Journal of Scientific Agriculture 2023, 7: 13-16
doi: 10.25081/jsa.2023.v7.8216
https://updatepublishing.com/journal/index.php/jsa

Research Article

ISSN: 2184-0261

Biology of *Spodoptera litura* on natural and artificial diet under laboratory conditions

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ABSTRACT

Armyworm, *Spodoptera litura* (Lepidoptera; Noctuidae) is one of the most economically significant insect pests in global agriculture. The current study was performed to study the biology of *S. litura* under laboratory conditions. In the current study, the biological parameters of pests i.e., egg, larva, pupa and adult along with the duration were determined. The mean incubation period of pests on cabbage, maize and artificial diet was 2.86±0.33, 3.09 ± 0.12 and 3.97±0.77 days, respectively. *S. litura* had five instars. The mean developmental period of the first, second, third, fourth, fifth and sixth larval instar on cabbage was 3.44±0.11, 2.09±0.12, 4.11±0.12, 3.00±0.20, 6.68±0.23 and 5.94±0.18 days, respectively while 2.81±0.77, 3.55±0.33, 3.64±0.45, 4.43±0.71, 6.55±0.21 and 5.98±0.19 days on the maize, respectively. The mean developmental periods were 3.85±0.54, 3.45±0.63, 3.67±0.67, 4.37±0.82, 6.55±0.23 and 5.30±0.38 days of first, second, third, fourth, fifth and sixth larval instars on artificial diet, respectively. The mean total life period of *S. litura* was 33.43±5.86 days on cabbage and 34.79±6.95 days on maize while 35.98±7.86 days on an artificial diet. The longest developmental period of *S. litura* was recorded on the artificial diet while the minimum was on cabbage. The mean developmental period of pupa was 7.50±0.71 days on cabbage, 9.87±0.94 days on maize and 11.63±0.99 days on an artificial diet. Females were short-lived as compared to males. The pre-oviposition, oviposition and post-ovipositional period of *S. litura* on cabbage were recorded as a minimum while maximum on an artificial diet. The maximum number of eggs laid by females with the highest hatchability on cabbage followed by maize and artificial diet. An artificial diet was not good for pest development and growth as compared to a natural diet i.e., cabbage and maize. The findings will provide basic information about food pests which help in pest management.

KEYWORDS: Armyworm, *Spodoptera litura*, Biological paramters, Cabbage, Maize, Artificial diet, Pakistan

Received: October 10, 2022
Revised: January 27, 2023
Accepted: January 30, 2023
Published: February 03, 2023

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INTRODUCTION

The armyworm, *Spodoptera litura* is a generalist herbivore and one of the most significant economic pests. A type of economically significant insect pest known as *S. litura* has the potential to infest more than 120-300 distinct host crop plants and cause major crop damage including weeds, green manures, fruits, vegetables, tea, and floricultural plants. It has been distributed throughout the world, especially in Pakistan, India, Africa, China, Australia, and many other countries (Farhan *et al.*, 2022; Saljoqi *et al.*, 2022). This destructive pest caused 31-100 crop losses. Although scientists and researchers or farmers have invested a lot of time, energy, and resources towards reducing this noxious pest, it still poses a substantial threat, with significant outbreaks happening twice a year, from May to June and again from October to December. It was claimed that in the outbreak situation, at least 4-15 egg masses and 400-500 larvae were seen on agricultural crops (Saljoqi *et al.*, 2015; Narvekar *et al.*, 2018; Murtaza *et al.*, 2019).

Many researchers use a variety of management techniques, including cultural, biological, and chemical ones, to eradicate this infamous pest on a national and international scale. Insecticides are one type of chemical control that is widely used either alone or in conjunction with other chemicals to control this pest, *S. litura* (Tuan *et al.*, 2016; Ramzan *et al.*, 2019; Ramzan *et al.*, 2020a). Many farmers and researchers use both small-scale and large-scale applications of traditional insecticides as well as a variety of novel

chemical insecticides. Pests become resistant to a range of commonly used pesticides, primarily carbamates and pyrethroids, as a result of chemical misuse, which finally resulted in the failure of effective control measures (Abdullah *et al.*, 2019; Huang *et al.*, 2019; Kumar & Bhattacharya, 2019). To identify and manage this pest, it is necessary to ascertain the reproductive biology of pests on both natural and artificial diets. A pest population's capacity for host damage is represented by its fitness parameters, which can offer an integrated and thorough picture of the survival, development, and reproduction of a population. By keeping in view the importance, the current study was conducted under controlled conditions.

MATERIALS AND METHODS

The current study was conducted under controlled conditions from 2018-2019. Different stages of pests such as eggs and larvae were collected from different fields of cabbage and maize and then brought to the laboratory for rearing purposes. Each collected stage was kept separately and larvae were kept individually in the petri dishes with cabbage leaves as food till pupation. The pupae were collected and shifted into new plastic containers for adult emergence. The emerged adults were shifted into rearing cages for getting eggs and mass cultured. Adults were fed with a 10% honey solution. Eggs were collected till the death of adults. Eggs were collected and shifted into plastic containers for obtaining mass culture. Thirty newly emerged larvae were collected from the culture and shifted individually into a petri dish with a natural diet and another thirty larvae shifted into a petri dish containing artificial diets. The diets were changed on a daily basis and replaced with new food. The reproductive or biological parameters of pests from the egg to the adult stage were recorded on a daily basis. The fresh leaves of cabbage and maize were provided to newly emerged larvae. The artificial diet was used as suggested by Gupta *et al.* (2005). The rearing of the pest was done at 25 ±1°C temperature and 60-65% relative humidity with a photoperiod of 14:10 (Light: Dark) h. The recorded parameters were statistically analyzed using statistical software.

RESULTS AND DISCUSSION

This pest can be found in many tropical and temperate regions and affects over 120 plant species, including rice and citrus plant leaves as well as weeds, flowers, and vegetable crops. The type of food consumed by the bug during its larval stage determines how it grows and develops. Raising economically significant insect pests is necessary to learn about their feeding patterns and life histories (Saljoqi *et al.*, 2015). Eggs were laid by females of *S. litura* in masses dorsal and lower side of the leaves while on the wall of the containers in the laboratory conditions. The eggs were yellowish-white and round in shape covered with small hairs (Ramzan *et al.*, 2019).

The mean incubation period of pests on cabbage, maize and artificial diet was 2.86±0.33, 3.09±0.12 and 3.97±0.77 days, respectively. The mean developmental period of the first, second, third, fourth, fifth and sixth larval instar on cabbage was 3.44±0.11, 2.09±0.12, 4.11±0.12, 3.00±0.20, 6.68±0.23 and 5.94±0.18 days, respectively while 2.81±0.77, 3.55±0.33, 3.64±0.45, 4.43±0.71, 6.55±0.21 and 5.98±0.19 days on the maize, respectively. The mean developmental periods were 3.85±0.54, 3.45±0.63, 3.67±0.67, 4.37±0.82, 6.55±0.23 and 5.30±0.38 days of first, second, third, fourth, fifth and sixth larval instars on artificial diet, respectively. The total developmental period of the 1st to 6th larval instar was 30-35 days on the cabbage as given in Table 1 and 32-39 days on maize (Table 2), while 35-41 days on the artificial diet as given in Table 3. The mean total life period of *S. litura* was 33.43±5.86 days on cabbage and 34.79±6.95 days on maize while 35.98±7.86 days on the artificial diet. The longest developmental period of *S. litura* was recorded on the artificial diet while the minimum was on the cabbage. It was recorded that cabbage was the most preferable host plants or food for pest as compared to maize and artificial diets. Our current study findings are almost similar to the previous study findings which were conducted by many researchers and scientists around the globe under controlled and open conditions. For example, Ramzan *et al.* (2020b) reported similar findings that cabbage is the most suitable host or food for pest feeding and Ramzan *et al.* (2020a) also reported similar results about host plants of *S. litura*. The male and female longevity on the artificial diet was 6.66±0.69 and

Table 1: Biology of *S. litura* on cabbage

Parameters	Mean±SE	Range
Incubation period	2.86±0.33a	2-3 days
1st instar	3.44±0.11b	3-4 days
2nd instar	2.09±0.12b	2-3 days
3rd instar	4.11±0.12a	4-5 days
4th instar	3.00±0.20a	3-4 days
5th instar	6.68±0.23b	6-7 days
6th instar	5.94±0.18b	5-6 days
Total larval period (1st-6th)	30.86±0.56b	30-35 days
Pupal period	7.99±0.42c	7-11 days
Male longevity	6.33±0.22a	6-8 days
Female longevity	7.79±0.11b	7-10 days
Total life cycle (eggs-adults)	33.43±5.86a	33.52-35.91

Table 2: Biology of S. litura on maize

Parameters	Mean±SE	Range
Incubation period	3.09±0.12a	3-4 days
1st instar	2.81±0.77a	2-3 days
2nd instar	3.55±0.33a	3-4 days
3rd instar	3.64±0.45a	3-5 days
4th instar	4.43±0.71c	4-5 days
5th instar	6.55±0.21a	6-7 days
6th instar	5.98±0.19a	5-7 days
Total larval period (1st-6th)	32.08±0.12b	32-39 days
Pupal period	7.85±0.63a	7-14 days
Male longevity	6.11±0.37a	6-8 days
Female longevity	6.91±0.48a	6-9 days
Total life cycle (eggs-adults)	34.79±6.95a	35.06-37.54

Table 3: Biology of *Spodoptera litura* on artificial diet

Parameters	Mean±SE	Range
Embryonic period	3.97±0.77a	3-4 days
1st instar	3.85±0.54a	3-4 days
2nd instar	3.45±0.63a	3-5 days
3rd instar	3.67±0.67c	3-7 days
4th instar	4.37±0.82a	4-6 days
5th instar	6.55±0.23b	6-9 days
6th instar	5.30±0.38a	5-9 days
Total larval period (1st-6th)	35.54±0.74a	35-41 days
Pupal period	7.09±0.65b	6-7 days
Male longevity	6.66±0.69b	5-7 days
Female longevity	6.45±0.11a	5-8 days
Total life cycle (eggs-adults)	35.98±7.86a	36.33-43.59

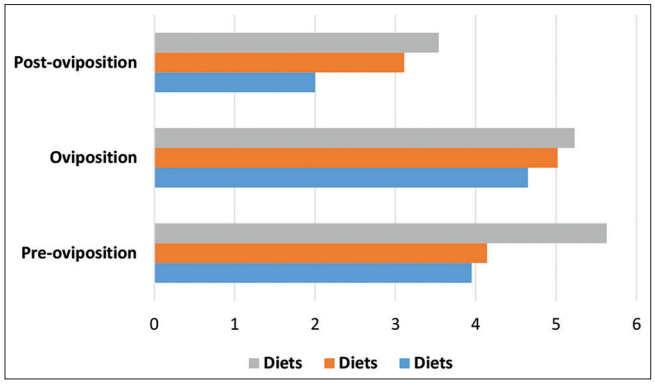

Figure 1: Ovipositional period of *S. litura* on different diets

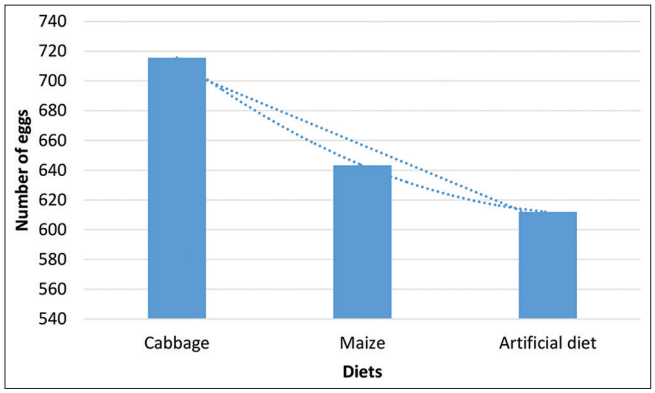

Figure 2: Number of eggs laid by female on different diets

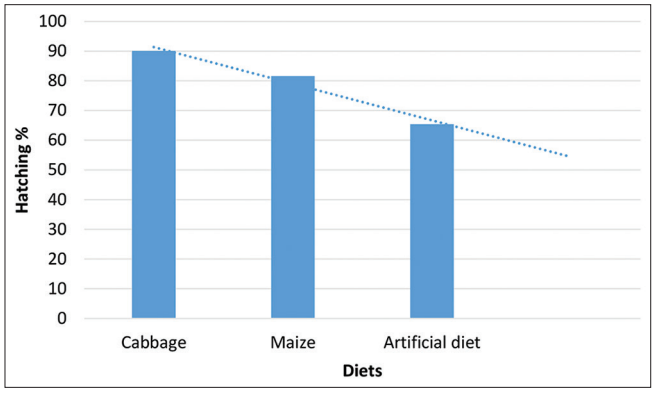

Figure 3: Hatchability percentage on different diets

6.45±0.11 days, respectively. Anjali *et al.* (2014) reported the similar findings.

The pre-oviposition, oviposition and post-ovipositional period of *S. litura* on cabbage were recorded as a minimum while maximum on an artificial diet as shown in Figure 1. The previous studies conducted around the globe on *S. litura* reported similar findings (Narvekar *et al.*, 2018). Ashwini *et al.* (2016), Jeyasankar *et al.* (2013) and Javar *et al.* (2013) reported similar findings about the biological parameters of pests under controlled conditions by using different hosts. The maximum number of eggs laid by females were on the cabbage followed by maize and an artificial diet. Naik *et al.* (2017) reported the maximum egg laying capacity of pests on soybean, while Farahani *et al.* (2011) conducted a study on vegetables and soybean and reported similar findings. According to the current study findings, the artificial diet was not good for pest development and growth as compared to the natural diet i.e., cabbage and maize as shown in Figure 2. The maximum hatchability was found in cabbage followed by maize and an artificial diet. The females developed from artificial diets were not recorded as proficient as compared to the maize and cabbage diet as shown in Figure 3. The cabbage and maize were the most preferable food for pest growth and development as reported by many other researchers (Abhishek & Patel, 2011; Ramaiah & Maheswari, 2018).

CONCLUSION

The biology of *Spodoptera litura* is essential for figuring out the best diet that can be used to mass-raise *S. litura* and sustain its development. Similar to this, understanding the life history traits of *S. litura* in connection to different meals can help in the creation of efficient control strategies for this harmful economic pest. It was discovered that the artificial diet had the longest larval growth time, whereas maize and cabbage had the shortest. All of the biological traits of *S. litura* that were tracked during the study were influenced by the diet.

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