Studies on Nutrition, Utilization and Hosts Preference of Feeding Fall Armyworm Larvae, *Spodoptera frugiperda* on Some Vegetable Crops Leaves

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Abstract

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The fall armyworm (FAW), *Spodoptera frugiperda* (J. E. Smith, 1797) (Lepidoptera: Noctuidae), appeared in 2016 on maize crop in the Americas. Thereafter, it was recorded as an invasive pest in Africa during 2017. In Egypt, this study was conducted during 2022 to investigate the nutritional indices and host preference of the 3rd and 5th instars of FAW larval stage on fifteen vegetable crops under laboratory conditions. Experiments were conducted under constant temperature in an incubator at 27±1°C, relative humidity of 65±5% and a photoperiod of 14:10 hrs (light: dark). The results obtained showed that the hosts *Beta vulgaris* L., *Cichorium intybus* L., *Fragaria x ananassa* L., *Brassica rapa* L. and *Zea mays* L. var. *everta* were significantly favoured as primary hosts for FAW development. These hosts had higher larval and pupal weight and feeding indices: consumption index (CI), approximate digestibility (AD), efficiency of conversion of ingested food into body matter (ECI), efficiency of conversion of digested food into body matter (ECD) and relative growth rate (RGR). Whereas the hosts *Vigna unguiculata*, *Lactuca sativa*, *Brassica oleracea* var. *capitata*, *Brassica oleracear* var. *botrytis*, *Eruca vesicaria* subsp. *sativa*, *Pisum sativum* and *Vicia faba* were favored as secondary hosts for FAW development, with lower values for larvae and pupae weight and feeding indices. However, the larvae did not prefer and did not complete feeding on the hosts *Cucumis sativus*, *Solanum lycopersicum* and *Phaseolus vulgaris*.
Keywords: *Spodoptera frugiperda*, biology, nutritional indices, host preference.

Introduction

The fall armyworm (FAW), *Spodoptera frugiperda* (J. E. Smith, 1797) (Lepidoptera: Noctuidae), is the most important pest in the Americas from 1980 on the bermuda grass plant. FAW outbreak affected bermuda grass yield and forage quality (Jamjanya, 1987). In addition, FAW became an invasive pest in west and central Africa where the outbreak occurred for the first time in 2016. Moreover, FAW first appeared in Nigeria during 2016 and was intercepted in Europe, in specimens incoming to Germany and the Netherlands (CABI, 2017; Clark *et al.* 2007; Goergen *et al.*, 2016; Gutierrez-Moreno *et al.*, 2020). Recently, it has been recorded in southern Egypt on maize crop (Al-Jubouri *et al*., 2021; FAO, 2018)

FAW is a highly competitive pest due to its characteristic features such as a high reproductive rate and short generation time of approximately 30 days under favorable climatic conditions (Casmuz *et al*., 2010). The awareness of pest biology is necessary for ensuring successful control (Cruz *et al*., 2007; 1999; Du Plessis *et al*., 2020). A total of 353 *S. frugiperda* larval host plant are reported in 76 plant families. A detailed study of *S. frugiperda* host plants is essential to better understand the biology and ecology of this pest to help in developing integrated pest management program (Montezano *et al.*, 2018).

So far, the most preferred host plant is maize, but it can feed on other plants in the absence of the preferred host (Wu *et al*., 2021). In Egypt, a study was conducted to rear armyworms at different temperatures on turnip leaves. The insect showed high survival ability on this plant, especially at high temperatures, which explains its ability to feed on other hosts (Ouda *et al*., 2022). The nutritional indices are key tools in the evaluation of the host suitability of *S. frugiperda* in spreading in sorghum growing areas. Survival of insects is strongly related to the different host plants they feed on (Mccormick *et al*. 2019).

As the FAW is threatening food security, the aim of this study is to assess its biology, nutrition and utilization indices feeding on some vegetable crops which are economically important in Egypt. Few reports are available on this pest feeding on other crops. Furthermore, a detailed record of *S. frugiperda* host plants is essential to better understand the biology and ecology of this pest.

Materials and Methods

Laboratory experiments

The experiment was carried out during 2022. Fall armyworm (FAW) larvae were reared in the laboratory as previously described (Ouda *el al*., 2022). Fresh leaves of hosts plants (Table 1) were collected from Qaha Agriculture Station, Qalyubia Governorate and transferred to the laboratory and reared in an incubator under constant temperature at 27±1°C., R.H. 65±5% and a photoperiod of 14:10 hours (light:dark) until pupation.

First instar larvae fed on fresh plant leaves were placed inside a plastic container (40×20×15 cm) covered with fine muslin cloth and secured with a rubber band. Leaves were

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weighted before and after larvae feeding measure the amount of consumed food and leaves were replaced daily. Leaves after weighting were kept under the same set of conditions to determine the natural loss of moisture. Calculating the Corrected weight of consumed leaves was determined by applying the formula described by Ghanema (2002) as follows:

$$\text{Corrected weight of consumed leaves} = \frac{Cb}{Ca} \times Ta$$

Where: Cb = initial fresh weight of leaves without larvae. Ca = final weight of leaves without larvae. Ta= final weight of leaves with larvae after feeding.

The experiment was conducted on the 3rd and 5th instars larvae by using 10 larvae per one leaf of each host plant (Table 1) with 10 replicates for each host. The weight of the third and fifth instar larvae was calculated before and after feeding to obtain the initial and final instars weight and pupa weight. Differentiation of larval instars was made by skin molting. Fresh food residue leaves and feces were removed daily. Food residue leaves and feces were kept until dry under the same set of laboratory conditions to determine natural loss of moisture (Rath *et al*. 2003; Sridevi, 2009). The different nutritional indices were calculated as described by Waldbauer (1968) as follows:

$$\text{Consumption index (CI)} = \frac{E}{TA}$$

$$\text{Approximate digestibility (AD)} = \frac{E-F}{A} \times 100$$

$$\text{Efficiency of conversion of ingested food into body matter (ECI)} = \frac{G}{E} \times 100$$

$$\text{Efficiency of conversion of digested food into body matter (ECD)} = \frac{G}{F-E} \times 100$$

$$\text{Relative growth rate (RGR)} = \frac{G}{E} \times T$$

Where: A= Mean fresh weight of larvae during feeding period (g). E= weight of food consumed (g). F= weight of feces produced (g). G= Fresh weight gain of larvae during feeding period (g). T= Duration of the feeding period (days).

Statistical analysis

Data obtained was subjected to analysis of variance (ANOVA), followed by a comparison of means with the least significant difference at P=0.05 using statistical software (SAS Institute, 1997).

Results

Results obtained (Table 2) showed that there was no significant differences between averages duration of *S. frugiperda* larvae fed on the following hosts: *B. vulgaris*, *V. unguiculata*, *L. sativa*, *C. intybus*, *F. x ananassa*, *B. oleracea*, *B. botrytis*, *B. rapa*, *E. vesicaria*, *P. sativum*, *V. faba* and *Z. mays v. everta*. Whereas, the larvae did not complete feeding and development on *S. lycopersicum*, *C. sativus* and *P. vulgaris* hosts (Figure 1).

Table 1. List of host plants used in this study.

Family	Common name	Scientific name
Chenopodiaceae	Table beet	*Beta vulgaris* L.
Compositae	Lettuce	*Lactuca sativa* L.
	Chicory	*Cichorium intybus* L.
Cruciferae	Cabbge	*Brassica oleracea* var. *Capitata* L.
	Cauliflower	*Brassica oleracear* var. *botrytis* L.
	Turnip	*Brassica rapa* L.
	Rocket salad	*Eruca vesicaria* subsp. *sativa* L.
Cucurbitaceae	Cucumber	*Cucumis sativus* L.
Gramineae	Pop corn	*Zea mays* var. *everta* L.
Rosaceae	Strawberry	*Fragaria x ananassa* L.
Leguminosae	Common bean	*Phaseolus vulgaris* L.
	Pea	*Pisum sativum* L.
	Brood bean	*Vicia faba* L.
	Cowpea	*Vigna unguiculata* L.
Solanaceae	Tomato	*Solanum lycopersicum* L.

The highest average of 3rd and 5th instars larvae weights were obtained when fed on hosts *B. vulgaris*, *C. intybus*, *F. x ananassa*, *B. rapa* and *Z. mays* var. *everta* hosts and there was significant difference between the average larvae weights fed on each of these hosts, as well as other hosts (*V. unguiculata*, *L. sativa*, *B. oleracea*, *B. botrytis*, *E. vesicaria*, *P. sativum*, and *V. faba*). Overall, it can be concluded that *B. vulgaris*, *C. intybus*, *F. x ananassa*, *B. rapa* and *Z. mays* var. *everta* hosts were favoured primary hosts and they were the most suitable for FAW development compared to the other host plants investigated.

The 3rd instar larvae fed on hosts (*V. unguiculata*, *L. sativa*, *B. oleracea*, *B. botrytis* and *V. faba*) had less average larvae weights and there was significant differences between the average larvae weights fed on each of these hosts and hosts *E. vesicaria* and *P. sativum*. Whereas the 5th instar larvae fed on *V. unguiculata*, *L. sativa*, *B. oleracea*, *E. vesicaria*, *P. sativum* and *V. faba* hosts had less average weights with significant difference between the average larvae weights fed on each of these hosts as well as the hosts of *B. botrytis*. It can be concluded that these hosts were least suitable host plants for *S. frugiperda* development compared to other host plants.

Results obtained (Table 2) indicated that the lowest average of 5th instar larvae weights was for those fed on the *B. botrytis* and was significantly different from that fed on each of the previous hosts. It can be concluded that this host was the least suitable host plant for *S. frugiperda*. It was clear that the hosts *B. vulgaris*, *C. intybus*, *F. x ananassa*, *B. rapa* and *Z. mays* var. *everta* were favoured and the most suitable for *S. frugiperda* for the growth and higher indices compared to the hosts *V. unguiculata*, *L. sativa*, *B. oleracea*, *B. botrytis*, *E. vesicaria*, *P. sativum* and *V. faba* that were considered the least suitable.

Results obtained (Table 2) showed that the highest average of *S. frugiperda* pupae weights were on the hosts *B. vulgaris*, *C. intybus*, *F. x ananassa*, *B. rapa* and *Z. mays* var. *everta* and significantly differences between the average pupae weights on each of these hosts and each of hosts *V. unguiculata*, *L. sativa*, *B. oleracea*, *B. botrytis*, *E. vesicaria*, *P. sativum*, and *V. faba*. Whereas, the least average pupae weights was on the hosts *V. unguiculata*, *L. sativa*, *B. oleracea* and *P. sativum* and significantly differences between the average pupae weights on each of these hosts and each of the hosts *B. botrytis*, *E. vesicaria* and *V. faba*. The less average of pupae weights on host *B. botrytis*, *E. vesicaria* and *V. faba* and significant differences between the average of pupae weights for each of these hosts and each of previous hosts.

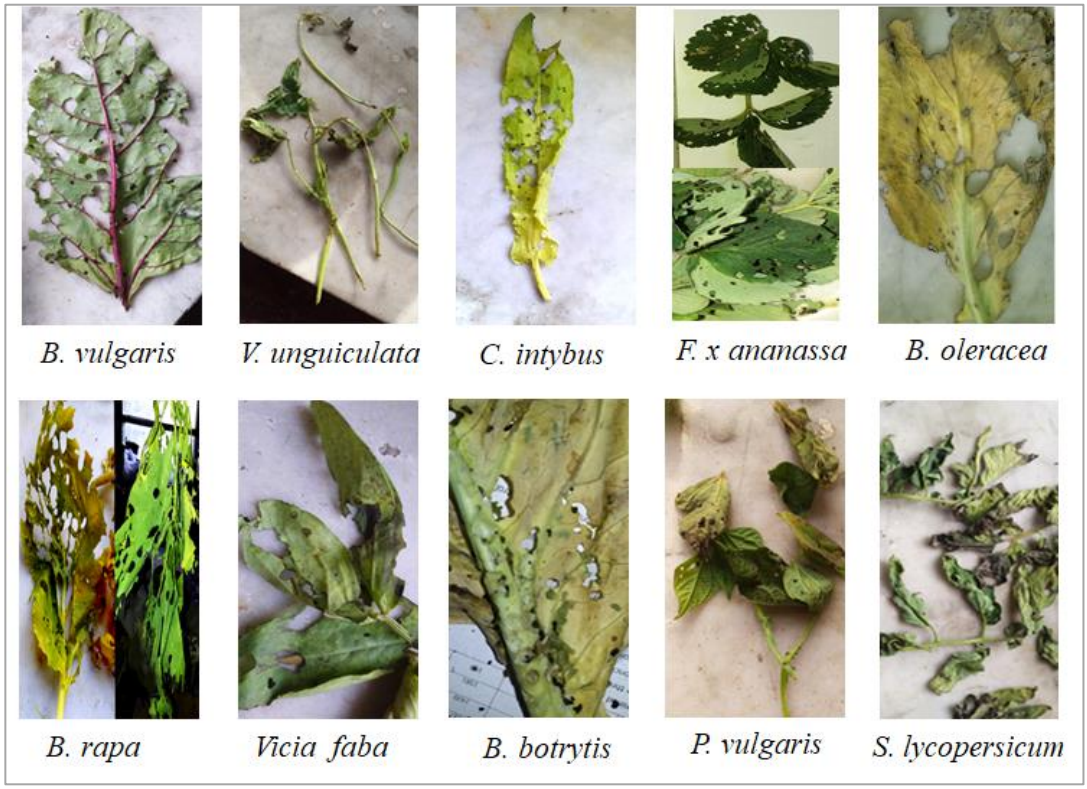

Figure 1. Symptoms of larvae feeding on leaves of the different tested hosts.

Table 2. Mean duration of larval instars, larval and pupal weight for third and fifth instars of *Spodoptera frugiperda* fed on some different vegetable crops.

Host	Mean duration of larval instar of *S. frugiprda*						Mean total of larval duration	Larval weight/mg		Pupal weight/mg
	1st	2nd	3rd	4th	5th	6th		3rd instar	5th instar	
B. vulgaris	2.8	2.4	2.5	2.4	2.6	3.0	15.7	0.3677 a	0.6632 a	0.3269 a
V. unguiculata	2.5	2.3	2.4	2.5	2.5	2.8	15.0	0.2670 bc	0.5325 b	0.2699 b
L. sativa	2.2	2.5	2.3	2.6	2.3	2.4	14.3	0.2865 b	0.5236 b	0.2776 b
C. intybus	2.4	2.3	2.8	2.2	2.3	2.5	14.5	0.3815 a	0.6762 a	0.3111 a
F. x ananassa	2.2	2.3	2.5	2.2	2.4	2.7	14.3	0.3561 a	0.6631 a	0.3152 a
B. oleracea	2.2	2.1	2.8	2.3	2.6	2.6	14.6	0.2395 bc	0.4806 bc	0.2513 bc
B. botrytis	2.1	2.4	2.6	2.8	2.4	2.8	15.1	0.2630 bc	0.4356 c	0.2335 c
B. rapa	2.3	2.6	2.2	2.1	2.5	2.5	14.2	0.3940 a	0.6748 a	0.3139 a
E. vesicaria	2.1	2.4	2.3	2.5	2.2	2.8	14.2	0.2370 c	0.5075 b	0.2386 c
P. sativum	2.4	2.3	2.6	2.4	2.8	2.4	14.9	0.2305 c	0.5181 b	0.2705 b
V. faba	2.3	2.6	2.5	2.4	2.6	2.8	15.2	0.2660 bc	0.5006 b	0.2321 c
Z. mays v. everta	2.1	2.9	2.9	2.2	2.0	1.7	13.9	0.3975 a	0.7137 a	0.3389 a
S. lycopersicum	2.9	2.8	*	*	*	*	*			
C. sativus	2.6	2.5	*	*	*	*	*	*	*	
P. vulgaris	2.7	2.8	*	*	*	*	*			

Means followed by the same letters in the same column are not significantly different at P=0.05.
* Larvae did not complete development on this hosts.

Nutritional indices of FAW larvae

Results obtained (Table 3) indicated that the highest averages of nutritional indices (CI, AD, ECI, ECD and RGR) for the third and fifth instars of FAW larvae was on the hosts *B. vulgaris*, *C. intybus*, *F. x ananassa*, *B. rapa* and *Z. mays* var. *everta* and significantly differences between these indices averages and each of the hosts *V. unguiculata*, *L. sativa*, *B. oleracea*, *B. botrytis*, *E. vesicaria*, *P. sativum*, and *V. faba*. The less averages of (CI) indice was on the hosts *V. unguiculata* and *L. sativa* for the third and fifth instars and significantly differences between the (CI) indice averages on each of these hosts and each of hosts *B. oleracea*, *B. botrytis*, *E. vesicaria*, *P. sativum*, and *V. faba*. Whereas, the lowest averages of (CI) indices on hosts *B. oleracea*, *B. botrytis*, *E. vesicaria*, *P. sativum*, and *V. faba* for the third and fifth instars and significantly differences between the (CI) indice averages on each of these hosts and each of the previous hosts. Whereas, the lower of AD indice average for the 3rd instar larvae of FAW feeding on *V. unguiculata*, *L. sativa* and *P. sativum* hosts was significantly different on each of these hosts and each of *B. oleracea*, *B. botrytis*, *E. vesicaria*, and *V. faba* hosts. While, the lowest of AD indice average for 5th instar larvae fed on *V. unguiculata*, *L. sativa*, *E. vesicaria*, *P. sativum* and *V. faba* hosts with significant difference between these hosts and each of *B. oleracea* and *B. botrytis* hosts. Additionally, the lower averages of ECI indice for FAW larvae fed on *V. unguiculata*, *L. sativa* and *P. sativum* hosts for the third instar larvae, with significant difference between each of these hosts and each of *B. oleracea*, *B. botrytis*, *E. vesicaria* and *V. faba* hosts. Also, the lower ECI indice averages for the 5th instar larvae fed on *V. unguiculata*, *L. sativa*, *B. oleracea*, *E. vesicaria*, *P. sativum* and *V. faba* hosts with significant difference between each of these hosts and *B. botrytis* host.

The lower averages of FAW 3rd instar larvae for ECD indice fed on *V. unguiculata*, *L. sativa* and *P. sativum* hosts with significant difference between each of these hosts and each of hosts *B. oleracea*, *B. botrytis*, *E. vesicaria* and *V. faba*. In addition, The lower averages of FAW 5th instar larvae for ECD indice fed on *V. unguiculata*, *L. sativa*, *E. vesicaria*, *P. sativum* and *V. faba* hosts, with significant differences between each of these hosts and each of *B. oleracea*, *B. botrytis* and *V. faba* hosts.

The lower FAW 3rd instar larvae of RGR index on *V. unguiculata*, *L. sativa* and *P. sativum* hosts, with significant differences between each of these hosts and each of *B. oleracea*, *B. botrytis*, *E. vesicaria* and *V. faba* hosts. For the 5th instar FAW larvae, the lower of RGR index was *V. unguiculata*, *L. sativa*, *B. oleracea*, *E. vesicaria*, *P. sativum* and *V. faba* hosts, with significant differences between each of these hosts and *B. botrytis* host. Results obtained from nutrition indices clearly showed that the *B. vulgaris*, *C. intybus*, *F. x ananassa*, *B. rapa* and *Z. mays* var. *everta* hosts were the most suitable for FAW growth and development, compared with the hosts *V. unguiculata*, *L. sativa*, *B. oleracea*, *B. botrytis*, *E. vesicaria*, *P. sativum* and *V. faba*.

Discussion

When the larvae of *S. frugiperda* fed on different host plants, a significant difference in larvae and pupae weight was observed Higher values of feeding larvae and nutrition indices was found on the hosts *B. vulgaris*, *C. intybus*, *F. x ananassa*, *B. rapa* and *Z. mays* var. *everta* and were the most suitable for FAW growth and development, as compared to the hosts *V. unguiculata*, *L. sativa*, *B. oleracea*, *B. botrytis*, *E. vesicaria*, *P. sativum* and *V. faba*. These results are agreement with Babou *et al*. (2022) in Senegal, Débora *et al.* (2018) in Brazil, and Meagher *et al.* (2004) in the USA. The results of this study were also similar of Ullah *et al.* (2023) who studied the biology and feeding potential of *S. frugiperda* on three economically important crops including maize, *Zea maize* L. (Poaceae); sorghum, *Sorghum bicolor* L. (Poaceae); and cabbage, *Brassica oleracea* L. (Cruciferae) under laboratory conditions. In general, it is evident that the maize crop was the most suitable host plant for FAW growth and development compared to other host plants in this study. However, in the absence of the favored host (maize), the pest can feed and develop on other hosts such as sorghum and cabbage.

Table 3. The mean nutritional indices for 3rd and 5th instars larvae of *S. frugiperda* on different vegetable crops.

	Consumption Index(CI/mg)		Approximate digestibility (AD/%)		Efficiency of conversion of ingested food (ECI/%)		Efficiency of conversion of digested food (ECD/%)		Relative growth Rate (RGR/mg)	
Hosts	**3rd**	**5th**	**3rd**	**5th**	**3rd**	**5th**	**3rd**	**5th**	**3rd**	**5th**
B. vulgaris	6.94a	9.46 a	71.16 a	79.66 a	60.66 a	64.71 a	74.36 a	80.65 a	0.73 a	0.79 a
V. unguiculata	3.33 b	6.93 b	57.91 b	62.01 bc	47.68 bc	55.18 b	53.87 b	54.98 bc	0.52 bc	0.59 bc
L. sativa	4.18 b	6.98 b	62.81 b	64.11b	48.18 b	55.08 b	57.57 b	62.97 b	0.59 b	0.63b
C. intybus	6.05 a	9.45 a	70.91 a	77.21 a	60.68 a	67.50 a	70.48 a	75.13 a	0.70 a	0.78 a
F. x ananassa	6.24 a	9.84 a	70.36 a	77.56 a	62.16 a	70.36 a	72.96 a	79.06 a	0.725 a	0.82 a
B. oleracea	1.85 c	4.86 c	44.41 cd	55.01 c	42.28 ce	50.28 bc	39.68 c	47.98 c	0.49 c	0.56 bc
B. botrytis	1.79 c	4.82 c	40.41 d	50.20 c	37.88 ce	44.81 c	38.38 c	45.21 c	0.45 c	0.48 c
B. rapa	6.25 a	9.20 a	72.18 a	80.06 a	61.19 a	66.71 a	71.06 a	78.65 a	0.70 a	0.79 a
E. vesicaria	1.59 c	5.33 bc	46.91 c	61.49 bc	34.18 e	50.34 bc	39.68 c	59.11 b	0.40 c	0.58 bc
P. sativum	2.00 c	4.06 c	59.91 b	63.48 bc	47.08 bc	48.09 bc	52.17 b	60.88 b	0.60 b	0.63 bc
V. faba	2.02 c	4.40 c	40.21 d	58.03 bc	34.28 e	50.41 bc	37.18 c	48.21 c	0.45 c	0.54 bc
Z. mays v. everta	6.38 a	9.61 a	76.38 a	80.36 a	62.70 a	72.81 a	73.86 a	80.65 a	0.75 a	0.80 a

Means followed by the same letters in the same column are not significantly different at P=0.05.

It can be concluded from this study that the hosts *Beta vulgaris* L., *Cichorium intybus* L., *Fragaria x ananassa* L., *Brassica r*apa L. and *Zea mays* L. var. *everta*) are favourable primary hosts for FAW development with highly significant differences compared to other host plants and the hosts *Vigna unguiculata*, *Lactuca sativa* L., *Brassica oleracea* var. *capitata* L., *Brassica oleracear* var. *botrytis* L., *Eruca vesicaria* subsp. *Sativa* L., *Pisum sativum* L., *Vicia faba* L. were preferred secondary hosts. Furthermore, FAW larvae did not complete their development on the hosts *Cucumis sativu*s L., *Solanum lycopersicum* L. and *Phaseolus vulgaris* L. Information on the biology and nutrition indices of pests could be very useful tool in developing integrated pest management tactics to improve crop production.

الملخص

عودة، محمد إبراهيم. 2024. دراسة مختبرية عن التغذية، الاستفادة والتفضيل العوائلي لتغذية يرقات دودة الحشد الخريفية (*Spodoptera frugiperda*) على أوراق بعض محاصيل الخضر. مجلة وقاية النبات العربية، 42(3): 269–274.

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تعدّ دودة الحشد الخريفية (*Spodoptera frugiperda* JE Smith) (Lepidoptera: Noctuidae) من آفات القارة الأمريكية قديماً على محصول العلف الأخضر عشبة البرمودا (*Cynodon dactylon*) وحديثاً، في العام 2016، على محصول الذرة. في العام 2019، سجلت الاصابة بدودة الحشد الخريفية في جنوب مصر على الذرة الشامية. وفي الآونة الأخيرة، سجل وجود دودة الحشد على محاصيل أخرى فى بعض دول العالم، وبدأ انتشارها بالتوسع على عوائل متعددة. اعتماداً على التنوع العوائلي الحالي لحشرة دودة الحشد الخريفية، جاءت فكرة هذا البحث بدراسة التفضيل العوائلي ليرقة دودة الحشد الخريفية على بعض محاصيل الخضر الاقتصادية فى المختبر بالاعتماد على معادلات Waldbauer، ونفذت التجربة في مركز البحوث الزراعية خلال العام 2022، على أوراق خمسة عشر نوعاً من محاصيل الخضر باستخدام العمر اليرقي الثالث والخامس داخل حاضنة عند درجة حرارة 27±1°س ورطوبة نسبية 65±5%. أظهرت النتائج أن عدداً من العوائل النباتية (الشوندر/بنجر المائدة، الهندباء/الشكوريا، الفريز/الفروالة، اللفت وذرة الفيشار) أعطت أعلى أوزان لليرقات والعذراء ومؤشرات التغذية، مما يثبت أنها عوائل أولية مفضلة لدودة الحشد، مع وجود فروق معنوية كبيرة بينها وبين بقية العوائل (اللوبياء، الخس، الملفوف/الكرنب، القرنبيط، الجرجير، البازلاء والفول الأخضر)، التي أعطت أقل أوزان لليرقات، العذراء ومؤشرات التغذية، مما يؤشر لكونها أقل تفضيلاً لدودة الحشد الخريفية. في حين لم تفضل اليرقات التغذية على الخيار، البندورة/الطماطم والفاصولياء. تظهر هذه الدراسة أن العوائل الشوندر/البنجر، الهندباء/الشكوريا، الفريز/الفروالة، اللفت وذرة الفيشار تعتبر من العوائل الأولية المفضلة للإصابة بدودة الحشد الخريفية عن العوائل اللوبياء، الخس، الملفوف/الكرنب، القرنبيط، الجرجير، البازلاء والفول الأخضر التي تعتبر من العوائل الثانوية للإصابة. يستفاد من هذه الدراسة أن العوائل (الشوندر/بنجر المائدة، الهندباء/الشكوريا، الفريز/الفروالة، اللفت وذرة الفيشار) تعتبر من العوائل الاولية المفضلة للإصابة بدودة الحشد الخريفية عن العوائل (اللوبياء، الخس، الملفوف/الكرنب، القرنبيط، الجرجير، البازلاء والفول الأخضر) حيث تعتبر من العوائل الثانوية للإصابة كما أظهرت نتائج هذا البحث. وبناء عليه، في حال عدم وجود نباتات الذرة يمكنها أن تصيب محاصيل الخضر المذكورة. فإنّ التعرف على المعلومات الحيوية ومؤشرات تغذية الآفات يفيد في معرفة معيشة الآفة على العائل ودرجة التفضيل، وخصوصاً للآفات الغازية حديثاً مما يساعد في تطوير أساليب الإدارة المتكاملة للآفات للسيطرة عليها.

كلمات مفتاحية: *Spodoptera frugiperda*، حياتية/بيولوجيا، مؤشرات التغذية، عوائل نباتية.

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