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Biological control of *Helicoverpa armigera* (*Heliothis armigera*) (Hübner) in tomato farms of Ahwaz township by braconidae

Golnaz Balipoor, Ahmad Reza Ommani*

Department of Agricultural Management, Shoushtar Branch, Islamic Azad University, Shoushtar, Iran

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Abstract

The purpose of research was analyzing tendency of tomato farmers to biological control of Helicoverpa Armigera (Heliothis Armigera) (Hübner) in Ahwaz Township by Braconidae and identifying affecting factors. This study was carried out by survey during March and October 2013. The method of research was correlative descriptive. A random sample of Tomato farmers of Ahwaz Township, Khouzestan Province, Iran (n=162) were selected for participation in the study. A questionnaire was developed to gather information regarding tendency of farmers to biological control of Helicoverpa Armigera (Heliothis Armigera) (Hübner) in Ahwaz Township by Braconidae. The questionnaire was pilot tested and reliability was estimated by calculating Cronbach's alpha. Reliability was (Cronbach's alpha=0.89). Level of farmer's tendency about items of biological control of Helicoverpa Armigera (Heliothis Armigera) (Hübner) revealed mean on all items was less than 3. This indicates that tendency of tomato farmers regarding biological control is not a good situation. The results indicate 51.85% of farmers had low and very low tendency regarding biological control. Based on the results there is significant correlation between tendency of tomato farmer's with knowledge regarding biological control, skill regarding biological control, participation in extension programs and level of education.

* **Corresponding Author:** Ahmad Reza Ommani ✉ ommani75451@yahoo.com

Introduction

Tomato (Lycopersicon esculentum Mill.) is the second most important vegetable crop next to potato. The tomato is a major vegetable crop that has achieves tremendous popularity over the last century. It is grown in practically every country of the world - in outdoor fields, greenhouses and net houses. The tomato plant is very versatile and the crop can be divided into two categories; fresh market tomatoes, which we are concerned with and processing tomatoes, which are grown only outdoors for the canning industry and mechanically harvested. In both cases, world production and consumption has grown quite rapidly over the past 25 years (Wener, 2009). The present world production is about 100 million tons of fresh fruit produced on 3.7 million hectares. Tomato production was reported in 144 countries (Bal and Abak 2007). Iran is ranked seventh in the world as a tomato producer. In Iran tomato is planted on about 140000 hectares with an average yield of 37 tons per hectare (Alemzadeh Ansari and Mamghani 2008). Tomato is one of the most popular and commercially important vegetable crops in Iran. The purpose of research was analyzing tendency of tomato farmers to biological control of Helicoverpa Armigera (Heliothis Armigera) (Hübner) in Ahwaz Township by Braconidae and identifying affecting factors.

Among many factors responsible for low yields of tomato, insect pests are major ones that have been reported to attack tomato at all stages of crop growth. Among insect pests, the damage caused by fruit borer, *Helicoverpa armigera* Hubner surpass the loss caused by all other insect pests together and it has been reported that the loss due to this pest range from 20-50 percent. The tomato fruitworm, Helicoverpa armigera (Hübner), is a major pest in processing tomato crops in Iran.

Tomatoes being a commercial vegetable crop, the farmers have a tendency to indiscriminately use insecticides to control this destructive pest. Consequently it has led to many problems like build up of insecticide resistance, pest resurgence, replacement of natural enemies and insecticide residue in the tomato fruits (Karabhantanal And Awaknavar, 2012).

Helicoverpa Armigera (Heliothis Armigera) (Hübner) is a polyphagous pest that has tomato and corn as principal hosts, followed by cotton, pepper, as well as legumes and ornamental plants, etc. It can complete the cycle on the natural vegetation. Larvae prefer feeding on the parts of the plant with high concentrations of nitrogen. On tomato, the fruits are the most affected part, but flowers, stems and leaves can also be damaged, resulting in optimal conditions for rot or attack of secondary pests. If larvae are big and the fruits are small one larva can attack some fruits per day (Open Natur Company, 2009).

Biological control is a bioeffector-method of controllingpests (including insects, mites, weeds and plant diseases) using other living organisms.

The use of natural enemies to reduce the impacts of pests has a long history. The ancient Chinese, observing that ants were effective predators of many citrus pests, augmented their populations by taking their nests from surrounding habitats and placing them into their orchards. Today's insectaries and air-freight delivery of natural enemies across the country or around the world are simply modern adaptations of these original ideas. In this article we will examine approaches to biological control and applications of these approaches in modern pest management. While the principles of biological control can be applied against various pest organisms (e.g. weeds, plant pathogens, vertebrates and insects), we will limit our discussion to the use of biological control of insects, primarily using other insects as natural enemies (Landis and Orr, 2013). Biological control is a strategy that was proposed half a century ago. Indeed, a symposium held in Berkeley in 1965 was entitled: 'Ecology of soilborne plant pathogens; prelude to biological control' **(**Alabouvette, Olivain and Steinberg, 2006**).**

The Braconidae is a large family of parasitoid wasps.

There are approximately 17,000 recognized species and many thousands more undescribed (Jones *et al*, 2009).Most braconids are internal and external primary parasitoids on other insects, especially upon the larval stages of Coleoptera,Diptera, and Lepidoptera, but also some hemimetabolous insects such as aphids, Heteroptera, or Embiidina. Most species kill their hosts, though some cause the hosts to become sterile and less active. Endoparasitoid species often display elaborate physiological adaptations to enhance larval survival within the host, such as the co-option of endosymbiotic viruses for compromising host immune defenses (Piper, 2007).

Material and methods

Method of research

This study was carried out by survey during March and October 2014. The method of research was correlative descriptive. A random sample of tomato growers of Ahwaz Township, Khouzestan Province, Iran (n=162) were selected for participation in the study.

Research tool

A questionnaire was developed to gather information regarding tendency of farmers to biological control of Helicoverpa Armigera (Heliothis Armigera) (Hübner) in tomato farms of Ahwaz Township by Braconidae and identifying affecting factors. The validity was analyzed by panel of experts. The questionnaire was pilot tested in Shoushtar Township. Questionnaire reliability was estimated by calculating Cronbach's alpha. Reliability was (Cronbach's alpha=0.89). Data collected were analyzed using the Statistical Package for the Social Sciences (SPSS). Appropriate statistical procedures for description (frequencies, per cent, means, and standard deviations) were used.

Results

Demographic Profile

The first section described farmers' demographic profile in Ahwaz Township, Khuzestan Province of Iran. Approximately, the mean of years old was 44.30. The maximum was 70 and minimum was 17 years old. Based on the crop yield 42% had 1-25 ton in hectare, 29.61% had 26-50, 10.5% had 51-75, 11.7% had 76-100, and 6.2% had 101-400. The mean size was 45.28 ton in hectare.

Table 1. Crop yield (ton/hectare) of tomato growers (n=162).

Crop yield (ton/hectare)	Frequency	Percent	Cumulative Percent
1-25	68	42	42
26-50	48	29.6	71.6
51-75	17	10.5	82.1
76-100	19	11.7	93.8
101<	10	6.2	100
Total	162	100	

Tendency of farmers to biological control of Helicoverpa Armigera (Heliothis Armigera) (Hübner)

For analyzing tendency of tomato farmers regarding to biological control of Helicoverpa Armigera (Heliothis Armigera) (Hübner) in Ahwaz Township, 10 items were designed. Lowest point for each item was (Min=1) and highest point was (Max= 5). Based on number of questions (n=10) and point range of each question, the minimum and maximum scores of farmers were 10 and 50, respectively. Thus people who had a score of 10 to 18 located in first group, those who had of 18 to 26 were in the second group. People who had a score of 26 to 34, were in the third group and people who had a score of 34 to 42 were in fourth group. Finally people who had score 42 to 50; they were on the fifth group.

Level of farmer's tendency about items of biological control of Helicoverpa Armigera (Heliothis Armigera) (Hübner) revealed mean on all items was less than 3. This indicates that tendency of tomato farmers regarding biological control of Helicoverpa Armigera (Heliothis Armigera) (Hübner) by

Braconedae is not a good situation (Table 2). The results of table (3) indicate 51.85% of farmers had low and very low tendency regarding biological control of Helicoverpa Armigera (Heliothis Armigera) (Hübner) by Braconedae. The mean of tendency was (Mean=2.635).

Affecting factors on tendency of farmers to biological control of Helicoverpa Armigera (Heliothis Armigera) (Hübner) by Braconedae:

For identifying affecting factors on tendency of tomato farmers regarding to biological control of Helicoverpa Armigera (Heliothis Armigera) (Hübner) in Ahwaz Township, 11 items were designed. Lowest point for each item was (Min=1) and highest point was (Max= 5). Based on Coefficient of Variation (CV) the most important factors that affect on tendency of farmers to biological control of Helicoverpa Armigera (Heliothis Armigera) (Hübner) respectively were (Table 4):

1) Lack of awareness
2) Unfamiliarity
3) Lack of educational programs
4) Lack of knowledge and skills
5) Lack of belief in the effectiveness of this method.
6) Lack of demonstration farms

Table 2. Tendency of tomato farmers regarding to biological control of Helicoverpa Armigera (Heliothis Armigera) (Hübner) by Braconedae.

Level of tendency*:	VL		L		M		H		VH		Mean	sd	CV	Rank
Biological control of Helicoverpa Armigera (Heliothis Armigera) (Hübner) by Braconedae...	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%				
...has a good effect on product quality.	31	24.8	35	28.0	31	24.8	18	14.4	10	8.0	2.528	0.985	0.390	7
...ensure protection of natural ecosystems and the environment.	29	23.2	37	29.6	28	22.4	22	17.6	9	7.2	2.560	0.979	0.382	5
...is will prevent the risk to human health.	18	14.4	44	35.2	35	28.0	17	13.6	11	8.8	2.672	0.916	0.343	1
...causing a reduction in water pollution.	25	20.0	39	31.2	33	26.4	21	16.8	7	5.6	2.568	0.919	0.358	3
...economically affordable.	33	26.4	28	22.4	32	25.6	19	15.2	13	10.4	2.608	1.042	0.400	9
...socially acceptable.	28	22.4	32	25.6	29	23.2	18	14.4	18	14.4	2.728	1.074	0.394	8
...is consistent with local knowledge.	24	19.2	41	32.8	32	25.6	16	12.8	12	9.60	2.608	0.966	0.370	4
...reduce dependence on chemical pesticides.	32	25.6	33	26.4	35	28.0	11	8.8	14	11.2	2.536	1.015	0.400	10
...is easy to application.	29	23.2	27	21.6	38	30.4	16	12.8	15	12.0	2.688	1.030	0.383	6
...is available.	19	15.2	44	35.2	32	25.6	18	14.4	12	9.6	2.680	0.942	0.352	2

*VL: very low, L: low, M: moderate, H: high, VH: very high.

Table 3. Frequency of tomato farmers based on overall tendency regarding biological control of Helicoverpa Armigera (Heliothis Armigera) (Hübner) by Braconedae.

Level of tendency	Frequency	Percent	Cumulative Percent
Very low	39	24.07	24.07
Low	45	27.78	51.85
Moderate	41	25.31	77.16
High	21	12.96	90.12
Very High	16	9.88	100.00
Total	162	100.00	

Mean: 2.635.

Correlation Study

Table 5 displays the results which show that there is a relationship between tendency of tomato farmer's regarding biological control of Helicoverpa Armigera (Heliothis Armigera) (Hübner) and some of independent variables.

Based on the results there is significant correlation

between tendency of tomato farmer's with knowledge regarding biological control, skill regarding biological control, participation in extension programs and level of education.

Regression analysis

Table 6 shows the result for regression analysis by stepwise method. Predicator variables that were significantly related to the tendency of tomato farmers about biological control of Helicoverpa Armigera (Heliothis Armigera) (Hübner) were entered. The result indicates that 68.3% of the variances in the tendency of respondents could be explained by the knowledge regarding biological control, skill regarding biological control, participation in extension programs and level of education.

Table 4. Affecting factors on tendency of farmers to biological control of Helicoverpa Armigera (Heliothis Armigera) (Hübner).

Affecting factors	VL		L		M		H		VH		Mean	sd	CV	Rank
	f	%	*f*	%	*f*	%	*f*	%	*f*	%				
Unfamiliarity	13	10.4	26	20.8	32	25.6	25	20.0	29	23.2	3.248	1.041	0.321	2
Lack of awareness	12	9.6	14	11.2	29	23.2	32	25.6	38	30.4	3.560	1.030	0.289	1
Lack of knowledge and skills	15	12.0	21	16.8	32	25.6	24	19.2	33	26.4	3.312	1.074	0.324	4
Lack of demonstration farms	17	13.6	26	20.8	28	22.4	26	20.8	28	22.4	3.176	1.082	0.341	6
Lack of educational programs	15	12.0	22	17.6	29	23.2	29	23.2	30	24.0	3.296	1.062	0.322	3
Not used by other farmers	21	16.8	27	21.6	33	26.4	31	24.8	13	10.4	2.904	0.994	0.342	7
Lack of belief in the effectiveness of this method.	22	17.6	20	16.0	41	32.8	32	25.6	10	8.0	2.904	0.958	0.330	5
Lack of government support	19	15.2	22	17.6	29	23.2	26	20.8	29	23.2	3.192	1.099	0.344	8
Not recommended by agricultural experts	25	20.0	17	13.6	22	17.6	29	23.2	32	25.6	3.208	1.174	0.366	10
Expensive	22	17.6	19	15.2	26	20.8	34	27.2	24	19.2	3.152	1.096	0.348	9
Not available	21	16.8	19	15.2	28	22.4	28	22.4	29	23.2	3.200	2.562	0.801	11

Table 5. Correlation measures between tendency of tomato farmer's regarding biological control of Helicoverpa Armigera (Heliothis Armigera) (Hübner) and independent variables.

Variable 1	Variable 1	r	p
Knowledge regarding biological control	Tendency of tomato farmer's regarding biological control of Helicoverpa Armigera (Heliothis Armigera) (Hübner)	0.594	0.000**
Skill regarding biological control		0.612	0.000**
Participation in extension programs		0.509	0.000**
Level of education		0.713	0.000**
Age		0.086	0.094
Income		0.078	0.099
Social participation		0.091	0.091
Farm size		0.109	0.082

*p < 0.05; **p < 0.01.

Table 6. Multivariate regression analysis.

Multivariate regression analysis	B	Beta	T	Sig
Constant	2.098	-------	3.713	0.000
Knowledge regarding biological control	0.761	0.592	2.938	0.000
Skill regarding biological control	0.619	0.608	2.716	0.000
Participation in extension programs	0.624	0.615	2.987	0.000
Level of education	0.614	0.792	3.593	0.000

R^2=0.683

$Y=2.098+0.761X_1+0.619X_2+0.624X_3+0.614X_4$.

Conclusion

Level of farmer's tendency about items of biological control of Helicoverpa Armigera (Heliothis Armigera) (Hübner) revealed mean on all items was less than 3. This indicates that tendency of tomato farmers regarding biological control of Helicoverpa Armigera (Heliothis Armigera) (Hübner) by Braconedae is not a good situation. The results indicate 56% of farmers had low and very low tendency regarding biological control of Helicoverpa Armigera (Heliothis Armigera) (Hübner) by Braconedae. The mean of tendency was (Mean=2.635).

Based on Coefficient of Variation (CV) the most important factors that affect on tendency of farmers to biological control of Helicoverpa Armigera (Heliothis Armigera) (Hübner) respectively were:

1) Lack of awareness
2) Unfamiliarity
3) Lack of educational programs
4) Lack of knowledge and skills
5) Lack of belief in the effectiveness of this method.
6) Lack of demonstration farms

Based on the results there is significant correlation between tendency of tomato farmer's with knowledge regarding biological control, skill regarding biological control, participation in extension programs and level of education. Also the result indicates that 68.3% of the variances in the tendency of respondents could be explained by the knowledge regarding biological control, skill regarding biological control, participation in extension programs and level of education.

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