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Life History Parameters of Fall Armyworm, *Spodoptera frugiperda* (JE Smith) on Maize in Haryana (India)

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Abstract: The biology of fall armyworm, *Spodoptera frugiperda* (JE Smith) was studied at laboratory, Department of Entomology, CCS Haryana Agricultural University, Hisar during, 2020-21 to know their life history and duration of different developmental stages. Insect culture was collected from the experimental area forage section, CCSHAU to get nucleus culture and to further study the biological parameters i.e. incubation period, per cent hatchability, larval period, pupal period, sex ratio, ovipositional periods etc. The eggs laid by *S. frugiperda* were ranged from 87-729 eggs with 82.0% hatchability, incubation period of 2.57 days, larval period of 16.32 days and pupal period of 7.22 days. Pre-ovipositional, ovipositional and post ovipositional period ranged from 2-3 (2.68±0.32), 3-4 (3.02±0.16) and 3-4 days (3.82±0.65), respectively. Total life cycle of males and females was observed as 33.32 and 34.75 days, respectively.

Key words: Biology, fecundity, larva, maize, pupal period, *Spodoptera frugiperda.*

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Invasive alien species are serious threat to agricultural ecosystems and biodiversity. The entry and spread of invasive species are closely associated with increasing trade and have become a global concern and hence managing their threats effectively (Wan and Yang, 2016). Fall armyworm, *Spodoptera frugiperda* (Insecta: Lepidoptera: Noctuidae) is native to tropical and sub-tropical areas of the America (Sparks, 1979). This pest has invaded in 47 African countries and 18 Asian countries in the last three years because of its high migration ability (over 100 km per night), and its ability to feed on a broad range of plants in different habitats (Tendeng *et al.*, 2019; Sun *et al*., 2019). This pest has a wide host range of more than 300 plants from 76 families i.e. Poaceae (106), Fabaceae (31) and Asteraceae (31). *S. frugiperda* occurs in two different strains viz., "rice strain" (R strain) and a "corn strain" (C strain), the former preferentially feed on rice and the other on grasses, maize and sorghum (Cock *et al*., 2017; Montezano *et al*., 2018; Dumas *et al*., 2015). It infests maize plants at all growth stages i.e., from seedling to tasseling by destroying young plants, causing defoliation, grain deterioration and reducing yield quantity and quality (Peairs and Sanders, 1979). It occurs throughout the year with overlapping generations wherever

host plants are available and climatic conditions are favorable (Abrahams *et al.,* 2017). India is known for intensive cultivation of crops. Even in some parts of the country, farmers have adopted cultivation of two or more than two crops per year. Maize is growing in both the seasons as kharif and rabi maize in Haryana. So, land use with consecutive crops throughout the year favors continued survival of pests even in the absence of their preferred hosts that leads to frequent outbreaks under various agro-ecosystems (Kennedy and Storer, 2000). It is very important to understand the factors responsible for quicker adaptation of polyphagous pests with different agro-ecosystems (Bortolotto *et al*., 2014). The management of invasive pests requires a holistic approach that focus not only on major crop in the field, but also on diverse cropping systems (Herde, 2009). The availability of alternate host and crop rotation sequences play an important role in pest outbreaks. Hence, the study of insect pest biology and feeding preferences on different hosts must be studied for sustainable solutions against them (Behmer, 2009). The occurrence of this new invasive pest was reported for first time in India by Sharanabasappa *et al.* (2018), from Shivamoga (Karnataka). Now, its occurrence has been reported from all other states of India with more than 70%. In Haryana, *S. frugiperda* was reported first time during September, 2019 and thereafter this pest is causing heavy losses in maize. The present study on biological parameters of *S. frugiperda* is aimed towards identifying its most damaging stage and suitable time for its management.

Material and Methods

The culture was initiated by collecting the larvae from maize field in the farm area of the CCS Haryana Agricultural University and adjoining farmer's fields. The culture was maintained at room temperature by providing fresh maize leaves and stem of hybrid HQPM 1 daily till pupation. The pupae developed were transferred into clean jars, covered with muslin cloth and fastened with rubber bands, until the emergence of moths. The adults emerged were paired and allowed to mate in separate glass jars. The moths were fed with on cotton swabs soaked in 10 per cent honey solution for proper egg laying. The eggs laid were used as a nucleus culture for further biological studies. After hatching, the larvae (n = 20) were transferred into glass test tube and reared individually on fresh maize leaves that were changed daily. Adults emerged were reared in glass battery jars. The maintained culture was used for study on biological parameters like incubation period, per cent hatchability, larval period, pupal period, sex ratio, ovipositional periods etc.

Result and Discussion

Eggs

The eggs were laid in masses and covered with scales of females ranged from 87-729 eggs on all plant parts. Average eggs laid per female were about 1500 (a maximum of over 2 000) in Africa, demonstrating the capacity of fecundity (Prasanna *et al.,* 2018). The eggs were deposited in layers, but mostly spread over a single layer. The freshly laid eggs were pale green in color and became brown to black just before hatching. Sharanabasappa *et al.* (2018) studied that the freshly laid eggs were light green, became golden yellowish after one day and then turned black before hatching. Incubation period of *S. frugiperda* ranged from two to three days with an average of 2.57 days with 82.0% egg hatchability. Similar results for damage have been reported in other studies (Murua *et al*., 2008; Sharanabasappa *et al*., 2018; Prasanna *et al*., 2018).

Larval instars and duration

The larva of *S. frugiperda* passed through six larval instars. The mean duration of first to sixth instar larvae were 2.86, 2.38, 2.40, 2.70, 3.20 and 2.78 days, respectively (Table 1, Fig.1 A-C). Guo *et al.* (2020) reported that the mean developmental periods for six larval instars were 2.62, 2.94, 3.06, 3.23, 3.28, and 2.88 days on maize, respectively. Sharanabasappa *et al.* (2018) observed that the mean duration of first, second, third, fourth, fifth, and sixth instar larvae reared on maize were 2.60, 2.20, 2.00, 2.00, 2.40, and 4.50 days, respectively. Larval period varied from 13-20 days with an average of 16.32 days. Hutasoit *et al.* (2020) observed the mean larval period of *S. frugiperda* (female and male) when it fed on maize was 12.69 and 12.84 days, respectively. The first instar larvae were greenish to dark brown in colour with black head. The second instar larvae were greenish brown. The third instar was brownish with three dorsal and lateral white lines. Fourth

Table 1. Duration of different developmental stages of S. frugiperda on maize

Developmental Stages	Mean±SD	Range (Days)
Incubation period (days)	2.57±0.03	2-3
Larval period	16.32±0.05	13-20
1st instar	2.86±0.04	2-3
2nd instar	2.38±0.08	2-3
3rd instar	2.40±0.02	2-3
4th instar	2.70±0.07	2-3
5th instar	3.20±0.04	3-4
6th instar	2.78±0.08	2-4
Pupal period	7.22±0.32	6-9
Pre-oviposition period	2.68±0.32	2-3
Oviposition period	3.02±0.16	3-4
Post- oviposition period	3.82±0.65	3-4
Female longevity	8.64±0.46	8-10
Male longevity	7.21±0.38	7-9
Fecundity/female	87-729	87-729
Egg hatchability (%)	82.0±0.38	77-86
Total life cycle (Female)	34.75±0.37	29-42
Total life cycle (Male)	33.32±0.64	28-41
Sex Ratio (F:M)	1.07 : 1	

Average temp. 29.7°C, RH: 65.3%.

instar larvae with white dorsal lines and alight lateral line. Black tubercles were found dorsally on the body which bears spines. The late instar had a white inverted "Y" line on frons and four black dots in a square pattern were more prominent (Fig.1 A). Similar moulting pattern, colour characteristics and number of larval instars on maize has been reported by (Sharanabasappa *et al.,* 2018; Guo *et al.,* 2020). Larval survival of 79.2% was recorded in *S. frugiperda*. Dias *et al.* (2016) revealed that *S. frugiperda* larval survival rate on maize was 90%. Pinto *et al.* (2019) observed similar trends in their experiment indicating that the larval survival of *S. frugiperda* differed significantly among different corn-based diets i.e., 48 to 94.7%. The variations between the current results and those of previous researchers may be due to differences in the host variety and meteorological variations at the time of experimentation.

Pupal period and sex ratio

The late instar in pre pupal period stop feeding. Freshly formed pupa was soft and greenish in colour, later on the pupa becomes shiny reddish-brown. Pupal period of *S. frugiperda* ranged from 6 to 9 days (average 7.22 days). The pupal sexing can be done by

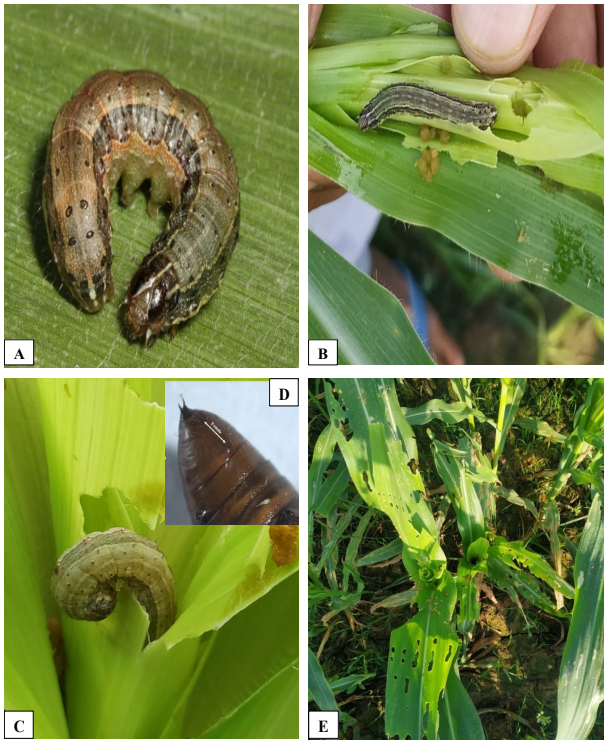

Fig. 1. Immature stages of Fall Armyworm, Spodoptera frugiperda. A, B and C. Larval instars showing 4 dots forming a square on last abdominal segment and inverted 'Y' on head; D. Female pupae E. Damaged plants. (Research Photographs, Experimental Laboratory and Field, Department of Entomology, CCSHAU-Hisar).

genital opening and anal slot distance which will be more in females than males. The genital opening in female pupa was present on 7th abdominal segment while it was present on 9th segment in male pupa (Fig. 1.D). The current investigations are almost similar to those of Kalyan *et al.* (2020), who found that the mean pupal duration of *S. frugiperda* on maize was 8.96 days. Lekha *et al.* (2020) observed that the pupal duration varied between 7.00 to 11.00 days in response to five different artificial diets gives support to present findings. The sex ratio of male: female reported during the study was 1:1.07. Similarly, Murua *et al.* (2008) has also reported the preponderance of females over males (1.2:1).

Ovipositional periods and adult

The pre-ovipositional, ovipositional and post ovipositional period ranged from two to three days (2.68±0.32), 3-4 (3.02±0.16) and 3-4 days (3.82±0.65), respectively, with 87-729 eggs/ female (Table 1). The present investigations are in conformity with Sharanabasappa *et al.* (2018)

who reported the pre-oviposition, oviposition and post oviposition period of three to four, two to three and four to five days, respectively with fecundity of 835 to 1169 eggs/female. The current results are also in accordance with Kalyan *et al.* (2020) who observed that pre-oviposition, oviposition and post-oviposition period of 3.47, 2.96 and 6.13 days in *S. frugiperda* on maize. Forewings of female moth were less conspicuous, varying in colour from uniform greyish brown to delicate grey with brown spots. Male forewings were brown and grey scaled with a white triangular patch at the apical and a circular spot in the mid of the wing. Both males and females have silvery white hind wings with a narrow dark margin. The adult males were survived for 7.21 days with a range of seven to nine days as compared to females 8.64 days with a range of eight to ten days. The morphological characteristics and longevity of *S. frugiperda* adults were found in similarity with those described earlier (Oliver and Chapin, 1981; Sharanabasappa *et al.,* 2018; Hutasoit *et al.,* 2020). The total life span of males and females ranged from 28-41 days (33.32±0.64 days) and 29-42 days (34.75±0.37), respectively. Similarly, Sharanabasappa *et al.* (2018) reported the total life of 37.50 days in males and 40.50 days in females on maize. The study has also been supported by the findings of other researchers (Lekha *et al.*, 2020; Rosa *et al.*, 2012).

Conclusion

The studies on biological parameters of insect helps to determine the duration of different developmental stages, their behaviour, survival rate, most damaging stage and suitable time for its management. The larva are the most damaging stage having the duration of 13-20 days. The later instars were reported to feed maximum and may cause severe damage. The adults also survived longer leads to more egg laying and pest dispersal. So, this study will be helpful in the development of further management strategies to manage *S. frugiperda.*

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