p<0.05$).

The number of damaging axial shoot of *Lasioptera* sp. and the number of pupae in the axial shoot are directly proportional. The highest number of pupae is also seen intensely in late June and the first weeks of July.

Büyüköztürk (2016), reported that the procedure of taking axial shoot was determined as a result of the fact that the damage done by the scissors or the knife instead of splitting the branch, and the 4-5 cm branch made it difficult to enter the body. It is reported that when the farmers' pruning method compared with left axial shoot method used in that study provided 77.75% protection against that pest. Although these data are in agreement with the results of our study, they are not compared with the length of the axial shoot left and the effects of cutting the axial shoot with different methods; by hand or by scissors.

The number of pupae found in damaged axial shoot was close to each other in different treatments applied in our study. However, the average of the pupae found in axial shoot cut at 5 cm with scissors or manual pruning were significantly different. It can be inferred from this data that the females prefer to lay eggs on 5 cm long axial shoot than 8 cm axial shoot. The plot obtained from this data is shown in Figure 3.

These results are thought to be derived from the defense mechanisms of plants against wounding. Studies have been reported that to help cell differentiation and regeneration, transport bundles when plants are wounded (Jacobs, 1952). Terrestrial plants encounter numerous environmental conditions that can damage or destroy above ground and below ground tissues. Herbivores are serious threats to plants. It has been reported that plants perceive tissue damage and trigger innovative mechanisms to respond to wounding of (Howe & Jander, 2008). Plant hormones play a central role in regulating these highly dynamic and adaptive responses (Pieterse et al., 2009; Santner et al., 2009).

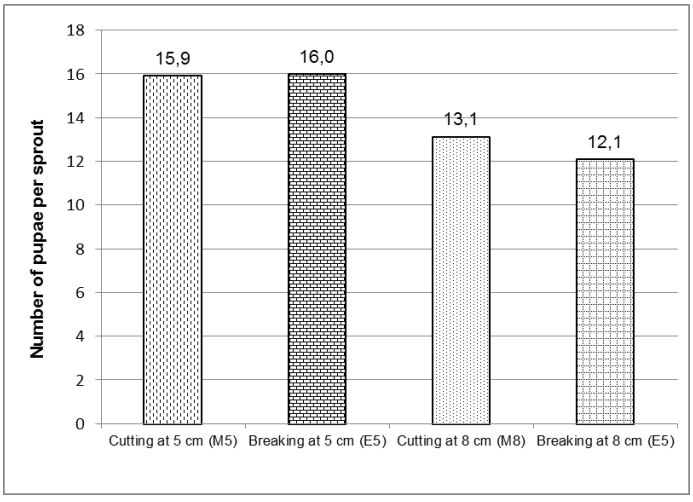

Figure 3. Average number of pupae per damaged in *axial* shoots for application.

Volatile organic compounds emitted by plants can act as semiochemicals. The insects play an important role in their identification of main plants or in attracting hunters and parasitoids (Kappers et al., 2005; Bruce et al., 2005). In our study, it was thought that semiochemicals secreted from plants in the process of taking up axial shoot in tomatoes were attractive for insects. In a similar study, terpene compounds were found to be effective in directing *Bemicia tabaci* (Gennadius) (Hemiptera: Aleyrodidae) to tomato varieties (Bleeker et al., 2009).

Plants of the Solanaceae family, such as tomatoes, have been reported to benefit from terpenes in defense against herbivores (Kennedy, 2003) and some terpenes have repellent properties against insects (Peterson et al., 2002; Terry et al., 2007). Despite the positive results of leaving the axial shoot, we aimed to find out how many centimeters of these axial shoot would be left and how to implement them. The results obtained suggested that the tissues cut with straight scissors would release less wound hormones by the plant than by manual pruning of the axial shoot to repair these areas. It is thought that the more surface of the fractures in the manually broken areas, the more the wound hormones are secreted, and the more repellent effect was showed against insects.

It is considered that the pruning method of axial shoot is compatible with environment friendly, economical and sustainable control strategies and will form a basis for future study against this harmful organism. As a result of this study, it was determined that the harmful pests preferred the axial shoot cut by 5 cm length with the scissors to lay eggs. The least preferred practice was in the axial shoot broken manually by 8 cm length. This is the result of the role of wound hormones from the semiochemicals that are secreted by the plants. For closure of the wound due to the greater release of hormonal activity in the molecules with a surface area of the slider manually broken to heal wounds are made from more secretion. This is due to make an impact repellent against insects hormonal secretions also may cause excess secretion of manually broken by the result of the exile seat insects to increase this effect to prefer less.

In addition, the result showed that pruning axial shoot by scissors at 5 cm is preferred more than the other treatments in this region. According to these results, axial shoots with 8 cm cut length of the by manually pruning is less preferred by the insects than the other applications. As a result, pruning or manual pruning at 8 cm length of axial shoot is recommended to the producers. This will be an effective way of control against this insect if the resultant fodder, which breaks from the bottom of the axial shoot, will prevent laying eggs in the opened crop. Therefore no other injury to the tomato plant will be inflicted. However, care

should be taken not to cut off the dried and damaged axial shoot. It is inevitable that they will be infected again in the axial shoot.

It has also been reported that plant-generated semiochemicals can potentially be used as a naturally occurring insect repellent as an alternative to the use of insecticides (Peterson & Coats, 2001). It has been shown that terpene emission and applications can make plants more attractive to herbivores (Degenhardt et al., 2003; Kappers et al., 2005; Schnee et al., 2006). In the light of this information it should also be considered that biotechnical control should be carried out with respect to this insect. The repellent substances contained in these compounds influencing adults can be identified and tested for controlling this insect.

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