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Orijinal araştırma (Original article)

Effects of 5 different insecticides on mortality of the Leafroller parazitoid *Itoplectis maculator* (Fabricius, 1775) (Ichneumonidae, Hymenoptera)[1]

Beş farkli insektisitin Yaprakbükenler üzerinde parazitoid olan *Itoplectis maculator* (Fabricius, 1775) (Ichneumonidae, Hymenoptera)'un mortalitesine etkisi

Mitat AYDOĞDU[2]* **Utku GÜNER[2]**

Summary

In this study, effects of five different insecticides used in orchards on mortality of the parasitoid *Itoplectis maculator* of the leafroller pests [*Archips rosana* (Linnaeus, 1758) (Lepidoptera: Tortricidae)] were evaluated. Insecticides were applied to adult parasitoids in particular doses using a petri dish bioassay technique. Experiments were performed in five replicates and observed deaths were recorded periodically for 24 hours. Diazinon, Dichlorvos and Deltamethrin caused a 100% mortality rate at the end of the first 8-hour period, whereas Lambda-cyhalothrin and Alpha-cypermethrin caused the same mortality at the end of 24 hours. The ranking according to their effects on duration of mortality was Dichlorvos>Diazinon>Deltamethrin>Alpha-cypermethrin>Lambda-cyhalothrin. All these information will contribute to the development of biological control methods in orchards against leafroller pests.

Key words: Alpha-cypermethrin, Diazinon, Dichlorvos, Deltamethrin, *Itoplectis maculator*, Lambda-cyhalothrin,

Özet

Bu çalışmada, yaprakbükenler [*Archips rosana* (Linnaeus, 1758) (Lepidoptera: Tortricidae)] üzerinde parazitoid olan *Itoplectis maculator* üzerinde meyve bahçelerinde kullanılan 5 farklı insektisitin mortalite süresine etkisi değerlendirildi. Petri içinde ergin parasitoidler uygulama dozundaki insektisetlerle muamele edildi. Deneyler beş tekrarlı olarak gerçekleştirilerek 24 saat boyunca gözlenen ölümler belirli periyotlarda kayıt edildi. Diazinon, Dichlorvos ve Deltamethrin ilk 8 saatlik periyot sonucunda %100 ölüme yol açarken Lambda-cyhalothrin ve Alpha-cypermethrin 24 saatlik periyodun sonunda ölüme neden olduğu belirlenmiştir. Mortalite süresine göre Dichlorvos > Diazinon > Deltamethrin > Alpha-cypermethrin > Lambda-cyhalothrin sıralaması bulunmuştur. Bütün bu bilgiler meyve bahçelerinde yaprakbükenler ile biyolojik mücadele yöntemlerinin geliştirilmesine katkı sağlayacaktır.

Anahtar sözcükler: Alpha-cypermethrin, Diazinon, Dichlorvos, Deltamethrin, *Itoplectis maculator*, Lambda-cyhalothrin

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[2] Department of Biology, Faculty of Sciences, Trakya University, 22030, Edirne, Turkey
* Sorumlu yazar (Corresponding author) e-mail: maydogdu75@gmail.com

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Introduction

When insecticides are applied in an agro-system, they affect not only the pests in the environment but also, direct or indirectly, the beneficial organisms, i.e. parasitoid bees, that keep down pest populations partially (Bernard et al., 2010). Frequent and overdose use of insecticides eliminate parasitoids of pests species, in addition to the pests themselves, thus leading to removal of insects that are in natural competition with pests (El-Ghar & El-Sayed, 1992; Kerns & Gaylor, 1993). As a result, natural balance is destroyed (Ahmad et al., 2011; Bendahou et al., 1999), species diversity decreases and new pest species which were not considered to be harmful previously might emerge (Kalyoncu et al., 2009; Moreau et al., 2010). The pesticides used in an integrated pest management system developed to overcome this problem need to be harmless to beneficial insects possessing importance in terms of biological control.

Agricultural activities in developed and developing countries following the 2^{nd} world war became strongly mechanized and addicted to pesticides. Such activities carried on with the aim of increased product yield are also the main source of a number of environmental problems. The increased sensitivity of consumers due to increased use of insecticide and fertilizers promote, in turn, the importance of the subject. Therefore, decreasing insecticide use is gathering a cumulative attention over the world. In today’s world, different agricultural systems are an important research topic for sustainable agriculture and rural agriculture. In particular, organic agriculture has been developed after 1980s in many European countries and in USA. This type of agriculture in Turkey is relatively new established compared to Europe and constitutes about % 0,5 of the total market in the country (Rehber & Cetin, 1999).

The leafroller *Archips rosana* (Linnaeus, 1758) (Lepidoptera: Tortricidae), a fruit pest, is an important polyfagous species causing harm especially in Thrace region (Çetin et al., 2008). *Itoplectis* maculator (Fabricius, 1775) (Ichneumonidae, Hymenoptera) is a specific and dominant endoparasitoid of *A. rosana* (Aydogdu et al., 2011). Therefore, *I. maculator* is a potential biological control agent that could be used in orchards and hence its relationship with insecticides should be revealed.

In this study, effects of five different insecticides (Alpha-cypermethrin, Diazinon, Dichlorvos, Deltamethrin, Lambda-cyhalothrin) used in orchards on 24 hour mortality rates of the parasitoid *I. maculator* of *A. rosana* (Linnaeus, 1758) (Lepidoptera: Tortricidae)] were evaluated in laboratory conditions. The primary aim was to determine the insecticide that kills *I. maculator* in a short time (more effective) and to obtain useable data for integrated pest management.

Materials and Methods

Pest lepidopteran larvae were collected from almond, apple, plum and cherry trees in early mornings by keeping hand contact with the larvae in minimum. *Itoplectis maculator* was obtained from chemical-free areas on infected *Archips rosana* larvae during corresponding time of the year, which is from March to June between 2009 and 2011. *A. rosana* larvae were fed in laboratory in petri plates and obtained *I. maculator* adults were used in mortality experiments. 4 alive *I. maculator* adults and leaves (treated with insecticides in 1 ml of application dose and then dried) were place in a single disposable petri plate in 60 mm diameter. A diluted honey (%50) solution embedded in cotton pieces were used as the food source during the experiments (Newman et al., 2004). Experiments were performed in five replicates. Animals were kept at 24°C and %60 relative humidity and mortality rates were recorded at different times of a 24 hour period (1, 2, 4, 8, 12, 16, 20 and 24th hours). At the end of the recording period, mortality was calculated individually for each insecticide.

Effectiveness evaluations of insecticides were done according to IOBC (International Organization for Biological Control) class values (Hassan et al., 1994). Effects of insecticides on adult parasitoids were calculated based on living specimens (Table 1).

Table 1. IOBC class values (see Hassan et al., 1994).

Category (Toxicity class)	Affect (%)	Classifications
1	<30	Harmless or slightly harmful
2	30-79	Moderately harmful
3	80-99	Harmful
4	>99	Harmful

The commercial formulations of 5 different insecticides (Alpha-cypermethrin, Diazinon, Dichlorvos, Deltamethrin, Lambda-cyhalothrin) commonly used in orchards in Thrace region were included in the study (Table 2). Distilled water was used as the negative control throughout the experiments.

Table 2. The insecticides used to reveal their affects on the endoparasitoid species *Itoplectis maculator* in laboratory conditions.

Insecticide name	CAS no	Commercial Name	Formulation	Active substance amount	Dose (ml/da)	Class
Alpha-cypermethrin	67375-30-8	Super Takimethrin 100 EC	EC	100 g/l	20	Synthetic pyrethroid
Diazinon	65863-03-8	Basudin 60 EM	EC	630 g/l	75	Synthetic Organophosphate
Dichlorvos	95828-55-0	Aydın DDVP 550 EC	EC	550 g/l	200	Organophosphate
Deltamethrin	52918-63-5	Izoldesis 2,5 EC	EC	25 g/l	30	Synthetic pyrethroid
Lambda-cyhalothrin	68085-85-8	Tekvando 5 EC	EC	50 g/l	20	Synthetic pyrethroid

Emulsion Concentration (EC)

Qcal software was used calculation for LT/KDT50 and LT/KDT90 (Lethal Time/Knockdown Time as hours on Table 3) values each insecticide (Irma-Qcal, 2013).

Results and Discussion

The affects of pesticides on the pest species greatly varies from species to species and according to the type of the pesticide. Pesticide affects occurring with direct contact with toxins have often great impacts on natural enemies. Population densities of parasitoids decrease due to insecticide affects leading to a decrease in parasitoitism rates (Dalci et al., 2009; Williams & Price, 2004).In addition, pest species are known to acquire resistance to these substances in time. The need of new control methods have arouse as a result of problems caused by chemical control methods which contrast natural balance, and a method termed Integrated Pest Management (IPM) were developed. The aim of an IPM is to minimize pesticide use, evaluate all types of pest control opportunities and make use of natural enemies of pest organisms as high as possible (Ahmad et al., 1997; Sak & Uçkan, 2009). Therefore, eco-friendly applications are being started to be applied among which “Biological Control” is the leading. Parasitoids are probably the most suitable biological control agents with their low risks and high specificities. Therefore, *I. maculator*, an endoparasitoid of the leafroller pests, was used in the present study (Aydogdu et al., 2011).

The chemicals used against pest insects are known to affect, in addition to the target species, also other insects in the environment (Kandemir et al., 2010). Our results showed that all 5 insecticides used affected an organism which is out of the target range. The 24 hour observations revealed that the insecticides (Alpha-cypermethrin, Diazinon, Dichlorvos, Deltamethrin, Lambda-cyhalothrin) applied had a killer affect on the parasitoid bee species used. No mortality was observed in the negative control group with distilled water. However, different mortality times were recorded for different insecticides. For instance, Diazinon, Dichlorvos and Deltamethrin treated experimental bees died at the end of the 8th hour of the observation while those treated with Lambda-cyhalothrin and Alpha-cypermethrin died at the end of the 24 hour (Figures 1 and 2).

Table 3. Calculation of time response result of 5 different insecticides on *Itoplectis maculator.*

	Lambda-Cyhalothrin	Alpha-cypermethrin	Dichlorvos	Diazinon	Deltamethrin
Intercept	-25.57	-25.70	-2.14	-3.74	-14.17
Slope	9.73	10.11	1.96	2.84	5.67
LT/KDT50	2.63	2.54	1.09	1.32	2.50
LT/KDT90	2.85	2.76	2.21	2.09	2.89
Stand. Error	11.73	12.79	1.04	1.51	6.01
z-value	-2.18	-2.01	-2.06	-2.48	-2.36
p-value	0.03	0.04	0.04	0.01	0.02

LT/KDT50 , LT/KDT90 (Lethal Time/Knockdown Time) as hours

Results showed that mortality occurred in different times of the observation period, leading to differences between the insecticides applied. The ranking based on the time period that the insecticides caused mortality is as Dichlorvos > Diazinon > Deltamethrin > Alpha-cypermethrin > Lambda-cyhalothrin (Figure 3).

Therefore, any type of insecticide that will be used in agricultural areas should be evaluated in detail for its possible affects on various organisms other than the target one in order to keep the parasitoid species, like *I. maculator* used here, constituting the major part of biological control applications. It is important to determine which insecticide is how effective, their application durations and time in order to prevent parasitoids to die.

Mortality studies performed with different parasitoids of leafrollers showed that Diazinon effect on mortality occurred in shorter time periods compared to other pesticides and that this pesticide caused a %100 mortality rate in 48 hours after exposure (Newman et al. 2004). We showed here that the fastest mortality effect after Dichlorvos was observed with Basudin whose active substance is Diazinon. The effect of deltamethrin on adults of *Trichogramma* (Hymenoptera: Trichogrammatidae) was classified as “harmful” according to the standard method of IOBC (Hassan et al., 1994). Our results also showed that among the insecticides used, deltamethrin was placed in harmful group.

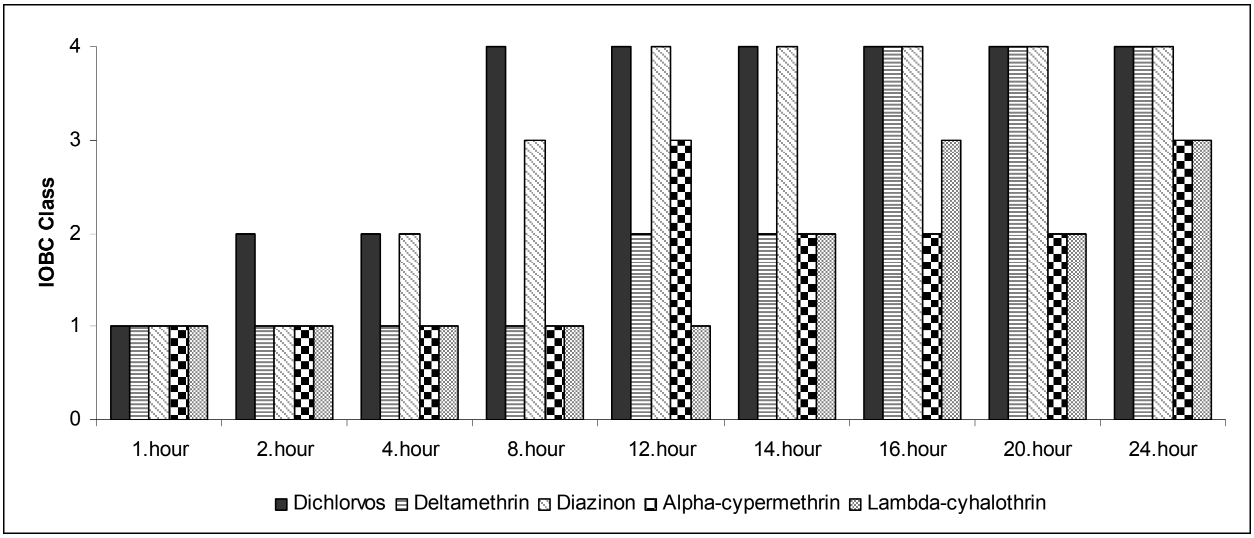

Figure 1. IOBC class values of five different insecticides (from table 1) percentage

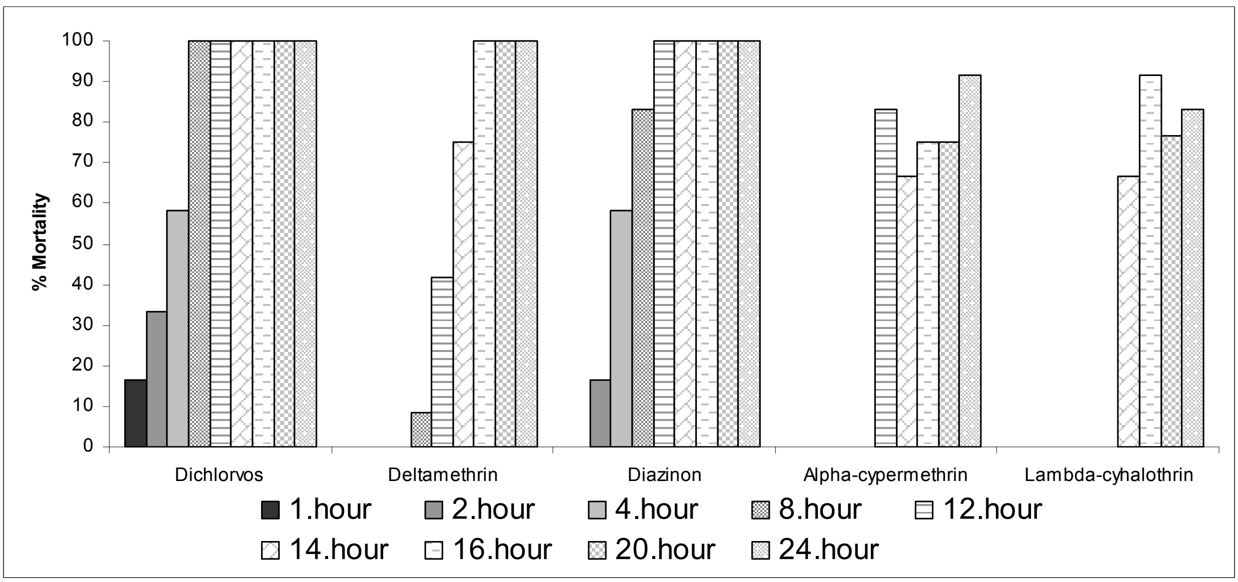

Figure 2. The time periods needed to cause mortality by 5 insecticides used in 24 hours.

The organophosphorus Dichlorvos used as an insecticide and acaricide is a pesticide type leading to a rapid death when exposed via respiration or touch. Dichlorvos was previously reported to be the insecticide with the highest toxicity among the 14 insecticides tested (Wang et al. 2008). Dichlorvos also appeared to be “harmful” according to IOBC criteria, among the 5 insecticides tested here.

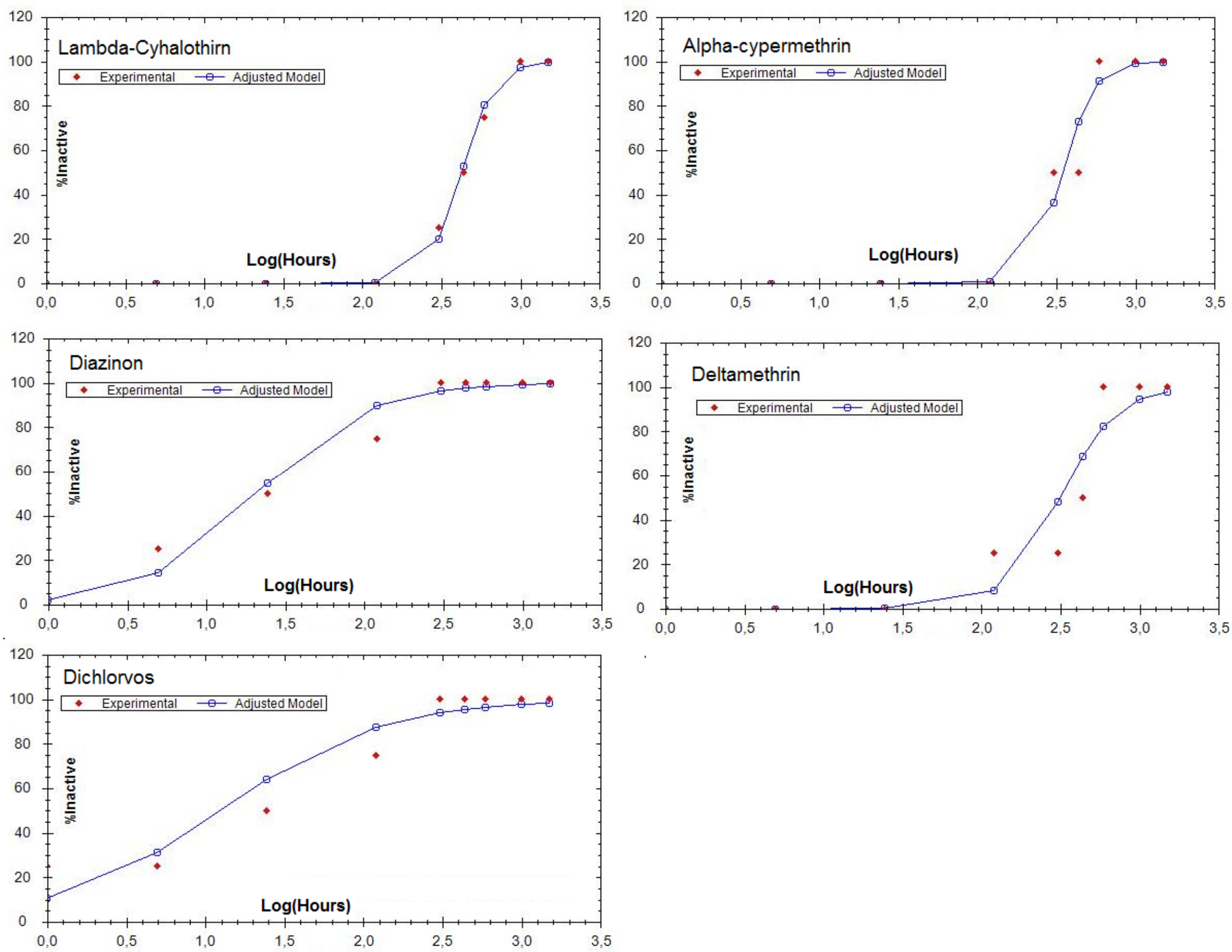

Figure 3. Binary logistic model of 5 different insecticides on *Itoplectis maculator.*

In a study performed with adults of another Ichneomonid species, *Diadegma insulare,* Xu et al. (2004) showed that lambda-cyhalothrin caused all experimental insects to die in 1 day. Similarly, all insecticides we used caused a full mortality on *I. maculator* adults within 24 hours. The ranking of the 5 insecticides we determined based on the mortality rates they led are one of the factors that will determine the abundances and parasitized of the parasitoid bees that might be used as biological control agents in agricultural fields.

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