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# Biology of fall armyworm *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera; Noctuidae) on maize in Konkan region of Maharashtra

**JJ Dubale, BD Shinde, SK Mehendale, PS Bodake and SV Sawardekar**

**Abstract**
The biology of fall armyworm *Spodoptera frugiperda* (J. E. Smith) was studied under the laboratory condition at Department of Agricultural Entomology, College of Agriculture, and Dapoli during Jan-April 2020. Eggs were laid by gravid female in clusters ranged from 974 to 1537. The incubation, total larval, pre-pupal and pupal period ranged from 2-3, 14-18, 1-2 and 8-10 days, respectively. The pre-oviposition, oviposition and post oviposition period ranged from 2-3, 3-5 and 2-3 days, respectively. The total life cycle of male and female ranged from 34-38 and 37-39 days, respectively. The female adult survived for 9.8 days with a range of 9-11 days compared to male (8.7 days) with a range of 7-11 days.

**Keywords:** *Spodoptera frugiperda*, maize, fecundity, egg, larval, pupal period, total life cycle

## Introduction
Maize (*Zea mays* L.) is the second most important cereal crop in the world in terms of acreage and is called the 'Queen of Cereals'. After paddy and wheat, maize is the third most grown cereal crop within India; however, in terms of overall value, it is one of the most important cereal crops of the world. The fall armyworm (FAW), *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae) is an insect that is native to tropical and subtropical regions of the America. It is a serious pest of corn but also known to attack more than 100 hosts. In addition, it is reported to cause major damage to economically important cultivated crops such as rice, sorghum and sugarcane as well as horticultural crops like cabbage, beet, tomato, potato and onion besides cotton, pasture grasses, peanut, soybean, alfalfa and millets (Pogue, 2002; Chapman *et al.*, 2000; Anon., 2016) [13, 3, 1]. In India, it is reported for first time on maize from Shivamogga district of Karnataka during May-June, 2018 (Sharanabasappa *et al*., 2018a) [18]. It was entered first time in Maharashtra in the month of September 2018 and its feeding on two months old sugarcane crop, variety (Co 86032) was noticed at Ghogaon village of Sangli District (Maharashtra). Other than sugarcane, it was also reported on maize, sorghum and sweet corn in different districts of Maharashtra. (Chormule *et al*., 2019) [4]. Fall armyworm feeds on all growth stages of maize but most frequently in the whorl of young plants up to 45 days old. Larvae usually consume a large amount of foliage and sometimes destroy the growing point of the plant. First instar larvae usually eat the green tissue from one side of the leaf, leaving the membranous epidermis on the other side intact. The older instars begin to make holes in the leaf and the fourth to sixth instars may completely destroy small plants and strip larger ones. To formulate proper and effective management it is necessary to understand the biology of *S. frugiperda.*

## Material and Method
The biology of fall armyworm, *S. frugiperda* on Maize was studied under the laboratory condition at Department of Agricultural Entomology, College of Agriculture, and Dapoli during Jan-April 2020 on maize. The host plants were sown in a plot size of 10m x 10m during *Rabi* 2019-20. The another set of the same host plant was sown after 15 days of first sowing in order to get continuous supply of fresh leaves to the test insect under study at the Farm of Central Experiment Station, Wakawali, Tetawali block-B during 2019-20. The initial culture of *S. frugiperda* was collected from Maize field. The collected larvae were reared individually in round clean plastic jars. After pupation, the adults were allowed in an oviposition cages. In these cages, paper towels were lined as oviposition substrate and covered with nylon mesh on upper side. In each cage, pair of (male and female) adults were released.

The adults were fed with 10% honey solution soaked on cotton pads offered in small plastic caps or hanging inside the cages. It was replaced daily. Eggs of FAW laid on paper towels were collected for further multiplication. After hatching, the larvae (n=30) were reared individually on fresh leaves bits of Maize which was changed daily. The leaves were kept on moist filter paper to keep it fresh in the plastic container. This served as immediate source of food for the first instar larvae. The leaves were changed when the larvae entered into the second instar. Thereafter containers were cleaned with 2% formaldehyde, shade dried and fresh maize leaves were given every day till the larvae entered into the last larval instar. Late larval instars were collected from containers and transferred to petri plate having soil for pupation. Pupae thus obtained were collected and kept in oviposition cages for adult emergence. During the process, male and female pupae were separated based on external genitalia. The observations on fecundity, oviposition period, incubation period, hatching percentage, larval period, % larvae pupated, pre-pupal and pupal duration, % adult emergence, life-cycle and duration of male and female moths were recorded on Maize.

## Result and Discussion

### Egg

Eggs laid by gravid female in clusters ranged from 974 to 1537 on the under or upper surface of the maize leaf, base of the plant and also in whorls. The eggs were dorso-ventrally flattened, initially these were pale green, turned to golden yellowish and ultimately turned to black before hatching. The female covered the egg mass with layer of scales and this gave moldy appearance. Incubation period ranged from 2-3 days with a mean of 2.40 days. The present findings are in close agreement with the earlier research work of Kalyan *et al.,* (2020) [8] reported average fecundity of 1662 eggs on maize. Incubation period of 2-3 days on maize reported by Reddy *et al.,* (2020) [16] and Dileep Kumar and Murali Mohan (2022) [7]. Vishwakarma *et al.,* (2020) [21] noticed 939 eggs average fecundity per female with incubation period 2-3 days on maize. Dandu (2021) [5] recorded average fecundity of 1017.8 eggs with incubation period of 3.3 days. Keerthi *et al.,* (2021) [10] reported average fecundity of 1083.6 with average 2.38 days egg period on maize. Siddhapara *et al.,* (2021) [20] reported incubation period of 2.40±0.50 days.

### Larva

First instar larvae were greenish with a black head, and turned greenish brown in the second instar. The third instar was brownish with three dorsal and lateral white lines on body surface. Fourth to the sixth instars were brownish black and had three white dorsal lines and alight lateral line. Larva had four black tubercles found dorsally on the body of 8$^{th}$ abdominal segment which bears spines. The frons had a white inverted "Y" line. The total larval period ranged from 14-18 days with mean of 16.07 days and each larva passed through six larval instars. The average period of first, second, third, fourth, fifth and sixth instar was observed 2.47±0.51, 2.33±0.48, 2.10±0.31, 2.03±0.18, and 2.47±0.51 and 4.67±0.76 days, respectively. The present findings are in close agreement with the earlier research work of Reddy *et al.,* (2020) [16] observed total larval period ranged from 15-18 days with mean duration of 16.33±6.86 days ( I$^{st}$ instar 2.33±0.29 days with a range of 2-3 days, II$^{nd}$ instar 2.33±0.29 days with a range of 2-3 days, III$^{rd}$ instar 2.67±0.21 days with a range of 2-3 days, IV$^{th}$ instar 2.33±0.29 days with a range of 2-3 days, V$^{th}$ instar 3.00±0.61days with a range of 3-4 days and VI$^{th}$ instar 3.67±0.83 days with a range of 3-5 days). Keerthi *et al.,* (2021) [10] recorded total larval period of 14.04 days with first to sixth instars period 2.40, 2.11, 2.00, 2.00, 2.21, 5.08 days respectively. Reddy *et al.,* (2021) [17] observed 18.02 days total larval duration, wherein first, second, third, fourth, fifth and sixth instars period were 2.6, 2.7, 2.5, 2.4, 2.7 and 5.1 days respectively.

**Table 1:** Duration of life stages of fall armyworm *S. frugiperda* on Maize under laboratory conditions (n=30)

| No. | Particulars (Stages) | Duration (days) | |
|---|---|---|---|
| | | Mean±SD | Range |
| 1. | Incubation period | 2.4±0.52 | 2-3 |
| 2 | **Larval period** | | |
| | I instar | 2.47±0.51 | 2-3 |
| | II instar | 2.33±0.48 | 2-3 |
| | III instar | 2.10±0.31 | 2-3 |
| | IV instar | 2.03±0.18 | 2-3 |
| | V instar | 2.47±0.51 | 2-3 |
| | VI instar | 4.67±0.76 | 4-6 |
| | Total larval period | 16.07±1.28 | 14-18 |
| 3. | Pre-pupal period | 1.47±0.51 | 1-2 |
| 4. | Pupal period | 9.13±0.73 | 8-10 |
| 5. | % larva pupated | 97.78±1.92 | 96.67-100 |
| 6. | % adult emergence | 95.56±1.92 | 93.33-96.67 |
| 7. | Pre oviposition period | 2.7±0.48 | 2-3 |
| | Oviposition period | 4.6±0.70 | 3-5 |
| | Post oviposition period | 2.6±0.52 | 2-3 |
| 8. | Fecundity/female (Number) | 1125.4±176.24 | 974-1537 |
| 9. | Egg hatchability (%) | 72.1±11.99 | 43-85 |
| 10. | **Adult longevity** | | |
| | Male | 8.7±1.16 | 7-11 |
| | Female | 9.8±0.79 | 9-11 |
| 11. | **Total life cycle (egg to adult)** | | |
| | Male | 35.4±1.51 | 34-38 |
| | Female | 38.0±0.82 | 37-39 |

**Pre-pupal stage**

Full grown larvae stop feeding, turned greenish to bright brown colour and undergwent pre-pupal stage which was ranged from 1-2 days with average of 1.47 days.

The present findings are in close agreement with the earlier research work of Deole and Paul (2018) [6] noticed 1-2 days pre-pupal period on maize. Praveen and Mallapur (2019) [14] reported pre-pupal period of 2.0 days on maize. Dandu (2021) [5] noticed pre pupal period of 1.2 days.

**Pupal stage**

Newly formed pupa observed green in colour and turned dark reddish brown in colour finally. The pupal period ranged from 8-10 days with mean of 9.13 days. The% larva pupated were observed in a range of 96.67-100%. The present findings are in close agreement with the earlier research work of Manjula *et al.,* (2019) [11] reported pupal period of 9.0 days on maize. Maruthadurai and Ramesh (2019) [12] noticed 8.60 days pupal period on maize. Ramya and Maheswari (2019) [15] reported 8-9 days period for pupal stage. Ashok *et al.,* (2020) [2] reported pupal period of 8.24 days on maize. Reddy *et al.,* (2020) [16] reported 8-10 days with mean duration of 9.00±2.81 days. Reddy *et al.,* (2021) [17] reported pupal period of 9.92 days on maize. Siddhapara *et al.,* (2021) [20] noticed 9.30 days pupal period on maize.

**Adult**

Forewings of male observed grey and brown in colour, with triangular white patch at the apical region and circular spot at the center of the wing. The forewings of females were uniform grayish brown to a fine mottling of gray and brown. The hind wing was silver-white with a narrow dark border in both male and female. The% adult emergence was observed with 93.33-96.67%. The Pre-oviposition, oviposition and post oviposition period ranged from 2-3-5 and 2-3 days, respectively. Each female laid 974-1537 eggs with mean of 1125.4. The average egg hatchability was observed with 72.1%. The total life cycle of male and female ranged from 34-38 and 37-39 days, respectively. The female adult survived for 9.8 days with a range of 9-11 days compared to male (8.7 days) with a range of 7-11 days. The present findings are in close agreement with the earlier research work of Sharanabasappa *et al.,* (2018b) [19] reported total life cycle of male of 32-43 days and female of 34-46 days. Vishwakarma *et al.,* (2020) [21] recorded longevity of male and female moth ranged from 7-9 days and 8-13 days with an average of 8.0 and 10.5 days, respectively. Dandu, (2021) [5] recorded mean pre-oviposition, oviposition and post oviposition periods were 3.2, 2.5, 4.8 days respectively. The adult longevity (male and female), total life cycle (male and female) was recorded as 8.1, 9.6, 35.9, 38.6 days respectively. Kavitake, (2021) [9] recorded fecundity, pre-oviposition, oviposition and post-oviposition period ranged from 890-1180 eggs, 3-4, 2-3 and 4-5 days, respectively. Siddhapara *et al.,* (2021) [20] reported total life cycle of 34.50±1.80 days (male) and 37.20±2.52 days (female). Dileep Kumar and Murali Mohan (2022) [7] recorded total life cycle male and female of 35.05 and 38.30 days, respectively.

**Conclusion**

The biological studies of fall armyworm on maize revealed that, the average fecundity was 1125.4 eggs with average incubation period of 2.40 days. The mean larval period was 16.07 days. The pupal period was 9.13 days. The total life cycle of male and female was 34-38 and 37-39 days, respectively. The proper biological knowledge of this pest can be utilized for the effective management during the entire growth stages of maize.

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