The Pharma Innovation Journal 2021; 10(9): 1997-2001

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(9): 1997-2001

www.thepharmajournal.com
Received: 10-07-2021
Accepted: 13-08-2021

N Anil Reddy
Post Graduate Student, Department of Agricultural Entomology, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India

YS Saindane
Assistant Residue Analyst, AINP on Pesticide Residues, Department of Agricultural Entomology, Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India

CS Chaudhari
Scientist, Pulses Improvement Project, MPKV, Rahuri, Maharashtra, India

SA Landage
Assistant Entomologist, AICRP on Forage Crops, MPKV, Rahuri, Maharashtra, India

Corresponding Author:
N Anil Reddy
Post Graduate Student, Department of Agricultural Entomology, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India

Biology of fall armyworm *Spodoptera frugiperda* (J.E. Smith) on maize under laboratory conditions

N Anil Reddy, YS Saindane, CS Chaudhari and SA Landage

Abstract
The investigations were carried out on study of biology of fall armyworm on maize revealed that the average fecundity of this pest was 1015 eggs per female and the incubation period was 3.32 days. During larval development, larvae passed through six instars and total larval duration was observed to be 18.02 days, wherein first, second, third, fourth, fifth and sixth instar were 2.6, 2.7, 2.5, 2.4, 2.7 and 5.1 days respectively. The pupal period lasted for 9.92 days. The pre oviposition, oviposition and post oviposition period was observed as 10, 3.02, 4.40 days respectively. Mean longevity of males was observed as 9.10 days while in case of females, it was 11.52 days. The total life cycle of male and female was completed in 40.34 and 42.76 days. The morphometric data *viz*., larval body length; pupal length and adult body length and wing span were measured.

Keywords: Fall armyworm, *spodoptera frugiperda*, life span, duration, period

Introduction
Maize (*Zea mays*) originated in central Mexico. It belongs to the grass family Poaceae. Maize is an important cereal crop in many industrialized and emerging nations. It gives the higher genetic yield potential among the cereals, this crop is globally popular as the "Queen of cereals" (Jeyaraman, 2017) [3]. Now a days, the maize production is hindered by several biotic and abiotic factors. Although there are around 141 insect pests that cause different degrees of harm to maize crop, but only about a dozen of them are significant enough to necessitate management methods. (Reddy and Trivedi, 2008; Kumar *et al*., 2015) [9, 4]. i.e. maize stalk borer, pink stem borer and shoofly are the insects of national importance, Apart from these the recently introduced pest fall armyworm, *Spodoptera frugiperda* is a serious concern due to its notorious and polyphagous behaviour became an invasive challenge across the world
Fall armyworm (FAW) is native to tropical and subtropical America and known as a pest in the United States since 1797. In India this new invasive pest was reported for the first time by Sharanabasappa and Kalleshwara swamy in 2018 [10]. Presence of FAW was observed during regular surveillance in maize fields at the College of Agriculture, Shivamogga and neighbouring districts. It affects maize at all phases of growth, from seedling up to ear development. FAW larvae feed on opening leaves by scraping and skeletonizing the top epidermis, resulting in a silvery translucent membrane and papery patches. Pinhole symptoms appear on the leaves as a result of the injury. Late instar damage (3rd instar onwards) causes severe defoliation of leaves as well as the appearance of huge numbers of faecal pellets in whorls.
The development and survival of *Spodoptera frugiperda* larva have been found vary with host plant species. Since different species of host plants play a significant influence in maintaining continuity of the pest throughout the year, so there is a need to know the biology of the pest on common cultivated crops for practical significance. Also, it will be used for subsequent research to know the ecological adaptations due to global warming and also for the pest management practices keeping this in view, research was undertaken entitled with "Biology of fall armyworm, *Spodoptera frugiperda* (J. E. Smith) on maize under laboratory conditions".

2. Materials and Methods
Biological and morphometrics parameters of *S. frugiperda* were studied at Post Graduate Laboratory, Department of Agricultural Entomology, MPKV, Rahuri during 2020-2021. In order to study biology of *S. frugiperda* on maize, initially larvae were collected from maize fields of Post Graduate Institute Farm, MPKV, Rahuri, brought into the insect culture room and was allowed to grow until they become adult.

After adult emergence the male and female moth were separated and placed for mating in transparent jars, covered with a fine muslin cloth and was secured with rubber band. The inner surface of transparent jars was lined with a black paper sheet, which provided clear visibility of eggs on the surface. 10 per cent honey solution on a cotton swab was placed in each jar for moth feeding.

Eggs of fall armyworm laid on black paper sheet were collected for further multiplication and use. The egg mass was collected and transferred to a clean container by providing young fresh maize leaves. The leaf was kept in the plastic container containing moist filter paper to keep it fresh. This served as immediate source of food for the first instar larvae. The leaf was changed when the larvae entered into the second instar. There after containers were cleaned with 2 per cent formaldehyde, shade dried and fresh maize leaves were given every day till the larvae entered into the last instar larval stage. These late larval instars were collected from containers and released in to petri plate having soil for pupation. Pupae thus obtained were collected and kept in small plastic jars covered with muslin cloth for adult emergence. During the process, male and female pupae were separated based on external genitalia. (Ramaiah, 2017) [7]. Data was recorded on pre oviposition period, oviposition period, fecundity, incubation period, larval period, pupal period and adult longevity of male and females. Morphometrics observations were taken with the help stereozoom binocular microscope and by visually graphical method.

2.1 Statistical analysis

Data collected on size of different stages of insect i.e., egg, larva, pupa and adult using stereozoom binocular microscope and by visual graphical method and were analysed for calculating mean and standard deviation.

3. Results and Discussion

Results pertaining to biology of *S. frugiperda* on maize revealed that total life cycle period of male and female lasted for about 40.34 and 42.76 days (Table 1 and Fig 1) and observations on morphometric were shown in Table 2.

3.1 Morphological description of *Spodoptera frugiperda*

3.1.1 Egg: The eggs were generally laid in masses of 25-330, which were either laid in a single layer or stacked up in two to three layers. The eggs were somewhat dome shaped and covered with greyish-white scales from the female abdomen. The colour of the eggs was white to creamish that turned brown to black just before hatching. The incubation period was found to vary from 2-4 days, with mean incubation period of 3.32 ± 0.67 days. (Table1). The results are in accordance with the observations of Deepika Kalyan *et al.* (2019) [2] observed incubation period of 3.38 days. In case of size of the eggs, the average length and width was measured to be 0.33 ± 0.05 and 0.29 ± 0.01 mm, respectively (Table 2). The present findings are in agreement with Manjula *et al.* (2019) [5] who reported that average length and width of eggs of *Spodoptera frugiperda* 0.47 and 0.29 mm.

Table 1: Developmental period of different life stages of fall armyworm, *Spodoptera frugiperda* (J. E. Smith) on maize

Sr. No	Particulars	Mean ± SD (days)	Range (days)
1.	Incubation period	3.32 ± 0.67	2.00-4.00
2.	Larval period	18.02 ± 2.16	14.00-21.00
	I Instar	2.6 ± 0.51	2.00-3.00
	II Instar	2.7 ± 0.48	2.00-3.00
	III Instar	2.5 ± 0.52	2.00-3.00
	IV Instar	2.4 ± 0.51	2.00-3.00
	V Instar	2.7 ± 0.48	2.00-3.00
	VI Instar	5.1 ± 0.87	4.00-6.00
3.	Pupal period	9.9 ± 0.99	9.00-12.00
4.	Pre oviposition period	1 ± 0.73	4.00-5.00
5.	Oviposition Period	3.02 ± 0.78	3.00-4.00
6.	Post oviposition period	4.40 ± 0.51	4.00-6.00
7.	Fecundity/female (Number)	1015 ± 115.48	855.00-1172.00
8.	Egg hatchability %	96.60 ± 1.43	95.00-98.00
9.	Male adult longevity	9.10 ± 1.44	9.00-13.00
10.	Female adult longevity	11.52 ± 1.88	11.00-15.00
11.	Total life cycle (days)		
	Male	40.34 ± 27	34.00-50.00
	Female	42.76 ± 4.44	36.00-52.00

3.2 Larvae

3.2.1 First instar larvae

The first larval instars were very tiny. They completely devoured the egg shells from which they hatched. They had a comparatively large flattened circular black head and a whitish body covered with minute hairs. The duration of first instar larvae ranged from 2.00-3.00 days with a mean of 2.6 ± 0.51 days (Table 1 and Fig. 1). In past Sharanabassapa *et al.* (2018) [10] and Deepika Kalyan *et al.* (2019) [2] reported the average duration of first instar larva of *Spodoptera frugiperda* was 2.60 ± 0.49 and 2.82 days respectively which support the present findings. The mean length and width of first instar larvae were 1.42 ± 0.28 mm and width 0.28 ± 0.06 mm, respectively (Table 2). Which are in line with the results noticed by Deepika Kalyan *et al.* (2019) [2] who reported the average length of 1.8 ± 0.15 mm

3.2.2 Second instar larvae: The second instar larvae had amber coloured head and a pale white to yellowish coloured body with a tinge of brown on the dorsum. The body also developed faint white dorsal and subdorsal lines at this stage. The duration of second instar larvae ranged from 2.00-3.00 days with a mean of 2.7 ± 0.48days (Table 1 and Fig. 1). According to Deepika Kalyan *et al.* (2019) [2] the average duration of second instar larvae was 2.5 days which is in conformity with present investigation. The mean length and width of second instar larvae were 3.32 ± 0.48 mm and width 0.69 ± 0.04 mm, respectively (Table 2).

3.2.3 Third instar
The colour of the body shifted from light white to a greenish brown. On the dorsal side the larvae were light brown, while on the ventral side, they were greenish. The white lines on the dorsal and sub-dorsal sides were clearly visible and the black dots became more prominent. The duration of third instar larvae ranged from 2.00-3.00 days with a mean of 2.5 ± 0.52 days (Table 1 and Fig. 1). Previously, it was reported as 2.5 days by Rashmi *et al.* (2020) [8] which is similar to present investigation. The mean length and width of third instar larvae were 5.78 ± 0.56 mm and width 1.88 ± 0.19 mm, respectively (Table 2). The present findings are more or less similar with Deepika Kalyan *et al.* [2].

3.2.4 Fourth instar
The larvae showed a distinct difference from third to fourth instar in their appearance. Their body colour varied from olive brown to dark brown. The dorsal and sub-dorsal white lines also became conspicuous. The larvae exhibit a prominent inverted "Y" on head capsule. The duration of fourth instar larvae ranged from 2.00-3.00 days with a mean of 2.4 ± 0.51days (Table 1 and Fig. 1). The present reports are in support of work done Sharanabassapa *et al.* (2018) [10] who reported as average duration of fourth instar larvae was 2.0 days. 25 The mean length and width of fourth instar larvae were 10.0 ± 0.60 mm and width 3.08 ± 0.34 mm, respectively (Table 2). Similar observations was recorded by Deepika Kalyan *et al.* (2019) [2] reported average length as 9.7±0.55 mm.

3.2.5 Fifth instar
Fifth instar larvae were observed similar to their older instar but increased in size. Larvae has a distinct pattern of four "dots" on the eighth abdominal segment. The duration of fifth instar larvae ranged from 2.00-3.00 days with a mean of 2.7 ± 0.48 days (Table 1 and Fig. 1). In past Sharanabassapa *et al.* (2018) [10] and Deepika Kalyan *et al.* (2019) [2] reported the average duration of fifth instar larvae of *Spodoptera frugiperda* was 2.8 days which support the present findings. The mean length and width of fifth instar larvae were 16.5 ± 0.99 mm and 4.74 ± 0.33 mm, respectively (Table 2). Similar observations was recorded by Deepika Kalyan *et al.* (2019) [2] reported average length as 16.8 ± 1.08.

3.2.6 Sixth instar
During this stage, the larvae was more thick and bulged and it was slightly cylindrical. Their body was smooth with clear and distinct segmentation. The head was dark and bilobed in appearance. The body was greyish brown on the dorsum and greenish speckled with reddish brown colour on the ventral and sub-ventral sides. The duration of sixth instar larvae ranged from 4.00-6.00 days with a mean of 5.1 ± 0.87 days (Table 1 and Fig. 1). Previously, it was reported as 4 to 6 days by Rashmi *et al.* (2020) [8]. The mean length and width of sixth instar larvae were 33.6 ± 1.67 mm and 5.90 ± 0.26 mm, respectively (Table 2). The present findings are in agreement with the findings of Sonali *et al.* (2018) [11] who reported the length and width of sixth instar larva is 32-35 mm and 6.01 mm.

Table 2: Measurements of different developmental stages of *Spodoptera frugiperda* (J. E Smith) on maize

Sr. No.	Stage	Length(mm)		Width(mm)	
		Range	Mean	Range	Mean
1	Egg	0.3-0.4	0.33 ± 0.05	0.28-0.32	0.29 ± 0.01
2	Larva				
	I instar	1.0-1.8	1.42 ± 0.28	0.2-0.38	0.28 ± 0.06
	II instar	2.8-4.0	3.32 ± 0.48	0.62-0.74	0.69 ± 0.04
	III instar	5.0-6.5	5.78 ± 0.56	1.6-2.3	1.88 ± 0.19
	IV instar	9.2-10.5	10.0 ± 0.60	2.7-3.6	3.08 ± 0.34
	V instar	15.0-17.4	16.5 ± 0.99	2-5.1	4.74 ± 0.33
	VI instar	32.0-36.0	33.6 ± 1.67	5.5-6.2	5.90 ± 0.26
3	Pupa	14-18.0	16.08 ± 1.3	4.7-5.1	4.94 ± 0.15
4	Adult	Body length(mm)		Wing span (mm)	
	Male	14.0-17.0	15.20 ± 1.30	30-35	32.4 ± 2.07
	Female	13.1-17.2	15.0 ± 1.58	29-35	31.8 ± 2.38

3.2.7 Total larval period
The total larval duration varied from 14 to 21 days with mean duration of 18.0 ± 2.16days. (Table 1). The results showed similarity with the earlier findings of Murua *et al.* (2008) [6] who reported that the average duration of larva of *Spodoptera frugiperda* was 18.18 days. The results showed similarity with the earlier findings of Assefa (2018) [1] and Rosa *et al.* (2012) reported the duration of total larval period ranges from 14-22 days and 10.7-21.7 days.

3.3 Pupa
The newly developed pupae of *Spodoptera frugiperda* were orange-brown in appearance and changed to dark reddish brown with time. The distance between the genital and anal entrance slots were used to differentiate male and female pupae. This distance was greater in female pupae than in male pupae. The pupal period was found varied from 9 to 12 days with mean duration of 9.9 ± 0.99 days (Table 1). According to Sharanabassapa *et al.* (2018) [10] and Rashmi *et al.* (2020) [8] the duration of pupa was 9-12 days and 9- 11 days with mean duration of 10.5 days and 10 days which is in accordance with present results. The average length and width of pupa was 16.08 ± 1.3 and 4.94 ± 0.15 respectively (Table 2). The results showed similarity with the earlier findings of Sonali *et al.* (2018) [11] who reported the length and width of 12-16 mm and 4.5- 4.9 mm.

3.4 Adult
The adult of *Spodoptera frugiperda* is a small to medium sized moth. Sexual dimorphism was clearly evident, in males the forewings were generally shaded in grey and brown colour, with triangular white spots at the tip and near the center, while in females the forewings were less distinctly marked, ranging from a uniform greyish brown to a fine mottling of grey and brown. The hind wings were iridescent silver white with a narrow dark border in both sexes.

Morphometric data of the adults reveal that the males were slightly larger than the females. The mean body length (mm) of the male moths were 15.20 ± 1.30 while that of the female moths were, 15.0 ± 1.58 respectively (Table 2). The present findings are more or less similar with Deepika Kalyan *et al.* (2019) [2] who reported mean body length of male and female

was reported as 15.8 ± 1.03 and 15.0 ± 1.22. Wing span (mm) of the male moth is 32.4 ± 2.07 while that of the female moths were 31.8 ± 2.38 respectively, (Table 2) which is similar in accordance with Sharanabassapa *et al.* (2018) [10] who recorded wing span of male and female moth is 32.5 mm and 32.00 mm.

3.5 Pre-oviposition Period
The pre ovipositional period ranged from 4 to 5 days with an average of 1 ± 0.73 days (Table 1) which is in accordance with observations of Deepika Kalyan *et al.* (2019) [2] recorded average pre oviposition period of 4.06 days.

3.6 Oviposition Period
The oviposition period of female moths of *Spodoptera frugiperda* was reported 3 to 4 days, with an average of 3.02 ± 0.78 days (Table 1). The present results are in line with Sharanabassapa *et al.* (2018) [10] recorded average oviposition period of 2.8 days.

3.7 Post Oviposition Period
After completion of egg laying, the female moths of *Spodoptera frugiperda* lived for 4 to 6 days with an average post-oviposition period of 4.40 ± 0.51 days (Table 1). The results are in accordance with Sharanabassapa *et al.* (2018) [10] recorded average post oviposition period of 4.30 days

3.8 Fecundity
The egg laying capacity of female varied from 855.00-1172.00 eggs with an average of eggs, 1015 ± 115.48 (Table 1). The present study is in agreement with work done by Sharanabassapa *et al.* (2018) [10] who reported that the female laid average eggs of 1064.80 ± 109.53 during the life span under controlled environmental conditions.

3.9 Longevity of Adults
The observations revealed that female moths lived more than the male moths. Male longevity was varied from 9.00-13.00 days with mean duration of 9.10 ± 1.44 (Table 1). While that of female longevity was observed as 11.00-15.00 days with mean duration of 11.52 ± 1.88 days. The results are in accordance with Deepika Kalyan *et al.* (2019) [2] who observed male longevity as 10.66 days and female longevity as 13.83 days.

3.10 Hatchability %
Hatchability of eggs of *Spodoptera frugiperda* was 95.6 per cent (Table 1). Similar findings were recorded by Sharanabassapa *et al.* (2018) [10] observed the hatchability of eggs ranged from 95.00-98.00 per cent.

3.11 Total Life Span
The average life span of male and female of *Spodoptera frugiperda* was observed to be 40.34 ± 27 and 42.76 ± 4.44 respectively (Table 1). The present findings are in line with the results noticed by Assefa (2018) [1] who reported life cycle of male and female was 39.2 and 42.0 days.

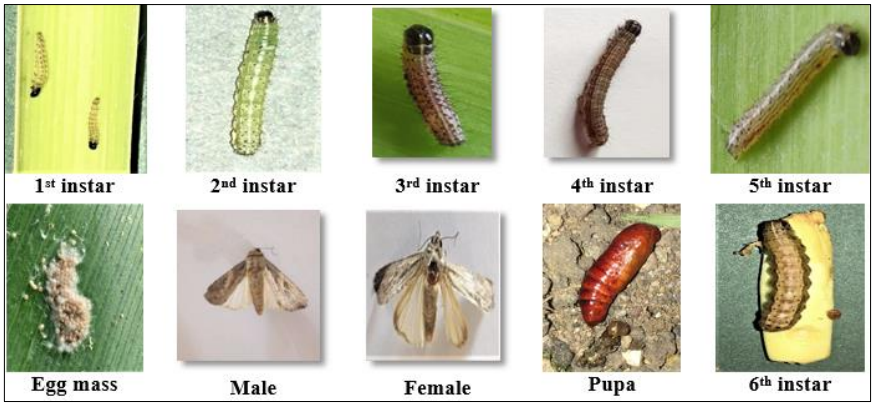

Fig 1: Different life stages of *Spodoptera frugiperda*

4. Conclusion
The knowledge of biology of fall armyworm can be utilized for effective management of this pest. Studies on biology of fall armyworm on maize revealed that the female adult laid 1015 eggs per female the incubation period was 3.32 days. The total larval duration was observed to be 18.02 days. The pupal period lasted for 9.92 days. The pre oviposition, oviposition and post oviposition period was observed as 10, 3.02, 4.40 days respectively. Mean longevity of males was observed as 9.10 days while in case of females, it was 11.52 days. The total life cycle of male and female was completed in 40.34 and 42.76 days. The morphometric data *viz*., larval body length; pupal length and adult body length and wing span were measured.

5. Acknowledgements
I want to thank ICAR for monitory support and help from Head of Department, Department of Entomology, Post Graduate Institute, MPKV, Rahuri for the study.

6. References
1. Assefa. Status of fall armyworm (*Spodoptera frugiperda*), biology and control measures on maize crop in Ethiopia. Int. J Entomol. Res 2018;6(2):75-85.
2. Deepika Kalyan, Mahla MK, Kalyan RK, Swathi P. Biological Parameters of *Spodoptera frugiperda* under Laboratory Conditions. Int. J Curr. Microbiol. Appl. Sci 2019;9(5):2319-7706
3. Jeyaraman S. Field crops production and management vol. I. New Delhi: Oxford 2017.
4. Kumar P, Mahla MK, Ameta Lekha OP, Mordia A. Seasonal incidence of insect pests fauna in maize. Indian J Entomol 2015;29(4):45-49.
5. Manjula K, Saheb YP, Sudheer MJ, Rao AR. Studies on biology, feeding habits and natural enemies of fall armyworm, *Spodoptera frugiperda*, a new invasive pest in India. J Entomol. Zool. Stud 2019;7(6):1245-1250.
6. Murua G, Vera MT, Abraham S, Juarez ML, Prieto S, Head GP *et al.* Fitness and mating compatibility of

Spodoptera frugiperda (Lepidoptera: Noctuidae) populations from different host plant species and regions in Argentina. Ann. Entomol. Soc. Am 2008;101(6):639-649.
7. Ramaiah M, Uma Maheswari. Biology studies of tobacco caterpillar *Spodoptera litura*. J Entomol. Zool. Stud 2017;6(5):2284-2289.
8. Rashmi V, Kumari P, Shrikant P, Das SB, Ashish N. First report of fall armyworm, *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae) on maize (*Zea mays*) from Madhya Pradesh. J Entomol. Zool. Stud 2020;8(6):819-823.
9. Reddy YVR, Trivedi S. Maize Production Technology. Academic Press 2008, 190-192.
10. Sharanabasappa, Kalleshwaraswamy CM, Maruthi MS, Pavithra HB. Biology of invasive fall armyworm *Spodoptera frugiperda* on maize. Indian J Entomol 2018;80(3):540-543.
11. Sonali Deole, Nandita Paul 2018. First report of fall army worm, *Spodoptera frugiperda* (J.E. Smith), their nature of damage and biology on maize crop at Raipur, Chhattisgarh. J Entomol. Zool. Stud 2018;6(6):219-221.