ABSTRACT

The fall armyworm Spodoptera frugiperda (J.E. Smith) has become one of the factors threatening the productivity of agricultural crops worldwide. In the Egyptian fields, it became one of the most dangerous pests that attack maize at the country level. In northern Egypt, the larvae were found feeding on plant species such as corn, okra, mallow, amaranth, also the larvae were found feeding on the fruits of tomato and pepper plants and table beets. Therefore, it was bred in a laboratory on these plants and fruits, which showed the ability to survive in all these plant families with rates 90, 80, 76.7, 83.3, 70, 63.3 and 10%. The eggs incubation period was similar in all plants with ranged 2.5-3.0 days. Larval duration recorded 13.0±1.0, 15.0±1.0, 16.0±0.5, 13.0±1.0, 19.0±1.0, 19.5±0.0 and 18±0.0 days, pupal duration found to be similar in all host plant with range 6.0±0.6 to 6.3±0.6 days. Adults longevity exhibited a significant difference between maize, okra, amaranth, mallow with 10.5±0.13 day and that on tomato, pepper and table beet with 8.0±1.0, 6.0±1.0 and 4.0±0.5 days, respectively. The female prepoviposition period lasted 2.0±0.5 days in all plant species, also oviposition period lasted 5.0±0.5 days, and post oviposition period lasted 2.00±0.0 days. In egg laying choice test females laid eggs on maize and amaranth plants, meanwhile in no-choice test, females laid eggs on all plants.

Keywords: Fall Armyworm, Biology, longevity

INTRODUCTION

The fall armyworm (FAW), Spodoptera frugiperda (J.E. Smith) is one of the crop pests and socioeconomic environmental transboundary factors which causing very high economic yield losses ranged 20 to 40 percent in the world (CABI 2017, CABI 2018, FAO, 2018). In China, FAW recorded by the end of 2018 and became the top serious pest in 2021 (Wang et al. 2020, Wu Li-hong et al. 2021, Zhou et al. 2021). In Africa, FAW is recorded in 2016 and by one year is occurred in 47 countries (Goergen et al., 2016; Etienne Tendeng et al., 2019). Without control methods, FAW has the ability to cause maize damage in 12 African countries with range of 20-53% of losses (Day et al., 2017; De Groote et al., 2020). In Egypt, FAW recorded in upper Egypt in 2019 attacking maize and sorghum (Mohamed et al. 2021; Hend et al., 2022). Maize and grasses are the main hosts for FAW, it can exceed maize with high infestation that reached to100% (Cruz et al., 1999; Hardke et al., 2015; Moreblessing et al., 2019). Also FAW was recorded on 353 plant species (Montezano et al., 2018; Wan et al., 2020). In the absent of maize, FAW can infest and damages other vegetable crops such as Okra (Abelmoschus esculentus L.), mallow (Corchorus olitorius), table beet (Beta vulgaris) many solanaceous crops, and damage the fruits such as bell pepper (Capsicum annum) and tomato (Solanum lycopersicum Mill), and other weeds such as (Amaranthus spp.) (Abrahams et al., 2017, Day et al., 2017; Montezano et al., 2018), the fruit damage of tomato ranged 10 to 33.5% (El Sheikh, 2021). As a lepidopteran pest (Lepidoptera: Noctuidae), FAW have two strains, one infesting maize (Zea mays L.) and the other infested rice and grasses (Juárez et al., 2012). FAW were affected by cold temperature for long period and have no diapause (Rodney et al., 2015, Geogern et al., 2016). The larval length influenced by temperature before developing to adults (Aguilón et al., 2015). The suitable temperature of develop and survival rate of larvae found in the range 25 to 30 degree (Mohamed et al., 2021). The host plant species affected on the duration and survival rate of larvae (Salem et al., 2021). With the end of the season of maize by converting it to silage in the area under study, armyworm may have an economic impact, especially during the autumn to the new crops. Therefore, the suitability of host plants on development and survival rate was studied to estimate the damage could be happened in the same aria.

MATERIALS AND METHODS

Host plant studies:

Armyworm classification confirmed with the beginning of the appearance at the end of September 2020 on maize and amaranth which were planted in Qutour Center, Gharbia Governorate. The onset of infection on different plants in the same location were investigated, till September 2022 and were recorded monthly. Direct counts of the larvae and bite eggs were used.

Biological studies:

The laboratory study of the fall Armyworm was carried out in the Vegetable Pest Research Laboratory at the Plant Protection Research Institute, Dokki Giza. The study was carried out at a temperature of 28±2 °C, a humidity of 60% and a light period of 12:12 hours. Fall armyworm larvae were collected from the corn plants on which they are located in the field and transferred to the laboratory. These larvae were bred until they turned into pupae and full insects on the
corn plants. Corn, okra, mallow and amaranth plants were bred in small pots up to 40 days old, and green young fruits were obtained for tomato and pepper plants to be used in the breeding process, also amaranths plats were transplanted from the field to the laboratory. The incubation period of egg stage was recorded on various plants. In respect to the larval stage, the first instar larvae were divided and reared in a plastic container containing parts of plant leaves of maize, okra, mallow, amaranth, table beet, pepper and tomato. For each plant species, 10 larvae were reared in each container and the experiment was repeated three times with total 30 larvae/plant species. The development and survival rate of the larval stage were monitored. Once larvae completed their development to pupae, all pupae were collected and counted on each plant to record their development and survival rates. After adult emergence, adults were reared on two kinds of cages: A cage was made in small greenhouse, covered with nets, with an area of 2 x 4 meters and a height of 1.5 meters and planted with the seven plant species with 40 day-olds to study the host preferences and choice test of egg laying. The second cage was equipped in the laboratory, with an area of 40 x 40 cm and a height of 60 cm, covered with net, also contain a planted cups with different species, also in both cages a 5% sugar solution was presented in a plastic box containing a piece of cotton to feed the moth and each plant species to investigate, the adult longevity, preoviposition period, oviposition period, post oviposition period, female fecundity and the selection of plants to lay eggs with or without maize.

The developmental times and survival rate were analyzed using an ANOVA at 0.05 probability level. In case of significant, means were separated using Duncan’s multiple test.

**RESULTS AND DISCUSSION**

**Results**

Data in Table (1) indicate that the mean numbers (±SE) of immature stage durations of *S. frugiperda* rearing on different plants. The incubation period was similar in all plants and recorded 2.5±0.5 day. The larva duration receded the lowest duration on maize and amaranth with 13.0±1.0 day, meanwhile the longest larval duration was recorded on pepper by 19.5±0.5. A significant differentiation found on the total period between host plants, the total duration from eggs to adults recorded the longest period on tomato and pepper, meanwhile the lowest period recorded on maize, okra and amaranth.

**Table 1. Effect of different host plants on durations (±SE) of the immature stages of *S. frugiperda*.

<table>
<thead>
<tr>
<th>Host plants Parameters</th>
<th>Maize Means ±SE</th>
<th>Okra Means ±SE</th>
<th>Mallow Means ±SE</th>
<th>Amaranth Means ±SE</th>
<th>Tomato Means ±SE</th>
<th>Pepper Means ±SE</th>
<th>Table beet Means ±SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incubation period</td>
<td>2.5±0.5 a</td>
<td>2.5±0.5 a</td>
<td>2.5±0.5 a</td>
<td>2.5±0.5 a</td>
<td>2.5±0.5 a</td>
<td>2.5±0.5 a</td>
<td>2.5±0.5 a</td>
</tr>
<tr>
<td>1st instar</td>
<td>1.5±0.3 b</td>
<td>2.0±0.5 a</td>
<td>2.0±0.5 a</td>
<td>1.5±0.3 b</td>
<td>3.5±0.5 c</td>
<td>3.0±0.0 d</td>
<td>3.0±0.0 d</td>
</tr>
<tr>
<td>2nd instar</td>
<td>1.5±0.3 b</td>
<td>2.0±0.5 a</td>
<td>2.0±0.5 a</td>
<td>1.5±0.3 b</td>
<td>3.0±0.0 d</td>
<td>3.5±0.5 c</td>
<td>3.0±0.0 d</td>
</tr>
<tr>
<td>3rd instar</td>
<td>2.0±0.5 a</td>
<td>2.0±0.5 a</td>
<td>2.0±0.5 a</td>
<td>2.0±0.5 a</td>
<td>3.5±0.0 c</td>
<td>3.0±0.0 d</td>
<td>2.0±0.0 a</td>
</tr>
<tr>
<td>4th instar</td>
<td>2.0±0.5 b</td>
<td>2.0±0.5 b</td>
<td>3.0±0.5 c</td>
<td>2.0±0.5 b</td>
<td>3.5±0.5 c</td>
<td>3.5±0.0 c</td>
<td>3.5±0.0 c</td>
</tr>
<tr>
<td>5th instar</td>
<td>3.0±0.0 c</td>
<td>3.0±0.0 c</td>
<td>3.0±0.0 c</td>
<td>3.0±0.0 c</td>
<td>3.5±0.5 c</td>
<td>3.5±0.0 c</td>
<td>3.5±0.0 c</td>
</tr>
<tr>
<td>6th instar</td>
<td>3.5±0.5 c</td>
<td>4.0±0.0 c</td>
<td>4.0±0.0 c</td>
<td>3.5±0.5 c</td>
<td>3.5±0.5 c</td>
<td>3.5±0.0 c</td>
<td>3.5±0.0 c</td>
</tr>
<tr>
<td>Total larval stage</td>
<td>13.0±1.0 a</td>
<td>16.0±0.5 b</td>
<td>16.0±0.5 b</td>
<td>13.0±1.0 a</td>
<td>19.0±1.0 c</td>
<td>19.5±1.0 c</td>
<td>18±0.0 a</td>
</tr>
<tr>
<td>pre pupal</td>
<td>1±0.0</td>
<td>1±0.0</td>
<td>1±0.0</td>
<td>1±0.0</td>
<td>1±0.0</td>
<td>1±0.0</td>
<td>1±0.0</td>
</tr>
<tr>
<td>Pupal stage</td>
<td>5.0±0.6 a</td>
<td>5.0±0.6 a</td>
<td>5.0±0.6 a</td>
<td>5.0±0.6 a</td>
<td>6.0±0.6 a</td>
<td>6.3±0.6 a</td>
<td>6.3±0.6 a</td>
</tr>
<tr>
<td>Total Immature (Egg-Adult)</td>
<td>23.5±0.2 a</td>
<td>26.5±0.4 b</td>
<td>26.5±0.4 b</td>
<td>23.5±0.2 a</td>
<td>29.1±0.5 c</td>
<td>29.7±0.6 c</td>
<td>28.0±0.5 c</td>
</tr>
</tbody>
</table>

Values in the same row followed by different letters are significantly different by ANOVA test (P<0.05).

Data in table (2) show the survival rate of the immature stages of *S. frugiperda* on different host plants. On larval stage the rate of survival recorded 100%, but about 50% only survived on table beet, the total survival of larval stage showed no differences between maize, okra, mallow, meanwhile in mallow, pepper and tomato the survival rate were significant with the first group. On table beet recorded the lowest survival rate with 10%.

**Table 2. Survival rates of the fall armyworm *S. frugiperda* on various host plants.

<table>
<thead>
<tr>
<th>Host plants Parameters</th>
<th>Maize %</th>
<th>Okra %</th>
<th>Mallow %</th>
<th>Amaranth %</th>
<th>Tomato %</th>
<th>Pepper %</th>
<th>Table beet %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incubation period</td>
<td>100.0 a</td>
<td>100.0 a</td>
<td>100.0 a</td>
<td>100.0 a</td>
<td>100.0 a</td>
<td>100.0 a</td>
<td>100.0 a</td>
</tr>
<tr>
<td>1st instar</td>
<td>100.0 a</td>
<td>100.0 a</td>
<td>100.0 a</td>
<td>100.0 a</td>
<td>100.0 a</td>
<td>100.0 a</td>
<td>100.0 a</td>
</tr>
<tr>
<td>2nd instar</td>
<td>100.0 a</td>
<td>100.0 a</td>
<td>100.0 a</td>
<td>100.0 a</td>
<td>100.0 a</td>
<td>100.0 a</td>
<td>100.0 a</td>
</tr>
<tr>
<td>3rd instar</td>
<td>100.0 a</td>
<td>100.0 a</td>
<td>100.0 a</td>
<td>100.0 a</td>
<td>100.0 a</td>
<td>100.0 a</td>
<td>100.0 a</td>
</tr>
<tr>
<td>4th instar</td>
<td>100.0 a</td>
<td>90.0 a</td>
<td>90.0 a</td>
<td>100.0 a</td>
<td>100.0 a</td>
<td>83.3 a</td>
<td>100.0 a</td>
</tr>
<tr>
<td>5th instar</td>
<td>100.0 a</td>
<td>92.6 a</td>
<td>96.3 a</td>
<td>100.0 a</td>
<td>86.7 a</td>
<td>96.0 a</td>
<td>80.0 a</td>
</tr>
<tr>
<td>6th instar</td>
<td>100.0 a</td>
<td>100.0 a</td>
<td>88.5</td>
<td>86.7</td>
<td>92.3</td>
<td>95.8</td>
<td>100.0 a</td>
</tr>
<tr>
<td>Total larval stage</td>
<td>96.7 a</td>
<td>83.3 a</td>
<td>76.7 b</td>
<td>86.7 a</td>
<td>76.7 b</td>
<td>66.7 b</td>
<td>16.7 c</td>
</tr>
<tr>
<td>Pupal stage</td>
<td>96.6 a</td>
<td>83.3 a</td>
<td>75.3 a</td>
<td>82.0 a</td>
<td>95.8</td>
<td>82.6</td>
<td>62.5</td>
</tr>
<tr>
<td>Total Immature (Egg-Adult)</td>
<td>96.4 a</td>
<td>80.0 a</td>
<td>70.7</td>
<td>96.2</td>
<td>70.0</td>
<td>63.3</td>
<td>10.0</td>
</tr>
</tbody>
</table>

Values in the same row followed by different letters are significantly different by ANOVA test (P<0.05).

Data in Table (3) show the preoviposition, ovipositional, post oviposition, adult’s longevity and female fecundity of the fall armyworm *S. frugiperda* on different host plants. It can be indicated that no differences found in preoviposition period in all host plants. In oviposition period showed also no differences in all host plants Except for females produced from table beets, it didn’t produce eggs. Adult longevity found to be significant differences between tomato and the female Fecundity showed the highest egg production on maize, okra, mallow and amaranths, this plant group produce around 1600 to 1700egg/female. A significant difference on egg production found between tomato and pepper from one side and the others from the other side.
Data in Figure (1) show the female egg laying under choice and no-choice host plant tests of the fall armyworm S. frugiperda. Data showed that female armyworms preferred laying eggs on corn and amaranth plants, in the presence of other plant hosts. While when placing the females with each plant host without the presence of the optional, the results showed that the eggs were not laid on the beet, pepper and tomato plants, but when placing the green fruits of tomatoes and peppers, it laid eggs on them. It was also noted that the females placed eggs on the wall of the cages, in the presence or absence of their favorite host plant.

Fig. 1. Choice test of the fall armyworm S. frugiperda egg-laying preferences on different host plants.

Discussion

On duration times, the incubation period of the fall armyworm in maize and okra is longer than male which is in consistent with the findings of Ganta et al. (2018). Further, the preoviposition period, oviposition and post oviposition did not differ between all host plants except table beet which is agreed with Wu Li-hong et al. (2021). Female egg productivity found with range of eggs affected by the plant feed type and temperature.

REFERENCES


الجانب البيولوجي لدودة الحشد الخريفية مع اختلاف العوائل النباتية

محمود عبدالجديد سامي، سمير السيد قاسم و مصطفى فاروق أحمد عليم

معهد بحوث وقاية النبات - مركز البحوث الزراعية - الجيزة

الملخص

أصبحت دودة الحشد الخريفية أحد العوائل التي تهدد إنتاجية المحاصيل الزراعية في جميع أنحاء العالم. في الحقول المصرية، أصبحت من أكثر الآفات التي تصيب الذرة على مستوى الدولة. في شمال مصر، وجدت اليرقات تتغذى على أنواع نباتية مثل الذرة، البامية، الملوكية، القطيفة، ثمار نباتات الطماطم والفلفل، وبنجر المائدة. تم تربيتها معمولاً على هذه النباتات، فأظهرت قدرتها على البقاء في كل هذه الفصائل النباتية بنسبة 90 و 80 و 76.7 و 83.3 و 70 و 63.3 و 50 و 30 و 10 و 0٪. فترة حضانة البيض متشابهة في جميع النباتات حيث سجلت 2.5 و 3.0 و 3.0 و 3.0 و 3.0 و 3.0 يوم. سجلت طول اليرقات 13.0 ± 0.5 و 13.0 ± 0.5 و 13.0 ± 0.5 و 13.0 ± 0.5 و 13.0 ± 0.5 و 13.0 ± 0.5 يوم. طور العذراء مشابه في جميع النباتات، حيث سجلت 6.0 ± 0.1 و 6.0 ± 0.1 و 6.0 ± 0.1 و 6.0 ± 0.1 و 6.0 ± 0.1 و 6.0 ± 0.1 يوم. حوالي 5.0 ± 0.0 و 7.0 ± 0.0 يوم، وبشكل متوازن بين الذرة، البامية، القطيفة، والملوكية، من خلال طول اليرقات، والبنجر المائدة، مع 8.0 ± 0.1 و 10.5 ± 0.2 يوم، وكلاً على حدة، في جميع النباتات. تمت فترة البضائع 0.6 ± 0.1 و 0.6 ± 0.1 و 0.6 ± 0.1 و 0.6 ± 0.1 و 0.6 ± 0.1 و 0.6 ± 0.1 يوم. استمرت فترة اليرقات من خلال مرحلة التوريد، 0.5 ± 0.0 يوم. في حالة الاختيار بين العوائل، وردت الإناث جميع العوائل على نباتات الذرة، البامية، القطيفة، والبنجر المائدة، ثم على ثمار الطماطم والفلفل الأخضر. في حالة عدم الاختيار، تضع البيض على جميع النباتات المضيفة، وعلى ثمار الطماطم والفلفل الأخضر.