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DEVELOPMENT OF THE BLACK BEAN APHID (*Aphis fabae* Scop.) DEPENDING ON VARIOUS PHOTOPERIODIC CONDITIONS

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РАЗВИТИЕ СВЕКЛОВИЧНОЙ ТЛИ (*Aphis fabae* Scop.) В ЗАВИСИМОСТИ ОТ РАЗЛИЧНЫХ ФОТОПЕРИОДИЧЕСКИХ УСЛОВИЙ

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Abstract. Among the sucking pests of sugar beet crops in Azerbaijan, black bean aphid (*Aphis fabae* Scop.), which occurs on beet seedlings from the moment of development of true leaves, causes significant damage. Based on this, the task of our study was to study the main life processes of beet aphids depending on photoperiodic conditions. The work was carried out in the Laboratory of Ecology and Physiology of Insects and the Center for Applied Zoology of Azerbaijan National Academy of Science in 2013–2019. The experiments were carried out in special photo thermostats with automatic control of temperature and light. The results obtained show that the light factor is of secondary importance for the duration of the larval, reproductive periods and for the entire development cycle compared to temperature. It should be noted that winged forms (about 50%) appear in aphid colonies during a 12-hour photoperiod at a temperature of 17 °C. Under the conditions of Azerbaijan, such photoperiod is observed at the end of March and at the beginning of October, when aphids migrate from primary to intermediate plants and vice versa in autumn (early October) from intermediate to primary. The length of the day established in the experiments, which causes the appearance of winged forms, is consistent with the phenology of this species.

Аннотация. В Азербайджане из сосущих вредителей существенный вред посевам сахарной свеклы причиняет свекловичная тля (*Aphis fabae* Scop.), которая встречается на всходах свеклы с момента развития настоящих листьев. Исходя из этого, задачей наших исследования было изучение основных жизненных процессов свекловичной тли в зависимости от фотопериодических условий. Работа выполнена в Лаборатории экологи и физиологии насекомых и Центре прикладной зоологии Академии наук Азербайджана в 2013–2019 гг. Опыты проводились в специальных фототермостатах с автоматической регулировкой температуры и света. Полученные результаты показывают, что фактор света имеет второстепенное значение для продолжительности личиночного, репродуктивного периодов и для всего цикла развития по сравнению с температурой. Надо отметить, что при 12-часовом фотопериоде при температуре 17 °C в колониях тли появляются в основном крылатые формы (около 50%). В условиях Азербайджана такой фотопериод наблюдается в конце марта и в начале октября, когда и происходит миграции тлей с первичных растений на промежуточные и наоборот осенью (начало октября) с промежуточных на первичные. Установленные в опытах длины дня вызывающие появление крылатых форм, согласуется с фенологией этого вида.

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Keywords: Aphis fabae, temperature, photoperiod, development, ontogenesis.

Ключевые слова: свекловичная тля, температура, фотопериод, развитие, онтогенез.

The solution of an important problem that contributes to an increase in the productivity of agriculture is possible based on the knowledge about the dependence of the life of harmful species on environmental conditions.

Ecological research sets the task of clarification of the regularities that reveal the features of the insects' vital activity under various combinations of environmental factors. These data are necessary for understanding one of the most important manifestations of insect activity.

Aphids damage young plants most of all, which at the same time lag far behind in growth and development, and sometimes die. Very often, plants damaged by aphids are deformed in various ways; leaves turn yellow, wrinkle, curl; the intensity of fruiting decreases. Saprophytic fungi settle on the honeydew (sticky liquid, secreted by aphids). In addition to the harm caused by sucking juices, aphids are also carriers of some viral plant diseases.

The influence of environmental factors on the vital activity of aphids is noted by all researchers involved in the study of this group of insects. However, the question of the prevailing significance of one or another factor remains still unresolved, since the authors' opinions are contradictory.

It is quite natural that rhythmic phenomena in nature are not only endogenous but are also due to regularly repeated changes in environmental factors. One of these factors, the photoperiod, is the most accurate and reliable signal that warns the onset of a particular season, as it depends solely on astronomical reasons and is not related to climate variability in a particular region.

Therefore, both the widest distribution of physiological reactions to the photoperiod and their decisive role in the temporal organization of annual cycles are natural [1–5].

An extensive literature is devoted to studying the influence of the light factor on the development of aphids, starting from the work of Marcovitch [6, 7] to studies carried out by various authors in subsequent years [8–14].

Among the sucking pests of sugar beet crops in Azerbaijan, black bean aphid (*A. fabae* Scop.), which occurs on beet seedlings from the moment of development of true leaves, causes significant damage. Based on this, the task of our study was to study the main life processes of beet aphids depending on photoperiodic conditions.

Material and Methods of Study

The work was carried out in the Laboratory of Ecology and Physiology of Insects and the Center for Applied Zoology of Azerbaijan National Academy of Science in 2013–2019.

In the experiments were used black bean aphid (*A. fabae* Scop.), in which a mandatory change of fodder plants occurs during their life. The aphids used in the experiments were descendants of one wingless parthenogenetic female, were characterized by age homogeneity, and long before the start of the experiment were brought up at a temperature of 19–20 °C and under the round-the-clock lighting.

The experiments were carried out in special photo thermostats with automatic control of temperature and light [15]. A DC-40 lamp served as light sources. Relative air humidity in the cameras was maintained within 70–85%. The study of the influence of the photoperiod on the

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development and reproduction of aphids was carried out at a temperature of 17; 20; 25 °C and photoperiods 0; 8; 10; 12; 14; 16 hours of light per day, and round-the-clock lighting.

When studying the effect of photoperiodic conditions on the development and reproduction of aphids, the following were taken into account: the duration of the larval period, the survival of larvae during the development period, the duration of the reproductive period, the fecundity of females and the life span of aphids.

The duration of ages was taken into account in days from molting to molting and the duration of all larval development of degeneration to imaginal molting. The reproductive period is from the beginning of the birth of the first larvae to the birth of the last larva, and the period of time after the cessation of reproduction until the natural death of the female corresponded to the period after reproduction. The life expectancy of aphids was taken into account in the days from the day of birth to the natural death of the female.

The fecundity of females was recorded daily throughout the reproduction season. In these experiments, aphids were raised individually on individual plants grown in flowerpots. Experiments were carried out in at least five repetitions. The results of the studies were subjected to a variational — statistical analysis by E. K. Merkureva [16].

Results and Their Discussion

The results obtained show that the light factor has its own characteristics of action on beet aphid. The light factor is of secondary importance for the duration of the larval, reproductive periods and for the entire development cycle compared to temperature.

When containing aphids at 17 °C under conditions of short daylight hours (8 hours of light per day), the duration of the larval period increases to 8.9 days against 7.2 days with a 16-hour photoperiod. In conditions of round-the-clock lighting, the larval period ends in 7.1 days (Table 1).

Table 1

DURATION OF LARVAL DEVELOPMENT
OF BEET APHID DEPENDING ON PHOTOPERIODIC CONDITIONS

Photoperiods (in hours)	*Average duration of ages (in days)*				*The duration of the entire larval period*
	I	*II*	*III*	*IV*	
0	1.88±0.028	1.82±0.051	1.82±0.050	2.02±0.052	7.69±0.085
8	1.91±0.021	1.88±0.038	1.96±0.014	2.42±0.062	8.97±0.063
10	1.90±0.020	1.86±0.104	1.93±0.031	2.40±0.012	8.69±0.076
12	2.01±0.027	1.84±0.084	1.72±0.060	2.37±0.053	7.80±0.085
14	2.50±0.052	1.82±0.092	1.66±0.062	2.28±0.107	7.29±0.040
16	1.72±0.053	1.85±0.080	1.62±0.064	1.98±0.081	7.23±0.101
24	1.89±0.075	1.80±0.052	1.82±0.050	2.06±0.064	7.17±0.063

Such pattern of this period can be explained with an unequal level of metabolic processes.

Influence of long light day is similar to action of the increased temperatures — at 16 hours of light a reduction in the reproductive period is also observed in beet aphids. The reproduction period of aphids at 16 hours of light per day and at temperature of 17 °C was equal to 9.1 days. Round-the-clock lighting and darkness also extend this period compared to 16-hour lighting (Table 2).

The shortening of the photoperiod to 8 hours led to an increase in the reproduction period up to 12.2 days.

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This pattern was also obtained under other temperature (20° and 25°) conditions. So, for example, at 20 °C and during a photoperiod of 8 hours, the reproductive period lasts 13.8 days, and with a long day (16 hours), it is reduced to 11.9 days. With round-the-clock lighting, this period lasts an average of 11.2 days.

Similar results were also obtained at a temperature of 25 °C. In a short photoperiod, the duration of the reproductive period is 11.4 days, and in a long photoperiod (16 hours), it is 9.8 days.

Lighting conditions also affect the life span of beet aphids. When containing aphids at 17 °C under conditions of short daylight hours (8-hour lighting), life expectancy increases to 44.2 days, against 42.1 days with a 16-hour photoperiod.

During the reproduction of aphids, the duration of lighting is also important. In all cases, the largest number of larvae in aphids is degenerated by wingless virgins under conditions of 14-hour lighting at 20°C, the smallest number of larvae is degenerated under conditions of short (8; 10 hours) daylight (48–50 larvae). Apparently, the formation of embryos with a short photoperiod occurs more slowly, while light stimulates the maturation of embryos.

Table 2

DURATION OF THE REPRODUCTION PERIOD OF BEET APHIDS DEPENDING ON PHOTOPERIODIC CONDITIONS (in days)

Photoperiods	*Pre-reproductive period*	*Period of maximum reproduction*	*Post-reproductive period*	*The entire period of reproduction*
0	1.62±0.078	10.20±0.222	3.60±0.609	16.32±0.320
8	1.55±0.067	12.21±0.348	3.99±0.419	17.67±0.624
12	1.68±0.891	11.56±0.329	3.78±0.650	16.89±0.240
16	1.72±0.094	9.12±0.150	3.94±0.492	14.91±0.318
24	1.66±0.081	10.10±0.170	4.72±0.472	15.36±0.504

It should be noted that we also studied the effect of different photoperiods at 17 °C, 20 °C and 25 °C on the development of aphids during three successive generations. At a temperature of 25 °C in the first and second generations, the same pattern is observed as at temperatures of 17 °C, 20 °C in all three generations, i. e. with an increase in the length of the day in these regimes, a regular reduction in the larval and reproductive periods and the complete life cycle of this species was observed. However, this pattern at 25 °C in the third generation is violated. Fertility in the third generation is reduced sharply compared to previous generations at 25 °C and with three generations at 17 °C and 20 °C. Apparently, the constant high temperature negatively affects the development of this species.

Thus, the data obtained allow us to conclude that the main factor determining the duration of the entire ontogenesis (and its phases) of beet aphids is temperature in combination with a certain length of the day, which modifies the duration of each period or phase of its development.

It should be noted that winged forms (about 50%) appear in aphid colonies during a 12-hour photoperiod at a temperature of 17 °C. Apparently, this is due to the phenology of this species in the conditions of Azerbaijan.

Under the conditions of our republic, such photoperiod is observed at the end of March and at the beginning of October, when aphids migrate from primary to intermediate plants and vice versa in autumn (early October) from intermediate to primary.

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The length of the day established in the experiments, which causes the appearance of winged forms, is consistent with the phenology of this species.

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