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БАЯНДАМАЛАРЫ

ДОКЛАДЫ

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РЕСПУБЛИКИ КАЗАХСТАН

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MORPHOLOGICAL CHARACTERISTICS AND BIOECOLOGICAL PECULIARITIES OF DEVELOPMENT OF *TUTA ABSOLUTA* POVOLNY (LEPEDOPTERA:GELECHIIDAE) UNDER LABORATORY CONDITIONS

Abstract. The article provides data on the determination of morphological features and bioecological features of the development of a particularly dangerous object *Tuta absoluta* (Povlony) in laboratory and greenhouse conditions. In greenhouses and laboratory conditions, the imago begins to actively mate 3-4 hours before sunrise. In laboratory conditions, females lay eggs on the surface of leaves (35%), below (45%), stems (15%), fruit leaves (5%), but the fruit was not laid. After hatching from the eggs, the larvae chew through the entrance to the mesoderm of the leaf and penetrate for 5 minutes. The Larva Of *T. absoluta* is almost cylindrical in shape, with a distinct head, three pairs of pectoral legs, and five pairs of ventral pseudopods. After completing all five stages of development, the larvae emerge from the mine, and sometimes pupate there. Before pupation, the larva changes its color from dark green to light green. The pupa of the tomato moth, as in other Lepidoptera, is of the “obtecto " type, that is, with the future appendages of adults. It has the shape of a cone 4.5-5 mm long and 1.3-1.5 mm wide, greenish in color, turning to a more intense brown, and at the end of development becomes brown.

In the population, females predominate over males. At a temperature of 15°C and 33°C the ratio of female to female life expectancy varies. The higher the air temperature, the more females predominate in the population.

Keywords: tomato, tomato moth, eggs, caterpillar, pupa, imago, temperature, humidity, development.

Introduction. *T. absoluta,* included in the European and Mediterranean plant quarantine and protection organizations (e & D) as a quarantine form in the A1 classification list in 2004. However, since the phytosanitary instruction 2000/29/EC does not contain information about it, the import of tomato fruits imported through export from third countries to the European Union is not prohibited, and quarantine checks were not carried out [1]. It is obvious that this situation has spread to countries around the world, including in Europe, despite the good organization of the plant protection service.

In the United States, to reduce the spread of *T. absoluta*, the departments of animal husbandry and plant protection (APHIS) regularly update the list of countries that have passed technical inspection of all imported goods and received permission to export tomato fruits.

The distribution biology of this species can be divided into several stages: emergence, adaptation, and distribution [2]. Local (endemic) exuberance of the tropical zone in the last decade as a result of this property is rapidly spreading in the fields and introduced into the production of tomatoes, for example, in southern Europe and North Africa. Quickly entered the entire world production of vegetable crops as a particularly dangerous pest.

In recent years, tomatoes have been intensively grown in covered areas in the southern and South-Eastern regions of Kazakhstan. This provides only 67% of the domestic demand in the off-season. Therefore, we depend on imported goods coming from outside. According to the center for trade policy development JSC, Kazakhstan received 41855 tons of tomato products from Central Asia and other countries in 2017 [3]. As a result of this exchange trade, *T. absoluta*, a quarantine pest of tomato culture, has already entered the territory of Kazakhstan for the first time. Tomato moth can enter the territory of Kazakhstan with imported goods, as this dangerous pest is found in neighboring countries. In the Bukhara and Tashkent regions in 2015, tomato fruits were found damaged by the tomato moth [4].

According to the plant quarantine service of the Republic of Kazakhstan, in 2015 a particularly dangerous pest of vegetable crops was detected in Aktobe, Kyzylorda, Turkestan and Zhambyl regions, and in 2016-in Atyrau, Aktobe and Almaty regions [5].

Research materials and methods. Laboratory practice was held in the laboratory "useful arthropods" of the Kazakh research Institute of plant protection and quarantine named after Zh. Zhiembayev from 30.04.2018 to 30.09.2018. As a parent population, *T. absoluta* was collected in the southern region of Kazakhstan from the Kulan greenhouse. Tomato seedlings that were planted and grown 50 days ago as a plant are managed. Tomatoes were sown in plastic containers with a diameter of 15 cm, which were in the ratio of soil: peat (1: 1). In a 40×40×50 cm cell, the mother population was bred by placing 4 plants. It was carried out with the control of development and harmfulness at different temperatures. The experiment was repeated 5 times, the results were taken into account every day. The development stage of *T. absoluta* occurred between the minimum stage of 80C and the maximum temperature of 38^0C. In practice, in the temperature range of 8-9^0C, 10-13^0C, 15-18^0C, 20-23^0C, 25-28^0C, 30-33^0C and 35-38^0C, the humidity was 50-60% and the photoperiod was 16: 8 (L:D). Light showed luxometer 910-970 LUX model "TKA-LUX". Since our region is located in the temperate zone, data on development activity during this period is very necessary.

A mole of tomato was sent to a cell for 4 tomato plants in the ratio of 1: 1 (figure 1).

Figure 1 – Tomato plant damaged by the fruit moth in the experiment

The type of imago in tomatoes was determined by the external description and signs of the genital organ of males A. A. Sineva et al Authors with data and the determinant of the vole family [6,7].

Research result. At rest, *T. absoluts* body is yellowish, gray, and rod-shaped with a length of 5-6 mm. The wingspan is 10-13 mm. In the upper part of the forewings, clear black lines are visible, arranged in rows, radially arranged in yellow-yellow color, along the extreme walls of the wings there are dashes formed by gray scales. On the main half of the wing, black dots are visible, if some are clear, others are not noticeable.

The forewings of *T. absoluta* are thin, lance-shaped, and the margins, especially the underside, are scaly. The hindwings are trapezoidal, curved, with a fringe on the outer side. At rest, the wings stick to the body (figure 2 a).

The head went from yellowish to black. Mustache rings are white and black. The bottom is usually black, with the addition of thin white dashes. In the head Department, you can observe simple eyes [6].

In the pest population, females are somewhat predominant. The male is separated from the female by the structure of the wings, the male consists of one large bristle, and the female-of three thin bristles. The underside of the male's abdomen is dirty whitish, the edges of which turn to gray, the female is white, with 4 black lines curved along the edge. Females lay 70-260 eggs.

To more accurately determine which species the tomato moth belongs to, you can find out by the structure of the male's sexual organ. The male's penis is hook-shaped, with a large Prong located in the center of the inner side.

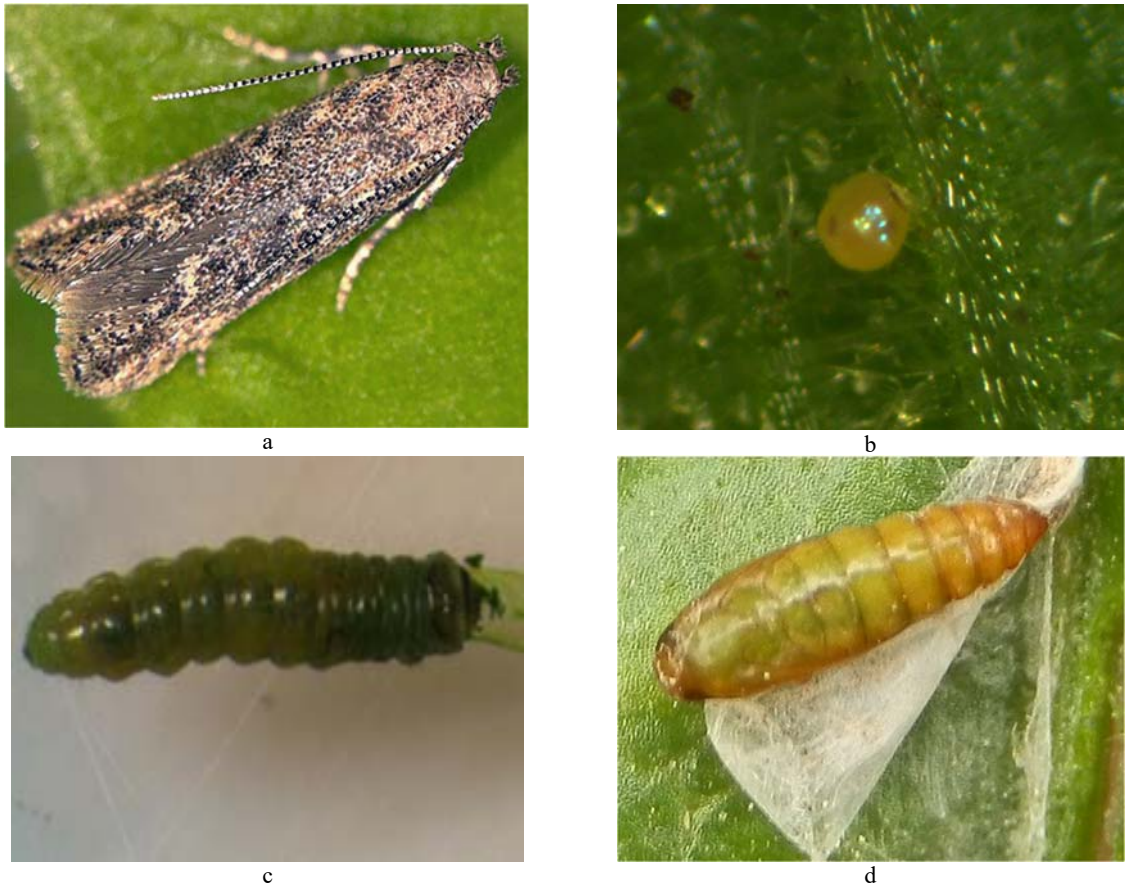

Figure 2 – Stages of development of *Tuta absoluta*: a-imago, b-egg, c-star, d-pupa

Adults are beginning to glow for 3-4 hours before sunrise. Usually in the southern part of Kazakhstan, it gives 7-9 generations per year, and the indicator changes from South to North. It develops intensively in greenhouse conditions from spring to autumn.

Eggs are elliptical-cylindrical, without fins, length-0.35-0.38 mm, width-0.22-0.25 mm, light white color, the color corresponding to the development of larvae inside, varies from yellowish to brown. Chorions are covered with a microscopic grid (Fig. 2B).

According to research p. Estea, females lay eggs mainly on plant leaves (73%) and a smaller part on stems and edges (21%), on bowl leaves (5%) and on green fruits (1%) [8].

Under laboratory conditions, females lay eggs on the front side of the leaves (35%), on the underside (45%), on the stems (15%), on the Cup-shaped leaves of the fruit (5%), and egg laying on the fruit is extremely rare. Oviposition on fruits was not observed even according to the studies of A. Monsterat [9]. Females, under favorable conditions, lay eggs in a chain on a leaf plate.

The caterpillar is cylindrical in shape, the head is clearly visible, there are 3 pairs of legs on the chest, and 5 pairs of false limbs on the stomach. At this stage, the pest is very dangerous. The newly made asterisk is not large (0.5 mm), the color is yellowish. As the colors develop (figure 2 in), they change to yellowish-green. On the back there is a noticeable scarlet color, in the form of a spot or in the form of lines arranged in width. At the front wrought iron legs there are hooks of different sizes, arranged in a

circle. The development of a starship consists of 4 stages. Caterpillars from eggs, moving away from their origin (especially if they are in groups), after 3-40 minutes feed only on parenchymal tissues, penetrating inside, creating a vertical hole up to 0.2 mm wide on the surface of leaves and fruits. First, the caterpillar increases in length, and then begins to blur in width. When reaching the size of 5-7 mm, the affected area of the leaf becomes an enlarged spot (mine) up to 1-2 square cm. From the damaged parts of the leaf, excrement in the form of granules is clearly visible. With dense damage, the affected areas on one sheet expand, connecting with each other. In this case, if the surface of the leaves is not enough for all the caterpillars, they leave their original places and go in search of other parts of the plant to complete the development stage.

The food of the caterpillars in the leaves and fruits of the bowl is different. A caterpillar that has emerged from an egg on the leaves of a bowl, due to its limited size, is forced to wander for 1-2 days, leaving its original zone, and begins to penetrate the fruit. It is usually observed when the leaves and stems are not able to complete their development, that is, they do not lay eggs on the fruits, but explain their damage. The holes located around the bowl on the fruit are faintly visible at first, as they are often covered with petioles. Only a few days after the penetration of asterisks, holes begin to be visible, as the damaged parts become black as a result of the accumulation of excrement. In the case of mine propagation, the fruit may be subject to necrosis, as the cause is the ingress of secondary pathogens through damaged pathways. The most dangerous can be considered damage to the growth point at the top of the stem, since in this case the growth and development of the entire plant stops. Damage to the product from the pest reaches 80-100% (figure 3).

Studies on the biology of tomato moth development at air temperatures from 8 to 38^{0}C are shown in table 1.

Table 1 – Duration of development of *Tuta absoluta* (day) depending on the air temperature (Laboratory of Biological plant protection, 2018)

Air temperature, ^{0}C	Day				Total number of days
	eggs	larva	pupa	imago	
8-9	15,34±0,44	46,9±0,90	31,2±0,41	32,8±1,08	126,24±0,71
10-13	8,375±0,37	39,8±0,74	18±0,57	22±1,6	79,57±0,82
15-18	7,8±0,13	28,6±0,57	12,5±0,25	23±0,5	71,9±0,36
20-23	5,4±0,20	11,1±0,20	7,6±0,27	17,2±0,65	41,3±0,33
25-28	4,6±0,20	10,9±0,20	6,3±0,22	16,9±0,41	38,7±0,26
30-33	1,8±0,13	7,14±0,17	5,04±0,10	16,2±0,41	30,18±0,41
35-38	3,2±0,13	8,8±0,41	5,44±0,27	16,4±0,27	33,84±0,27

* The experiment was conducted in laboratory conditions.

The results of the study show that the lifespan of eggs, caterpillars and pupae decreases with increasing average temperature, and also weakens as a result of lower weathering. The lower temperature threshold of the egg, caterpillar, and pupal development stage is 8-9° C.

According to the data shown in table 1, the duration of the development of the average period of harmfulness of a starship is from 10 to 25 days. These data show that the normal development of a starship depends on many indicators, including temperature and the quality of the power source. In our practice, at 70C, stargazers fall into suspended animation. Well, the most suitable temperature showed an interval of 25-28^{0}C and 30-33^{0}C. With these indicators, the starlet develops quickly, with a sufficient amount of food, the duration of development is reduced,and the size of the pupae reaches 5-5.5 mm. The temperature of 30-33^{0}C was the most suitable for starships. Their transition from one stage to another took 2-3 days. If the air temperature indicator decreases, the duration of development will continue. And if you rise above the norm, the periods of development will continue. A sharp decrease or instantaneous increase in air temperature will negatively affect the viability of the imago. Therefore, controlling the temperature regime allows the imago to influence the life span. In practice, it turned out that 85.2% of adults ceased to exist as a result of a sharp decrease or increase in temperature. To do this, use shelters that shade from the sun in greenhouse conditions, or lower the external temperature conditions at the beginning of the growing season of tomatoes.

In practice, the duration of development of the same asterisk can last several days, if there is a lack of food, the development stage may not end in one place, but go to another. Under such conditions, their

shape and size do not correspond to the stage of their own development. Only by looking at their head capsule and other identifying marks can we determine what stage of development the Stargazer is at, meaning the Stargazer and pupa will have a much smaller shape than usual. However, the imago from the doll will also be smaller in size .

Surviving from unfavorable environmental conditions, caterpillars, feeding in the plant tissues, after completing the development stage, go to the pupa outside the leaf (figure 3). After hatching from the leaves, the pupa passes within 2 days. At this stage of the star-shaped development of the pest, it is favorable for secondary treatment with contact (chemical and biological) preparations.

After development is complete, most star-shaped animals fall to the ground or are wrapped on a silk elephant (7-9 mm long) on the same leaf, to which soil particles can adhere. In our practice, we found that 72.8% of starworms were rolled up on the leaf surface of an elephant, and then, after completing the puppet stage, from the number of adults that flew out. After the caterpillars completed the development stage, we scraped the surface part of the plant into a separate cell, and the soil in a plastic container was placed in separate cells. The air temperature and humidity were at the same level. Depending on the temperature in each experiment, the imagos began to fly for a certain period of time. At this point, the undeveloped pupa determined the output ratio of paternity and motherhood (table 2). the Caterpillars are looking for a dry leaf and stem for the pupa. Finding a comfortable place, they weave themselves silk cocoons. Thus, the caterpillar returns to the cocoon even on withered leaves and stems.

Table 2 – The ratio of males to females in the resulting population (Laboratory of Biological plant protection, 2018)

Temperature, ^{0}C	Starworms	Number of males, PCs.	Number of females, PCs.	The ratio of the male to the female
15-18	13,2±1,17	13,4±1,15	13±1,32	1:0,97
20-23	14,6±1,6	13±1,17	16,2±1,7	1:1,2
25-28	20±1,75	17,2±1,02	22,8±1,38	1:1,32
30-33	27,5±3,5	21,4±0,44	33,6±2,04	1:1,57

After returning to the cocoon, the caterpillar remains stationary for 1-2 days. Under our observations, the average duration of the doll stage is 6-12 days. In Kazakhstan, *T. absoluta* does not have a pronounced diapause and falls into anabiosis in unfavorable environmental conditions, in particular at low or high temperatures. In the colder months of the year, pupae predominate in populations. According to table 2, at a temperature of 20-380C, humidity above 50%, the output of Queen cells from the doll prevailed, and a decrease in temperature and humidity contributed to the output of Queen cells from the doll

Figure 3 – The difference between the shape of dolls and the influence of the external environment and lack of nutrition

The pupa is conical in shape, 3-5 mm long, 1.1-1.8 mm wide, green to brown, dark brown towards the end of the development stage. Pupal development takes an average of 6-12 days. The pupa passes in the soil, on the leaf surface, wrapped in a cocoon.

The doll cremaster, which facilitates the exit of the imago from the pupa, is visible on the X and last segment of the abdomen, it consists of braided rigid and curved (10-11 pairs) bristles, 4 pairs are located on the back, 6-7 pairs-on the periphery [10].

Exit from the pupa most often occurs at night, the most active time for adults. Freed from the doll, the imago remains motionless until the wings are completely dry and moves away from it for some distance. It takes some time to complete the maturation of the male's sex glands: from a few hours in males to 20-22 hours in females. During mating, the male and female abdominal parts are in a sticky state from a few minutes to 4-5 hours, females lay eggs after fertilization on the leaves, mainly at night, for a week (maximum 3-5 days). Females live longer than males.

Table 3 – The effect of temperature on biological parameters of *Tuta absoluta* (Laboratory of Biological plant protection, 2018)

Temperature, ^{0}C	Viable eggs, %	Number of eggs from 1 female, PCs.	Imago life span, day	
			males	females
15-18	48,7	70±3,2	12,06±0,28	23±0,5
20-23	67,00	165,4±5,69	7,10±0,37	17,2±0,65
25-28	75,50	183,4±2,63	6,1±0,44	16,9±0,41
30-33	95,2	219,8±7,16	5,30±0,28	16,2±0,41

The ratio of the life span of the male and female in the temperature range from 15°C to 33°C is different (table 3). the life Span of females depends on the intensity of their egg laying. The most favorable air temperatures for females are 25-28^{0}C and 30-33^{0}C. There is not much significant difference between these indicators. In these indicators, we observed that females have a higher egg production, a shorter life span, and at lower temperatures, egg laying is less and a higher life span. In male imagos that have emerged from eggs, within 24 hours after the development of the sex glands cease to exist, reflecting from the female. This information was obtained through the experience of determining their survival rate by keeping males and females in a cage at low temperatures in a ratio of 1: 1. When counting after 5 days, the killed individuals were pulled out of the cage, the sex was determined under binoculars and taken into account. The imago does not tolerate an immediate increase or decrease in air temperature, but the eggs and larva have become more stable. During the experiment, adults adapted to a temperature of 250C, the death rate from fluctuations in air temperature was 95%, and the inedibility of eggs showed 9.8%. Therefore, the use of negative factors and methods that negatively affect the survival of starships can affect the normal functioning of the pest population.

Conclusion. The tomato moth quickly adapted to the new region and, as a result of its resistance to environmental conditions, entered the countries of Central Asia, and in 2015 it spread across the territory of Kazakhstan in the Aktobe, Kyzylorda, Turkestan and Zhambyl regions. Biological development of the pest occurs at a temperature of +8 - +38^{0}C, this indicator contributed to the appearance of 7-9 generations per year in the southern regions. The air temperature of 7^{0}C entered a state of suspended animation, that is, it does not fall into diapause in adverse conditions. The ratio of females to females depends directly on the air temperature and humidity. When the air temperature drops below 20^{0}C, males predominate, and when the rise is higher, females predominate. The harmfulness of the tomato moth, which has fallen into a new zone, destroys the tomato crop by 80-100%. Farmers suffer economic losses due to ignorance of the biology of this pest and the lack of natural entomophages.

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ЗЕРТХАНАЛЫҚ ЖАҒДАЙДАҒЫ *TUTA ABSOLUTA* POVOLNY-НЫҢ (LEPEDOPTERA:GELECHIIDAE) МОРФОЛОГИЯЛЫҚ БЕЛГІЛЕРІ МЕН ДАМУЫНЫҢ БИОЭКОЛОГИЯЛЫҚ ЕРЕКШЕЛІКТЕРІ

Аннотация. Мақалада зертханалық және жылыжай жағдайында аса қауіпті *Tuta absoluta* (Povlony) нысанының морфологиялық белгілері мен биоэкологиялық даму ерекшеліктерін анықтау бойынша деректер келтіріледі. Жылыжай мен зертханалық жағдайда имаго күн шығардан 3-4 сағат бұрын белсенді шағылыса

бастайды. Ұрықтанған аналық 1-1.5 тәулік өткен соң бір апта бойы түнгі мезгілде жұмыртқа салады. Зертханалық жағдайда аналықтар жұмыртқаны бір-бірден немесе кездейсоқ ретпен жапырақ бетіне (35%), төменгі жағына (45%), сабағына (15%), тостағанша жапырағына (5%) салады, ал жеміске жұмыртқа салу жағдайы байқалмады. Жұмыртқадан шыққан жұлдызқұрттар сол аймақтан алыстамай 5 минут аралығында жапырақ мезодермасына енеді. *T. absoluta* жұлдызқұрты цилиндр тәрізді, басы айқын, үш жұп кеуде аяқтары және бес жұп құрсақ жалғанаяқтан тұрады.

Зерттеуімізде жұлдызқұрттың даму сатысының ұзақтығы даму кезеңінде бір аймақта қоректенген жұлдызқұрттармен салыстырғанда азық іздеп, бірнеше рет орын ауыстырған жұлдызқұртың бойында бірнеше күнге артатынын көрсеттік. Қызанақпен қоректенетін жұлдызқұрттар басқа қоректік өсімдікпен (мысалы, баклажан мен картоп) қоректенетін жұлдызқұрттармен салыстырғанда жылдам дамитыны атап өтілді. Тағам сапасы құнарлылыққа, жұмыртқалардың өмір сүруіне және дернәсіл өліміне де әсер етеді. Даму кезеңінің барлық бес сатысын аяқтағаннан кейін, жұлдызқұрттар інінен шығып немесе сол жерде қуыршақтана бастайды. Жұлдызқұрттар қуыршақтанар алдында түсін қою жасылдан ашық жасылға өзгертіп, өзін өрмекшелі коконға орап, 1-1.5 тәулік бойы қозғалыссыз жатады.

Қызанақ күйе көбелегінің қуыршағы, басқа қабыршыққанатылар секілді «obtecto» пішіндес, яғни болашақ үлкен өсінділермен бірге болады. Қуыршақ ұзындығы 4.5-5 мм және ені 1.3-1.5 мм, конус тәрізді, жасыл түске боялған, даму сатысының соңында қоңыр болады.

Популяцияда аталықтарға қарағанда аналықтары басым. 15°С және 33°С температурада аналық пен аталықтың өмір сүру ұзақтығы әртүрлі болады. Ауа температурасы неғұрлым жоғары болса, популяцияда аналықтар басым түседі.

Түйін сөздер: қызанақ, қызанақ күйе көбелегі, жұмыртқа, жұлдызқұрт, қуыршақ, имаго, температура, ылғалдылық, даму.

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МОРФОЛОГИЧЕСКАЯ ХАРАКТЕРИСТИКА И БИОЭКОЛОГИЧЕСКИЕ ОСОБЕННОСТИ РАЗВИТИЯ *TUTA ABSOLUTA* POVOLNY (LEPEDOPTERA:GELECHIIDAE) В ЛАБОРАТОРНЫХ УСЛОВИЯХ

Аннотация. В статье приводятся данные по определению морфологических признаков и биоэкологических особенностей развития особо опасного объекта *Tuta absoluta* (Povlony) в лабораторных и тепличных условиях, когда имаго начинает активно спариваться за 3-4 часа до восхода Солнца. Спустя 1-1.5 дней после спаривания, самки откладывают яйцо в ночное время в течение недели. В лабораторных условиях самки откладывают яйцо по одному или беспорядочно на поверхности листьев (35%), снизу (45%), в стеблях (15%), на листьях чашек (5%), а на плодах почти не откладывают. После вылупления из яиц личинка прогрызает вход на мезодерму листа и проникает в него в течение 5 минут. Личинка *T. absoluta* имеет почти цилиндрическую форму, с четко выраженной головой, тремя парами грудных ножек и пятью парами брюшных псевдоножек.

Показано, что продолжительность личиночной стадии увеличивается на несколько дней для тех особей, которые неоднократно перемещались в поисках пищи по сравнению с теми, которые находились на одном месте на всем протяжении развития данной стадии. Отмечено, что личинки, питавшиеся на томатах, развиваются быстрее по сравнению с личинками, питавшимися на других растениях-хозяевах того же семейства (например, баклажанах и картофеле). Качество пищи оказывает влияние и на плодовитость, выживание яиц и смертность личинок. После завершения всех пяти стадий развитии, личинки выходят из мины, а иногда там же окукливаются. Перед окукливанием личинки меняют свой цвет от темно-зеленого на светло-зеленый цвет. Перед окукливанием гусеница оплетает себя паутинным коконом и в неподвижном состоянии остается в течение 1-1,5дней.

Куколка томатной моли, как и у других чешуекрылых, имеет тип “obtecto”, то есть с будущими отростками взрослых особей. Она имеет форму конуса длиной 4.5-5 мм и шириной 1.3 – 1.5 мм, зеленоватого цвета, переходящего к более интенсивному коричневому, и в конце развития становится коричневого цвета.

В популяции самки преобладают над самцами. При температуре 15°С и 33°С соотношение продолжительности жизни самки и самки различается. Чем выше температура воздуха, тем больше в популяции преобладают самки.

Ключевые слова: томат, томатная минирующая моль, яйцо, гусеница, куколка, имаго, температура, влажность, развитие.

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