Effect of maize hybrids on the biological characteristics of the fall armyworm, Spodoptera frugiperda (J.E. Smith) (Lepidoptera: Noctuidae), under laboratory conditions

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4 authors:

Mohamed Ali Mohamed Youssef
Plant Protection Research Institute (PPRI)

Moustafa Mohamed Sabry Bakry
Plant Protection Research Institute (PPRI)

Nagdy Abdel-Baky
Mansoura University

Nagdy F Abdel-Baky
University of California, Riverside

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Original Article

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Efeito de híbridos de milho nas características biológicas da lagarta-do-cartucho, *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae), em condições de laboratório

M. A. M. Youssef[a], M. M. S. Bakry[b] and N. F. Abdel-Baky[c,d]*

[a]Agricultural Research Center, Plant Protection Research Institute, Field Crop Pests Department, Giza, Egypt
[b]Agricultural Research Center, Plant Protection Research Institute, Department of Scale Insects and Mealybugs Research, Giza, Egypt
[c]Mansoura University, Economic Entomology Department, Faculty of Agriculture, Mansoura, Egypt
[d]Qassim University, College of Agriculture and Foods, Plant Protection Department, Buraidah, Qassim, Saudi Arabia

Abstract

The fall armyworm (FAW), *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae), an invasive and polyphagous pest affecting various vital crops globally, was studied to assess how different maize hybrids impact its biological parameters under controlled laboratory conditions. Maize, a crucial crop for food security in Egypt, requires effective Integrated Pest Management (IPM) strategies to manage pests like *S. frugiperda*. This article explores how *S. frugiperda* performs on five maize hybrids—Hi-Tech 2031, Wataniya 6, Giza 10, Giza 128, and Giza 168. Significant differences were observed in larval duration across the hybrids, with the shortest duration (14.08 days) on Hi-Tech 2031. Giza 128 resulted in the longest pupal period (9.39 days), and adult lifespans varied between 8.91 and 9.61 days. Reproductive parameters also diverse, with pre-oviposition periods ranging from 4.64 to 4.90 days and oviposition periods from 3 to 4.14 days. The highest average egg count (1352.19 eggs) was recorded with Giza 10. Hybrids Hi-Tech 2031 and Giza 128 had a lower male proportion (44.81% and 43.45%, respectively). Giza 10 also yielded the highest pupation rate (93.33%), while Hi-Tech 2031 showed the highest emergence rate (96.33%).

Keywords: *Spodoptera frugiperda*, fall armyworm, FAW, biological parameters, maize, hybrids, IPM, invasive species.

Resumo

A lagarta-do-cartucho (FAW), *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae), uma praga invasora e polífaga que afeta muitas culturas importantes ao redor do mundo, foi estudada para avaliar de que modo diferentes híbridos de milho impactam seus parâmetros biológicos em condições de laboratório. O milho é uma das culturas de cereais mais amplamente distribuídas e desempenha um papel importante na segurança alimentar no Egito. Vários métodos de Manejo Integrado de Pragas (MIP) devem, portanto, ser usados para controlar essas pragas que ocorrem esporadicamente. O controle cultural, químico, biológico e integrado de pragas é comumente usado para infestações de *S. frugiperda*. Portanto, este artigo tem como objetivo explorar como *S. frugiperda* se comporta em cinco híbridos ne milho, nomeadamente Hi-tech 2031, Wataniya 6, Giza 10, Giza 128 e Giza 168. A duração larval diferiu significativamente quando as larvas foram criadas com diferentes híbridos de milho. A menor duração larval (14,08 dias) foi observada quando as larvas foram criadas com o híbrido Hi-tech 2031. O maior período de pupação (9,39 dias) ocorreu com as larvas criadas com o híbrido Giza 128. A vida útil dos adultos variou de 8,91 a 9,61 dias. Os diferentes híbridos de milho influenciaram significativamente a reprodução de *S. frugiperda*. O tempo antes da oviposição variou de 4,64 a 4,90 dias. Os períodos de oviposição das fêmeas variaram de 3 a 4,14 dias. O maior número médio de ovos (1352,19 ovos) foi observado quando as larvas se alimentaram do híbrido Giza 10. A proporção de machos foi menor que a proporção de fêmeas nos insetos alimentados com os híbridos Hi-tech 2031 e Giza 128, 44,81 e 43,45%, respectivamente. As larvas de *S. frugiperda* alimentadas com o híbrido Giza 10 apresentaram a maior porcentagem de pupação (93,33%). As larvas de *S. frugiperda* alimentadas com o híbrido Hi-tech 2031 registraram a maior porcentagem de emergência (96,33%).

Palavras-chave: *Spodoptera frugiperda*, lagarta-do-cartucho, FAW, parâmetros biológicos, milho, híbridos, MIP, espécies invasoras.

*e-mail: nafabdel2005@yahoo.com
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1. Introduction

Maize is one of the most worldwide-distributed cereal crops, second only to wheat, the most corn-growing countries in the world are the United States, Brazil, China, Mexico, and Romania (Elasraag, 2017). In Egypt, it comes first in terms of the area of cultivated grain crops in summer. Corn plays an important role in food security in Egypt, as it is considered a source of food for humans and animals alike (Shawky et al., 2020). Maize crop in the Sohag region, Egypt, is infested by about 30 genera of pests, some of the most harmful pests on maize are fall armyworm (FAW), *Spodoptera frugiperda* (Youssef, 2018, 2021; Ali et al., 2022; Bakry and Abdel-Baky, 2023a).

The fall armyworm is an extremely polyphagous lepidopteran pest, that infests millions of hectares of maize crops, causing serious economic damage and thus poses a major threat to food security (Chen et al., 2022; Bakry and Abdel-Baky, 2023b). Therefore, the herbivores insect-like FAW must obtain essential nutrients from their host plants, and host plants also influence FAW performance, e.g. biology. *S. frugiperda* is an invasive pest that is very harmful to leguminous crops, especially maize. Its home is the American continent, from where it has spread to all countries of the world, where it was detected for the first time in Africa in Nigeria in 2016 (Goergen et al., 2016). The Egyptian Ministry of Agriculture announced that the infestation of maize plants in the Aswan governorate with FAW was in 2019 (Dahi et al., 2020).

There are many ways to combat FAW in the world, and one of the most important means of control is pesticides. Despite the high effectiveness of pesticides against pests, they pose many risks to human health and the environment (Navasero, et al., 2021), as well as the unregulated use of pesticides led to the emergence of insect resistance to some pesticides (Yu, 2006). In addition to the use of pesticides, other methods of pest control can also be used. One way to reduce pest populations through an integrated pest management strategy is to use pest-resistant hybrids (Mihm, 1997). It is possible to estimate the effect of host plants and hybrids of the same plant species on insect pests by analyzing biological parameters such as duration, growth rate, weight, and mortality. By estimating these measurements, sources of resistance can be identified (Santos et al., 2003).

Investigating the utilization of various host plants by *S. frugiperda* as food sources and understanding their host preferences in basic biological studies are crucial. These inquiries help assess the impact of different crops' nutrient compositions on this pest, as highlighted by Scriber and Slansky Junior (1981) and Barros et al. (2010). Previous research, including studies by Ball et al. (2006) and Storer et al. (2010), has delved studies into the biology of *S. frugiperda*.

Given the global invasive nature of *S. frugiperda*, it is imperative to develop effective control strategies for new habitats with different host plants. Establishing a knowledge base on the biological parameters of the FAW and the effectiveness of the plant families it targets is a logical first step, as emphasized by Acharya et al. (2022). Numerous studies, including those by Nabity et al. (2011), have explored the effects of utilizing various weeds like Ipomoea sp. or crops such as rice, maize, and other grasses as hosts for *S. frugiperda*. Understanding these dynamics is crucial for comprehending the survival, population growth, and infestation patterns of this species throughout the year, impacting the population dynamics in an agricultural landscape (Tisdale and Sappington, 2001).

The larval stage of FAW prefers feeding on maize leaves and tender shoots, particularly on cultivated grasses. It becomes a tissue chewer, causing damage to 353 species, 227 genera, and 76 plant families, including economically significant cereal crops like maize, wheat, and sorghum, as documented by Paredes-Sanchez et al. (2021) and Early et al. (2018).

Therefore, this study aims to evaluate the impact of different maize hybrids on the biological parameters of the Egyptian population of the fall armyworm, *Spodoptera frugiperda*, under laboratory conditions to inform effective integrated pest management (IPM) strategies.

2. Materials and Methods

2.1. Colonies of S. frugiperda

Spodoptera frugiperda larvae were collected from the farm of the Agricultural Research Station in Shandaweel, Sohag Governorate, Egypt, and then transported to the laboratory to prepare a laboratory colony. The larvae were fed on castor leaves until they reached the pupal stage while the adults were fed a 10% sugar solution. The materials used for rearing *S.frugiperda* in the laboratory, as shown in Figure 1, include plastic cups in which the larvae are housed. Figure 1 also provides specific biological details about the larva of the first larval stage of *S. frugiperda*, including the structure of the larval head capsule and the developmental stages, such as larva, pupa, and exuvia.

2.2. Maize plants

For this study, five maize hybrids were utilized: Hi-Tech 2031, Wataniya 6, Giza 10, Giza 128, and Giza 168. These hybrids were sourced from the maize research department of the Field Crops Research Institute at the Agricultural Research Center and the local markets. The seeds of these hybrids were subsequently planted.

2.3. Biology of S. frugiperda on various maize hybrids

The experiment was carried out in the plant protection laboratory at the Agricultural Research Station in Shandaweel under controlled conditions [26 ± 2 °C, 14:10 (L) photoperiod, and 70 ± 10% relative humidity]. For each maize, ten newly hatched larvae were placed in plastic cups, with each setup replicated three times. The larvae were fed daily with fresh corn leaves, which were replaced each day until the larvae pupated. To maintain leaf freshness, a wet filter paper was placed under the corn leaf until the larvae reached the third instar, after which it was replaced with soft sawdust to absorb moisture from the larvae's frass. Pupae were weighed 24 hours after pupation and then left to complete their development. After 48 hours of adult emergence, each

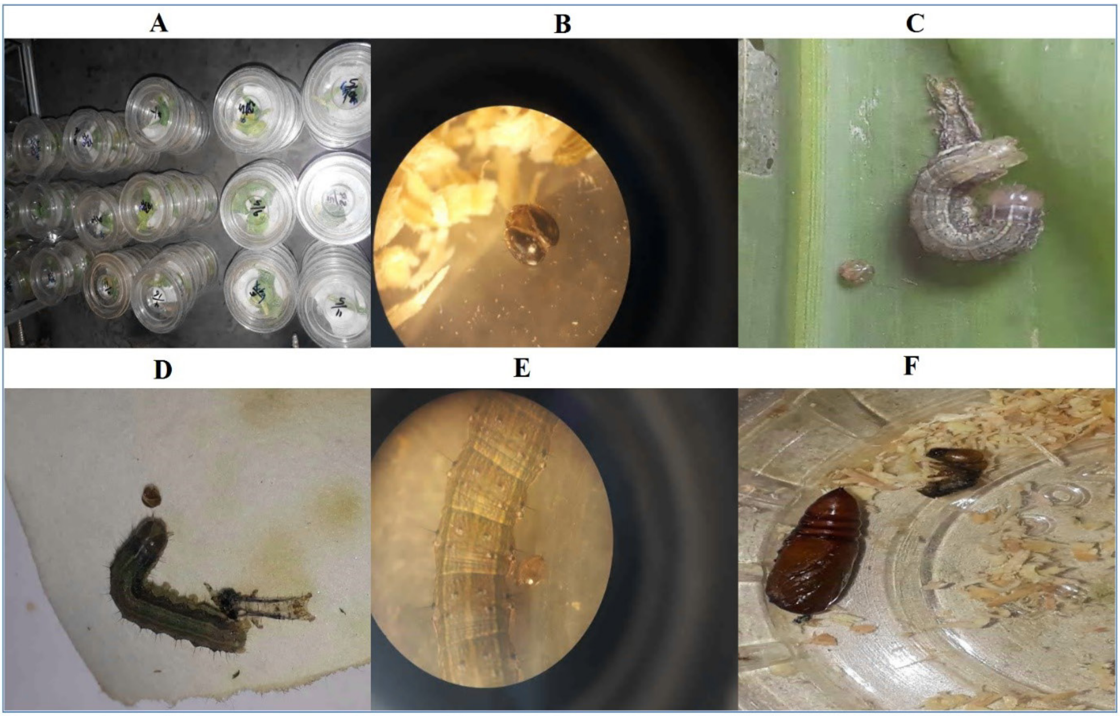

Figure 1. (A) Plastic cups containing *S. frugiperda* larvae; (B) head capsule of *S. frugiperda* larva; (C) and (D) Larva, head capsule and exuviae; (E) *S. frugiperda* larva and head capsule; (F). *S. frugiperda* pupa and exuviae.

male-female pair was placed in a plastic container covered with gauze and secured with a rubber band. A cotton swab soaked in a 10% sugar solution was provided for feeding. The biological parameters recorded included larval instars, larval duration, pre-pupa and pupal durations, pre-oviposition, oviposition, and post-oviposition periods, adult duration, fecundity, male and female durations, sex ratio, pupal weights, pupation percentage, and adult emergence rates.

2.4. Data analyses and statistics

The data were analyzed statistically using a one-way analysis of variance. To assess the significance of differences between treatments, means were compared at $P \leq 0.05$ using the LSD test, as performed by MSTATC software (Michigan State University, 1980).

3. Results

3.1. Larval instars, pre-pupa, and larval duration of S. frugiperda reared on different corn hybrids

Table 1 shows the effects of five maize hybrids on the larval stages, the prepupal stage, and the total larval duration of *S. frugiperda*. The first larval instar was significantly affected by the maize hybrids, with the shortest duration (2.93 days) observed in the hybrid Hi-tech 2031, while the longest duration (3.96 days) was recorded in the hybrid Giza 168. No significant differences were observed between the hybrids for the second larval stage; however, hybrid Giza 10 had the longest duration (2.25 days).

In the third larval stage, there were significant differences between the hybrids, with the shortest duration (1.26 days) in hybrid Giza 128 and the longest (1.50 days) in hybrid Giza 168. Similar to the second larval stage, no significant differences were observed between the hybrids in the fourth larval stage, although hybrid Giza 10 had the longest duration (1.75 days). Significant differences were found between the hybrids for the fifth and sixth larval stages. The hybrids Watania 6 (2.08 days) and Giza 128 (3.40 days) had the shortest residence time for the fifth and sixth larval stages, respectively, while the hybrids Giza 10 (2.32 days) and Giza 168 (3.92 days) had the longest residence time for the respective stages.

The duration of pupation also varied considerably among the hybrids, with the shortest duration (1.43 days) observed in hybrid Giza 128 and the longest (1.82 days) in hybrid Giza 168. Overall, larval duration was significantly influenced by the different maize hybrids. The shortest total larval duration (14.08 days) was observed in the hybrid Hi-tech 2031 and the longest (15.47 days) in the hybrid Giza 168.

3.2. Pupal and adult duration of S. frugiperda reared on different corn hybrids

Table 2 shows the effects of five maize hybrids on pupal duration, adult lifespan, and male and female duration of *S. frugiperda*. The data show that pupal duration was significantly influenced by the maize hybrid on which the larvae were reared. The longest pupal duration (9.39 days) was observed in the hybrid Giza 128, and the shortest (8.82 days) in the hybrid Hi-tech 2031.

Table 1. Larval instars, pre-pupa, and larval duration of *S. frugiperda* reared on various maize hybrids.

Hybrids	Larval instars						Pre-pupa	Larval duration
	1st	2nd	3rd	4th	5th	6th		
Hi-tech 2031	2.93 ± 0.02	2.22 ± 0.01	1.45 ± 0.02	1.73 ± 0.03	2.11 ± 0.01	3.63 ± 0.01	1.52 ± 0.01	14.08 ± 0.02
Watania 6	3.40 ± 0.04	2.11 ± 0.01	1.56 ± 0.02	1.62 ± 0.02	2.08 ± 0.02	3.82 ± 0.02	1.52 ± 0.04	14.59 ± 0.03
Giza 10	3.65 ± 0.04	2.25 ± 0.02	1.39 ± 0.01	1.75 ± 0.02	2.32 ± 0.03	3.78 ± 0.01	1.68 ± 0.01	15.14 ± 0.02
Giza 168	3.96 ± 0.02	2.08 ± 0.05	1.50 ± 0.04	1.71 ± 0.01	2.29 ± 0.03	3.92 ± 0.05	1.82 ± 0.05	15.47 ± 0.09
Giza 128	3.52 ± 0.03	2.17 ± 0.02	1.26 ± 0.01	1.74 ± 0.01	2.17 ± 0.02	3.40 ± 0.02	1.43 ± 0.01	14.25 ± 0.03
AVERAGE	3.49 ± 0.02	2.17 ± 0.01	1.43 ± 0.01	1.71 ± 0.01	2.19 ± 0.01	3.71 ± 0.01	1.59 ± 0.01	14.71 ± 0.04
C.V.%	2.68	3.43	4.52	3.91	3.15	2.6	4.85	0.96
L.S.D. at 5%	0.18**	N.S.	0.12**	N.S.	0.13**	0.18 **	0.15**	0.27**

S.E. = standard error; L.S.D. = least significant difference; C.V.% = coefficient of Variation; N.S. = insignificant. **Highly significant at P ≤ 0.01.

Table 2. Duration of the pupal and adult stages of *S. frugiperda* reared on various maize hybrids.

Hybrids	Pupal duration	Adult duration	Male duration	Female duration
Hi-tech 2031	8.82 ± 0.02	9.35 ± 0.04	9.11 ± 0.06	9.52 ± 0.07
Watania 6	9.10 ± 0.03	8.95 ± 0.03	8.78 ± 0.01	9.18 ± 0.06
Giza 10	9.01 ± 0.04	9.48 ± 0.01	9.31 ± 0.02	9.67 ± 0.05
Giza 168	9.29 ± 0.01	8.91 ± 0.03	8.67 ± 0.10	9.19 ± 0.06
Giza 128	9.39 ± 0.03	9.61 ± 0.04	8.97 ± 0.10	10.07 ±0.04
Average± S.E.	9.12 ± 0.01	9.26 ± 0.02	8.97 ± 0.02	9.52 ± 0.02
C.V.%	0.89	0.73	2.19	1.72
L.S.D. at 5%	0.15 **	0.13**	0.37*	0.31**

S.E. = standard error; L.S.D. = least significant difference; C.V.% = coefficient of Variation; N.S. = insignificant. *significant at P ≤ 0.05; **Highly significant at P ≤ 0.01.

The duration of adults was also significantly influenced by the maize hybrids, with the duration of adults ranging from 8.91 to 9.61 days. The duration of adult males also varied significantly, with the longest duration (9.31 days) recorded in insects reared on hybrid Giza 10 and the shortest (8.67 days) in hybrid Giza 168. The residence time of females was highly influenced by the maize hybrids, ranging from 9.18 to 10.07 days. The average duration for male and female adults was 8.97 and 9.52 days, respectively.

3.3. Reproduction of S. frugiperda reared on different maize hybrids

Different maize hybrids significantly affected the reproductive parameters of *S. frugiperda*, as shown in Table 3. Female pre-oviposition ranged from 4.64 to 4.90 days, while the time of oviposition ranged from 3 to 4.14 days. The longest oviposition period was observed in larvae fed with the hybrid Giza 128, while the shortest time was measured in larvae fed with the hybrid Watania 6. The female post-oviposition period was longest in insects fed with the hybrid Hi-tech 2031 (1.24 days) and shortest in insects fed with Giza 168 (0.77 days).

There were also considerable differences between the maize hybrids in the fertility of *S. frugiperda* females. The highest average number of eggs (1,352.19) was produced by females whose larvae were fed with the hybrid Giza 10, while the lowest average (656.33 eggs) was recorded in females fed with the hybrid Watania 6.

3.4. Sex ratio of S. frugiperda adults reared on various maize hybrids

Table 4 shows the sex ratio of adult *S. frugiperda* reared with different maize hybrids. Insects fed with the hybrids Hi-tech 2031 and Giza 128 had a lower proportion of males compared to females, 44.81% and 43.45%, respectively. In contrast, insects fed with the hybrids Watania 6, Giza 10, and Giza 168 had a higher proportion of males than females: 55.71%, 53.33%, and 54.23% respectively.

3.5. Pupal weight of S. frugiperda reared on different maize hybrids

Table 5 shows the significant influence of the different maize hybrids on the pupal weight of *S. frugiperda*. The highest pupal weight (0.194 g) was observed when larvae were reared on hybrid Watania 6, while the lowest weight (0.179 g) was recorded for larvae reared on hybrid Giza 168. The highest weight of male and female pupae was 0.199 g and 0.192 g for larvae fed on hybrid Watania 6 and Giza 128, respectively. Conversely,

Table 3. Reproduction of *S. frugiperda* reared on various maize hybrids.

Hybrids	Period (days)			Fecundity / ♀
	Pre-oviposition	Oviposition	Post-oviposition	
Hi-tech 2031	4.64 ± 0.03	3.48 ± 0.01	1.24 ± 0.03	915.00 ± 4.81
Watania 6	4.79 ± 0.02	3.00 ± 0.05	1.16 ± 0.01	656.33 ± 4.59
Giza 10	4.80 ± 0.03	3.80 ± 0.03	0.88 ± 0.01	1352.19 ± 10.76
Giza 168	4.90 ± 0.05	3.14 ± 0.05	0.77 ± 0.02	775.24 ± 7.92
Giza 128	4.77 ± 0.02	4.14 ± 0.01	0.81 ± 0.02	1131.59 ± 8.89
Average± S.E.	4.78 ± 0.01	3.51 ± 0.03	0.97 ± 0.01	966.07 ± 17.27
C.V.%	2.3	2.82	7.22	2.31
L.S.D. at 5%	N.S.	0.19**	0.13**	41.93**

S.E. = standard error; L.S.D. = least significant difference; C.V.% = coefficient of Variation; N.S. = insignificant. **Highly significant at P ≤ 0.01.

Table 4. *Spodoptera frugiperda* sex ratio of adults reared on various maize hybrids.

Sex ratio %	Hybrids				
	Hi-tech 2031	Watania 6	Giza 10	Giza 168	Giza 128
Male	44.81	55.71	53.33	54.23	43.45
Female	55.19	44.29	46.67	45.77	56.55

Table 5. Pupal weight of *S. frugiperda* reared on various maize hybrids.

Hybrids	Pupal weight	Male weight	Female weight
Hi-tech 2031	0.187 ± 0.002	0.191 ± 0.002	0.181 ± 0.001
Watania 6	0.194 ± 0.001	0.199 ± 0.001	0.184 ±0.001
Giza 10	0.183 ± 0.001	0.184 ± 0.001	0.179 ± 0.001
Giza 168	0.179 ± 0.001	0.180 ± 0.001	0.177 ± 0.001
Giza 128	0.191 ± 0.001	0.187 ±0.001	0.192 ± 0.001
Average± S.E.	0.187 ± 0.001	0.188 ± 0.001	0.182 ± 0.001
C.V.%	1.670	1.740	1.150
L.S.D. at 5%	0.01**	0.01**	0.001**

S.E. = standard error; L.S.D. = least significant difference; C.V.% = coefficient of Variation; N.S. = insignificant. **Highly significant at P ≤ 0.01.

the lowest weight of male and female pupae (0.180 g and 0.177 g) was recorded when the larvae were fed with the hybrid Giza 168. Overall, the average pupal weight of the males (0.188 g) was higher than that of the females (0.182 g)

3.6. Pupation and emergence percentage of S. frugiperda reared on various maize hybrids

The effect of different maize hybrids on the pupation and emergence rate of *S. frugiperda* is shown in Table 6. The highest pupation rate (93.33%) was observed in larvae fed with hybrid Giza 10, while the lowest pupation rate (76.67%) was observed in larvae fed with hybrid Giza 128. Conversely, the highest percentage of emergence (96.33%) was observed in larvae reared with hybrid Hi-tech 2031 and the lowest percentage of emergence (89.17%) in larvae fed with hybrid Giza 10.

4. Discussion

S. frugiperda, commonly known as the armyworm, is an extremely destructive pest that causes considerable damage to maize plants. The larvae are particularly notorious for their aggressive feeding behavior, which leads to large, irregular holes in the leaves, often resulting in a “skeletonized” appearance of the foliage with only the veins remaining intact (Han et al., 2023; Li et al., 2023; Palli et al., 2023).

As the larvae feed, they strip away crucial tissues from the leaves, which diminishes the plant’s ability to perform photosynthesis effectively, thereby severely impacting its growth and yield. During severe infestations, the larvae can also tunnel into the whorl or growing points, causing further damage that may result in stunted growth or even the death of the plant. Figure 2 provides a detailed depiction of these typical damage symptoms, including leaf cracking and the accumulation of larval frass within the topmost leaves of maize. It also highlights the fall armyworm's various developmental stages and feeding patterns, which collectively underscore its status as a major agricultural pest. A heavy infestation can lead to complete defoliation, stunted growth, and yield losses (Han et al., 2023; Li et al., 2023; Palli et al., 2023). The pest can also penetrate the ears and impair the grain quality. Due to its high reproduction rate and adaptability, *S. frugiperda* is a major threat to maize cultivation in many regions (Bakry and Abdel-Baky; 2023a, b).

Previous studies have shown that the type of food has a significant impact on the development, life cycle, and reproduction of *S. frugiperda* (Maharani et al., 2021; Navasero et al., 2021; Wijerathnam et al., 2021; Xie et al., 2021; Bankar and Bhamare, 2022; El-Shennawy et al., 2022). In the current study, different maize hybrids were found to influence various biological aspects of *S. frugiperda*. For example, the Hi-tech 2031 hybrid resulted in the shortest larval duration, while the Giza 128 hybrid prolonged the pupal and adult stages. Additionally, the Giza 10 hybrid enhanced the fecundity of *S. frugiperda*, whereas the Watania 6 hybrid led to the highest pupal weight. The highest pupation rate was observed in insects fed on the Giza 10 hybrid, while the highest adult emergence rate was recorded in those fed on Hi-tech 2031.

These findings are consistent with other research on the impact of various maize types on *S. frugiperda*. Santos et al. (2003) found no significant differences in larval instar duration, sex ratio, and mortality rates between sweet corn and field corn genotypes. Conversely, Nogueira et al. (2019) reported that larvae fed on the Pérola corn landrace had the longest development time and lowest survival rates. Chiriboga Morales et al. (2021) evaluated six maize cultivars

Table 6. Pupation and emergence percentage of *S. frugiperda* reared on various maize hybrids.

Hybrids	Non-pupated larvae %	Pupated larvae %	Non-emerged adult %	Emerged adult %
Hi-tech 2031	10.00	90.00	3.67	96.33
Watania 6	10.00	90.00	10.00	90.00
Giza 10	6.67	93.33	10.83	89.17
Giza 168	20.00	80.00	7.87	92.13
Giza 128	23.33	76.67	8.33	91.67

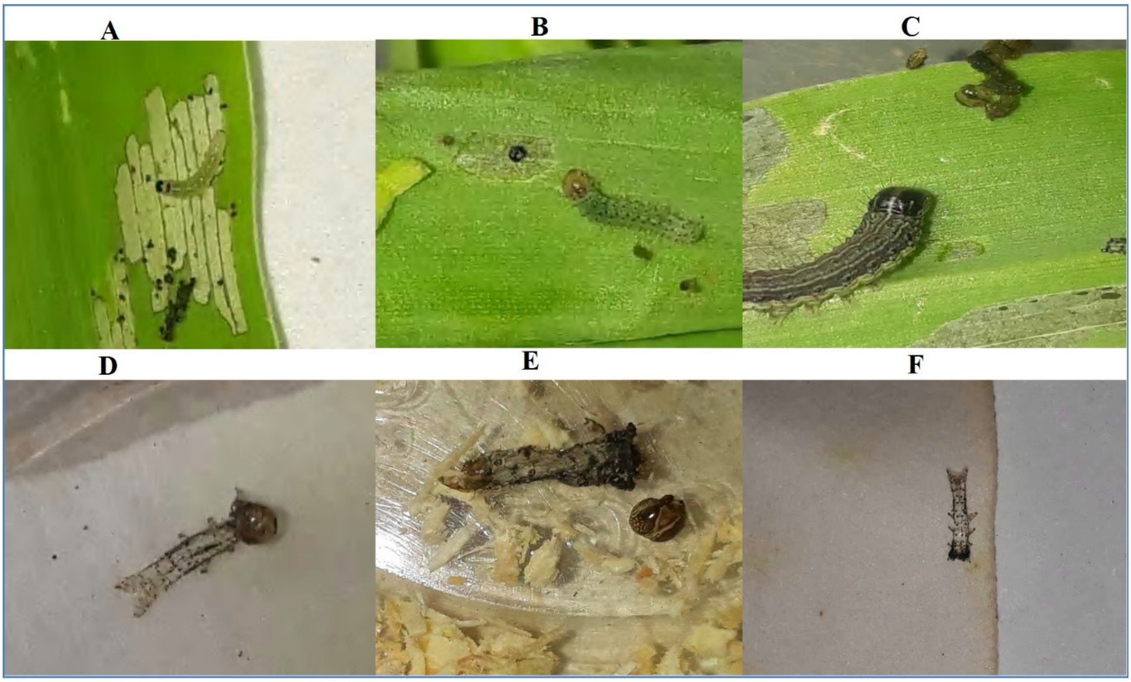

Figure 2. (A) Neonate larva of *S. frugiperda*; (B) and (C) larva and head capsule after ecdysis; (D) and (E) head capsule and exuviae; (F) exuviae of *S. frugiperda* larva. The larva feeding symptoms on maize leaves, creating large, irregular holes and skeletonizing the foliage.

in Kenya for resistance to FAW. Although no complete resistance was found, differences in larval preference and growth were observed: 'SC Duma 43' exhibited antibiosis effects, while 'Rachar' and 'Nyamula' had higher growth indices. Plant damage varied but did not show significant statistical differences between cultivars. They found that the SC Duma 430 maize cultivar resulted in the lowest pupal weight.

The impact of maize hybrids on the reproductive traits of *S. frugiperda* was assessed by examining pre-oviposition, oviposition, post-oviposition periods, total egg production, and egg infertility. Newly emerged female *S. frugiperda* were placed in glass vials with leaves from four maize varieties: CML-159, CML-161, CML-144, and a control. The study revealed that CML-159 notably affected reproductive parameters. Females fed on CML-159 had a significantly longer pre-oviposition period compared to those fed on CML-161, CML-144, and the control (Gonzalez et al., 2021; Lima et al., 2019). Additionally, CML-161 and CML-159 reduced the oviposition period relative to the control (Silva et al., 2022). Females consuming CML-159 also experienced a prolonged post-oviposition period and lower total egg production, indicating reduced fertility (Almeida et al., 2020). Conversely, CML-161 and CML-144 decreased egg infertility compared to the control (Pereira et al., 2024). Overall, CML-159 significantly impaired the reproductive potential of *S. frugiperda*.

Anyanda et al. (2022) observed significant differences in larval duration across six maize genotypes, with the CKH191221 genotype showing the longest duration. Vishwakarma et al. (2022a, b) demonstrated that corn hybrids such as CHH-213 and JM-218 significantly influenced fecundity, incubation periods, and egg hatching, with the JM-218 genotype resulting in the longest larval and pupal periods as well as extended adult longevity. Nelly et al. (2023) found that the Sukmaraga variety led to prolonged larval and pupal stages and the lowest pupal weight. Zhang et al. (2023) reported that *S. frugiperda* exhibited shorter development times but higher reproduction and pupal weights on certain maize varieties, particularly the Baitiannuo variety, which recorded the highest fecundity and pupal weights for both sexes.

Anyanda et al. (2022) assessed six maize genotypes for resistance to FAW under artificial infestation. Variations in larval development and damage were noted: 'CKH191221' showed the longest development time and lowest damage, while 'KDV4' had the highest damage and shortest development time. Yield reductions ranged from 6% to 64%, highlighting the potential for developing FAW-resistant maize germplasm. Marcos et al. (2023) evaluated the resistance of various maize genotypes to natural infestation by *Spodoptera frugiperda*, Their field experiment using a randomized block design with 10 treatments and three replications revealed significant differences in damage levels among the genotypes. The highest pest densities were recorded in Gema, ZM523, SY644, SY5944, and SC403, while Namuli, PAN53, and SC403 showed higher grain yields. While, Chisonga et al. (2023) found that although *Spodoptera frugiperda* damage to maize leaves slightly affects yield, especially at specific developmental stages, the impact is minimal. Therefore, Integrated Pest Management (IPM) strategies should focus on enhancing plant vigor and utilizing natural enemies over direct pest control.

As well as, *S. frugiperda* was more abundant in 2018, particularly early in the season and at 3 weeks after planting (WAP) in Ibadan, Nigeria (Ojumoola et al., 2022). Despite weekly foliar damage, its relationship with larval abundance was weak, and most kernel damage was attributed to stem borers rather than fall armyworms. Regular scouting during the first three weeks after planting is recommended for effective management.

From an IPM perspective, our study highlights the significant impact of maize hybrids on fall armyworm biological parameters and underlines the potential benefit of integrating high insect resistance into maize varieties. Among the maize hybrids tested, some hybrids showed higher resistance compared to others. Given that fall armyworm is an important pest that develops resistance to synthetic pesticides, corn hybrids with increased resistance could play a crucial role in sustainable pest control. The use of resistant maize hybrids could reduce dependence on synthetic insecticides and support more environmentally friendly pest control strategies.

Therefore our study highlights the critical role of selecting appropriate maize hybrids to manage the growth and development of *S. frugiperda*, which is essential for devising effective pest management strategies.

5. Conclusion

S. frugiperda successfully completed its development on all the maize hybrids studied. However, there were notable differences among the hybrids that influenced key biological parameters such as larval duration, pupal duration, pupal weight, adult longevity, and reproductive capacity. These differences directly impact the pest's population dynamics in the environment. For example, variations in the sex ratio can significantly affect population growth, with a higher proportion of females leading to an increased likelihood of egg-laying, and consequently, a larger population size.

Among the hybrids tested, Giza 168 stands out as a relatively better option for cultivation in areas with high *S. frugiperda* infestation. Although this hybrid results in a higher percentage of females (the sex ratio favored females), it also prolongs larval and pupal stages, reduces pupal weight, and negatively impacts egg-laying, which could help in managing the pest's population growth.

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