THE STUDY OF *HELICOVERPA ARMIGERA* (HÜBNER) AND *SPODOPTERA EXIGUA* (HÜBNER) BIOLOGICAL LIFESTYLES IN ARMENIA

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ABSTRACT

In 2021-2022, studies on the biological lifestyle of Helicoverpa armigera (Hübner) and Spodoptera exigua (Hübner) were carried out in the pepper fields of Khoronk community, Armavir marz, Republic of Armenia. As a results show that the flight of the adults of Spodoptera exigua (Hübner) starts from the third ten days of May to the third ten days of June. Females lay eggs in piles on the upper and lower surfaces of pepper leaves. She lays 87-173 eggs in each pile. The newly hatched larvae feed on the leaves, causing them to ossify, while the mature larvae feed on the fruit, entering the fruit and feeding on the seeds. After finishing feeding, they descend into the ground and mate at a depth of 2-6 cm. Spodoptera exigua (Hübner) overwintering in the soil in the puporial stage. It develops in 2-3 generations during vegetation. The flight of adults of Helicoverpa armigera (Hübner) starts from the first ten days of June and continues until the third ten days of June. Females lay eggs in small piles on the leaves, buds, and stems of pepper, laying 5-7 eggs in each. Each female can lay 396-472 eggs during her lifetime. The newly hatched larvae first feed on the flowers or flower buds, then move onto the leaves and start feeding on the leaves. Mature larvae feed on fruits. As a result of damage, the fruits lose their marketable appearance and rot. After completing the development, the larvae descend to a depth of 4-11 cm into the soil and pupation. The Helicoverpa armigera (Hübner) overwinters in the puporial phase. It develops in 2 generations per year in the pepper fields.

Key words: pest, biological lifestyle, research, butterfly, larva

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دراسة أنماط الحياة البيولوجية لـ (Helicoverpa Armigera (HÜBNER وSpodoptera exigua (Hübner) في أرمينيا

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باحث **أستاذ**
1 **مركز أبحاث تقييم المخاطر وتحليلها في مجال سلامة الغذاء، أرمينيا– [2]جامعة الزراعة الوطنية الأرمنية، أرمينيا**

المستخلص

في عامي 2021–2022، أجريت دراسات على نمط الحياة البيولوجية لـ (Helicoverpa armigera (Hübner و Spodoptera exigua (Hübner)) في حقول الفلفل في مجتمع Khoronk، Armavir marz، جمهورية أرمينيا.أظهرت النتائج أن طيران البالغين من Spodoptera exigua (Hübner) يبدأ من الأيام العشرة الثالثة من شهر مايو إلى الأيام العشرة الثالثة من شهر يونيو. تضع الإناث البيض في أكوام على السطح العلوي والسفلي لأوراق الفلفل. تضع 87–173 بيضة في كل كومة. تتغذى اليرقات حديثة الفقس على الأوراق مما يتسبب في تحجرها، بينما تتغذى اليرقات الناضجة على الثمار وتدخل الثمار وتتغذى على البذور. بعد الانتهاء من التغذية تنزل إلى الأرض وتتزاوج على عمق 2–6 سم. Spodoptera exigua (Hübner) تشتي في التربة في مرحلة العذراء. تتطور في 2–3 أجيال أثناء فترة النمو النباتي. يبدأ طيران البالغين من Helicoverpa armigera (Hübner) من الأيام العشرة الأولى من شهر يونيو وتستمر حتى الأيام العشرة الثالثة من شهر يونيو. تضع الإناث البيض في أكوام صغيرة على أوراق وبراعم وسيقان الفلفل، وتضع 5–7 بيضات في كل منها. تستطيع كل أنثى أن تضع 396–472 بيضة خلال حياتها. تتغذى اليرقات حديثة الفقس أولاً على الأزهار أو براعم الزهور، ثم تنتقل إلى الأوراق وتبدأ في التغذية عليها. تتغذى اليرقات الناضجة على الثمار. ونتيجة للتلف، تفقد الثمار مظهرها القابل للتسويق وتتعفن. بعد اكتمال النمو، تنزل اليرقات إلى عمق 4–11 سم في التربة وتتحول إلى شرنقة. تقضي Helicoverpa armigera (Hübner) الشتاء في مرحلة الشرنقة. تتطور في جيلين في السنة في الحقول.

الكلمات المفتاحية: آفة، نمط حياة بيولوجي، بحث، فراشة، يرقة

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INTRODUCTION

Vegetable growing in Armenia is one of the primary sub-branches of agriculture, which has a history and traditions of thousands of years. Vegetables are one of the main components of agricultural production in the world (4), and are considered as an important agricultural product for consumers because they contain antioxidants, oil, vitamins, proteins and calcium,which are part of the vital substances needed by humans (3, 21). Pepper is one of the main vegetable plants in Armenia. It belongs to the Solanaceae family (24, 34). It is notable for its taste and high nutritional properties and amount of vitamins, it is rich in non-nitrogen extractive substances, crude protein and fats. Its chemical composition is highly variable depending on the variety, degree of maturity and growing conditions. The amount of dry substances ranges between 5-12%, sugar makes up 2-8.6%, Cellulose - 1.06-1.16%, ash - 0.06-0.35%. One of the most valuable properties of pepper is that it contains a large amount of vitamin C. It is 4-5 times more in pepper than in lemon (32). However, many pests cause a lot of damage to pepper during the summer vegetation (49), among which *Helicoverpa armigera* (Hübner) (syn. *Chloridea armigera Hübner*) and *Spodoptera exigua* (Hübner) (syn. *Caradrina exigua Hübner*) stand out due to the damage they cause to the plant in the larval stage. The *Helicoverpa armigera* (Hübner) was first described in 1803-1808 by Hubner (Hemming 1937), and Hardwick created the genus *Helicoverpa* in which he included *Helicoverpa armigera Hardwick* (38). The pest is widespread in Europe, Africa, Australia and certain parts of Asia (27, 46), in several countries of North America (11), Brazil (14, 31), in Argentina, Bolivia, Peru, Colombia (35). *Helicoverpa armigera* (Hübner) is also known by other names: cotton bollworm, the old world bollworm, scarce bordered straw worm, tomato fruit worm, the gram pod borer, tobacco budworm, corn earworm, African cotton bollworm, and American bollworm (26):======*Spodoptera exigua* (Hübner) is native to Southeast Asia, but was first discovered in North America in Oregon in 1876 and then spread to Mexico and the Caribbean (48). It is also popular by the following names: asparagus fern caterpillar, cotton worm, lesser armyworm, lesser cotton worm, onion armyworm, small mottled willow moth, sugarbeet armyworm (37), small earthworm (1): It is widespread in the European part of Russia, Belarus, Moldova, Kazakhstan, Southern Europe, Africa, Australia, Asia, North and Central America (2), Israel (25), China (13, 17, 39), in Japan (53), in Malaysia (8), in Pakistan (19). *Helicoverpa armigera* (Hübner) and *Spodoptera exigua* (Hübner) belong to the Noctuidae family of the Lepidoptera order (6). They have a complete development cycle, which includes four main stages of development: egg, larva, pupa, adult (16, 29). *Spodoptera exigua* (Hübner) in Iran (7) and Japan (45) it overwinters in the larval stage, in China it overwinters in the pupa (53) and adult stages (28). *Spodoptera exigua* (Hübner) gives 3 generations annually in the Spanish southeastern (9), 5 in California (22), 5-7 in China (44), and up to 11 generations in East Asia (18). *Helicoverpa armigera* (Hübner) overwinteres in the soil during the larval stage in regions with a mild climate (Australia, Greece, China) (15, 23, 33). *Helicoverpa armigera* (Hübner) gives 1-2 generatios per year in China (Feng et al. 2009), 3-4 in the Iran (36), 5-7 in the India (42) and up to 10 -11 generations in Vietnam (51).

MATERIAL AND METHODOLOGY

The studies of the biological characteristics of *Helicoverpa armigera* (Hübner) and *Spodoptera exigua* (Hübner) were carried out in 2021-2022 in the pepper fields of Khoronk community of Armavir region of the Republic of Armenia, and some researches were carried out in the entomology laboratory of the National Agrarian University of Armenia. Some features of the pest's biological lifestyle (the course of development of individual stages, fertility, the number of generations) were revealed in kapron insulators installed in the pepper field. In order to study the biological lifestyle, the corresponding stages of the pests were placed on pepper plants and isolated in kapron isolators. Adult butterflies were fed with 10% honey syrup (8, 30). Pest eggpiles were placed in Petri dishes and calculations were conducted on daily observations. The larvae hatched from the

eggs of each of the pests were separated into 10 pieces and again placed in Petri dishes and their development process was observed. Experiments were performed with 10 times repetitions (51). Between 2021-2022, studies of the dynamics of the flight of *Spodoptera exigua* (Hübner) and *Helicoverpa armigera* (Hübner) adults were carried out with the help of pheromone traps. Pheromone traps manufactured by Russell IPM, UK were used. The traps were placed every 100m on the edges of the pepper fields, in places protected from direct sunlight. The traps were tied to wooden poles, the bottom of the trap was at a height of up to 50 cm. The pheromone pods were changed every 30 days (20). After setting the traps, they were checked daily, and every 3 days after the appearance of butterflies and the number of caught butterflies was counted.

RESULTS AND ANALYSIS

During 2021-2022, the biological lifestyle of *Helicoverpa armigera* (Hübner) and *Spodoptera exigua* (Hübner) was studied in the pepper fields of Khoronk community. Khoronk community is located at an altitude of 830m above sea level. According to studies conducted with pheromone traps, the flight of *Spodoptera exigua* (Hübner) adults starts from the third ten days of May to the third ten days of June. They feed on the nectar of various plants. Butterflies are gray. There are well-defined kidney-shaped spots on the upper wings. 2-4 days after flight, females begin to lay eggs. Females lay eggs in piles on the upper and sometimes the lower surface of pepper leaves. Each female lays 5 piles, each with 87-173 eggs, according to other sources 9-160 eggs (41) or 50-150 (10) can be laid in each pile, after that the female covers them with an accessory genital gland and abdominal hairs. Eggs are spherical, roundish, at first light milky, then acquire a yellow-green shade, and at the end of development, the color darkens. Embryonic development of eggs lasys 4-10 days. Newly hatched larvae first feed in groups in the same place, after which they spread throughout the plant and from there to neighboring plants. In our studies, the color of the larvae was different, from light green to dark green, gray, brown, and according to other authors, the larvae can be yellowish (10), sometimes also black (52). During the hot hours of the day, *Spodoptera exigua* (Hübner) larvae can be seen on the bottom tier of the plant or on the other side of leaves attached to the soil. Young larvae first feed on the leaves, causing them to skeletonify, and then as they develop, they move on to feeding on the fruit, gnawing, making deep holes, entering the fruit, where they continue their diet and feed on the seeds. Such fruit spoil after a short time. According to our research, the duration of the larval stage is 15-23 days. During their development, *Spodoptera exigua* (Hübner) larvae molt 5 times, after which they descend to the soil, prepare the soil cradle, and proceed to mating. Larvae pupate at a depth of 2-6 cm in the soil. Pupas are initially brown, then acquire a darker coloration. According to our research, the duration of the puporial phase is 11-16 days. *Spodoptera exigua* (Hübner) overwinteres in the puporial phase at a depth of 9-12 cm in the soil. According to our studies, the length of development of one generation of *Spodoptera exigua* (Hübner) within the research years was 29-49 days, and according to other data, 21-24 (12), 31-38 (40) (Fig. 1).

Figure 1. Development stages of *Spodoptera exigua* (Hübner) (a. egg, b. larva, c. pupa, d. adult)

The duration of the development stages of *Spodoptera exigua* (Hübner), depending on the climatic conditions, is presented in Table (1).

Table 1. The duration of *Spodoptera exigua* (Hübner) development stages under the conditions of

Developme nt stages	2021			2022		
	Average temperature of the air 0 C	Average relative air humidity, %	Duration in days	Average temperature of the air 0 C	Average relative air humidity, %	Duration in days
First generation						
Egg	**29.1**	**32**	**4**	**23.5**	**45**	**10**
Larva	**26.8**	**39**	**15**	**23.8**	**44**	**19**
Pupa	**27.1**	**41**	**11**	**25.1**	**36**	**14**
Second Generation						
Egg	**28.2**	**36**	**6**	**26.4**	**38**	**7**
Larva	**23.7**	**38**	**19**	**27.6**	**39**	**14**
Pupa	**20.6**	**45**	**18**	**26.0**	**35**	**13**
Third generation						
Egg	-	-	-	**24.0**	**39**	**9**
Larva	-	-	-	**22.5**	**39**	**22**
Pupa	-	-	-	**18.6**	**48**	

According to our research, *Spodoptera exigua* (Hübner) developed 2 generations in the pepper fields in 2022 at an average air temperature of 20.6-29.1 ^{0}C and an average relative air humidity of 32-45%, and 3 generations in 2023, under conditions of average air temperature of 18.6-27.6 ^{0}C and average relative humidity of 35-48%. The results of the studies of the flight dynamics of *Spodoptera exigua* (Hübner) adults carried out with thehelp of pheromone traps between 2021-2022 are presented in Figure (2).

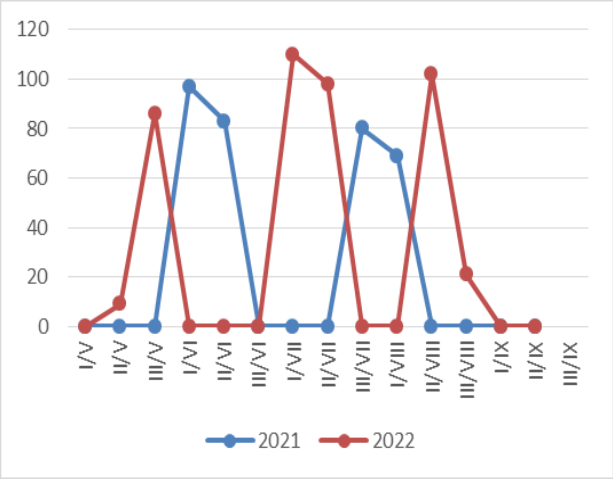

Figure 2. Peak flight of *Spodoptera exigua* (Hübner) adults in 2021-2022

According to the studies carried out in 2021-2022, the flight of *Helicoverpa armigera* (Hübner) adults starts from the first ten days of June and continues until the third ten days of June. Adults feed on nectar from various plants. Butterflies can be light brown, dark brown or greenish-gray in color. A few days after fledging, the adults are fertilized and after another 3-4 days they begin to lay eggs. *Helicoverpa armigera* (Hübner) lay eggs in small egg clusters on pepper leaves, buds and stems. Females laid up to 5-7 eggs in each clutch. According to the data of our research, each female laid 396-472 eggs on the pepper. According to literary sources, females can fertilize several times and lay hundreds of eggs, one or in clusters (15), and sometimes they can lay up to 3000 eggs (5). Eggs are round, white in color at first, then acquire a greenish tint, and at the end of development, the color darkens to ash-brown. Embryonic development of eggs takes 3-7 days. Newly hatched larvae first feed on flowers or flower buds, then move onto leaves and start feeding on leaves, and according to some sources, newly hatched larvae feed on eggshells, and if they do not find suitable food, they eat the viable eggs and not the newly hatched inactive larvae (38). The larvaes are always on the plant. They feed on the vegetative and generative organs of the plant. Young larvae feed first on the upper leaf and then on the epidermis, leaving the lower leaf unharmed. The already mature larvae feed on the fruit, make holes in them and enter the fruit and feed on the seeds. Damaged fruits rot after some time, as various harmful pathogens enter through the open holes and cause secondary damage (Fig. 3). In our studies, *Helicoverpa armigera* (Hübner) larvae were multicoloured, from light green to dark green, yellowish, dark

brown, with one yellowish stripe on both sides, and three more brown stripes on the back. However, it can also be reddish-brown (43). The duration of the larval stage is 12-20 days.

Figure 3. Development stages of *Helicoverpa armigera* (Hübner) (a. egg, b. larva, c. pupa, d. adult)

After the larvae have completed development, they descend to the soil to pupate. They usually mate at a depth of 4-11 cm in the soil, but according to other literary sources, they pupate at a depth of 2-17.5 cm (15). Pupas are light brown at first, then acquire a darker coloration. The duration of the puporia phase is 13-16 days. The *Helicoverpa armigera* (Hübner) overwinteres in the larval stage in a cradle made in the soil. During the years of our research, the length of development of one generation of *Helicoverpa armigera* (Hübner) is 29-43 days, and according to different literary sources it can last 23-34 days (45), 30-34 (29). The duration of *Helicoverpa armigera* (Hübner) development stages depending on the climatic conditions is shown in Table (2).

Table 2. The duration of development stages of *Helicoverpa armigera* (Hübner) under the conditions of Khoronk community

Development stages	2021 Average temperature of the air 0 C	2021 Average relative air humidity, %	2021 Duration in days	2022 Average temperature of the air 0 C	2022 Average relative air humidity, %	2022 Duration in days
			First generation			
Egg	22.8	35	7	24.8	38	5
Larva	26.4	34	16	23.5	45	20
Pupa	26.8	39	16	25.1	36	15
			Second Generation			
Egg	26.0	43	4	26.4	38	3
Larva	27.1	41	14	27.6	39	12
Pupa	28.2	36	11	28.0	35	12

Helicoverpa armigera (Hübner) developed 2 generations per year in the pepper fields in our research. During 2021-2022, the results of studies of the flight dynamics of *Helicoverpa armigera* (Hübner) adults using pheromone traps are presented in Figure (4).

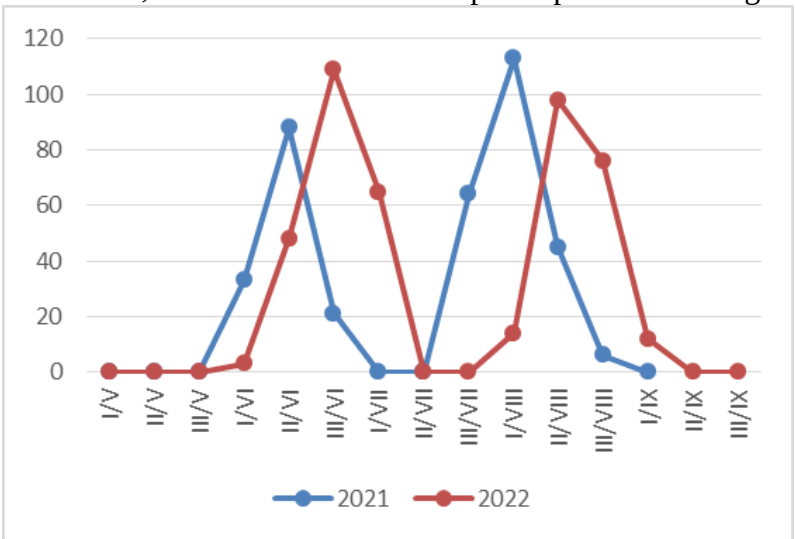

Figure 4. The peak flight of *Helicoverpa armigera* (Hübner) adults between 2021-2022

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Conclusion

In the Republic of Armenia, *Spodoptera exigua* (Hübner) and *Helicoverpa armigera* (Hübner) are one of the main pests of pepper. Egg laying is carried out mainly on leaves. Plants are damaged in the larval stage. The main damage is done to leaves and fruits. Feeding on the leaves, they cause complete destruction of the leaf, and entering the fruits, they feed on the seeds, as a result of which the fruits rot. Both pests overwinter in the soil in the larval stage. During the growing season, depending on the climatic conditions, *Helicoverpa armigera* (Hübner) gives 2 generations, and *Spodoptera exigua* (Hübner) - 2-3 generations.

Conflict of interests: The authors declare that there is no competing interest.

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