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The Biology of Fall Army Worm (*Spodopterafrugiperda*. J. E. Smith) in Sudan

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Abstract

The Fall armyworm (*Spodoptera frugiperda*) is considered among the economic important pests in Sudan. Therefore, it became necessary to study and understand its biology and find out the appropriate control measure (s). To achieve the above objective, experiments based on Randomized Complete Block Design (RCBD) were carried out during the period from September 2018 to August 2019, where the Fall armyworm (FAW) was reared in the laboratory and fed on a nutrient médium composed of Corn leaves. The results displayed the ranges of eggs laid by a female was 890–1169. The egg incubation period ranged between 3-13 days. The larval duration ranged between (13-50) days and the pupal duration was between (7-20) days under a temperature of 21-30ºc and a Relative Humidity (RH) of 65 ± 5%. The longevity of the adults was 1-20 days, and the range of the full lifecycle was (24-100). However, six generations of FAW were obtained within one year. This study concludes that in Sudan FAW breeds continously throughtout the year and it recommends further studies on the biology and effective management of this invasive pest

Introduction

The Fallarmyworm (FAW), *Spodopterafrugiperda*, J.E.Smith, is found all over the world (Pitre, et, al.; 1983, Capinera, 2017)[1,2], but, basically, it is an indigenous pest throughout the

Americas. The studies showed that, it is one of the most damaging crop pests, feeding on over 80 different crops including Maize, Rice, Sorghum, and Sugarcane in addition to many others which include Cotton, Tomatoes, Potatoes, Millet, Cabbage and many Grasses.

Studies carried out on this pest showed that it is a polyphagous insect of enormous agricultural importance. The larvae can feed on more than 150 plant species, and the adult can produce several generations per year, and the moth can fly up to 100 km/night (Montezano, et, al.; 2018) [3].

The first reports on the distribution of FAW in Africa were from West Africa (Georgen,*et, a.;* 2016; Cock. et. al.; 2017)[4,5]. Later in 2017, additional reports indicated that 28 African countries have confirmed the presence of FAW. In 2018, its distribution has extended to more than 60 countries (FAO, 2018)[6]. In Sudan, FAW was recorded for the first time in 2017 on hybrid Maize in the experimental farm of Al Damazin Research Station (Blue Nile State) (El Nour, et, al.; 2017; Abraham, et. al.; 2017)[7,8]. Later surveys were carried out by Plant Protection Directorate up to 2020 showed that FAW was reported from 11 other states in the country (Plant Protection Directorate-Unpublished Reports, 2020)[9].

Concerning the economic importance of the FAW, surveys were carried out during 3-4 months in 8 states showed that 6 crops; namely. Maize, Sorghum, Millet, Sesame, Peanut and Tomatoes were affected by this pest. The damage ranged from high (100%) in 2 States (Khartoum and Sennar), to moderate (33.4%) in 2 States (Aljazira and South Kordofan) and low in 4 States (Blue Nile, Al Gadaref, Kassala and Western Darfur).

Since its discovery in Sudan, no study has been carried out on its detailed biology. Accordingly, this research was carried out to study the biology of the FAW after its wide distribution in Khartoum State. As a new invasive pest, it is important to understand its life stages and biological parameters in order to allow for planning effective strategy for control measures.

Materials and Methods

During the period from September 2018 up to the end of August 2019, regular surveys were made in the Maize fields infested with FAW (*S. frugiperda*) at the Agricultural farms in Shambat, to determine the life cycle and annual generations of the insect under laboratory conditions. Infested Maize crops were collected and brought to the laboratory. FAW Larvae were collected from the infested plants and reared in plastic cages (29×20×20 cm), under laboratory conditions of a temperature range of 21-30^{0}c and 65±5 % RH.

After adult emergence, ten pairs, each of a male and a female, were released in separate cages. The adults were fed on 10% sugar solution soaked on cotton pads offered in small plastic caps inside the cages and replaced daily. The pre-oviposition, oviposition and post-oviposition periods and number of eggs laid by each female were recorded. The eggs were collected and kept in a circular insect breeding dish and were examined at intervals of 12 hrs, for hatching. After hatching, thirty larvae (n = 30) were reared individually and fed on fresh maize leaf bits which were changed daily. The number of larval instars, larval and pupal durations and longevity of emerging adults and sex ratio were recorded. Annual generations of the FAW were also observed. These procedures of rearing adults and larvae were repeated regularly during the observation periods on the FAW development during the whole year.

Results and Discussion

In the present study, the biological parameters observed and recorded during the development of the FAW from oviposition up to the adult emergence, within a period of twelve Months. The results are shown in the following tables (1 and 2).

During the past decades, large numbers of studies were made on the biology of the FAW in various

Table 1. The Biological Parameters of *Spodoptera frugiperda* recorded during one Year, under Laboratory Conditions (Shambat-Sudan 2018-2019)

Stage	Range(Days)	Mean ± SD
Pre-oviposition Period	3.00 – 4.00	3.6 ± 0.49
Oviposition Period	2.00 – 3.00	2.8 ± 0. 40
Post-oviposition Period	4.00 – 5.00	4.3 ± 0.46
Female Fecundity (No. of Eggs)	890.00 - 1169	1029.8 ± 139.5
Egg Hatchability(%)	90% - 95%	92.5 ± 2.5
Adult Male Longevity	7.00 – 9.00	8.20 ± 0.75
Adult Female Longivity	9.00 – 12.00	10.80 ± 0.87
MaleTotal Life Cycle(Egg – Adult)	24 – 54	39 ± 15.00
FemaleTotal Life Cycle(Egg – Adult)	26 – 57	41.5 ± 15.5

Table 2. The Six Generations of FAW (*Spodoptera frugiperda*) recorded during a period of Twelve Months under Normal Laboratory Conditions (Shambat-Sudan 2018-2019)

Generations	Month	Incubation Period Range (Days)	Larval Duration Range (Days)	Pupal Duration Range (Days)	AdultLongevity Range (Days)	Total Life cycle Range (Days)	Normal Lab. Conditions	
							Temp. ^{o}C	Humid.%
1st	9,10	3-5	13-24	7-12	1-13	24-54	27	65
2nd	10,11	3-6	15-39	7-15	2-15	40-74	25	68
3rd	12, 1,2,3	3-10	25-50	18-20	1-20	47-100	21	66
4th	4,5	8-13	29-40	15-20	1-12	53-85	22	70
5th	6,7	3-5	13-30	11-14	2-20	29-69	23	71
6th	7,8	3-5	15-25	7-10	1-15	26-55	30	69

countries in the world (Igyuve. et, al.; 2018; and Lamsal, et, al.; 2020) [10,11]. By reviewing those studies it was found that, in comparison, the results (table 1) shown in the present study were in full agreements with most of the results recorded in those studies. For example, the pre-oviposition (the period taken by a female to lay its whole eggs in several egg masses (100 t0 200 per egg mass) period is similar to those reported by Pitre, et. al.; (1983)[1] and Sharanabasappa, et.al.; (2018) [12]. Also, the oviposition period shown (2-3 days) are in agreement with those recorded by Lamsal,et. al.; (2020) and Silva et. al.; 2017 [10,13]. In addition, six larval instars were recorded in the present study, which were similar to those reported in some of the above mentioned studies (e.g., Pitre, et. al.; 1983; Sharanabasappa,et. al.; 2018) [1, 12] .

The regular observations of the (FAW) made in the present study in the fields, and in the laboratory, showed that its reproduction continued during the whole year round. Under normal laboratory conditions, six generations of the FAW were recorded during its development within Twelve Months. These are shown in Table 2.

According to the observations made, these generations of the FAW can be classified on seasonal bases to the following: two generations (the First and the Second generations) in the autumn, from September to late November. The third generation in the winter, from December to late March. The fourth and the fifth generations in the summer (from April to late June) and the sixth generation in autumn (during July and August).

Considering the number of FAW generations per year, the results of the present study are in agreement with those reported by Abraham, *et. al.*; (2017)[8]. They mentioned that, in Florida the (FAW) breeds continually, and the life cycle takes one month in summer, two months in spring and autumn and three months in winter. On the other hand, Tendeng.*et, al.*; (2019)[14], in Sengal, recorded Fifteen generations per year. However, Capinera (2017)[2], mentioned that, the number of annual generations of the (FAW) differs according to the different areas and different seasons.

Conclusion and Recommendations

The regular surveys and observations made on the FAW in the present study indicated that, its breeding is continuous through the year round, and so it represents a menace for the different crops in the field. Therefore , it is recommended that, more studies on the biology and ecology of the FAW would be of prime importance to determine a suitable time for its effective management in the future.

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