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Gryllotalpa gryllotalpa (Linnaeus, 1758): The dynamics of development of mole cricket in sugar beet aggregation

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Abstract
The article provides information on bioecology, phenology, and the damage level of ordinary mole cricket *Gryllotalpa gryllotalpa* (Linnaeus, 1758), that is one of the most dangerous pests in sugar beet, as a result of studies conducted in sugar beet fields in Imishli region of Azerbaijan.
The researches were carried out in sugar beet fields at Khalfali village of Imishli region during March-October 2014-2016. It has been established that the gryllotalpa of the main pests of the plant gives a generation in aggregate during the season, and goes to winter for both imago and larvae at the latter age. The mass output of individuals from wintering is observed at the end of March, in early April, at depths 10-15 cm in the soil, when the temperature is 10-13 °C, and the air temperature is 15-17°C. Egging process is long lasting, and continues in late July and sometimes even till September. They put their egg in the depths of 10-12 cm. A mother individual has the potential to egg up to 550-600 pieces. The embryonic development takes 12-24 days, depending on the temperature.

Keywords: Sugar beet, *Gryllotalpa gryllotalpa* L., polyphage, root fruit

1. Introduction
Sugar beet is a main source of raw materials, making about two-thirds of the worldwide sugar production. Sugar beet is one of the main sources of income in our country and plays an important role in ensuring food security in the country. The nature and climatic conditions of our Republic are very favorable for growing a sugar beet.
Sugar beet is a plant of a product and feed value. The root fruit contains 16-20% of sucrose [1]. Such high nutritional behavior results in the damage of the plant by the pest every year. Approximately 40 species of pest cause the damage of various degrees to sugar beet. This leads to a reduction in the productivity of the plant. At the same time, the pests transmit a number of diseases from one plant to another by damaging the underground and surface parts of the plant.
There is a number of information about the pesting features of mole cricket in our republic. Although Rahimov Z.A., Ismayilov M.R., Rustamova M.R (1986).,Mammadova S.R., Khalilov B.B. and others have provided information about the pesting feature of mole cricket in their works, its development and phenology in sugar beet aggregation is being studied for the first time [6, 10].

2. Material and Methods
The material collection and phenological observations were carried out in sugar beet fields of Khalfali village of Imishli region of Azerbajan in 2014-2016. The researches have been continuing from March to late October.
In order to determine the locations, number and distribution of mole crickets in aggregation, the routine methods, visual observations and the methods adopted in entomology were used. During the research, excavations were carried out on layers at depth of 30 sm and in 10 fields of 0.25 m^2 from various points of stationary areas from March. During the excavations, the amount of leaves, nests, eggs in these nests, larvae and imagos found in these layers were calculated per each m^2.
The observations on the biological characteristics of the mole crickets have been made and recorded every 7-10 days, and after the wintering, its active lifestyle, the lifetime, the number dynamics and the hibernation period have been clarified.

At the same time, their biological properties such as their nesting, egg laying, wintering depths, number of eggs in the nests etc. were investigated in the stationary areas.
Commonly accepted biometric methods have been widely used in mathematical processing of research results [2].

3. Result and Discussion

The mass of the fruit roots of sugar beet continues to grow at all stages of the vegetation ie. up to harvesting. The development of the leaf mass ends after reaching a certain extent. Usually, it happens near the end of the vegetation, ie. in early September. At the beginning of vegetation, the leaf mass exceeds the mass of the root fruit, and the opposite occurs at the end. Therefore, sugar is damaged by the pest in all stages of the vegetation (Table 1).
Both the pesting feature and the number of mole cricket was high during the researches held in stationary areas, that's why the biological characteristics and the dynamics of development of this species in agrochemicals have been studied more widely.

Table 1: Vegetation period of sugar beet

Month	March (5°C)			April (12°C)			May (15°C)			June (28°C)			July (30°C)			August (35°C)		September (20°C)				October (18°C)			November (13°C)		
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
Vegetatiion period of sugar beet																											
		Seed sowing																									
								Sprout																			
											Leaf																
														Root fruit													
																		Maximum sugar level									
																							Harvest				
																										-	

Gryllotalpa gryllotalpa (Linnaeus, 1758) – Mole cricket
Order: Orthoptera
Family: Gryllotalpidae
Species: Gryllotalpa

It is among a group of polyphage insects. The mole crickets seriously damages the root system of vegetables, melons, ochards, tea, citrus, technical crops, grain and decorative trees. The mole cricket is the most dangerous pest of the beet. These are humidous insects. Therefore, it can be seen in the most humid places.

Gryllotalpa gryllotalpa (Linnaeus, 1758) – Mole cricket

The mole crickets are widely spread throughout almost everywhere in Europe, in Asia, North Africa, and everywhere in Russia except its north. They can be seen in all the regions of Azerbaijan where beets are grown. They are more common in moist parts of sandy soils. It holds most of his development period under the soil. It is necessary to note that the spreading and pesting feature of the mole cricket in the vegetable fields, the young seedlings of fruit, fodder plants, greenhouse planting and cotton fields was noted by various authors [1, 3, 4, 7, 8, 14].

According to D.R.Islamgulov, R.I.Enikiev, the annual productivity of sugar beet is significantly lower in Russia due to pest activity. Although 400 species of different species take part in productivity decreasing of this plant, its permanent and horrible pests are no more than 40 species [5].
According to Rustamova, it was recorded that gryllotalpas are mass spread in 82776 hectares of 112876 hectares of cotton fields observed in the country in 1980, and there are 0.8-8.3 units of larvae and imago in every m2 in some places.
The author has also reported on re-sowing works in those areas as a result of the damage caused by the gryllotalpa (70-80%) in some areas [13].
·However, biological characteristics of the pest in the sugar beet, the number and dynamics of development in aggregation have been investigated by us for the first time in our republic.
Studies have revealed that the mole cricket's leaving the wintering is basically beginning in early March. Their mass going out the wintering begins at the end of March at the beginning of April. During this period the temperature at 10-15 cm depth of soil is usually 10-13^{0}C but the air temperature varies between 15-17 ^{0}C.
Imagos and larvae, which are in long-term conditions of wintering, begin to feed greedily after leaving the wintering. Fertilization begins among the imagos leaving the wintering at the end of March, beginning of April. The fertilized females performs egg laying operation in the second half of April. Egg laying process is long lasting, ending in late July, and sometimes even in August and September.
It should be noted that, as the old larvae (mainly the IV-VI instar larvae) go to wintering along with the imagos, because of the fact that these larvae are gradually transformed into a mature stage after wintering, a fertilization and egg laying process is observed among the young imagos almost in whole spring and summer period.

Table 2: Phenology of gryllotalpa gryllotalpa

Months																																											
	I			II			III			IV			V			VI			VII			VIII			IX				X		XI			XII									
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	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
(i)	(i)	(i)	(i)	(i)	(i)	i	[i]	[i]	[i]	[i]	[i]	[i]	i	i	i	i	i	I	i	i																								
(s)	(s)	(s)	(s)	(s)	(s)	s	s	s	s	s	s	s	s	s	i	[i]	[i]	[i]	[i]	[i]	i	i	i	i	i	i	i	i	(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	y																						
														s	s	s	s	S	s	s	s	s	s	s	s	s	s	(s)	(s)	(s)	(s)	(s)	(s)	(s)	(s)	(s)	(s)	(s)	(s)	(s)	(s)	(s)	(s)	(s)

Note: (i) - wintering implements
[i] - the mass coincidence period of imagos in aggression
i- imago leaving the wintering
s-active larvae,
y - eggs.
(s) - larvae upon wintering

Upon paying attention to the phenology calendar of mole cricket at the Table 2, interesting results can be obtained. So that, though the eggs laid on April -June belong to the imagos leaving the wintering, it was defined that the next eggs, it means the egges observed during July-September belong to the individuals developed and became the adult mature individuals after wintering that belong to the old individuals beginning their wintering in their old period. Individuals leaving their wintering in larvae stage begin the wintering in their imago stage.

Some part of the individuals who go to wintering during the larval stage are larvae obtained from the development of eggs laid by individuals leaving the wintering during imago stage, while the other part is the larvae arisen from the eggs laid by the individuals reached the imago stage in June. As you can see, the ordinary mole cricket has a very interesting development dynamics. Generations and development stages are intermingled and a complex phenological calendar is obtained.

When the mole crickets build a nest to lay eggs, they clean up not only underground plants in that area, but also all the plants on the nest, in order to create condition for more dropping the solar energy and to get more heating there.

Usually, they build the nests at a depth of 8-12 cm. The nest is oval in the soil layer and it is a top outlet for the emergence of the larvae. Female individuals settled in the nest of the egg after putting an egg, creating a barrier for the safe development of the eggs, preventing other individuals and predators from entering. A mother individual has the potential to put nearly 550-600 eggs.This figure is about 350 eggs on average in Ukraine.

The embryonic development can last for two to three weeks, depending on the development temperature.

According to M.R.Rustamova, the embryonic development at 26-28°C (relative humidity 60-65%) ends for 13-18 days. The pest can put 150-600 eggs in the cotton aggregate.

The larvae can emerge from the eggs almost for two or three days in the mass. The larvae remain under the control of the mother for some time after leaving the eggs. Then they move to one side and start out freely.

At the end of the second week, the larvae change their color, after the first shell change, they become more active, move to the bottom of the soil, and after a month, they become very strong after the second shell change, jump well, and begin to live independently. 8-9 shell changes happen during the period of their development.

The development of the larvae is more dependent on the air temperature. While larvae are fed with weeds in the early ages, they are rapidly spreaded to the beet roots. They even feed on the same amount as mature individuals. They roar the young part of the plant and damage the whole area. They directly move to the root of sugar beet from the tubers. Damaged plants are immediately destroyed, they are easily expelled from the soil, and the plant is completely destroyed since the damage is strong.

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