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Evaluation of armyworm *Spodoptera frugiperda* (JE Smith) preference for some vegetable crops as hosts on both oviposition and developmental rate

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Abstract
The fall armyworm *Spodoptera frugiperda* (JE Smith) (Lepidoptera: Noctuidae) is an invasive pest of maize. It is a highly polyphagous pest, with an expanding host range of nearly 353 plant species across more than 76 families. In this study results showed that sweet potato attracted the highest number of larvae it was the highest preference (it attracted 6.33 ± 0.88 and 5.6 ± 0.88 larvae of 2nd and 3rd instars, respectively). Meanwhile, among the Solanaceae family, pepper exhibited the highest preference by 2nd instar larvae (4.33 ± 0.33 larvae), followed by eggplant (3.0 ± 0.33) and tomato (2.66 ± 0.57). However, the 3rd instar larvae showed a relatively higher preference for eggplant (4.6 ± 0.32), while tomato was the least preferred (2.3 ± 0.66 larvae). The larval period was shortest on maize (20.83 ± 2.3 days) and sweet potato (21.0 ± 3.40 days). In contrast, the longest larval durations were recorded on tomato (26.16 ± 2.13 days), okra (26.33 ± 1.36 days), and eggplant (26.2 ± 2.58 days). Female longevity ranged from 11.83 ± 1.32 days (on tomato) to 13.53 ± 2.7 days (on pepper). The mean life cycle duration (egg to adult) was shortest on maize (33.5 days) and longest on eggplant (35.7 days), tomato (35.17 days), and okra (35.16 days). The mean generation time (T) was shortest on sweet potato (37.41 days) and longest on eggplant (43.76 days), suggesting that sweet potato supports more rapid generational turnover. The doubling time (DT) was shortest on sweet potato (4.49 days) and longest on okra (6.12 days). The chemical composition of leaves clear differences among plant species in their nutrient and biochemical contents. Maize (Zeamays) recorded the highest nitrogen content (3.92%) and total protein (24.52%), indicating its superior nutritional value compared to the other host plants. Sweet potato exhibited relatively high phosphorus (2.98%) and potassium (3.98%) In contrast, okra showed the lowest values for most chemical components, particularly nitrogen (1.57%) and total protein (11.33%), which explains why growth rate of *S. frugiperda* was fastest on maize and sweet potato moderate on pepper and eggplant but shorter on okra.

Keywords: *Spodoptera Frugiperda*, preference, host plants, development and plant contents

Introduction

One of the most important invasive pests of global significance is the fall armyworm, *S. frugiperda* (JE Smith) (Family: Noctuidae; Order: Lepidoptera) which causes significant damage to crops due to its multi-host population (Sagar *et al.*, 2020) [16] fall armyworm is known for its sporadic infestation patterns and strong migratory behavior. An adult moth can fly up to 100 km in a single night (Naganna *et al.* 2020) [14]. The characteristics and traits of the fall armyworm have led to its rapid spread across approximately 353 host plants from a total 76 crop families, including many cultivated crops. Nearly 30 % of the affected crops belong to the Poaceae family (Montezano *et al.* 2018) [13] Numerous studies have examined the life history traits of the fall armyworm (FAW) on a range of host plants, including cotton, millet, maize, sorghum, wheat, bermudagrass, soybean, peanut, oilseed rape, sunflower, tomato, pepper, and eggplant (, He *et al.*, 2020, He *et al.*, 2021, Wu *et al.*,2021 and shoman *et al.*, 2025) [10, 11, 17, 20]. Considering the behavior of the fall armyworm in its search for a suitable host, Lepidoptera's generally rely on volatile chemical signals released by host plants to find hosts for food and egg laying (Finch and Collier 2012, Tanga *et al.*, 2012, Anderson and Anton 2014, Cunningham and Zallucki 2014) [3, 8, 9] Although extensive studies have been conducted mostly on cereal crops, the available studies and information on the nutritional preference of the pest on vegetable crops, as well as information on the development and life table parameters of *S. frugiperda* when reared on vegetable crops are still unknown. So that the present study aims to investigate the biology and demographic parameters of *S. frugiperda* reared on sweet potato, eggplant, tomato, pepper, okra and maize under constant temperature regimes (25°C). The findings will provide essential insights into the pest's adaptability to vegetable hosts and the potential risks posed, ultimately contributing to more sustainable pest management strategies.

Materials and Methods

Collection of *S. frugiperda*

The colonies of *S. frugiperda* (as egg masses) were obtained from plant Protection Research Institute Agricultural Research center (ARC), Giza, Egypt. The study was conducted in the Economic Entomology Laboratory Faculty of Agriculture, Mansoura University. The experiments were conducted under controlled condition at a temperature of 25ºC and 70% relative humidity and a 10:14h L:D.

Feeding Preference

To determine the preference of larvae among different host plants the free-choice test experiment was conducted under laboratory condition. Seven host plants belonging to the four plant families of Solanaceae (tomato, pepper and eggplant), Malvaceae (Okra), Convolvulaceae (sweet potato) and cucurbitaceae (zucchini and cucumber) were used. Round breeding containers of dimensions 45 cm x 60 cm x 60 cm were used., where ach container was divided into seven lanes, approximately 120 grams of fresh plant leaves of each tested host plant were placed in each lane, with wet cotton under the plant leaves to prevent them from drying during the experiment, twenty 2nd instar larvae were released into the center of each container and the container was covered

with gauze to prevent the escape of the larvae. The number of larvae present on each host plant was recorded 6- hour after release. The remaining leaves of the host plants were weighed 24 hours later to calculate the rate of reduction in plant weight due to larval feeding. The experiment was replicated three times. The same experiment was conducted on 3rd instar larvae. Feeding preference was determined based on the attraction of larvae to the leaves of host plants, settlement on and feeding activity on the leaves of various host plants.

The Non-Choice Experiments

The development from egg to adult of *S. frugiperda* was assessed on different host plant (maize, sweet potato, pepper, eggplant, tomato and okara). Fresh egg masses were obtained from a laboratory colony. Newly hatched *Spodoptera frugiperda* larvae were separated on the day of exclusion and reared individually in transparent plastic containers (12 × 10.5 × 3.5 cm) supplied daily with fresh leaves from a single test host plant. As larvae grew older, the daily amount of leaves was increased to prevent starvation. When the larvae reach the fifth instar each container held a 2 cm saw dust as the medium for pupation till adult's emergence. Ten replicates were prepared for each host plant. Newly emerged adults were paired and confined to an oviposition cage. Five replicates of single male-female pairs were prepared for each tested host plant. Cages were observed daily and the number of egg masses was recorded.

Biological Aspects

Biological aspects of *Spodoptera frugiperda* were evaluated, including stage-specific developmental time and total life-cycle duration; egg incubation, larval, and pupal durations were recorded for all host–plant combinations, and total development time from egg to adult was used for statistical analyses; adult traits measured were female pre-oviposition, oviposition, and post-oviposition periods, female longevity, fecundity (eggs per female), and female fertility; and hatching success was calculated following Zidan and Abdel-Megeed (1987) [21].

Data Analysis

Biological aspects of *S. frugiperda* were analyzed using Costat Software (2004) [7]. Life table parameters of *S. frugiperda* females which reared on the tested host plants were calculated using LIFE 48 BASIC computer program of Abou-Setta *et al*. (1986) [1].

Analysis of Plant Components

Leaflet samples of tested host olant, were picked and kept in paper bags. The leaflet specimens were sent to laboratory belonging to Soil, Water and Environment Research Institute, Agricultural Research Center Mansoura. Leaves Chlorophyll (a and b) was measured using methanol (100%) as described by (Aminot and Rey 2000) [6] carotenoids were determined according to (Lichtenthaler and Buschmann 2001) [12]. To digest the plant samples (either leaves or seeds) for determining the content of N.P.K., samples were mixed of $HClO_4$+H_2So_4 was used as described by (Peterburgski 1968) [15]. Nitrogen levels were determined using the Kjeldahl method, phosphorus levels were analyzed through the spectrophotometric method, and potassium levels were ascertained using the flame photometer method (Ashworth *et al.,* 1997) [4].

Results

Data in (table, 1) showed that presents the feeding preferences of *S. frugiperda* larvae (2nd and 3rd instars) on various host plants from different plant families under free-choice conditions. Larval preference and feeding intensity varied significantly among the tested plant species, sweet potato attracted the highest number of larvae it was the highest preference at both instars (6.33 ± 0.88 and 5.6 ± 0.88 for 2nd and 3rd instars, respectively).

Meanwhile, among the Solanaceae family, pepper exhibited the highest preference by 2nd instar larvae (4.33 ± 0.33), followed by eggplant (3.0 ± 0.33) and tomato (2.66 ± 0.57). However, the 3rd instar larvae showed a relatively higher preference for eggplant (4.6 ± 0.32), while tomato was the least preferred (2.3 ± 0.66). Despite moderate initial attraction, eggplant recorded a relatively high feeding amount after 24 hours (24.82 g), compared to pepper and Tomato, which showed lower consumption, the remaining plant mass were (8.80 g and 8.46 g, respectively).

The host plants from the Cucurbitaceae family, particularly zucchini and cucumber, showed the lowest larval attraction at both instars (≤ 1.0), and registered the lowest biomass loss after 24 hours where, the remaining plant mass were (64.96 g for zucchini and 81.09 g for cucumber).

Table 1: Feeding preferences of *S. frugiperda* on different host plants from different plant families under free choice condition

Host plant		6 hr		Weight/plant Before Feeding	Weight/plant After Feeding in 24hr
		2nd instar	3rd instar		
Solanaceae	Tomato	2.66± 0.5 b	2.3±0.66 b	120.78gm	24.82 gm
	Pepper	4.33±0.3a b	3.6±0.33 b	120.36 gm	8.80 gm
	Eggplant	3.0±0.33 b	4.6±0.32ab	120.20gm	8.46. gm
Malvaceae	Okra	1.66±0.33 c	2.0±0.57 b	120.72gm	44.22 gm
Convolvulaceae	Sweet poptato	6.33±0.88 a	5.6±0.88 a	120.95gm	8.46 gm
Cucurbitaceae	Zucchini	0.66±0.33 c	0.66±0.3 c	120.01 gm	64.96gm
	Cucumber	1.0±0.577 c	1.0±0.57 c	120.73 gm	81.09 gm

The small letter between host plants on the columns Where, means have the same letter are not differed significantly

In (table, 2) summarizes the mean developmental durations and reproductive parameters of *S. frugiperda* reared on different host plants at a constant temperature of 25°C. Notable differences were observed in the insect's life cycle metrics across host plants, indicating variable host suitability. The larval period was shortest on Zea mays (20.83 ± 2.3 days) and sweet potato (21.0 ± 3.40 days). In contrast, the longest larval durations were recorded on tomato (26.16 ± 2.13 days), okra (26.33 ± 1.36 days), and eggplant (26.2 ± 2.58 days).

Similarly, the pupal period varied significantly, with the shortest duration observed on pepper (8.5 ± 1.04 days) and the longest on Zea mays (12.66 ± 2.5 days). Female longevity ranged from 11.83 ± 1.32 days (tomato) to 13.53

± 2.7 days (pepper). The pre-oviposition period remained consistent (approximately 4.5–5.5 days) across all hosts. However, significant variation was observed in the oviposition period, which was longest on Zea mays (5.66 ± 1.03 days) and shortest on okra (3.33 ± 0.51 days). Sex ratios were relatively balanced across treatments, ranging from 46.93% (tomato) to 55.12% (Zea mays).

The mean life cycle duration (egg to adult) was shortest on Zea mays (33.5 days) and longest on eggplant (35.7 days), tomato (35.17 days), and okra (35.16 days).

Table 2: Mean (±SE) of total development period (egg-adult) in days of fall armyworm (FAW), *Spodoptera frugiperda* that reared on different host plants under constant temperature 25° C

Parameters	Host plants					
	Zeamays	Sweet potato	Pepper	Eggplant	Tomato	Okra
Larval period	20.83±2.3 c	21.0 ±3.40 b	22.0±2.36 b	26.2±2.5 a	26.16±2.1 a	26.33±1.36 a
Pupal period	12.66±2.5 a	9.0±2.25 b	8.5±1.04 c	9.50±3 b	9.0±0.89 b	8.83±0.75 c
Female longevity	13.33±1.6 a	13.33±1.3 a	13.5±3.2 a	12.75±2.6 ab	11.83±1.3 b	12.33±1.9 ab
Pre-Ovipostion	4.8±0.98 b	4.5±0.83 b	4.83±0.98 b	5.5±1.25 a	4.83±0.72 b	4.83±0.75 b
Ovipostion period	5.66±1.03 a	5.33±1.86 a	5.16±2.13 a	4.5±1.25 ab	3.50±0.83 b	3.33±0.51 b
Sex ratio	55.12%	52.50%	50.47%	52%	46.93%	50.63%
Mean life cycles	33.5	30.0	30.5	35.7	35.17	35.16

Small letter between host plants under the same temperatures on the row

In (table, 3) outlines the life table parameters of *S. frugiperda* reared on six different host plants at a constant temperature of 25°C. The data reveal significant host-dependent variation in population growth potential and developmental dynamics.

The mean generation time (T) was shortest on sweet potato (37.41 days) and longest on eggplant (43.76 days), suggesting that sweet potato supports more rapid generational turnover.

The doubling time (DT)—an indicator of population expansion—was shortest on sweet potato (4.49 days) and longest on okra (6.12 days).

The net reproductive rate (R_o), which estimates the average number of females off spring produced per female, was highest on sweet potato (321.3) and Zea mays (317.49), and lowest on okra (109.36) and tomato (118.26). Similarly, the gross reproductive rate (GRR) followed the same trend, being highest on sweet potato (614.25) and lowest on okra (136.71).

The intrinsic rate of increase (r_m), which reflects the population growth potential per individual per day, was also highest on sweet potato (0.1543), followed by pepper (0.1496) and Zea mays (0.140). The lowest values were recorded on okra (0.1132) and tomato (0.1136).

Similarly, the finite rate of increase (λ) was highest on sweet potato (1.1668), followed by pepper (1.1614) and Zea mays (1.150), and lowest on tomato (1.1203) and okra (1.1199).

Table 3: life table parameters of *Spodoptera frugiperda* reared on different host plant at 25°C temperatures

life table parameters	Host plants					
	Zeamays	Sweet potato	Pepper	Eggplant	Tomato	Okra
Mean generation time (T) (in days)	41.078	37.408	38.126	43.7578	42.0141	41.4402
Doubling time (DT) (in days)	4.9429	4.491	4.6309	5.6932	6.1016	6.1184
Net reproductive rate (R_o)	317.49	321.3	299.79	205.92	118.2636	109.360
Intrinsic rate of increase (r_m)	0.140	0.1543	0.1496	0.1217	0.1136	0.1132
Finite rate of increase (λ)	1.150	1.1668	1.1614	1.1294	1.1203	1.1199
Gross reproductive rate (GRR)	363.79	614.25	545.08	322.4	197.1	136.71

Table (4) illustrates the variation in the chemical composition of leaflets from different host plants of *S. frugiperda*. The results show clear differences among plant species in their nutrient and biochemical contents. Maize (Zea mays) recorded the highest nitrogen content (3.92%) and total protein (24.52%), indicating its superior nutritional value compared to the other host plants. Sweet potato exhibited relatively high phosphorus (2.98%) and potassium (3.98%) levels, as well as the highest carotene concentration (27.22 mg/100g).

In contrast, okra showed the lowest values for most chemical components, particularly nitrogen (1.57%) and total protein (11.33%), suggesting its lower nutritional suitability for the insect. Chlorophyll content also varied among the host plants: chlorophyll a ranged from 0.53 to 0.76 mg/g fresh weight, while chlorophyll b ranged from 0.19 to 0.44 mg/g. The highest total chlorophyll content was observed in maize (46.47 mg/g) which explains why growth rate to *S. frugiperda* was fastest on maize and sweet potato moderate on pepper and eggplant but shorter on okra.

Table 4: Leaflet chemical composition of *S. frugiperda* different host plants

Host plant	Leaflet chemical composition						
	N%	P%	K%	Total protein	ChlorophyII a, mg/g F. W	ChlorophyII b, mg/g F. W	Carotene (Mg/100g)
Eggplant	2.91	0.55	1.76	18.18	0.53	0.19	1.41
Sweet potato	3.42	2.98	3.98	21.37	0.72	0.44	27.22
Pepper	3.09	0.42	2.92	19.31	0.76	0.29	0.29
Okra	1.57	0.24	1.39	11.33	0.57	0.40	1.70
Tomato	2.65	0.27	3.05	16.56	0.58	0.28	0.03
Zeamays	3.92	0.39	2.92	24.52	Total chlorophyll 46.47		131.4

These results indicate that zeamays emerged as the most suitable host in terms of developmental speed and reproductive potential, consistent with its status as a primary host of *S. frugiperda*. In contrast, solanaceous crops may serve as less favorable hosts these results agree with (Subhasree *et al.*, 2025) [18] indicated that larvae feeding preference in both the 2nd and 3rd instar had a much greater preference for maize, with a mean number of 6.60 larvae/leaf (2nd instar) and 7.20 larvae/leaf (3rd instar) settling after 24 hr out of 20 larvae released. Meanwhile, (Amira *et al.*, 2024) [2] indicated that larvae fed on leaves of maize, rice and artificial diets had the fastest larval and pupal development cycle, while those fed on pea and tomato had the longest one. In case of moth emerging from larvae fed on maize showed longest life span.

Life table parameters suggest that sweet potato and Zea mays are the most suitable hosts for the development and population growth of *S. frugiperda*, supporting faster development, higher fecundity, and greater intrinsic growth rates. Conversely, okra and tomato appear to be the least suitable hosts, exhibiting lower reproductive and growth metrics. These findings are consistent with the larval development and feeding preference data. The present results agree with the results of Shoman *et al.* (2025) [17]; they reported that *S. frugiperda* reared on maize leaves showed shortest developmental periods and adult longevity in comparison with those reared-on tomato leaves. Also, the same authors added that mean generation time (T) was higher on tomato leaves than on maize leaves; while, net reproductive rate (R_o) and intrinsic rate of increase (r_m) were higher on maize in comparison with tomato leaves.

Results findings indicate that the differences in leaf chemical composition among host plants may play an important role in influencing *S. frugiperda* host preference and physiological performance. Meanwhile the elevated crude protein and carotene contents in maize and sweet potato likely contributed to the strong preference of *S. frugiperda* larvae towards these host plants. (Ajmal *et al*., 2024) [5]

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