Research Article

EFFECTS of DIFFERENT IRRIGATION LEVELS on POPULATION DENSITIES of *Liriomyza trifolii* (Burgess, 1880) on TWO VEGETABLE SOYBEAN (*Glycine max* [L.] Merr.) CULTIVARS

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ABSTRACT

Liriomyza trifolii (Burgess, 1880) (Diptera:Agromyzidae) is an important insect pest on vegetable areas. A field-experiment was conducted to investigate population densities of *Liriomyza trifolii* (Burgess, 1880) on two vegetable soybean (*Glycine max* [L.] Merr.) cultivars in different irrigation levels in the semi-arid conditions. This research was carried out at the Agricultural Experimental Field of the Harran University (Sanliurfa, Turkey) during the growth periods of 2006, and 2007. The irrigation treatments were 33%, 67 %, 100 %, and 133 % ratios of total irrigation water applied (IW)/cumulative pan evaporation (CPE) with four day irrigation interval. The experiment area was checked once a week during the whole production period. Ten leaves were removed randomly from each plot and living larvae counted. Adult counts were made on yellow sticky trap which placed randomly in each plot. Bean yield was also recorded. Differences of adult number and living larvae were significant between varieties, but showed no significant changes in response to irrigation levels within variety. The number of living larvae and adult of *L. trifolii* were higher on cultivar Toyohomare than Toyokomachi. However, the population was over the economical damage threshold on all irrigation levels. The highest green pod yield was obtained from Toyokomachi, with I_{133} irrigation level. Based on the findings, varietal characteristics should be considered and select less sensitive cultivars to *L. trifolii* and water stress especially in semi-arid and arid areas for successfully growing soybean.

Key words: *Liriomyza trifolii*, population density, irrigation, vegetable soybean.

FARKLI SULAMA SEVİYELERİNİN İKİ SEBZE SOYA (*GLYCİNE MAX* [L.] MERR.) ÇEŞİDİNDE *LİRİOMYZA TRİFOLİİ* (BURGESS, 1880)'NİN POPULASYON YOĞUNLUĞUNA ETKİSİ

ÖZET

Liriomyza trifolii (Burgess, 1880) (Diptera: Agromyzidae) sebze alanlarında önemli bir zararlıdır. İki sebze soya (*Glycine max* [L.] Merr.) çeşidinde farklı sulama seviyelerindeki *Liriomyza trifolii* (Burgess, 1880)'nin populasyon yoğunluğunu belirlemek amacıyla semi arid iklim şartlarında bir tarla denemesi yürütülmüştür. Bu araştırma 2006-2007 yılları yetiştirme periyodunda Harran Üniversitesi, Ziraat Fakültesi (Şanlıurfa, Türkiye) Deneme Alanında yürütülmüştür. Sulama uygulamaları; toplam uygulanan sulama suyu (IW)/kümülatif pan buharlaşma oranlarının (CPE) %33, %67, %100 ve %133 seviyelerinde 4 gün sulama aralıkları ile uygulanmıştır. Yetiştirme periyodu süresince deneme alanı haftada bir kez kontrol edilmiştir. Her parselden tesadüf olarak on yaprak alınarak bulaşık yapraklardaki canlı larva sayımı yapılmıştır. Ayrıca her bir parsele yerleştirilen sarı yapışkan tuzaklarla da ergin sayımı yapılmıştır. Bakla verim değerleri kaydedilmiştir. Çeşitler arasında ergin ve larva sayıları arasındaki fark önemli bulunmuştur. Fakat çeşitlerin arasında sulama sevilerine tepkisi önemli değildir. Canlı larva ve ergin sayısı Toyohomare çeşidinde Toyokomachi çeşidine göre daha fazladır. Zararlı populasyonu bütün sulama seviyelerinde ekonomik zarar eşiğinin üzerinde olmasına rağmen, en yüksek bakla verimi Toyokomachi çeşidinde I_{133} sulama seviyesinde elde edilmiştir. Bulgular esas alındığında, çeşit karakterleri göz önüne alınmalıdır ve *L. trifolii*'ye daha az hassas çeşitler seçilmelidir. Su stresinin olduğu yarı kurak ve kurak bölgelerde sebze soya başarılı bir şekilde yetiştirilebilir.

Anahtar kelimeler : Liriomyza trifolii, populasyon yoğunluğu, sulama, sebze soya

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INTRODUCTION

Soybeans are widely cultivated and one of the world's most important crops, with a world production of 210.9 million tons (Anonymous, 2010). In Turkey, soybean production began after World War II and steady increased (as the second crop) until 1987 and the amount of production reached 250.000 tons. However, with periodic increase and decrease production, decreased to 75.000 tons in 2002, and to 25.000 tons in 2004 (Haskınacı, 2004). Turkey had to import soybean to supplement local production to meet the national consumption. Information on the soybean production is limited because high amount of soybean is imported. Vegetable soybean is rich in protein, fat, phospholipids, minerals, vitamins and diet fiber with large-seed nutty and sweet flavor (Mentreddy 2002; Anonymous, 2007; Singh, 2010). Vegetable soybean is similar with grain soybean in terms of plant characteristics and production requirements but vegetable soybean is harvested when immature at 80% pod fill or the R6 stage of development when the pods have full size seeds (Fehr et al., 1971; Rao et al., 2002).

Liriomyza trifolii (Burgess) (Diptera: Agromyzidae) is a worldwide pest of ornamental and vegetable crops. *L. trifolii* is a polyphagous leafminer (ca. 400 diffrent host plants) (Spencer, 1973) that undergoes larval development in the plant leaf tissue and forms serpentine mines within the leaves. Damage is caused mostly by larvae that feed their way inside the plant-host mesophyll, and adult females puncture both upper and lower leaf surfaces to feed and lay eggs. This action that decreases the plant's photosynthesis provides entry sites for plant pathogens, and creates small marks that reduce the aesthetic appearance of leaves (Parella et al., 1984; Broadbent & Pree, 1989, Broadbent & Matteoni, 1990; Keil & Parella 1990, Mac-Donald, 1991, Saito 1994, Civelek, 1999). The serpentine leafminer is an important pest in Aegean, Mediterranean, and South East Regions of Turkey (Ulubilir & Yabaş, 1996; Civelek, 1999; Çıkman & Uygun, 2003, Çıkman & Civelek, 2005). It is also an important pest on vegetable plants in the same regions.

The purpose of this study to investigate population densities of *L. trifolii* on two vegetable soybean cultivars in different irrigation levels.

MATERIALS and METHODS

Experimental Site and Meteorological Data

Field trial was conducted at Harran University Agricultural Experimental Field in Sanliurfa, Turkey, in 2006 and 2007. The study area was located in a semi-arid climate. The soil water contents (w/w %), determined by a gravimetric sampling method, at field capacity were 33.1, 33.2, and 33.7%, and at permanent wilting point 21.6, 21.9, and 22.8%, in 0-30, 30-60, and 60-90 cm soil depths. Table 1 shows some recorded meteorological data of experimental site.

Crop Management and Irrigation Treatments

Two determinate cultivars, Toyohomare (with gray pubescence and white flower) and Toyokomachi (whit grey pubescence and purple flowers) were grown to determine their responses to *L. trifolii* under different irrigation treatments. The seeds were sown 25 cm in a row with 70 cm between the rows space on 25 July in both years. Three to four seeds were sown and thinning was done to maintain 2 plants per hole after germination. The plants were fertilized with 40, 60, and 80 kg ha^{-1} of N, P_2O_5, and K_2O_5 respectively. The harvesting was made at an immature (R6) stage (Fehr et al. 1971) and green pod yield (GPY) per plant measured, and mean values per hectare (t ha^{-1}) were calculated.

All plants were fully irrigated (field capacity) pre-treatment in order to a good plant establishment. Four drip irrigation regimes were applied. The irrigation treatments were %33 (I_{33}), %67 (I_{67}), %100 (I_{100}), and %133 (I_{133}) ratios of total irrigation water applied (IW) /cumulative pan evaporation (CPE) with four days irrigation interval. Water balance model (Garrity et al., 1982) was used to calculated crop evapotranspiration under varying irrigation regimes:

$$ET_c = IW + P - D - R \pm \Delta S$$

where ET_c is the seasonal crop evapotranspiration (mm), IW is the total irrigation water applied (mm), P is the precipitation (mm), D is the drainage (mm), R is the run-off (mm), and ΔS is the variation in water content (mm) of the soil profile. All terms are expressed in mm of water in the root zone. The effective root depth was taken as 60 cm. Run-off was taken as to be nil since no run-off was observed in drip irrigation system.

The amount of irrigation water applied was calculated using a pan evaporation equation (Doorenbos & Pruitt, 1977):

$IW=A \times E_{pan}$

Where IW is the amount of irrigation water applied (L), A is the plot area (m^2), and E_{pan} is the amount of cumulative evaporation during an irrigation interval (mm).

The experimental design was a randomized complete block. Each plot had 30 hills (60 plants) with three replications. The data were subjected to standard analysis of variance using TARIST (Acikgoz et al., 2004) statistical software. Treatment means were compared using least significant difference (LSD) test.

Sampling of Living Larvae

The experiment area was checked once a week during the entire production period starting with the sowing of seeds. Each week ten leaves were removed randomly from each of treatment and brought to the laboratory set to 25±2 ºC temperature and 65±5% relative humidity. Leaves were examined under a stereo microscope, and living larvae were counted and recorded.

Mass Trapping and Sampling

The traps used in the study were constructed from yellow plastic boards (20x15 cm). The boards were coated on both sides with a sticky coating. One yellow sticky trap was placed in each plot and changed weekly. The traps elevated 10 cm above the top of the plants. The number of flies caught on each side of the boards were counted and recorded weekly.

RESULTS

Some recorded meteorological data of experimental site were shown in Table 1. The growing season was characterized by high temperature and light intensity and low humidity as typically observed in the summer time.

Table 1. Monthly mean value of air temperature (T_a), maximum air temperature (T_{max}), minimum air temperature (T_{min}), relative humidity (RH), class A pan evaporation (E_0), precipitation (P), total solar radiation ([R_s) and wind speed (u_2) of experimental site

Years		T_a (ºC)	T_{max} (ºC)	T_{min} (ºC)	RH (%)	E_0 (mm)	P (mm)	R_s (MJ m^{-2} day^{-1})	u_2 (km hr^{-1})
2006	July	32.2	43.0	20.8	45.5	448	0	27.25	7.2
	August	33.4	44.5	22.8	44.6	414	0	19.35	5.4
	September	27.2	40.0	16.0	42.3	249	0	19.06	6.5
	October	20.6	33.5	10.1	61.5	206	42.5	12.21	3.2
2007	July	34.0	43.7	22.0	31.3	454	8.0	23.16	7.6
	August	32.2	44.8	20.0	41.9	419	0	21.82	5.8
	September	28.4	42.0	16.5	36.4	233	0	17.89	6.1
	October	21.6	34.2	9.8	47.7	179	3.2	13.42	4.7

During in 2006 and 2007, adults numbers of cultivars and irrigation treatments on yellow sticky trap are given in Table 2.

Table 2. The adult numbers of cultivars and irrigation treatments in 2006-2007

Cultivars	I_{33}	I_{67}	I_{100}	I_{133}
Toyohomare	18.25 a	15.58 a	17.89 a	16.46 a
Toyokomachi	7.79 b	9.42 b	8.08 b	7.75 b
LSD (0.01)	1.145			

The numbers followed by the same letter vertically were not significantly different using LSD test

The lowest adult number was recorded on Toyokomachi cv in all irrigation levels. Statistically, there was significant difference between two cultivars. The number of adults per trap was the highest on Toyohomare in all irrigation levels (Table 2).

As it can be seen from Table 3, the number of adults continued to increase until 4th week, after which decrease was noted in 5th week on both cultivars. However, after the 5th week the number of adults continued to increase until whole counts period. Statistically, there was difference in terms of weekly adult numbers between two cultivars. During production period, the number of adults was the higher on Toyohomare than Toyokomachi.

Table3. The weekly average numbers of adult on cultivars in 2006-2007

Weeks	Cultivars		Mean of Cultivars
	Toyohomare	Toyokomachi	
1	7.92 a	4.33 b	6.13 f
2	13.08 a	5.71 b	9.40 e
3	16.42 a	8.13 b	12.27 cd
4	21.21 a	10.63 b	15.92 b
5	15.58 a	7.08 b	11.33 d
6	18.25 a	8.54 b	13.40 c
7	20.42 a	9.42 b	14.92 b
8	23.50 a	12.25 b	17.88 a
LSD (0.01)	1.62		1.15

The numbers followed by the same letter horizontally were not significantly different cultivars and vertically for mean of cultivars using LSD test for

Table 4. The larvae numbers of cultivars and irrigation treatments in 2006-2007

Irrigation treatments	Cultivars	
	Toyohomare	Toyokomachi
I_{33}	2.63 a	0.97 b
I_{67}	1.95 a	1.26 b
I_{100}	2.57 a	1.00 b
I_{133}	2.78 a	1.33 b
LSD (0.01)	0.462	

The numbers followed by the same letter vertically were not significantly different for cultivars and horizontally for the mean of irrigation treatments, using LSD test

The highest number of living larvae/leaf number was recorded in I_{133} irrigation level in both cultivars. Statistically, living larvae/leaf number was different between two cultivars (Table 4).

The number of living larvae, taken weekly, is given in Table 5. In both cultivars, the number of living larvae continued to increase until 3rd week, after which decreased until 7th week.

Statistically, living larvae of cultivars was different between two cultivars. On the other hand, the highest number of living larvae/leaf was recorded on Toyohomare (Table 5).

Table 5 The weekly average number of larva in two cultivars in 2006-2007

Weeks	Cultivars	
	Toyohomare	Toyokomachi
1	2.23 a	0.78 b
2	3.30 a	1.19 b
3	4.26 a	1.76 b
4	2.34 a	0.87 b
5	2.05 a	1.13 b
6	1.55 a	1.16 b
7	1.43 a	1.03 a
LSD (0.01)	0.687	

The numbers followed by the same letter horizontally were not significantly different using LSD test

The average values of IW for treatments (I_{133}, I_{100}, I_{67} and I_{33}) were 1058, 795, 533, and 263 mm and 1094, 823, 551, and 272 mm, for Toyohomare and Toyokomachi respectively (Table 6). Cultivars differed significantly in green pod yield per plant being higher in Toyokomachi than Toyohomare in all irrigation levels in both years. It is possible to explain this variation with varietal characteristics, such as, number of branch, node and total number of pods per plant and genotypeXenvironment interaction. The amount of applied irrigation water also significantly affected the pod yield, which increased as the amount of irrigation water applied increased. Similar results have been reported by Frederick et al. (1991), Rao et al. (2002), Isoda et al. (2006), Bustomi (2007) & Demirtas et al. (2010). The highest pod yield was produced with I_{133} on both cultivars and reduced 37% and 35% for Toyohomare and Toyokomachi cultivars received low irrigation (I_{33}) compared to those receiving high irrigation (I_{133}) (Table 6).

Table 6. Amount of irrigation water applied and mean values of green pod yield per plant in 2006-2007

Cultivar	Treatment	IW (mm)			Green Pod Plant^{-1} (g)		
		2006	2007	Average	2006	2007	Average
Toyohomare	I_{133}	1099	1016	1058	195.39	164.37	179.88
	I_{100}	826	764	795	147.70	116.54	132.12
	I_{67}	553	512	533	122.99	115.36	119.77
	I_{33}	273	252	263	108.86	117.10	112.98
Toyokomachi	I_{133}	1136	1052	1094	300.52	208.53	254.53
	I_{100}	854	791	823	265.97	173.52	219.74
	I_{67}	572	530	551	242.29	162.01	202.15
	I_{33}	282	261	272	206.55	123.65	165.10

DISCUSSION

The adult and living larvae numbers were different between varieties. On the other hand, there was no difference among irrigation levels in terms of adult and living larvae numbers.

This study evaluated irrigation levels to modify cropping environments as cultural control to reduce *L. trifolii* densities and investigated whether irrigation could use in the management leafminers damage in soybean. Irrigated plants were able to increase the leaf area and pod yield while irrigation had no effect on the *L. trifolii* populations on soybean.

Satpathy et al. (2000) reported that the lowest infestation was found on DMDR-2 variety with 41.66% leaf infestation ratio in sixteen melon varieties. The highest infestation was found on MR-12 variety with 75.83% leaf infestation ratios. Çıkman & Civelek (2007) tested eight chickpea varieties in terms of resistance to *Liriomyza cicerina* (Rondani). They assessed larval densities on leaves weekly. The *L. cicerina* larval population found the lowest on four varieties. There were very minor differences in yield among the eight varieties. There was no correlation between larval density and yield loss. These studies supported present study in terms of differences in varieties.

Çıkman & Civelek (2006) reported that population densities of *L. cicerina* on *Cicer arietinum* L. in different irrigated conditions. Their study showed that increased in irrigation level increased the number of living larvae and adult; however, this increase did not result in loss of yield. This study supports our present study partly; the lowest yield was achieved on Toyohomore cultivar and I_{33} and I_{67} irrigation levels in the years of 2006 and 2007 respectively. The highest yield was achieved on Toyokomachi cv, irrigation level with I_{133} in both years. The highest yield was achieved on Toyokomachi cv, irrigation level with I_{133} in both years. When two cultivars have been compared each other in terms of yield, the highest yield was recorded on Toyokomachi cv. Economical damage threshold of *L. trifolii* is 4-5/leaf infestation (Anonymous, 1996). The observations showed that in all irrigation levels, plants were more than 50% infested; thus, the pest population was over the threshold. This result lead to a conclusion that differences the number of living larvae and adult were significant between varieties, but showed no significant changes in response to irrigation levels within variety.

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