BIOMORPHIC PARAMETERS OF FALL ARMYWORM, *SPODOPTERA FRUGIPERDA* (LEPIDOPTERA: NOCTUIDAE) ON MAIZE UNDER LABORATORY CONDITION

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ABSTRACT: Fall armyworm, *Spodoptera frugiperda* is an invasive polyphagous pest that causes heavy damage to several agricultural crops especially maize and rice in the world. This pest attacks on more 353 host plants species, especially belong to poaceae family. The knowledge of developmental duration of FAW (*S. frugiperda*) is very necessary for predicting increases in field population and determining the appropriate timing and control techniques. For this purpose, the current research was conducted. The mean of incubation period was 3.55 ± 0.49 from 2 to 4 days. The average duration of first, second, third, fourth, fifth, sixth larval instar and pupa was 2.78 ± 0.43, 2.94 ± 0.53, 2.64 ± 0.91, 2.58 ± 0.36, 2.96 ± 1.95, 6.01 ± 0.41, and 8.32 ± 0.37 days, respectively. The average length of first, second, third, fourth, fifth, and sixth larval instar was 1.38 ± 0.56, 3.29 ± 0.68, 5.63 ± 0.73, 9.76 ± 0.54, 14.71 ± 1.89, and 30.11 ± 2.88 mm, respectively. The average width of first, second, third, fourth, fifth, and sixth larval instar 0.24 ± 0.10, 0.58 ± 0.09, 1.76 ± 0.22, 3.10 ± 0.26, 4.85 ± 0.31, and 5.74 ± 0.30 mm, respectively. Female was long lived as compared to male. The average preoviposition, oviposition and post oviposition period of adult was 1.02 ± 0.61, 3.11 ± 0.69, and 4.51 ± 0.74 days, respectively. The total life period of male and female was 33-45 and 38-50 days, respectively. The knowledge of developmental duration of FAW (*S. frugiperda*) will be helped in predicting the pest population in field and determining the suitable or best strategy to control this pest.

Keywords: Fall armyworm; Invasive pest; Maize; Rice; Poaceae; Biology; Morphology; Pakistan

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INTRODUCTION

The *Spodoptera frugiperda*, also known as the fall armyworm (FAW), is a significant crop pest that is native to the tropics and subtropics of the Americas. It has successfully encroached on the Canary Islands as well as in Africa, Asia, and Australia (Kenis *et al*., 2023). Agricultural crops, especially gramineous crops like corn, rice, sorghum, wheat, etc., are vulnerable to its devastating effects (Montezano *et al*., 2018; Malo and Hore, 2020; Wang *et al*., 2022). The FAW has a broad host range, broad adaptability, great migrational capacity, voracious feeding behavior, high reproduction, and quick pesticide resistance development (Sisay *et al*., 2019; Wu *et al*. 2021; Koffi *et al*., 2020). The pest has many generations per year since it does not go through diapause. In 12 main African maize-producing countries, it can result in yearly corn yield losses of 8.3 to 20.6 m tonnes, or 21-53% of total annual corn production (Sharanabasappa *et al*., 2019; Goergen *et al*., 2016).

Larvae attack maize plants at their growth sites and dig into the cob of corn to feed on the kernels, causing damage. The availability of host plants and the surrounding environment have an annual impact on the dynamics and abundance of insect populations. In areas with a harsh winter between crops, the cycle is broken, which lowers population abundance. Since then, reports on various crops like sorghum, sugarcane, and maize

have come from numerous regions of Pakistan (Ramzan *et al*., 2021a). The nation's maize crop has suffered significant damage as a result (Ramzan *et al*., 2021b).

It is obvious that FAW poses a serious threat to the maize crop, and as a result, a thorough understanding of its biology and morphology is essential for determining the pest's life stage and developing effective management strategies to combat it. These facts were taken into consideration when examining the biology of FAW on maize in a lab setting.

MATERIALS AND METHODS

A survey was conducted to collect the larvae. The larvae collected from maize fields were used to start the FAW culture. The natural host on which occurrence was observed, maize leaves, served as the larvae's primary food source. The adults that had emerged were utilized to start a lab colony that was grown on maize leaves. The larvae were raised in a circular insect breeding dish that included chopped-up maize leaves, was covered with a lid, and kept at 26°C, 65–70% RH. For oviposition, the adults were housed in an adult rearing cage. Paper towels served as the oviposition substrate in these cages, which had nylon mesh on the top side. Adult male and female pairs were released into each cage. The 10% honey solution was supplied to the adults inside the cages on cotton pads and was changed daily. For hatching, eggs were gathered and stored in a circular insect breeding dish. The eggs were then checked for hatching every 12 hours after that. The larvae (n=30) were raised separately on fresh maize leaf fragments that were switched out daily for nourishment after hatching. With their release into a rearing cage and 10% honey delivered and refilled everyday as food, male and female longevity was observed. Additionally noted were the larval and pupal stages, sex ratio, and adult emergence. Pre-oviposition, oviposition, post-oviposition periods and fecundity were also recorded during the study. Morphometrics parameters were taken by using stereozoom binocular microscope. The procedure of early researchers was followed for rearing the pest on maize (Reddy *et al*., 2021; Ramzan *et al*., 2021a).

RESULTS AND DISCUSSION

The current study was performed in the controlled conditions to check the developmental duration or parameters of the FAW. The findings of this study will proved helpful for future researchers and farmers to manage this pest on different crops especially maize. This is very dangerous pest which reported in Pakistan in 2019 from maize plants. The developmental parameters of this pest are similar as reported by researchers from others countries such as America and India and china (Kandel and Poudel, 2020; Manjula *et al*., 2019; Zhao *et al*., 2020). This risky pest has spread on the various regions of the country Pakistan and caused high economic losses in the county with in the very limited time of the report. Many researches have adopted management strategies in the country to control this serious and emerging pest but few informations are available on the developmental period of the FAW on the maize in the study area. The aim of the current study was to check the developmental period of the pest on the maize crop.

Table 1. Developmental period of immature stages of FAW.

Parameters	Mean ± SE	Range
Incubation period	3.55 ± 0.49	2-4 days
1st instar	2.78 ± 0.43	2-3 days
2nd instar	2.94 ± 0.53	2-3 days
3rd instar	2.64 ± 0.91	2-3 days
4th instar	2.58 ± 0.36	2-3 days
5th instar	2.96 ± 1.95	2-4 days
6th instar	6.01 ± 0.41	4-6 days
Pre-pupa	1.51±0.11	1-2 days
Pupa	8.32 ± 0.37	8-12 days

The mated female laid eggs in groups. The eggs laid on the dorsal side of the leaves ranged from 60-1061. Not only flattened pale green eggs laid by female on the dorsal side of the leaves but also on the base of the plant and also in whorls. Before hatching, pale green colour of eggs converted into golden yellowish and black. The mean of incubation period was 3.55 ± 0.49 from 2 to 4 days. The average duration of first, second, third, fourth, fifth, sixth larval instar and pupa was 2.78 ± 0.43, 2.94 ± 0.53, 2.64 ± 0.91, 2.58 ± 0.36, 2.96 ± 1.95, 6.01 ± 0.41, and 8.32 ± 0.37 days, respectively (Table 1). It was recorded that female was long lived as compared to male, while some researchers (Sharma *et al*., 2022;) had reported that male was long lived as compared to female (Table 2). This difference may be due to geographical variations. The total life period of male and female was 33-45 and 38-50 days, respectively. The reproductive parameters of FAW is given in table 3.

Table 2. Developmental period of mature stages of FAW.

Parameters	Mean ± SE	Range
Male adult longevity	8.97 ± 1.68	8-13 days
Female adult longevity	11.62 ± 1.63	9-15 days
Total life cycle of male	39.66 ± 1.35	33-45 days
Total life cycle of female	41.48 ± 3.29	38-50 days

Table 3. Reproductive parameters of FAW.

Parameters	Mean±SE	Range (Days)
Pre oviposition period	1.02 ± 0.61	3-4 days
Oviposition period	3.11 ± 0.69	3-5 days
Post oviposition period	4.51 ± 0.74	4-6 days
Fecundity/ female (Number)	1002±94.32	796-1198
Egg hatchability %	97.76 ± 1.10	92-98%

The preoviposition, post oviposition and oviposition period of adult was 3, 6 and 5 days, respectively. Many others authors have also reported the similar findings as reported in the current study about ovipositional period of FAW. The ovipositional period of FAW is shown in figure 1. Reddy *et al*. (2021) had reported 4-5 days of pre ovipositional period, while Deepika *et al*. (2019) reported 4.06 days of oviposition period. Sharanabassapa *et al*. (2018) had reported 3-4 and 4 to 5 days for ovipositional and post ovipositional period of female. Their findings are in line with our current study results. Many others researchers had reported the similar fimdings (Navasero *et al*., 2019a; Silva *et al*., 2017; Murtaza *et al*., 2019; Ramzan *et al*., 2019).

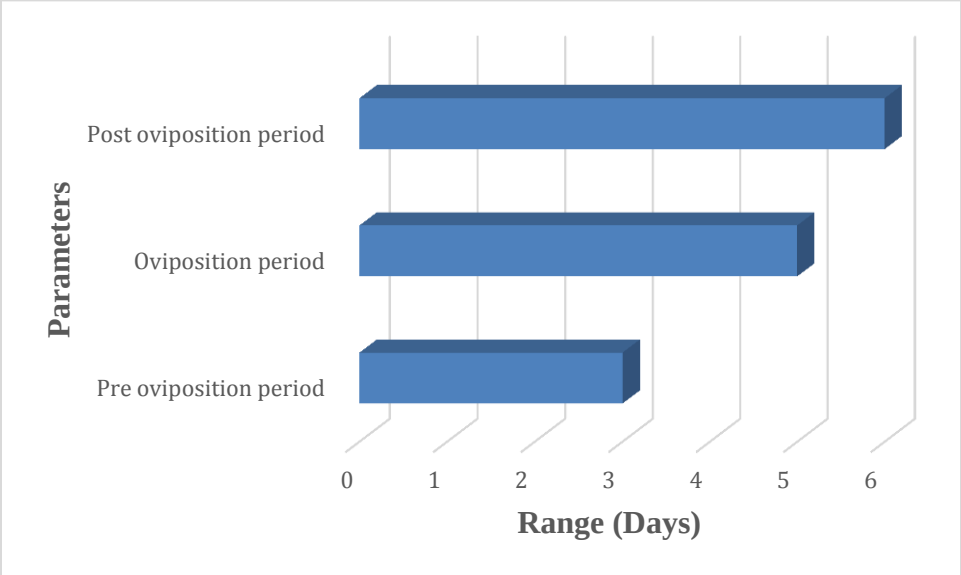

Figure 1. Ovi-positional parameters of FAW

Table 4. length and width of immature stages of FAW.

Parameters	Length (mm)		Width (mm)	
	Mean ± SE	Range	Mean ± SE	Range
Egg	0.29 ± 0.64	0.20-0.40	0.25 ± 0.09	0.28-0.32
1st instar	1.38 ± 0.56	1.02-1.90	0.24 ± 0.10	0.20-0.33
2nd instar	3.29 ± 0.68	2.17-4.31	0.58 ± 0.09	0.60-0.71
3rd instar	5.63 ± 0.73	5.10-7.22	1.76 ± 0.22	1.61-2.47
4th instar	9.76 ± 0.54	7.32-11.14	3.10 ± 0.26	2.65-3.89
5th instar	14.71 ± 1.89	13.02-16.01	4.85 ± 0.31	2.11-4.97
6th instar	30.11 ± 2.88	30.21-35.10	5.74 ± 0.30	5.34-6.11
Pupa	15.12 ± 2.44	13.01-17.02	4.82 ± 0.10	4.66-5.53

Table 5. Length of adult body and wing span.

Parameters	Length (mm)		Wing span (mm)	
	Mean±SE	Range	Mean±SE	Range
Male	14.11± 1.22	13.10-16.12	30.09± 2.66	30-34
Female	15.61± 1.76	14.0-18.0	30.99± 2.54	30-35

The average length of first, second, third, fourth, fifth, and sixth larval instar was 1.38 ± 0.56, 3.29 ± 0.68, 5.63 ± 0.73, 9.76 ± 0.54, 14.71 ± 1.89, and 30.11 ± 2.88 mm, respectively. The average width of first, second, third, fourth, fifth, and sixth larval instar 0.24 ± 0.10, 0.58 ± 0.09, 1.76 ± 0.22, 3.10 ± 0.26, 4.85 ± 0.31, and 5.74 ± 0.30 mm, respectively. The body length of male and female adult with wing span is given in table 5.

Conclusion: The knowledge of developmental period of fall armyworm can be utilized for effective management of this pest in field and laboratory conditions. Female was long lived as compared to male. The average preoviposition, oviposition and post oviposition period of adult was 1.02 ± 0.61, 3.11 ± 0.69, and 4.51 ± 0.74 days, respectively. The total life period of male and female was 33-45 and 38-50 days, respectively.

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