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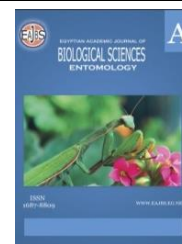
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Observation on Fall Armyworm, *Spodoptera frugiperda* (Lepidoptera: Noctuidae) on Maize Under Laboratory Conditions

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ABSTRACT

Spodoptera frugiperda is native to tropical and subtropical areas of the world and consider an invasive species in Pakistan since 2019. It is spreading continuously and become a threat to horticultural as well as agricultural crops especially maize all over the world. The developmental duration of each *S. frugiperda* stage was recorded on maize leaves under laboratory conditions. The embryonic period was 2.32 ± 0.22 days. The developmental duration of 1st, 2nd, 3rd, 4th, 5th and 6th larval instars were 2.37, 2.09, 2.01, 2.02, 2.27 and 5.10 days, respectively while the total larval period was 14-16 days. Female was long-lived as compared to male. The current study concluded that Fall armyworm, *S. frugiperda* is a primary pest and threat to vegetative as well as reproductive parts of maize crop which cause significant economic losses.

INTRODUCTION

The fall armyworm, *Spodoptera frugiperda* is an invasive pest of maize crop in various countries including Pakistan. It attacks more than 80 crops and grasses species such as rice, corn, cotton, soybean and millet, etc. (Casmuz *et al.*, 2010; Silva *et al.*, 2017; CABI, 2018). First-time pests have been reported from African countries in 2016 (Georgen *et al.*, 2016; Sisay *et al.*, 2018). In 2018, it has been reported from Bangladesh, India, Thailand, China, Sri Lanka and Myanmar (FAO, 2019 a, b).

In 2019, its larvae were collected from different maize crop areas of Sindh and sent to the Department of Entomology, Muhammad Nawaz Shareef University of Agriculture, Multan Pakistan for identification (Unsar Naeem-Ullah *et al.*, 2019). After careful identification, it was reported that larvae belong to *S. frugiperda*. Pest was a strong flier and easily reached India to Pakistan due to the presence of several agricultural crops (chilies, cotton, rice, corn, tomato and potato) that have been cultivated near India–Pakistan Border, commonly known as the International Border (IB).

Pest is continuously spreading all over the maize-growing areas of Pakistan. Now, the pest has been distributed in all maize-growing provinces of Pakistan in a very short period of invasion. Maize is a cereal crop and its products are used for various purposes such as raw material for the industry and food for domestic animals. Maize is cultivated on 1.34 million hectares in Pakistan (PBS, 2018). Since 2019 in Pakistan maize was found most infested crops with *S. frugiperda* larvae. The infestation of larvae is increasing day by day and causes economic losses of the crop.

There is a need to provide proper information about its stages such as egg, larva, pupa, and adults on maize crops in Pakistan. For this purpose, the current study was conducted to elaborate on the developmental time of each stage.

MATERIALS AND METHODS

Larvae were collected from different cornfields of district Multan and reared on maize leaves under laboratory conditions. Larvae were reared in the petri dish with fresh maize leaves and leaves were changed after an interval of three days. A pair of adults (male and female) was placed into an adult rearing cage for observing their mating behaviour and oviposition or egg collection. The duration of adult, pupa, larva and egg of this noctuid moth, *S. frugiperda* was recorded and noted (N=30).

RESULTS AND DISCUSSION

S. frugiperda is native to America and now distributed in various regions of the world including Pakistan. It has become a major issue for crop losses in tropical and subtropical areas (Early *et al.*, 2018). As polyphagous in nature, larvae can attack various agricultural crops including cotton and wheat (Hoy, 2013; Montezano *et al.*, 2018; Hardke *et al.*, 2015). The maximum larval infestation was observed on three to four weeks of maize crop germination (Evans and Stanly, 1990). The early as well as old instars larvae feed on the maize leaves and even cause 100% defoliation. Larvae attacked vegetative parts (stem and leaves) and reproductive parts (tassel, cob, bud and flower) of many host plants such as cotton, maize and rice, etc. (Tefera *et al.*, 2019). The symptoms of pest damage are similar to maize stem borer, *Chilo partellus* (Deole and Paul, 2018) and *Spodoptera litura* (Ramzan *et al.*, 2019). The current pest can become the cause of dead hearts in maize which is similar to *C. partellus* (Bateman *et al.*, 2018).

The severe *S. frugiperda* infestation had been reported from many African and other countries which caused 22-67% maize crop losses (Rwomushana *et al.*, 2018; Conrow, 2018; Day *et al.*, 2017; Kumela *et al.*, 2018; Baudron *et al.*, 2019). (Gu and Woo, 2019) had reported that about 80,000 hectares of land have been disturbed in China due to the attack of this destructive pest. with this pest in Yunnan province of China (Gu and Woo, 2019) whereas in the case of Sri Lanka 40,000 hectares of land has been infested by damaging 20% of its crop (UNNews, 2019).

The complete metamorphosis such as egg, larva, pupa and adult were observed in *S. frugiperda* (Luginbill, 1928). The current study findings are in agreement to various previous studies. The total life period from egg to adult is varying according to climatic conditions or seasons. The pest life cycle was recorded as prolong in the winter (80-90 days) season followed by autumn (60 days) and summer (30 days) (James and Engelke, 2010).

Dome shape eggs are laid in groups or batches and a single female can lay about 1000-2000 eggs in her life duration (Haftay and Fissiha, 2020). The majority of eggs can lay by a female in her early life. Khatri *et al.* (2020) had reported similar findings of the

oviposition of females. The average mean value of the incubation period was 2.32 ± 0.22 days.

The developmental period of 1st, 2nd, 3rd, 4th, 5th and 6th larval instars were 2.37, 2.09, 2.01, 2.02, 2.27 and 5.10 days, respectively. The total developmental period of 1-6th larval instar was 14-16 days on maize leaves under controlled conditions (Table 1). The colour variations were observed between different instar larvae. The colour of 4th to 6th instars was firstly brownish while change later light to dark brown. Had reported similar findings of colour variations of larvae.

Table 1: Duration of egg, larva, pupa, and adult of a noctuid moth, *S. frugiperda*

Parameter	n	Mean \pm SD	Range (days)
Egg	30	2.32 ± 0.22	2.31-3.09
First instar	30	2.37 ± 0.33	2.33-3.82
Second instar	30	2.09 ± 0.21	2.00-3.00
Third instar	30	2.01 ± 0.09	2.01-3.00
Fourth instar	30	2.02 ± 0.04	2.00-3.01
Fifth instar	30	2.27 ± 0.30	2.21-3.23
Sixth instar	30	5.10 ± 0.81	5.00-6.01
Total larval period	30	14.09 ± 0.81	14.03-16.00
Pupa + Prepupa	30	9.00 ± 0.61	9.00-11.00
Male pupa	30	9.03 ± 0.76	9.00-10.45
Female pupa	30	8.60 ± 0.91	8.44-10.66
Adult			
Male longevity	25	8.00 ± 0.66	7-9
Female longevity	25	10.00 ± 0.76	9.11
Total life cycle (Male)	30	37.16 ± 4.99	32-41
Total life cycle (Female)	30	39.96 ± 3.98	33-44

The morphometric of adults (male and female) and pupa were recorded during the study. It was observed that female was long-lived than male. The longevity of a female may be due to the consumption of her eggs as food which enhances the life period. The body length of males and females was 14.21 and 15.12mm, respectively. Female body length was longer than male body length. Our current study findings are similar to previous studies (Bhatti *et al.*, 2020). The colour of forewings and hindwings of *S. frugiperda* is gray-brown and silver-white with a darker border, respectively. The single forewing length and total wingspan width of the male were 12.10 and 32.20mm, respectively while the female was 15.12 and 33.45mm, respectively. It was observed that male and female pupal length was 13.18 and 14.12mm, respectively (Table 2). The wingspan description of the present study showed a similar investigation as reported by Prasanna *et al.* (2018). Sidana *et al.* (2018) had reported light brown forewings of males while Brambila (2013) discussed kidney shape. The moth is nocturnal and active in the humid and warmer evening time (Kalleshwaraswamy *et al.*, 2018). Many integrated pest management strategies against *Spodoptera* species have been adopted by many farmers and researchers under laboratory as well as field conditions (Murtaza *et al.*, 2019; Ramzan *et al.*, 2019). The different management strategies such as chemical, biological and cultural should be adopted to control this pest in the current.

Table 2: Morphometric of adult (male and female (mm)) and pupa

Parameter	Male	Female
	Mean \pm SD	Mean \pm SD
Body length	14.21 \pm 0.30	15.12 \pm 0.23
Single forewing length	12.10 \pm 0.32	15.12 \pm 0.21
Wingspan width	32.20 \pm 0.37	33.45 \pm 0.45
Pupal length	13.18 \pm 0.21	14.12 \pm 0.26

Conclusion

FAW is reported as an invasive species in Pakistan since 2019. One more *Spodoptera* species has become the part of Pakistani *Spodoptera* species. The complete metamorphosis is recorded in this pest and larva is found a highly destructive stage for agricultural crops especially maize. The complete information about each stage of the current pest is very necessary to adopt an effective management tool against this pest. The authentic information about the pest is provided in this manuscript. Further, need to adopt management strategies against this crop enemy.

Conflict of interest

The authors declare no conflict of interest.

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