Environment and Ecology 39 (2) : 442—446, April—June 2021
ISSN 0970-0420

Biology of Fall Armyworm, *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera : Noctuidae) on Sugarcane

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Received 15 April 2021, Accepted 15 May 2021, Published on 9 June 2021

ABSTRACT

The present study was undertaken during *kharif* 2019 to know the biology of fall armyworm, *Spodoptera frugiperda* on sugarcane. The results revealed that mean incubation period were 2.47±0.051 days. The larva passed through six different instars. The mean duration of first, second, third, fourth, fifth and sixth instar of fall armyworm was 2.48 ± 0.075, 2.45 ± 0.083, 2.73 ± 0.051, 2.35 ± 0.054, 3.28 ± 0.098 and 3.51 ± 0.075 days, respectively. The total larval period lasted for about 15 to 19 days with a mean of 16.82 ± 0.236 days. The mean pre pupal and pupal period were 2.55 ± 0.054 and 8.22 ± 0.075 days, respectively. In the present study, mean longevity of female and male moth were 11.36 ± 0.314 days and 7.59 ± 0.137 days, respectively.The pre oviposition, oviposition and post oviposition period ranged between 3 to 4, 3 to 4 and 4 to 5 days with a mean of 3.48 ± 0.054, 3.39 ± 0.240 and 4.48 ± 0.075 days, respectively.The number of eggs laid by female moth of *S. frugiperda* developed from larva fed on the leaves of sugarcane ranged from 413 to 654 eggs with a mean of 544.18 ± 12.53 and sex ratio of male to female was found to be 1: 1.2 when larvae fed with sugarcane.These results help in understanding the biology of *S. frugiperda* fed on sugarcane.

Keywords *Spodoptera frugiperda,* Life cycle, Sex ratio, Sugarcane.

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INTRODUCTION

Fall armyworm (FAW), *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae) native to the tropical and subtropical regions of America is one of the important invasive polyphagous pests. It occurs in several maize growing countries such as Brazil, Argentina, Mexico and the Unites states of America (Prowell *et al*. 2004, Clark *et al.* 2007). The FAW is one of the most important constraints to maize production throughout Mexico, including Latin American countries where this crop plays a principal role in both farm production and human diet. Chemical insecticides are routinely employed as a quick management strategy against this insect pest. Frequent use of chemical insecticides has led to development of resistance by *S. frugiperda* to several insecticides and posed a possible threat to human health and environment. Later, some alternatives to chemical control were explored, particularly the use of entomopathogenic agents (Williams *et al.* 1999). However,

complementary strategies of pest management such as development of pheromones, cultural practices and exploring new sources of plant resistance are still being worked out. Though *S. frugiperda* is a key pest of maize, due to its polyphagous nature it uses important cultivated species of poaceae as host and has ability to reach pest status on several of them (e.g., rice, wheat, sorghum and sugarcane) (Luginbill 1928, Sparks1979, Capinera and John 2017). FAW larvae were reported on more than 60 different species of plants, particularly graminaceous hosts, such as maize, sorghum and Bermuda grass. FAW is considered as a generalist feeder, feeding on a wide range of plants in several families, with preference for grasses. FAW due to its wide host range, is designated as one of the harmful pests threatening annual crops in tropical regions (Cruz *et al.* 1999).

About 30 years, it has been known that FAW, consists of two differentiated strains commonly referred as the rice-strain (R-strain) and the corn-strain (C-strain) (Nagoshi and Meagher 2004). The corn strain, for which corn is the preferred host, was also found to colonize cotton fields (Martinelli *et al*. 2007). Thus, FAWwith its unique habit of migrating, developing and reproducing in unrelated plant species has made it more harmful pest for majority of crop plants (Nagoshi 2009). The polygamous nature of FAW and the availability of different hosts might even result in the selection of insect populations with new food preferences (Barros *et al.* 2010). Hence, management of this pest has been a challenge for entomologists worldwide due to existence of differences in the crop phonologies and their cultivation throughout the year in proximity to each other which facilitate movement of the pest between crops.

In India, occurrence of this invasive pest was reported for the first time on maize from Karnataka by Sharanabasappa *et al*. (2018) during the month of May 2018. Presence of FAW was observed during regular surveillance in maize fields at the College of Agriculture, Shivamogga and neighboring districts. Its occurrence was further confirmed in Karnataka and other states like Tamil Nadu and Telangana. Molecular diversity of fall armyworm, *S. frugiperda* was studied from different states of India and indicated prevalence of R-strain. India being a subtropical, cultivates most of graminaceious food crops such as maize, wheat, rice, sorghum, sugarcane and many minor millets in all parts of the country.The invasive pest though prefers maize but being polyphagous could turn out to be a potential threat to food security of the country. Further, Biology of FAW as occurring in India is important for identifying the life stages and also for planning IPM strategies. Hence, this first study on the biology of FAW on sugarcane under laboratory conditions were undertaken.

MATERIALS AND METHODS

The present investigation was carried out at Department of Entomology, College of Agriculture, Rajendranagar during *kharif* 2019 to know the biology of *S. frugiperda* on sugarcane under laboratory conditions. During the experimental period the average room temperature was maintained at 25 ± 2°C and the relative humidity was maintained at 70 ± 5 %. The culture of FAW was initiated with larvae collected from maize fields at College farm, College of Agriculture, Rajendranagar, Hyderabad. The collected larvae were reared on chick pea flour based artificial diet described by Greene *et al.* (1976) under ambient conditions.

Larval feeding test: Freshly hatched, neonate larvae, (0-12 hrs old) of S. frugiperda obtained from the laboratory that were reared on artificial diet were used for the experiment. Neonate larvae of *S. frugiperda* were released individually in petri plates containing fresh leaves of sugarcane. The larvae were reared on sugarcane leaves till pupation. Fresh leaves of respective host plants were brought to the laboratory in separate polythene covers. Plant leaves were cleaned in distilled water, shade dried and later sandwiched between the two layers of blotting paper for removing the water. The leaves were then cut into small discs of around 7-8 cm diameter. These leaf discs were placed in small petri plates of 9 cm diameter containing circularly cut moist filter paper, to avoid drying of leaf discs. Proper care was taken to prevent the escape of larvae by covering petri plates with tissue parafilm paper and the lid was tightly secured with the help of rubber band. Leftover food material along with excreta were removed daily. Fresh leaves of host plants were provided to larvae at every 24 hrs

interval. This process was continued until the larvae entered into final instar. The final instar larvae were collected and transferred into another jar containing sand for pupation. Pupae thus formed were collected and placed in small plastic jars and covered with muslin cloth for adult emergence. Each petri plate was examined daily for recording observations on larval period, pre pupal period and pupal period.

Adult longevity and fecundity test: To study the impact of sugarcane on fecundity and adult longevity, a pair of freshly emerged healthy male and female adults that were reared on a sugarcane were selected. The adults were then released into plastic jars for mating. The jars were lined with yellow paper as substratum for egg laying and were covered with white muslin cloth that was held in position with the help of the rubber band. The adults were fed with10 % honey solution soaked in cotton swab placed in plastic cup inside the jar which was replaced daily. The eggs laid on the yellow paper and white muslin cloth were collected daily till the female stopped laying eggs and were placed in a separate jar for hatching. The eggs were counted daily using hand lens. The experiment was replicated six times with ten such pair of adults per replication. A total of sixty pair of adults were tested for adult longevity and fecundity. Average number of eggs laid per female and percent viability of the eggs were calculate. Observations were recorded at every 24 hrs interval on pre oviposition period, oviposition period, post oviposition period, adult longevity of male and female, sex ratio, fecundity, incubation period . Data were analyzed statistically for calculating mean and standard deviation.

RESULTS AND DISCUSSION

Biology of fall armyworm, *S. frugiperda* on sugarcane

Data pertaining to duration of different life stages of *S. frugiperda* viz., incubation period, larval period from first to sixth instar, total larval period, pre pupal period, pupal period, adult male and female longevity, pre oviposition, oviposition and post oviposition period, total developmental period, fecundity and sex ratio of *S. frugiperda* reared on sugarcane were presented in the Table 1.

Table 1. Biology of fall armyworm, *Spodoptera frugiperda* on sugarcane. SD: Standard deviation.

Sl.No.	Stage of the insect	Mean ± SD	Range
1.	Incubation period	2.58±0.098	2.00-3.00
2.	Larval period		
a.	I instar	2.48±0.075	2.00-3.00
b.	II instar	2.45±0.083	2.00-3.00
c.	III instar	2.73±0.051	2.00-3.00
d.	IV instar	2.35±0.054	2.00-3.00
e.	V instar	3.28±0.098	3.00-4.00
f.	VI instar	3.51±0.075	4.00-5.00
	Total larval period	16.82±0.236	15.00-19.00
3.	Pre pupal period	2.55±0.054	2.00-3.00
4.	Pupal period	8.22±0.075	7.00-9.00
5.	Adult longevity		
	a. Male	7.59±0.137	7.00-8.00
	b. Female	11.36±0.314	10.00-12.00
6.	Total life cycle		
	a. Male	36.81±0.390	33.00-42.00
	b. Female	40.56±2.289	37.00-43.00
7.	Pre oviposition period	3.48±0.054	3.00-4.00
8.	Oviposition period	3.39±0.240	3.00-4.00
9.	Post oviposition period	4.48±0.075	4.00-5.00
9.	Fecundity (no.)	544.18±12.53	413.00-654.00
10.	Sex ratio (M: F)	1:1.2	_

Incubation period

The incubation period of eggs was recorded as 2 to 3 days with an average of 2.58 ±0.098 days. Hatching of the eggs was observed in the early morning hours. The above results are in consonance with the findings of Matti *et al.* (2019) who reported that the incubation period of *S. frugiperda* as 2.40 ± 0.50 days on sugarcane.

Larval period

Total six instars were observed during the growth of *S. frugiperda* larvae. The duration of first, second, third, fourth, fifth and sixth instar of fall armyworm ranged from 2 to 3, 2 to 3, 2 to 3, 2 to 3, 3 to 4 and 4 to 5 days, respectively when fed on sugarcane. The mean duration was found to be 2.48 ± 0.075, 2.45 ± 0.083, 2.73 ± 0.051, 2.35 ± 0.054, 3.28 ± 0.098 and 3.51 ± 0.075 days. The total larval period lasted for about 15 to 19 days with a mean of 16.82 ± 0.236 days. Present results corroborate with the observation of Matti *et al.* (2019) who reported the total larval period as 16 to 22 days when fed on sugarcane.

Pre pupal and pupal period

The pre pupal and pupal period ranged between 2 to 3 and 7 to 9 days, with a mean of 2.55 ± 0.054 and 8.22 ± 0.075 days, respectively on sugarcane under laboratory conditions. Present results gain support from the results of Silva *et al.* (2016) who reported pre pupal period of 1.89 ± 0.06, 1.97 ± 0.09, 1.89 ± 0.08, 1.26 ± 0.07 and 1.69 ± 0.07 days on soybean, cotton, maize, oat and wheat, respectively. Present findings were also supported with the results of Matti *et al.* (2019) who reported that the *S. frugiperda* completed its pupal period within 13.60 ± 0.30 days on sugarcane. However, the shortest pupal period of 7.88 ± 0.74 days was observed in the present study might be due to the effect of variation in environment especially temperature during the rearing period.

Adult longevity

In the present study the longevity of adult female which were developed from the larvae reared on sugar cane leaves were in the range of 10 to 12 days with a mean of 11.36 ± 0.314 days while adult male longevity ranged between 7 to 8 days with a mean of 7.59 ± 0.137 days. These finding were almost similar to the results obtained by Matti *et al.* (2019) who reported that male longevity as 8.60 ± 0.60 days and female longevity as 10.40 ± 0.70 days when their larvae were fed on sugarcane under natural conditions.

Total developmental period

The study revealed that the total developmental period of male moth ranged from 33 to 42 days with a mean of 36.81 ± 0.390 days and female ranged from 37 to 43 days with a mean of 40.56 ± 2.289 days when *S. frugiperda* larvae were fed on sugarcane leaves under laboratory conditions. Present results were almost similar to the findings of Matti *et al*. (2019) who recorded 37.00 ± 9.50 days and 38.00 ± 8.20 days as total life cycle of male and female, respectively on sugarcane. Similar studies on the duration of total life cycle of other species of *Spodoptera* i.e., *S. litura* was found to be 39.80 ± 1.88 days on banana by Abhishek and Patel (2011), 29 to 35 days on pegaga by Javar *et al.* (2013), 35.44 (male), 36.04 (female) days on cabbage by Ashwini *et al.* (2016).

Pre oviposition, oviposition and post oviposition period

The pre oviposition period of females which were developed from larvae fed with sugarcane leaves was in the range of 3 to 4 days with a mean of 3.48 ± 0.054 days. However, oviposition and post oviposition period lasted for about 3 to 4 and 4 to 5 days with a mean of 3.39 ± 0.240 and 4.48 ± 0.075 days, respectively . The present results were found to be similar to the findings of Matti *et al.* (2019) who observed the pre oviposition, oviposition and post oviposition period as 4.20 ± 0.70, 2.40 ± 0.50 and 3.6 ± 0.70 days, respectively on sugarcane.

Fecundity

The number of eggs laid by female moth of *S. frugiperda* developed from larva fed on the leaves of sugarcane ranged from 413 to 654 eggs with a mean of 544.18 ± 12.53 per female under laboratory conditions . The above results were in consonance with the findings of Yashpal *et al.* (2005) who reported fecundity of *S. exigua* as 478.21±231.60 eggs when fed with the cotton.

Sex ratio

The results pertaining to sex ratio was female biased wherein slightly more female adults emerged when their larvae were fed with sugarcane. Sex ratio of male to female was found to be 1: 1.2 when larvae fed with sugarcane. Yashpal *et al.* (2005) while studying biology of *S. exigua* on cotton observed that the sex ratio (male: female) as 1: 1.24.

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