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Effects of spinosad on *Liriomyza cicerina* (Rondani, 1875) (Diptera: Agromyzidae) and its parasitoids in chickpea

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Summary

The aim of this study was to compare and control spinosad with cyromazine on *Liriomyza cicerina* (Rondani, 1875) (Diptera: Agromyzidae) which is an important pest in chickpea growing areas in Şanlıurfa (Turkey). Field trials were carried out in Turkeys's southeastern Şanlıurfa from march to june in 2007 and 2008. Spinosad was applied at a concentration of 25 ml/100 l water with 125 ml mineral oil/ 100 liter and cyromazine application was 20 g/100 liter to compare. When it comes to the result of the study, spinosad showed little or no effect on natural enemies of the pest whereas it had a significant impact on larvae of *L. cicerina*. However, in spinosad-treated plots, chickpea yield rate was higher than control plots.

Key words: *Liriomyza cicerina*, spinosad, cyromazine, chickpea, parasitoids

Anahtar sözcükler: *Liriomyza cicerina*, spinosad, cyromazine, nohut, parazitoit

Introduction

Liriomyza cicerina (Rondani, 1875) (Diptera: Agromyzidae) is widespread in Europe, particularly in south and extending eastwards to Turkey and the Ukraine; also Morocco and Tunisia (Spencer, 1976) and is a serious pest of Turkey. It recorded first time in 1957 in the western region (Izmir province) on chickpea (*Cicer arietinum* L.) (Giray,1971). Both the larvae and adults cause damage; the larvae primarily mine the spongy mesophyll, where chloroplasts are located, and the adult females puncture both the upper and lower leaf surface to feed and lay eggs (Lodos, 1962; Giray, 1971; Çıkman, 2006). This results in reduction of both chlorophyll content and stomal conductance and in cosmetic damage to leaves (Yıldırım et al., 2010).

There are currently no effective insecticides for use against adults, although growers continue to use whatever is available (deltamethrin, diazinon, endosülfan and malathion), and a few effective larvicides. Neem based insecticides, although effective against *L. cicerina*, are expensive for non-organic agriculture in Turkey. Turkey's Ministry of Agriculture recommends (Anonymous, 2000) to treat chickpea crops at least 2-3 leafminers larvae are observed per leaf and if they are seen again at least half of the field, but the farmers' practical applications are too far from the scientific recommendation. So, larvicides could quickly generate resistance on the leafminer. As a result of those early and high dose use.

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Spinosad is a naturally derived fermentation product of soil bacteria *Saccharopolyspora spinosa* Mertz & Yao, and mainly consists of spinosyns A and D mixture. It is the first member of the Naturalyte class of insecticides developed by Dow AgroSciences (Sparks et al., 1995), with a high level of activity against many economically important insect pests and low environmental and human risk (Medina et al., 2001; Nawrocka, 2008). It has been used a few agromyzid leafminers: *Chromatomyia horticola* (Goureau) (Saito, 2004), *Liriomyza chinensis* Kato (Choi, 2004), *Liriomyza trifolii* (Burgess) (Ferguson, 2004) and *Liriomyza huidobrensis* (Blanchard) (Weintraub & Mujica, 2006). The aim of this research was to evaluate effect of spinosad on *L. cicerina* and its parasitoids. Suitability for inclusion in IPM programs would be an important ascribe of spinosad.

Material and Methods

Study site

This study was carried out during 2007-2008 in Şanlıurfa province, southeastern Turkey, on two different insecticides application of chickpea plants grown area. *L. cicerina* was the examined species.

Experiment area

Favorable climatic conditions in Şanlıurfa region allow for two chickpea growing seasons per year (from january to may and from march to june). In this study, chickpea seeds (Gökçe variety) were sown simultaneously on March 8 in 2007 and on March 10 in 2008. Plants were harvested on June 5 in 2007 and on June 7 in 2008. The experiment was arranged in randomized complete block design with 4 replications and trials carried out over two years. Each plot was randomly designated. Each plot was 9 m^2, consisted of four rows, with 5 m long. Inter-rows spacing was 0.05 m. Harvested area, after eliminating side effects of 0.5 m. from plot lengths and one row from plot rows, was 3.6 m^2. There was a non-treated buffer zone of 2 m between each plots to prevent spray drift to adjacent plots. Also when insecticides applied each plots isolated with plastic to prevent spray drift to adjacent plots.

To determine yield of different application of insecticides, after chickpea was harvested, it was separately weighed for each plots. It showed an average value of four replicates and then it was converted kg/da yield. There was no watering and fertilizing application throughout the production period. The chickpea was harvested hand and weighed in the middle of June of each year.

Insecticide Application

Spinosad (Laser, obtained by Dow AgroSciences, Turkey) was applied at a concentration of 25 ml/ 100 l water +125 ml mineral oil / 100 l water (Gallery, obtained by Dow AgroSciences, Turkey). It was applied with mineral oil to spreader and the adhesive of spinosad on leaves. For comparison, Cyromazine, (Cyrogard 75 WP Novartis) was applied at the recommended rate of 20 g/100 l water. All treatments were applied with a low-pressure backpack sprayer. Insecticides were applied twice in the late afternoon till the end of the experiment period in 2007-2008. Application dates were set when the pest density reached to a level of 2-3 larvae/leaf in 50 % of plants in a field which are economic threshold (E.T) (Anonymous, 2000).

The application of insecticides were done twice on April 22 2007 and May 06 2007, and done on April 24 2008 and May 08 2008 because the pest density reached a level of 2-3 larvae/leaf in 50 % of plants in the field.

Sampling

The experiment area was checked weekly throughout the production period starting with the sowing of seeds. In both years, during the fifth week, when leaf miner infestation occurred, and each week thereafter, ten leaves were randomly removed from each plot, brought to the laboratory, and maintained at 25± 1°C and 65± 1 % r.h. Because the plants were immature and during the flowering and

early fruiting period, leaves need to protect the ripening pods. Another reason was to keep the study uniform at every stage. Leaves were examined under a stereomicroscope, and live larval counts were recorded. During counting, any larva that was dark in color was considered dead because a greenish yellow color indicates that the larva is alive. The leaves containing the larvae were cut and placed a small glass vial and then closed with a cotton ball covered with muslin. The vials were kept in plastic culture containers (30x20 cm) at 25 ºC and 65 % relative humidity to allow larvae to develop into adults. They were daily checked for the emerging leafminers and their parasitoids. They were counted and recorded (Çıkman & Kaplan, 2008) The identification of the *L. cicerina* was made by Dr. E. Çıkman (Harran University, Turkey), the identification of the Braconidae (Hymenoptera) was made by Dr. A. Beyarslan (Trakya University, Turkey), and the identification of the Chalcidoidea (Hymenoptera) was made by Dr. M. Doğanlar (Mustafa Kemal University, Turkey).

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. Twelve yellow sticky traps were placed randomly in each plot and replaced 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.

Statistics

Data were analysed by analysis of variance (breakdown one way ANOVA) and followed by the Tukey-Kramer method at P=0.05.

Results and Discussion

Effect of Spinosad insecticide on larvae and adult *Liriomyza cicerina*

Larvae were counted and recorded for 9 weeks from the first week of April to the first week of June of the study in 2007 and 2008. However, adults caught by yellow sticky traps were also counted and recorded from sowing till harvest. Considering data of 2007 and 2008 studies combined, Spinosad plots were applied indicated that mean number of larvae was 1.31 and 1.47 larvae/leaves in 2007 and 2008 respectively. The plot of control found a mean 3.04 and 3.53 larvae / leaves in 2007 and 2008 respectively (Table 1) in control plots. According to number of adults caught with yellow sticky traps, approximately 6.60 and 9.02 adult counted in 2007 and 2008 respectively and likewise 5.70 and 8.20 adults counted in cyromazine plots in 2007 and 2008 respectively. In control plots, the adult population level was 3-4 times higher than spinosad and cyromazine (P<0.05). There was no significant difference between spinosad and cyromazine in both years interms of larvae and adult numbers of *L. cicerina.*

Weintraub and Mujica (2006) reported that spinosad had an impact on all larval periods of *L. huidobrensis*. Similarly, Hossain & Poehling (2009) found that spinosad influenced all larval periods of *L. sativae* in tomato plants but did not have any ovicidal effects of the pest. Our study show that spinosad had impact on larvae of the pest and is likely to have repellent effects when adult individuals collected from among the lots were compared, which was increased by the fact that adult individuals of *L. cicerina* are likely to be 3.5 times less in comparison of spinosad plots than the control ones.

Table 1. Effect of spinosad and cyromazine on *Liriomyza cicerina* larval density and adults(Mean ± Standard Error/ leaf)

Pesticides	2007		2008	
	Larvae±SE*	Adult±SE*	Larvae±SE*	Adult±SE*
Spinosad	1.31± 0.24a	6.60± 2.41a	1.47± 0.27a	9.02± 2.57a
Cyromazine	1.16± 0.25a	5.70± 2.43a	1.35± 0.28a	8.20± 2.60a
Control	3.04± 0.41b	24.72± 5.73b	3.53± 0.47b	27.81± 5.44b

*Within columns, numbers followed by a common letter do not differ statistically at *P*=0.05.

Effect of spinosad on yield

Table 2 shows yield values in 2007 and 2008. The study was showed that Spinosad-used plots were harvested 95.28 kg/da and 92.05 kg/da while Cyromazine-applied plots gave 97.99 and 94.96 kg/da in 2007 and 2008 respectively. In the control plots, the yield was obtained less than spinosad and cyromazine plots with 82.59 kg/da in 2007 and 83.19 kg/da in 2008 respectively. It was concluded that considering data of both years Spinosad-applied plots harvested 13 % more than control plots, which is statistically significant ($P<0.05$).

Losses of yield are likely to appear due to damage from *L. cicerina* which could be eliminated by applying of insecticides (Çıkman et al., 2008). The present study pointed out that *L.cicerina* led to loss of yield and treatment of spinosad and cyromazine played a great role in helping eliminate such loss.

Table 2. Effects of pesticides on Yield (Mean ± Standard Error)

	2007	2008
Pesticides	Yield (kg/da)*	Yield (kg/da)*
Spinosad	95.28± 4.12a	92.05± 2.71a
Cyromazine	97.99± 4.36a	94.96± 1.17a
Control	82.59± 2.41 b	83.19± 2.39 b

*Within columns, numbers followed by a common letter do not differ statistically at *P*=0.05.

Effect of spinosad on parasitoids

The studies involved finding a total of 7 species of parasitoids, which are *Opius monilicornis* Fisher, 1962 from Braconidae (Hymenoptera) family and *Diaulinopsis arenaria* (Erdös, 1951), *Diglyphus crassinervis* Erdös, 1958, *Neochrysocharis ambitiosa* Hansson, 1990, *Neochrysocharis formosa* (Westwood, 1833), *Neochrysocharis sericea* (Erdös, 1954) and *Pediobius metallicus* (Nees, 1834) from Eulophidae family. The total number of individuals and total percentage of parasitism for each species were shown in Table 3. According to the results, *D. arenaria* has been found to be more dominant than other parasitoites in 2007 and 2008. It follows from the mean value of all applications that parasitism percentage of *D. arenaria* was 6.33 % in 2007 and 10.41 % in 2008, *N. formosa* was followed it with 5.85 % and 2.24 %.The minimum natural parasitism was shown by *P. metallicus* in 2007 and 2008.

Considering effects of spinosad and cyromazine practices on parasitoids, spinosad-applied plots had significantly more parasitoids than those cyromazine in both years (Table 3). The observations in both years show that spinosad were not have any negative effect on natural enemies of *L. cicerina.* The fact that spinosad applied plots included total parasitisms of 23.32% and 24.28% while control plots showed 22.90 and 23.49% in 2007 and 2008. Previous studies concluded the same result that spinosad had little or no effects on natural enemies (Vinuela et al., 2001; Vargas et al., 2002; Dastjerdi et al., 2008; Nawrocka, 2008). In the light of the above conclusions spinosad could well be used to control against *L. cicerina.* Spinosad should be taken into consideration in IPM studies and recommended for farmers to use as it has little or no negative impacts on natural enemies.

Table 3. Total number of *Liriomyza cicerina* and parasitoids (percent parasitism) reared from chickpea leaves from two fields for two years

Season	No. of Leaves	*Liriomyza cicerina*	*Total parasitoids*	*Opius monilicornis*	*Diaulinopsis arenaria*	*Diglyphus crassinervis*	*Neochrysocharis ambitiosa*	*Neochrysocharis formosa*	*Neochrysocharis sericea*	*Pediobius metallicus*
2007										
Spinosad	360	470	143 (23.32)	18 (2.94)	71 (11.58)	5 (0.82)	29 (4.73)	11 (1.79)	5 (0.82)	4 (0.65)
Cyromazine	360	416	72 (14.75)	7 (0.01)	32 (6.56)	1 (0.20)	15 (3.07)	11 (2.25)	5 (1.02)	1 (0.20)
Control	360	1084	322 (22.90)	27 (1.92)	174 (12.37)	12 (0.85)	67 (4.77)	19 (13.51)	14 (0.99)	9 (0.64)
2008										
Spinosad	360	524	168 (24.28)	23 (3.32)	89 (12.86)	6 (0.86)	27 (3.90)	12 (1.73)	6 (0.86)	5 (0.72)
Cyromazine	360	486	96 (16.49)	12 (2.06)	41 (7.04)	1 (0.17)	19 (3. 26)	16 (2.75)	5 (0.86)	2 (0.34)
Control	360	1355	416 (23.49)	54 (3.05)	201 (11.35)	16 (0.90)	75 (4.23)	40 (2.26)	23 (1.29)	7 (0.39)

Özet

Nohutta spinosad'in *Liriomyza cicerina* (Rondani, 1875) (Diptera: Agromyzidae) ve parazitoitlerine etkisi

Bu çalışmanın amacı Şanlıurfada (Türkiye) bulunan nohut ekim alanlarında önemli bir zararlı olan *Liriomyza cicerina* (Rondani, 1875) (Diptera: Agromyzidae)'nin mücadelesinde spinosad ile cyromazin'in etkinliğinin karşılaştırılmasıdır. Tarla denemeleri 2007 ve 2008 yıllarında, mart- haziran ayları arasında Türkiye'nin güneydoğusunda bulunan Şanlıurfa ilinde yürütülmüştür. spinosad 25ml/ 100 l su+ 125ml mineral yağ /100 l su konsantrasyonunda uygulanmıştır. Karşılaştırma olarak cyromazine 20g/ 100 l su dozunda uygulanmıştır. Çalışma sonucunda spinosad'ın *L. cicerina* larvaları üzerine önemli oranda etkili olduğu, ayrıca zararlının doğal düşmanlarına da olumsuz bir etkisi olmadığı gözlenmiştir. Bununla beraber, spinosad uygulanan parsellerde verimin kontrol parselinden daha yüksek olduğu saptanmıştır.

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