REPUBLIC OF AZERBAIJAN

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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

THE SUGAR BEET PESTS IN AZERBAIJAN (BEETLES AND BUTTERFLIES), BIOECOLOGICAL CHARATERISTICS OF AGRICULTURAL SPECIES AND THE ROLE OF ENTOMOPHAGOUS IN THE BIOLOGICAL CONTROL OF THESE SPECIES.

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INTRODUCTION

Relevance and degree of study of the topic: The condition of soil and climate in our republic provides basis for cultivation of various agricultural plants and getting abundant harvest from them.

One of the main issues in our Independent Republic is the establishment of abundance of food in the country.

Although Azerbaijan was one of the sugar-producing countries, the demand for sugar was met by other countries. Considering it, various farming and individual agriculture have been established for cultivation and high harvest of sugar beet that is the main raw material for sugar production in our Republic in the recent years.

It should be mentioned that, sugar beet is an essential technical plant. It is used both for the production of sugar and as food in the livestock. This plant is the only source of sugar production in Azerbaijan. More than 50 countries in the world produce the sugar from the sugar beets. However about 70 countries get sugar from the sugar cane. Currently, 144 thousand tons of sugar beet are produced in 127 countries around the world[1].

The sugar beet precedes twice fodder beet according to the nutritional value. Especially, the leaves of sugar beet are richer with food elements. There is approximate 2-3% protein, 0,4 % fat and different vitamins in the leaves. A lot of waste is obtained in the factories after the production of sugar, and alcohol, glyserin and pectin glue are obtianed from them. Furthermore, this pollution is used as food in the livestock and as manure in the agriculture.

The sugar beet becomes one of the important cropping fields in our Republic in the recent years. In order to develop this economical profitable sector, the comprehensive measures are taken by our country.

The approval of a number of state programs by the decree of the President of the Republic of Azerbaijan on the reliable assurance of the population with food products in the country proves this once

[1] Hasanov, S. P. Production of sugar beet and sugar. / Hasanova A.S. – Baku – 2007 - 75 p.

again. From this aspect, agricultural workers, as well as scientists and specialists, have a responsible task to increase agricultural productivity and improve the quality of products. After gaining independence, our Republic paid special attention to the production of sugar, which is a strategic product, along with other areas.

In this regard, the construction and develop of a sugar factory in our Republic is important in solving social problems such as the further development of the country's economy, employment of the population of the aran (lowlands) economic regions, etc. Namely, the detection of pests reducing the productivity of sugar beet that is the main raw material of this product, the study of their biological properties, the detection of entomophagous, which play a role in the biological regulation of harmful species is one of the most contemporary issues of the day.

The purpose and objectives of study: The main purpose of the study is to study the species of pests that damage plants in the Imishli and Agdash regions, where sugar beet is cultivated, to determine the main pests that lead to serious crop losses, to study their bioecological features, phenological calendar, to take more economically and ecologically effective control measures.

The following objectives are considered to achive a goal:

-To determine the species composition of pests that damage to the sugar beet in the region;

-To clarify the agricultural importance main species;

-To study the biecological features of the main pests belonging to the group of butterlflies (*Lepidoptera*), the dynamics of development in the agrocenosis and to detect their natural enemies;

-To study bioecological and phenological features of the pests belonging to the group of beetles (*Coleoptera*) in the agrocenosis, to identify their parasites and predators;

-To define the effective entomophgous that has important role in the regulation of number of pests;

-To prepare the effective complex control for the hazardous pests.

Methods of study. The collection of materials is carried out according to the general methods accepted by entomology. During

the study, the methods of Plokhonski, Lakin, Fasulati, Zlotin and others have been used.

The main provisions for defense:

1. The species composition of insects in the sugar beet agrocenosis.
2. Agricultural importance and some ecological features of species found in agrocenosis.
3. Bioecological and phenological features of species that damage the plants seriously.
4. Physiological features of population of some hazardous pests.
5. Entomaphagous having a role in the regulation of the number of pests in the agrocenosis.

Scientific innovation of study. For the first time in Azerbaijan, the species composition of pests in the sugar beet agrocenosis was studied in detail, and it was determined that there were 48 species of insects belonging to 5 groups, 15 families, 42 sorts that caused various damage to the plant**.**

For the first time, it was defined that 31 of the indicated species were rare and didn't cause economic damage to the agriculture, 11 of them were periodic species and could cause serious damage during the mass growth, and 6 of them were permanent habitants of the agrocenosis and cause serious damage every year.

The species composition of entomophagous having a role in the regulation of the number of pests in the agrocenosis was determined for the first time.

Theoretical and practical importance of study. For the firt time in Azerbaijan, a comprehensive study was carried out in the sugar beet agrocenosis, bioecological features, and the dynamics of development and agricultural importance of species that cause various damages to the plants.

For the first time, it was defined that 6 species (beet weevil, brassy flea beetle, southern flea beetle, beet leaf beetles, mole crickets and turnip moths) were the permanent habitants of agrocenosis and hazardous pests.

Phenological calendars of hazardous pests in the agrocenosis, daily and seasonal flying dynamics, as well as, effective entomopha-

gous of some species indicated that it is possible to use this information in the preparation of complex control measures for those pests. At the same time, according to the results of studies, practical implycations were made for the complex control for the pests.

Approbation and implementation of the study. The main provisions of dissertation were heard and discussed in the meetings of Center for Applied Zoology and Laboratory of Terrestrial Invertebrates of the Institute of Zoology of ANAS, in the Scientific Council and Scientific Seminars, as well as in the Republican and International Scientific-Practical Conferences mentioned below.

Integration Processes of the world science in the 21^{st} century. Ganja International Scientific Conference (2016).

Conference dedicated to the 93^{rd} birthday anniversary of national leader Heydar Aliyev. The actual problems of modern chemistry and biology. Ganja 2016.

International Scientific Conference "Global Science and İnnovations" Tashkent, Uzbekistan, (2020)

XXIII İnternational Scientific Conference "Modern Scientific Challenges and Trends" Poland, Warsaw (2020)

The 5^{th} international Symposium on EuroAsian Biodiversity, Kazakhstan Turkey (2021).

The obtained results can be used in the complex control for pests by the related organizations.

Structure and volume of dissertation work. The Disseration work consist of 221070 signs, introduction (8602 signs), chapter (176016 signs), conclusion (1961 signs) practical implications, (1916 signs), reference list in Azerbaijani, Russian, English languages (186 titles). The dissertation contains 18 tables, 30 figures and 6 charts.

The name of organization where the dissertation work is implemented. The research work was carried out at the Center for Applied Zoology of the Institute of Zoology of the Azerbaijan National Academy of Sciences.

CHAPTER I. REVIEW OF LITERATURE

Based on the literature information, this chapter gives detailed information on the bioecological features of sugar beet, its cultivation and importance in the agriculture, as well as in the national economy. Thus, if you look at the literature, it is clear that the pests of sugar beet and control methods for them have been studied in detail since the first half of the twentieth century, in different parts of the former USSR. In Azerbaijan, there was not any special attention to this area.

Although the pest fauna of sugar beet has not been studied in detail in our country, you can see brief information about it in various literatures. Hidayatov in 1964, Mammadova and Khalilov in 1986, Khalilov and Ibrahimov in 1988 gave brief information about sugar beet in their works [2].

CHAPTER II. MATERIAL AND METHODS OF STUDY

The studies have been taken in condition of laboratory and outside in 2013-2020. The laboratory experiences have been carried out in the Laboratory of Insect Physiology and Ecology of the Institute of Zoology of ANAS, and in the automatic-controlled specific thermostats (Горышин, 1966) and in room condition at the Center for Applied Zoology of the Institute of Zoology of ANAS. The outside practices were carried out in the specific stationary fields, in the private fields of Imishli and Agdash where the sugar beets were planted [3].

Bioecological features, phenological calendars, infection rates etc. characteristics of overspread and agricultural pests were investigated in both stationary areas and in laboratory condition.

The damage rate of the plants in the areas is calculated as following.

$$P=\frac{n*100}{N} \quad [2,1]$$

[2] Mammadova S.R., Khalilov B.B. (1986) Agricultural Entomology. Baku. Maarif. 372 p.

[3] Gorishin N. I. Technical equipment for environmental research in entomology. Edition. LSU, 1966, 235 p.

Here, P-Percentage of damage of plants in area
N- total number of reviewed samples
n- number of damaged plants
100- convertion ratio into percentage.

The parasite infection rate of host caterpillar and larvae collected from areas is calculated as following, (Fasulati K.K. 1971).

$$P=100\frac{n}{N} \quad [2,2]$$

Here, P-infection rate
n- total number of infected individuals,
N- total number of hosts.
100- convertion ratio into percentage.

In order to study the flying dynamics of nocturnal insects, PRK leds were used[4].

Various destination sources were used to specify the taxonomic relation of the species[5].

The mathematical operation of materials is based on the methods of Lakin and Plokhinski[6,7].

CHAPTER III. TAXONOMIC RELATION OF THE PESTS PREVALENT IN THE SUGAR BEET AGROCENOSIS

In regard with the annual expansion of sugar beet crops in our Republic, it is important to study the species composition of its pests in this agrocenosis. Thereby, it is very essential to study the species composition of pests in beet crops, to identify economical important

[4] A. Abdinbekova, B. A. Akhmedov, M. K. Mustafina, Kh. Z. Askerzade «Seasonal and diurnal dynamics of summer and the number of cotton bollworm butterflies in the conditions of the Mughan - Mil zone of Azerbaijan» ANAS Izvestiya. EDT. «ELM» 1984, №3.

[5] Gornostayev G. N. Insects SSR. Publishing house «Misl» Moscow, 1970, 372 p.

[6] Lakin G. F. (1990) Biometrics. M. 348 p.

[7] Plokhinskiy N. A. (1970) Biometrics. Edition of Moscow University 387 p. 187-

species that cause severe crop losses and are prevalent in the area, and to compile effective measures to control them.

Because of this reason, starting from March, regular expeditions were organized to the farms of Imishli and Agdash regions, where sugar beet was planted in 2013-2020, as well as, to the private crop fields of the population, and along with route observations, actual materials were collected.

During the route observations, the species that damaged the plants in the sugar beet planting areas were investigated, the species composition of the pests prevalent in the agrocenosis and the serious economical important species were identified. During the observations and researches carried out on the farms, 48 species of pests belonging to 5 groups, 15 families and 42 sorts were found in the agrocenosis. (Table1).

Table 1

Species composition of pests in the sugar beet agrocenosis

s/s	order	Family	genues	Species	Prevalence
1	2	3	4	5	6
I	Coleoptera L., 1758 (Beetles or bugs)	Scarabaeidae (Leaf-horned beetles)	Oxythyrea Muls., 1842	O.funesta Poda, 1761 (flower scarab)	+
			Pentodon Hope,1837	P. idiota Herbst, 1789 (hard-back beetles)	+
			Miltetrogus Ret, 1902	M.aeguinoctialis Herbst, 1790 (April beetles)	+ +
			Epicometis Burn, 1842	E.hirta Poda, 1761 (green rose chafer)	+

s/s	order	Family	genues	Species	Prevalence
1	2	3	4	5	6
			Cetonia F.,1833	C. aurata L, 1758 (rose chafer)	+
			Polyphylla Harris, 1841	P. olivieri Cst,1840 (white chafer)	+
			Amphimallon Berth, 1825	A. solstitialis,1758 (June chafer)	+ +
			Rhizotrogus Latr, 1825	R. aestivus Ol, 1789 (summer chafer)	+
			Melolontha L, 1775	M.melolontha, 1758 (May chafer)	+ +
			Anisoplia Sern, 1824	A.austriaca Herbst,1783 (cereal chafer)	+
				A.segetum Herbst,1783 (grain beetle)	+
		Elateridae (click beetles)	Agriotes Eschscholtz, 1829	A.sputator L,1787 (cropping click-beetle)	+ +
				A.lineatus L,1767	

s/s	order	Family	genues	Species	Prevalence
1	2	3	4	5	6
				(striped click-beetle)	+
			Athous Eschscholtz, 1829	A.hirtus Herbst,1784 (chaetiferous click-beetle)	+
				A.niger L.1778 (black click-beetle)	+
		Curculionidae (weevil beetles)	Tanymecus Germar,1817	T.palliatus Fabr,1787 (grey beet weevil beetles)	+ +
			Psalidium İlliger 1807	P .maxillosum F, 1792 (black beet weevil beetles)	+
			Bothynoderes Schönheer,1826	B. punctiventris nebulosus Gyll, 1824 (beet weevil beetles)	+ + +
		Chrysomelidae Latreille 1802	Chaetocnema Stephens, 1831	Ch.concinna March 1802) (brassy flea beetle)	+ + +

s/s	order	Family	genues	Species	Prevalence
1	2	3	4	5	6
		(leaf beetles)		Ch.breviuscula Fald, 1884 (sothern flea beetles)	+ + +
			Phyllotrata Chevrolat in Dejean, 1836	Ph.atra Fabricius, 1775 (crucifer flea beetle)	+
			Cassida Linnaeus, 1758	C.nebulosa, 1758 (beet leaf beetle)	+
II	Hemiptera (Homoptera) Linneus, 1758 Semi hard-winged beetles	Miridae Latreille, 1810 (woodworms)	Polymerus Hahn, 1831	P. cognatus Fieb,1810 (beet capsid bugs)	+
			Orthotylus Fieber, 1858	Orthotylus flavosparsus C. R. Sahlberg, 1841 (trefoil bugs)	+
		Piesmatidae Amyot & Audinet-Serville, 1843	Piesma Lepelitier Servilla, 1825	P. quadrata Fieb.1929 (rape leaf bugs)	+
		Aphididae	Aphis	Aphis fabae	

s/s	order	Family	genues	Species	Prevalence
1	2	3	4	5	6
		Latreille, 1802 (aphids)	Linnaeus, 1758	Scopoli, 1763 (beet leaf beetles)	+ + +
			Pemphigus Hartig, 1839	Pemp.fuscicornis Koch, 1857 (beet root beetle)	+
III	Orthoptera Latreille, 1793 (straight-winged beetles)	Gryllotalpidae Laicharting, 1781 (crickets)	Gryllotalpa Latreille, 1802	Gryllotalpa gryllotalpa Linnaeus, 1758 (mole crickets)	+ + +
			Gryllus Linnaeus, 1758	Gr.disertus Pall, 1771. (field cricket)	+
		Tettigonidae Krauss, 1902 (bush crickets)	Tettigonia Linnaeus, 1758	T.caudata Ch, Emerton, 1884 (bush cricket)	+
				T.viridissima L, 1758 (katydid)	+
		Acrididae MacLeay, 1819 (grasshoppers)	Heteracris (Walker, 1870)	H. herbacea Fil (Serville, 1838) (garden grasshopper)	+ +

s/s	order	Family	genues	Species	Prevalence
1	2	3	4	5	6
			Galliptamus Serville, 1831	G.İtalicus L., 1831 (Italian grasshopper)	+
			Locusta Linnaeus, 1758	Locusta migratoria (Linnaeus, 1758) (Asian grasshopper)	+
			Dociostaurus Fieber,1853	D. maroccanus Thumb,1815 (Moracco grasshopper)	+
IV	Diptera Linnaeus, 1758 (two-winged beetles or flies)	Anthomiidae Loew, 1862 (leaf-mining insects)	Pegomiya, Robineau Desvoidu, 1830	P.betae Curtis, 1847 (beet fly)	+
V	Lepidoptera Linnaeus, 1758 (moths or butterflies)	Noctuidae Latreille, 1809 (cutworms)	Phytometra Haworth, 1809	Ph.gamma L. (1758) (gamma moth)	+
			Chloridea Duncan & Westwood, 1841	Chl.armigera Hb. (Hübner, (1805) (bollworms)	+ +
			Lacanobia Billberg,	L.oleracea	

s/s	order	Family	genues	Species	Prevalence
1	2	3	4	5	6
			1820	(garden moths)	+
			Barathra Mamestra van der Goot, 1915	B.brassicae L. (Linnaeus, 1778) (cabbage moths)	+ +
			Agrotes Ochsenheimer, 1816	A.exclamation is L, 1778 (higher moths)	+
				A.segetumSeh Denis & Schiffermüller, 1775 (turnip moths)	+ + +
			Graphiphora Ochsenheimer, 1816	G. nigrum L. 1758) (black spotted moth)	+
			Noctua Linnaeus, 1758	Noc.pronuba L. 1758 (noctuid moths)	+
		Pieridae Latreille, 1829	Pieris D.Don	P.brassicae L.,1758 (cabbage	+ +

s/s	order	Family	genues	Species	Prevalence
1	2	3	4	5	6
				moth)	
		(diurnal butterflies)			
		Pyralidae	Syllepte Hübner,	Syllepte derogata	
		Latreille, 1809	1823	Fabricius,1775	
		(leaf moths)		(cotton leaf moths)	+ +
			Pyrausta Meyrick, 1890 (Loxostege)	P.sticticalis L.,1761	
				(lawn moths)	+
		Gelechiidae	Scrobipalpa Janse,	S.ocellatella Boyd,	
		Stainton, 1854	1851	1858	
				(beet moth)	+ +

Note: + rare species
++ common species
+++ mass widespread and hazardous pest species.

There are pests belonging to the coleopterans (Coleoptera), lepidopterans (Lepidoptera), hemipterans (Hemiptera), orthoperans (Orthoptera) and dipterans (Diptera) groups in the sugar beet agrocenosis (diagram 1,2,3).

31 of these species are rare and don't cause economic damage to the agriculture.

11 species are periodic species and can cause serious damage during the mass growth.

6 species are permanent habitants of the agrocenosis and cause serious damage every year.

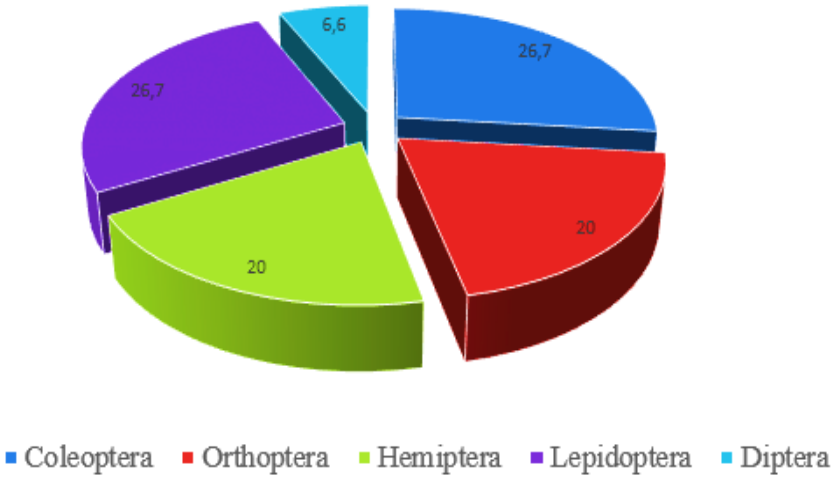

Diagram 1. Percentage of groups by families (%)

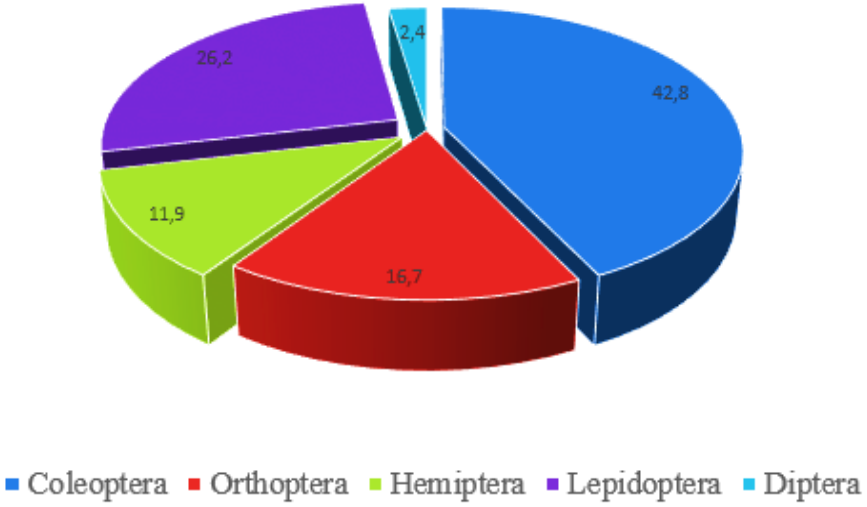

Diagram 2. Percentage of groups by sorts (%)

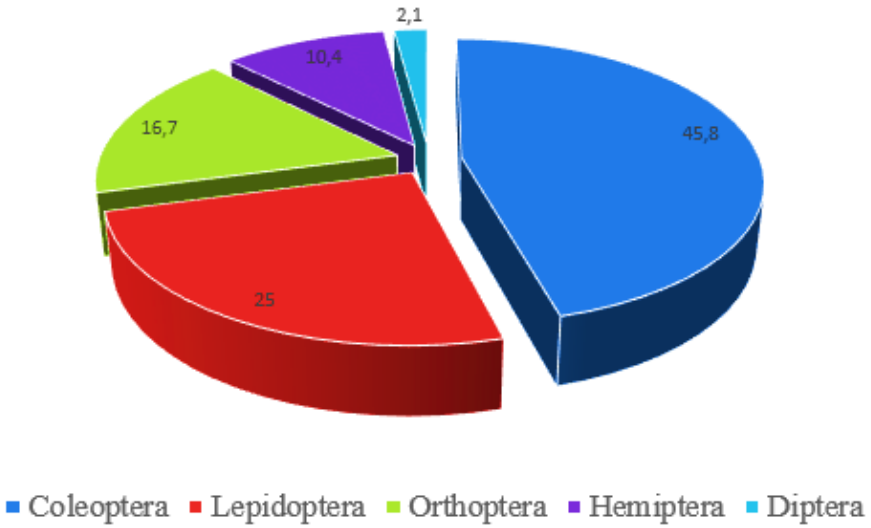

Diagram 3. Percentage of groups by the number of species (%)

As indicated in the tables and diagonals, the group of beetles and butterflies prevail in each 3 taxons in the agrocenosis.

CHAPTER IV. AGRICULTURAL IMPORTANCE AND BIOECOLOGICAL FEATURES OF PESTS WIDESPREAD IN THE AGROCENOSIS

As a result of our research in 2013-2020, we defined that among the pests prevalent in the agrocenosis, the insect group has a special place both in terms of the number of species and the degree of pest. Thus, 45.8% of the 48 species found in the agrocenosis fall to the group of insects, and their percentage of pests is higher than other groups.

In the research years, leaf-eating insects began to operate in the agrocenosis from the first leafing period of the beet plant in the stationary areas. Among them, brassy flea beetle and southern flea beetle spread more widely in the fields, destroying the leaves of the plant, as a result, the process of photosynthesis is disrupted and the plant is destroyed.

Brassy flea beetles (*Chaetocnema concinna* Marsham, 1802). Brassy flea beetle hibernates in the mature stage. Imagoes waking

from diapause firstly feed with weeds in the spring, especially with white goosefoot, saltbush, black spinach etc. For this reason, the pests are more widespread in the sugar beet fields with a lot of weeds. Then beetles feed with the sprouts of sugar beet just rising from the soil. They damage the tip sprouts of plants along with the leaves. The beetles make small proper holes feeding with parenchima and epidermis tissues of the leaves of sugar beet.

Female individuals lay eggs with groups on soil around the root of plant (sugar beet or weeds) in May. There are 2-6 eggs in each group. The productivity of one female individual is equal to 40-50 eggs. The incubation period lasts from 2-3 weeks. The larvae hatched from eggs are white, and the head, anterior lumbar, legs, and ventricular sclerites are black. The length of well-improved larvae is 4-5 mm. The larvae feed with roots and make "tunnel" in the root of the plant. After about a month, the larvae become pupas in soil. The pupation occurs in 10-15 cm depth of soil. The adult individuals hatched from pupas feed with the leaves of sugar beet and weeds as imagoes waking from hibernation in spring (table 2).

Table 2

Phenological calendar of brassy flea beetle (Imishli, 2014-2016)

Months	March 8,9°			April 12,5°			May 20,5°			June 25,1°			July 26,9°			August 27,5°			September 24,0°			October 16,1°			November 10,4°		
Decade	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
I generation	(i)	(i)	i	i	i	I Y	i Y	i y s	I Y S	s	s p	s p	p i	p i	i	i	i										
II generation														y	y s	y s	y s p	s p	s p i	s p i	p i	i	(i)	(i)	(i)	(i)	(i)

Note: (i) - hibernated beetles y - egg
s - larvae p - pupas
i - active beetles

As indicated in the phenological calendar, brassy flea beetle breeds twice a year in the research area. The growth of first generation is observed from the end of April to the end of August, but the growth of the second generation is observed from the second half of July to the end of October. Adult beetles gather their winter stock and go to the diapause at the end of September and in October[8]. The infection of plants (mainly in the private fields) with this pest sometimes becomes upper than 18-20 %.

Southern flea beetles - (*Chaetocnema breviuscula* Fald, 1802**).** During our researches in the stationary areas in Imishli, it was found that this pest breeds twice in these areas.[9]

The growth of first generation last from the beginning of April to the second half of August. However, the growth of the second generation last from the end of June to September. In this period, adult beetles feed actively and go to hibernation in these areas or under soil or among the residues of dense plants (table 3).

As indicated in the table, the damage caused by the beetle is observed mostly from the first ten-day of May to the second ten-day of June, and from the beginning of July to the middle of September. It should be mentioned that since the growth period of first generation coincides with the firs growth period of plant, the damage to the crops becomes greater. Since the leaves of the plant get rough in the growth period of second generation, the beetles lay their eggs on other weeds (especially, weeds belonging to the family Chenopodioideae, trefoil, autumnal crop fields etc.) with more juicy and young leaves. The infection with beetles became higher than 50-55% in some years (3-5 June, 2015).

Beet weevil (*Bothynoderes punctiventris* Gyll. 1824). The beet weevil is most harmful and prevalent among the qualified pests of beet. Fertilization between beetles is observed from the end of April

8 .Gazi S.G. The main pest of the sugar beet brassy flea beetle (*Chaetocnema breviuscula*). Ganja International Scientific Conference. 2015. p. 120-123

9 .Gazi S.G. On the bioecology of somepests of sugar beet. Baku. The works of the Institute of Zoology. Science, 2013. p. 126-130. № 2.volume 31.

to the beginning of June. The laying period lasts from the beginning of May to the second ten-day of July. Each female can lay average 80-120 eggs. They mainly lay their eggs next to the plant in 1-1, 5 cm of depth. The embryonic growth continues in 6-11 days according to the temperature. The mass prevalence of larvae in the beet fields is observed in the second ten-day of May and at the beginning of third ten-day. The larvae feed with the roots of plants entering into soil. The growth of larvae continues in 42-65 days. Protonymph stage ends in 4-5 days, but the pupation period ends in 8-18 days.

Table 3

Phenological calendar of southern flea beetle (Imishli 2014-2016)

Months	March 8,9°			April 12,5°			May 20,5°			June 25,1°			July 26,9°			August 27,5°			September 24,0°			October 16,1°			November - February
Decade	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	
I generation	(i)	(i)	i	i	i y	i y	y s	y s	y s p	s p	s p	p i	p i	i	i	i									HIBERNATION
II generation													y	y s	y s	y s	y s p	s p i	s p i	p i	p (i)	(i)	(i)	(i)	

Note: (i) - hibernated beetles
i - active beetles
y - egg s-larvae
p - pupa

It should be noted that the beetles usually feed with the sprouts and fresh leaves of plant. However, the larvae chew the roots and fruit roots of the plant and ruin it.

The pupation period of the pest can be observed in the second half of July in the agrocenosis, and the newly hatched beetles can be observed in the first ten-day of August. After feeding with various plants on the top of soil until the middle of autumn (until 15^{th}-16^{th} October), the beetles hatched from pupas go to the hibernation in the deep layers (15-25 cm) of soil (table 4).

Table 4

Phenology of brassy flea beetle (Imishli, 2016 – 2017)

Months	March 9,5°			April 13,8°			May 20,6°			June 25,8°			July 28,2°			August 28,6°			September 23,3°			October 14,9°	November - February
Decade	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	
Imagos	(i)	(i)	(i)	i	i	I	i	i	i	i	i	i											
Egg							y	y	y	y	y	y	y										
Larvae								s	s	s	s	s	s	S									QIŞLAMA
Pupa														P	p	p	p	p	p	p			
Imagos																i	i	i	i	i	i	i	

Note: (i) - hbernated beetles
y - egg
s - larvae
p - pupa
i - active beetles

The entomophagous of *Caenocrepis bothynoderes* Grom (Hymonoptera, Ptremolidae) plays important role in the regulation of this pest in the agrocenosis. Thus, they lay their eggs into the eggs of weevils laid in soil and continue their growth there. Only 1 larave of entomophagous grows in 1 egg of the pest. It shows that it is more efficient entomophagous.

Turnip moth – (*Agrotis segetum* Schif., 1775*)*. Considering that the turnip moth belonging to the moth (*Noctuidea*) family of butterflies (*Lepidoptera*) group is more prevalent in the beet fields,

some biological features, prevalence and development of it were studied in detail in the agrocenosis.

The research works were conducted on the farms of Agdash region where beets were grown in 2016-2017. Although there was various information on the bioecological features and damage rate of this pest in Azerbaijan, its relation with beet, development in the beet agrocenosis and damage characteristics weren't studied yet until our studies. It has been defined in our researches that, after hibernation in 15-20 cm depth of soil, when the temperature is above 11-12◦C in early spring, big older larvae of this pest rise upper layers of soil, feed with underground parts of the plants, go into pupation period. The pupation period lasts from 2-3 weeks regarding to the temperature. The hatching of butterflies from pupas is usually observed in early May and June. The mass flying of butterflies occurs in the second half of May.

Female ones can lay about 1500 eggs (450-1450). The female ones usually lay their eggs separately, but sometimes lay with little bales at the lower leaves or in soil next to the plant. The embryonic growth is able to continue in 5-17 days regarding to the temperature. The caterpillars of first generation operate on the fields from the end of May to the beginning of June. At the end of July, they go into 3-5 cm depth of soil, make special caves and become pupas there. In summer, the development of pupas last from 7-10 days and the butterflies of second generation start to fly. The butterflies of the second generation fly in the fields until the end of September. Laying period of butterflies occurs in the second ten-da of July and last from early September (table 5)[10].

In early September, the caterpillars start to hatch from the eggs of butterflies of the second generation. The hatched caterpillars feed until the second half of October and go to hibernation in the last age stage. Their hibernation continues at the edges of the areas and in the little various areas of cropping fields until the next spring[11].

[10] Gazi, S. Safarova, I. Development of Agrotis segetum (Lepidoptera: Noctidae) in sugar beet agrocenosis of Azerbaijan. Journal of Entomology and Zoology Studies, - 2018. -p. 1756 - 1758.

Table 5

Phenological calendar of turnip moth in the beet agrocenosis (Agdash, 2016-2018)

Months	March 9,1°			April 13,6°			May 21,2°			June 25,0°			July 29,5°			August 28,8°			September 23,9°			October 16,5°		
Decade	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	II I	I	II	III	I	II	III
I generation	(-)	-	-	♦	♦	♦	+	+ ●	+ ● -	+ ● -	+ ● - ♦	+ ● - ♦	- ♦	♦	♦									
II generation												+	+	+ ●	+ ● -	+ ● -	+ ● -	● -	-					
III generation																	♦	♦ +	♦ + ● -	♦ + ● -	+ ● (-)	(-)	(-)	(-)

Note: (-) – hibernated caterpillars - – active caterpilars
♦ – pupas + – butterflies
● – eggs

It was defined in the studies that, the turnip moth breed twice in the beet agrocenosis. The caterpillars exited from the hibernation and the first generation of caterpillars especially causes damage to the beet. Thus, since the development of those caterpillars coincides with the first development period of beet plant, they chew the sprouts, root system and fresh leaves of the beet and decrease its productivity. However, the second generation of caterpillars usually prefers to feed in the autumnal cropping fields. When soil cutting is conducted in the areas, 3-4 moths caterpillars are observed in each m^2.

[11] Eyvazov A.G. Ahmadov B.A., Shahverdiyeva Z.B., Mustafayeva I.E., Gazi S.G Cotton leaf moths (*Syllepte derogata* Fabricius, 1775 Lepidoptera, Crambidae). Conference dedicated to the 85th anniversary of the Institue of Zoology of ANAS.

Considering that Nəzərə alsaq ki, an economic loss quota is accepted for this pest as 2-3 caterpillars in 1 m^2, in this case the turnip moth is not considered as serious pest in agrocenosis.

The entomophagous such as Trichogramma evanescens, Habrobrakon hebetor, Orius niger etc. play important role in the regulation of this pest in sugar beet agrocenosis.

Cotton leaf moth - *(Syllepta derogata* Fabr., 1775) For the first time in 2017, the development dynamics, harmfulness and phenology of the pest were investigated in detail in beet agrocenosis of Laki village of Agdash region. As a result of experiments and observations, it was found that this moth gives one generation, the caterpilars of second generation go to the hibernation inside cocoon that they made between leaves of different plants (cotton, beet, fruit trees such as apple, pear, plum) [11].

As indicated in the table, the hibernated caterpillars become pupas in the net cocoon for next spring. The butterfies begin to fly from the pupas in the second ten-day of May. The flying of butterflies continues until early July. The fertilized females lay eggs on various plants (especially on cotton) from the end of May to the end of June.

In stationary areas, the eggs of pest can be observed even if it is few (7-9 eggs in 100 plants) in the middle of June.

The caterpillars hatched from eggs in early June. The caterpillars lick the leaves of the plant from the lower part and make it thinner.

Then they chew the edges of leaves and fold them and become pupas inside. The butterflies of the next generation fly from early June to early August. The fertilized females begin to laying in the second ten-day of Jule. However, after feeding until early September, the hatched caterpillars go to the hibernation inside the cocoon until next spring.

In the research years, the mass prevalence and serious damage of this pest are not observed in beet agrocenosis. It is also observed that the eggs and caterpillars of pest are destroyed by various predators and entomophagous (ladybugs, green lacewing, habrobracon hebetor, spiders etc.). Although the lack of pests in the fields can be explained by the majority of its natural enemies, on the other hand, the sharp

rise in the temperature of weather in recent years has also had an impact on. Thus, during the laboratory experiments, it was defined that the eggs of pest destroy in temperature higher than 34-35 ◦C.

Table 6

Phenological calendar of cotton leaf moth (Agdash, 2017-2018)

Months	April 13,6⁰			May 21,2⁰			June 25,0⁰			July 25,5⁰			August 28,8⁰			September 23,9⁰			October 16,5⁰		
Decades	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
I generation	(-)	(-)	(-)	(-)	(-) +	+ ●	+ ● -	+ ● -	+ ● - ●	+ - ●	● ●	●									
II generation										+	+ ●	+ ● -	+ ●	● -	● -	● -	(-)	(-)	(-)	(-)	(-)	(-)

Note: (-) - hibernated caterpillars ● pupas
+ - butterflies •• - eggs
−−− - active caterpillars

Mole crickets (*Gryllotalpa-gryllotalpa* Linnaeus, 1758). During the research years, considering the mass prevalence in the agrocenosis, we needed to conduct extensive research on the phenology and some bioecological features of this species in 2014-2016. The phenological researches were conducted in sugar beet fields of Xalfali village of Imishli region. In the researches, it was determined that the hibernation of mole crickets usually ends from early March. The mass exit from the hibernation of them lasts from the end of March to early April. In this period, in 10-15 cm depth of soil, the temperature usually changes from $10\text{-}13^0$ C, and the temperature of weather changes from $15\text{-}17^0$ C.

After a long period of hibernation, imagos and larvae begin to feed hungerly. The fertilization begins between imagos after

hibernation at the end of March, in early April. The fertilized females conduct to lay eggs in the second half of April. The process of laying eggs is long term period, can last from the end of July, even from August or September.

It should be mentioned that since the older larvae (especially IV-VI aged larvae) go to the hibernation along with imagos, as a result of the consistent maturation of these larvae after hibernation, the process of fertilization and egg-laying is observed among young imagos almost all spring and summer.

If we look at the phenological calendar of mole crickets, the results are interesting. Thus, the eggs laid in April-June belong to the imagos that come out winter, it has been defined that the eggs laid later, that is observed in July-September belong to the individuals go to hibernate in the adult larval stage and turn into adults after hibernation. The individuals that exit from the hibernation in larval stage hibernate in the imago stage [12].

Table7.

Phenology of Gryllotalpa gryllotalpa (Imishli 2014-2016)

Months																								
March 9,3°			April 13,2°			May 19,6°			June 25,1°			July 26,9°			August 32,7°			September 23,4°			October 16,0°			November 9,9° February
I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	HIBERNATION
I	[i]	[i]	[i]	[i]	[i]	[i]	i	i	i	i	i	i	i	i										
S	s	s	s	s	s	s	s	s	i	[i]	[i]	[i]	[i]	[i]	i	i	i	i	i	i	i	i	(i)	
				y	y	y	y	y	y	y	y	y	y	y	y	y	y							
						s	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s	(s)	(s)	

Note: (i) - hibernated imagos

[i] – mass prevalence periods of imagos in the agrocenosis

i-active imagos, s-active larvae, y- eggs, (s)-hibernated larvae

[12] Gazi S.Q. *Gryllotalpa gryllotalpa* (Linnaeus, 1758) – The dynamics of development of mole cricket in sugar beet aggregation Journal of Entomology and Zoology Studies, 2018. p. 2968-2970.

Some part of the individuals that go to hibernation in the larval stage consists of the larvae obtained from the growth of eggs laid by individuals of the imago stage of hibernation, and the other of them consist of the larvae emerged from the eggs laid by individuals in the imago stage in June. As you can see, the development dynamics of mole crickets is very interesting. Generations and stages of development are intermingled to form a complex phenological calendar. When mole crickets build nests for laying eggs, they remove not only the underground plants in the area, but also all the plants on the nest, allowing more solar energy to enter the nest and heat it up.

They usually make their nests in 8-12 cm depth. This pest causes damage to the sprouts of beet at the end of April and in early May. There are sometimes 3-4 or more individuals in different ages in each m^2(24-25/V-2015). This pest makes serious hazard for plants by increasing in the sugar beet agrocenosis, both in imago and larval stage.

CHAPTER V. DEVELOPMENT DYNAMICS OF SOME SERIOUS PESTS IN AGROCENOSIS

5.1. Daily and seasona flying dynamics of bollworm and turnip moths

Considering the economic importance of bollworms and turnip moths in the beet agrocenosis, we also find it essential to study the daily and seasonal flying dynamics of their (butterflies') imagos in the fields.

In 2015-2017, we did extensive researches on the daily and seasonal dynamics of the butterflies of these species in agrocenosis. In order to define the flying dynamics, the light traps (insect traps) provided with PRK-4 lamps were used.

During the observation and experience, it has been found that the flying of butterflies of turnip moths that exited from the hibernation last from early April to the third ten-day of May. The mass flying of butterflies occurs in late April and in I ten-day of May. The flying of butterflies of first generation starts from the third ten-day of June and continues until the end of second ten-day of July.

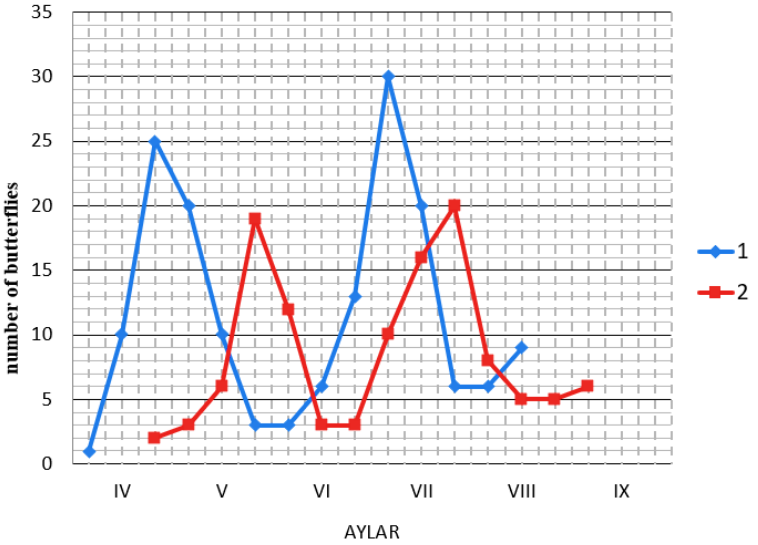

Figure4. Seasonal flying dynamics of bollworm (1) and turnip moths (2)

Maximum flying dynamics is observed in the first ten-day of July. It should be mentioned that these butterflies do not lay their eggs on the rough leaves of beet, but they lay on freshier and juicier plants (cotton, trefoil, weeds).

If we look at the daily flying dynamics of the turnip moths on the figure, this activity is observed in the form of two peaked wave. First peak, first mass activity is between 20^{30-} - 23^{30} p.m, but the second one is between 2^{30}–4^{30} p.m. It should be noted that the female ones prevail in the first ativity period (65-70%), but the male ones prevail in the second activity period (70-72%).

It seems that having such a ratio is related to the behavior of those individuals, so the first activity period is related to the egg-laying, but the second activity period is related to the fertilization.[13]

[13] Gazi S. G. (2020). The dynamics of development of cotton bollworm (*Helicoverpa armigera* Hübner, 1805) and turnip moth (*Agrotis segetum* Schif, 1775) (Lepidoptera; Noctuidae) in the sugar beet agrocenosis. Agricultural scientific journal. p. 54 - 57

It should be indicated that the daily flying dynamics can change to the right or left over time in different months and generations depending on the length of the day and the temperature of weather.

Although the results obtained from the study of flying dynamics of turnip moths is equal to the results of turnip moths accordingly, there are some differences according to the biology and phenology of turnip moths.

Thus, as the turnip moth goes to the hibernation in the larval stage, after hibernation the growth of caterpillars from late May to early June is to observed butterflies from the middle of June.

During the study of daily flying dynamics of turnip moths it has been found that the flying of butterflies lasts from 20^{00} p.m to 5^{00} a.m. The first mass flying occurs between 21^{30} - 23^{30} p.m, but the second one occurs between 02 - 03^{30}a.m.

It also should be noted that the second activity period is not so higher (in terms of number). It seems that it is firmly related to the biology and lifestyle of these species. Thus, bollworms lay their eggs on the top leaves and sprouts of the plant, as well as, move actively on the plants.

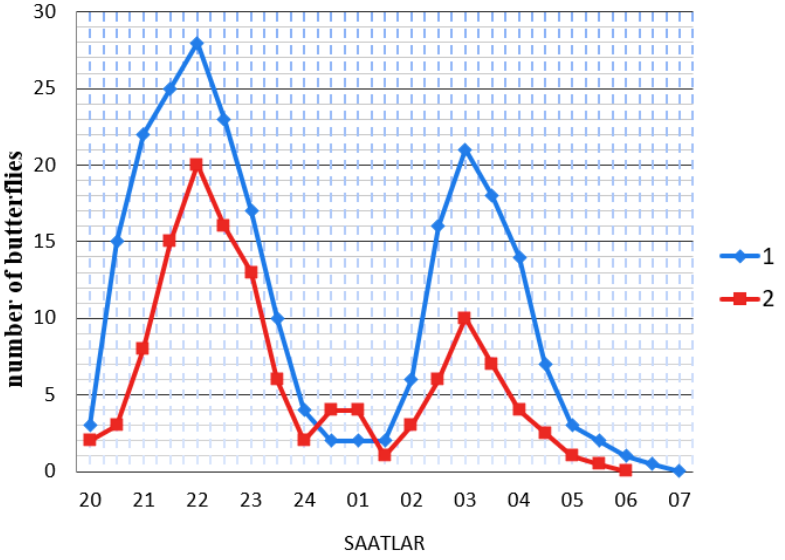

Figure5. Daily flying dynamics of bollworm (1;3-5.07) and turnip moths (2;27-30.07)

However, the turnip moths lay their eggs next to soil and on the lower parts of the trunk, and live in the lower parts of leaves.

Information on the flying dynamics of butterflies has great practical importance, it makes ground for determination of time of individual development stages of this pest and implementation of control measures against them.

5.2. Physiological indicators of population of some pests. Considering that mole crickets, turnip moths and brassy flea beetle are more prevalent in the agrocenosis, in beet cropping fields and private backyards during the researches, we investigated the condition of population of this pest particularly in 2017-2018.

It is known that in order to clarify the population of the pest, it is very essential to study the the number of species belonging to that population, their dynamics within time and place, reproductive intensity etc. Therefore, the population of above mentioned species has been investigated for 2 years in the relevant stationary areas and the results is given the following table (Table 8).

Table 8

Physiological indicators of some pests

№	Indicators	Formulas	Brassy flea beetle	Turnip moth	Mole crickets
1	Absolute habitat (2017)	$M_{m1}=K/M$	3,77	4,7	3,7
3	Absolute habitat (2018)	$M_{m2}=K/M$	3,59	4,7	4,4
4	Reproductive rate	$Ə_Ç=M_{M2}/M_1$	0,95	1	1,2

According to Zlotin's method, the number of individuals was considered in each m2 (on average in 10 samples) during the study of population of mole crickets and turnip moths, but during the study of population of brassy flea beetle the number of individuals in each 100 plants was considered.

As you can see from the table, compared to 2017, there wasn't any mass increase in the population of brassy flea beetle. However, compared to the previous years, the reproduction was more intensive in the other two species.

Certainly, as the increase of the other two species occurs underground, the overground disinfection hasn’t been affected the number of them. The decrease of beetles probably occurs due to the impact of overground disinfection.

This case shows that if the effective measures are not taken, the number of these pests can increase and damage the crops for next years.

CHAPTER VII. ENTOMOPHAGOUS OF SUGAR BEET PESTS AND THEIR ROLE IN THE CONTOL OF THEIR NUMBER IN AGROCENOSIS

In our Republic, there were many studies about the individual pests and their entomophagous and different information was obtained.

It should be mentioned that, until our research, there weren't detailed studies on beet pests and the natural regulators of their number in Azerbaijan. In 2013-2018, in the sugar beet farms of the country (Imishli, Agdam etc.) as well as, in the private backyards, the species compostion, bioecological characteristics of some species and efficiency rate of entomophagous that has a role in the control of number of insects that damage the agriculture were investigated, and scientific and practical important results were obtained.

Seven spotted variable, two spotted ladybugs, common green lacewing, syrphid fly, entomophagous belonging to aphidius and praon spices are more observed in the research areas. The eggs and elder caterpillars of the moths are destroyed by ladybugs, green lacewings, ants and wild bees. Even if they are few, the spiders also function. The parasites are observed in the caterpillars and pupas of moths.

Table 9

Entomophagous and their hosts in the agrocenosis

Entomophagous / Pests			Bollworm	Turnip moth	Cabage moth	Cabbage [illegible]	Cotton leaf	Beet weevil	Beet fly	Beet moth	Aphids
Group:		***Hymenoptera***									
	Family:	*Braconidae*									
	Species:	Apanteles glometarus L.			+	+					
		Habrobracon hebetor Say.	[+]	[+]			+				
		Apanteles kazak V. *Opius nitidulator* Nees.	+ +	+					+		
	Family:	*Icneumonidae*									
	Species:	Diaderma fenestralis Holm								+	
	Family:	*Trichogrammatidae*									
	Species:	Trichogramma evanescens West.	[+]	[+]			+				
	Family:	*Aphididae*									
	Species:	Aphidius ervi Hal.									+
		Diaeretiella rapae M.									+
	Family:	*Pteromalidae*									
	Species:	Pteromalis puparum Z.				[+]					
		Caenocrepis bothynoderes Grom.						+			
Group:		***Hemiptera (Heteroptera)***									
	Family:	*Anthocoridae*									
	Species:	Orius niger Wolff.	+	+		+			+		+
		Neuroptera									
Group:		*Chrysopidae*									
	Family:	Chrysoperla carnea	+		+						+
	Species:	***Coleoptera***									
Group:		*Coccinellidae*									
	Family:	Coccinella septempunctata L.	[+]		+		+				+
	Species:	Adalia bipunctata L.	+								+
		Hippodamia Variegata Çoeze.	+								+
		Carabidae									
	Family:	Calosoma inguisitor Hbst.	+							+	+
	Species:	Harpalus-affinus Schrank.	+	+			+		+		+
	Family:	Staphylinidae									
	Species:	Aleochara billineata Gyll.							+		

Note: **[+]** - common species, + - rare species

Thus, an infection with *Trichoqramma* in the eggs of turnip moths and other moths was 8-12%, an infection with *Apanteles kazak in the little caterpillars of moths was* 7-9%, and the infection with *Bracon hebetor in big older caterpillars was sometimes higher than* 35%. The Parasite of *Diaderma fenistralis* Holm is closely involved in the regulation of the number of beet moth that is one of the main pests. The predators such as *Calosoma auropunctatum* Hbst., *Harpolus distinguendus* Daft., *H. affinis* Sehruk and *Pterastichus crenuliger* Ch. that are the representatives of the Beetles (Coleoptera) have role in the destruction of aphids, moth eggs and elder caterpillars in the fields.

Although few of the complex entomophagous organisms in the fields, ground beetles, rove beetles, spiders and predator beetles from the predatory land beetles are almost economic important in the fields, finding food for themselves during the vegetation period.

35-40% of the pest population is destroyed each year in the vegetation period, as a result of the participation of complex entomophagous in the regulation of the number of turnip moths (Agrotis segetum) that is one of the serious pests of sugar beet.

One of the entomophagous of beet fly, 2 striped aleochara (*Aleochara billineata* Gyll. Coleoptera, Staphylinidae) should be specially mentioned.

As indicated in Table 9, the entomophagous such as *Bracon hebetor*, *Trichogramma evenascens*, *Pteromalis puparium*, *Coccinella septempunctata* play an important role in the regulation of the number of pests in the sugar beet agrocenosis. Therefore, mass reproduction of these entomophagous is very essential both ecologically and economically.

RESULTS

1. For the first time in our Republic, a detailed study of sugar beet agrocenosis was carried out, and it was determined that there are widespread 48 species of insects belonging to 5 groups, 15 seasons, 42 genera, causing various degrees of damage to the plants.
2. 22 species of the pests belong to hard-winged beetles, 5 species to semi hard-winged beetles, 8 species to straight-winged beetles, 1 species to two-winged beetles, and 12 species to a group of butterflies.
3. 31 of the species indicated in agrocenosis were rare and didn't cause economic damage to the agriculture, 11 of them were periodic species and could cause serious damage during the mass growth, and 6 of them (beet weevil, brassy flea beetle, southern flea beetle, beet aphids, mole crickets, turnip moth) were permanent habitants of the agrocenosis and cause serious damage every year.
4. During the studies, the phenological calendar of 7 species of beetles, 1 species of straight-winged beetles, 1 species of two-winged beetles and 5 species of butterflies has been prepared, and these calendars can be used in the preventive measures against those pests.
5. The phenological calendar of beet fly that is one of the main pests has been defined in agrocenosis, and it has been studied that this pest breeds three times a year. At the same time, it has been found that the growth of *Phaedrotoma nitidulator* that has an important role in the regulation of the number of the pest synchronizes with the growth of host.
6. For the first time, the phenology of turnip moth, daily and seasonal flying dynamics of butterflies in beet agrocenosis were studied, an important role of the entomophagous such as *Trichogramma evanescens*, *Habrobrakon hebetor* and *Apanteles kazak* in the regulation of the number of pests was defined, thus both scientific and practical significance of these results are undeniable.

7. For the first time, ecological indicators of populations of 3 species of serious pests (mole crickets, brassy flea beetles and turnip moth) were studied in agrocenosis.
8. For the first time, the species composition of entomophagous, which play a role in the regulation of the number of pests in sugar beet agrocenosis, was studied.

PRACTICAL IMPLICATIONS

1. Crop rotation system is to be applied in the areas where sugar beet is planted. In the first year, in the area where sugar beet is planted, for the second year, autumn barley, corn, peas, etc. should be planted in those area. So, the pests involved in these areas can cause mass destruction during the harvesting and processing of forage corn. At the same time, as a result of the rapid end of the vegetation stage of other considered plants and the proper development of the fields from an agro-technical point of view, some pests are destroyed during these measures. After harvesting the autumn barley, corn, peas, etc., the areas should be deeply plowed to destroy both weeds and pests in soil. The perennials should never be planted in beet fields. Because perennials are considered as a reservoir for pests.
2. Also, destruction of the weeds at the edges of cropping fields minimize egg-laying of some pests (mainly butterflies') and food relation of the caterpillars, thus it prevents the increase in the number of pests.
3. In summer months, inter-row plough allows caterpillars, larvae and pupas to emerge, destroy and are eaten by birds.
4. Plough and irrigation of the areas intended for planting in winter months is one of the main factors leading to the mass extinction of all pests inhabiting the soil.
5. Considering that most of the pests (mainly mole crickets and beetles) wintering in soil seek an optimal condition for inhabiting, it is necessary to dig holes of 50-60 cm depth in various parts of the fields and fill them with a mixture of dry manure, chaff and soil. It is more reasonable to carry out this

work after harvest (in November). After the pests have gathered in these attractive burrows, they can be considerably reduced in mid-February by destroying them in various ways (mixing some insecticides in the water and pouring them into the burrows, by mechanic impacts etc.).

6. The phenological information obtained during the research can be fully used in the implementation of complex control measures for pests.

The list of published works on the subject of dissertation

1. Gazi S. G., Ahmadov B. A. On the bioecology of some pests of sugar beet. Works of the Institute of Zoology, 31th volume, № 2 Baku, 2013, p. 126 - 130.
2. Gazi S. G. Some beetles that cause damage to the sugar beet (*Coleopter*a). Works of the Institute of Zoology, 33th volume, № 1 Baku; 2015, p. 78 - 86
3. Gazi S. G. Some butterflies that cause damage to the sugar beet *(Lepidoptera).* Works of the Institute of Zoology of ANAS, 33th volume, № 2 Baku; 2015, p. 113 - 118.
4. Gazi S. G. The main pest of sugar bee – brassy flea beetle (*Chaetocnema breviscula).* Ganja International Scientific Conference 2016, p. 120 - 123.
5. Gazi S. G. Bioecological characteristics of beet aphids. Ganja International Scientific Conference 2016, p. 51 - 58
6. Gazi S. G. *Gryllotalpa gryllotalpa* (Linnaeus, 1758) – The dynamics of development of mole cricket in sugar beet aggregation. Journal of Entomology and Zoology Studies, 2018. p. 2968 - 2970.
7. Gazi S. G., Safarova I. M. Development of *Agrotis segetum* (Lepidoptera: Noctidae) in sugar beet agrocenosis of Azerbaijan. Journal of Entomology and Zoology Studies. 2018, p. 1756 - 1758
8. Gazi S. G. Role of entomophages in sugar beet agrocenosis. XXIII International Scientific Conference “Modern Scientific challenges and trends” 2020, p. 17 - 19. Poland, Warsaw.

9. Gazi S. G. The dynamics of development of cotton bollworm (*Helicoverpa armigera* Hübner, 1805) and turnip moth (*Agrotis segetum* Schif, 1775) (Lepidoptera; Noctuidae) in the sugar beet agrocenosis. Agricultural scientific journal. 2020, № 11, p. 54 - 57.
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