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Influence of Maize Varieties on the Biological Aspects of the Granary Weevil *Sitophilus granarus* L. (Coleoptera: - Curculionidae)

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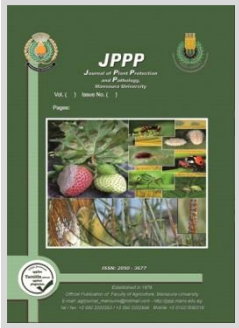

ABSTRACT

The granary weevil, *Sitophilus granarius* l. was reared on local maize varieties which cleaned from any insect infestation under laboratory condition with temp. 30±2°C and 65 ±5% relative humidity. The obtained results revealed that, under non-choice test method the maize variety S.c.173 was the most favorable variety and presented by 26.4 ±0.87 and 31.4 ±20.87 indiv. followed by T.W.C. 324 which presented 22.2±0.86 and 26.8±1.02 indiv. for F1 and F2 progeny, respectively. On the other hand, under free-choice test method also the maize variety S.C.173 recorded the most attracted variety and the highest mean emerged insect adults for the F1 progeny or F2 progeny and presented by 29.60 ±1.17 and 33.80 ±1.77 indiv., respectively. Moreover, the maize variety T.W.C. 324 came in the second category and presented by 25.20 ±0.97 indiv. for F1 and F2 progeny, respectively. Also, the maize variety S.C.173 had the highest percentage of weight loss after four weeks and eight weeks and presented by 2.40 and 3.70 %, respectively.

Keywords: the granary weevil, *Sitophilus granarius*, Maize varieties, biological aspects, weight loss.

INTRODUCTION

Maize (*Zea mays* L.) is the third most important cereal crop grown in the world. Egypt's maize grain production reached 6.4 to 7.4 million metric tons from the period between 2020-2022. Maize is a key crop due to its wide range of use as human food and livestock feed, as well as its importance in many critical fields. Maize is the world's third most important cereal crop, behind wheat and rice. (Siwale *et al.*, 2009). Maize is an essential element of global food security, providing a substantial source of nutrition to millions of people. It is the only food grain eaten from blossom to flour. (Boutard, 2012). In poor countries, it is cultivated both for food and feed. Its production is vital for raising agricultural status and increasing economic growth. (Byerlee *et al.*, 1997). Maize grains are stored mainly for maintaining its availability round the year for food and seed purposes for planting during coming season (Adetunji, 2007).

Insects, rodents, and mites frequently attack cereal grains, resulting in both quantitative and qualitative losses. Because grains must be stored for consumption, the majority of farmers are small and medium-sized, with inadequate drying and storage facilities. Global estimates of post-harvest losses range from 5 to 35 percent. (Suleiman *et al.*, 2015).

Insect pests damage to stored food products has become a significant problem that threatens food security. *Sitophilus spp*., the smaller grain borer, *R. dominica*; the red flour beetle, *Tribolium castaneum* Herbest; the rice moth, *Corcyra cephalonica*, and the angumois grain moth, *Sitotroga cerealella*, are among the insects that attack maize during storage. Sitophilus weevils are important pests of stored maize worldwide (Grenier *et al.,* 1994).

The granary weevil, *Sitophilus granarius* attacked several crops including maize, barley, oat, wheat and rice (Schwartz and Burkholder, 1991). The insect pest preferred the large cereal kernels to egg deposited (Stejskal and Kucerova, 1996). Moreover, the insect female deposited before (Niewiada *et al.* 2005). According to Fathalla,2024, the granary weevil *S.granarius* attacked the wheat varieties with the hole grains status with no-choice test after 30 or 60 days from infestation and found that, significant differences between the wheat varieties in the whole grain status and the results revealed that, Gimiza 12 wheat variety had the largest mean number of the adult emerged followed by Giza 171 and seeds 14 while Shandawel 1 had the lowest mean number of the emerged insect adult.

Therefore, the present work was conducted to study the influence of different maize varieties on certain biological aspects of the granary weevil *S. granarius* according to the free-choice test method and non-choice test method.

MATERIALS AND METHODS

The research was conducted from May to August 2023 in the Entomology department Laboratory, Faculty of Agriculture Mansoura University.

Culture of Granaries Weevil:

The granaries weevil, *Sitophilus granarius,* was bred using a local maize variety that is clean of any infestation. The breeding process took place in a controlled environment with a temperature of 30 ± 2 °C, relative humidity of 65 ± 5%. The kernels stored a two-days storage period at a temperature of -18°C to eradicate any developmental stage of pests that could potentially be found in the kernels, as well as to discard seeds exhibiting evident signs of damage. Then 250 unsexed adults of *S. granarius* placed into 1 kg capacity jar containing the 500 g of maize kernels that had been treated to remove any pests or pathogens. Adults were extracted from each bucket ten days following their introduction, and the containers were thereafter monitored until appearance of offspring that starting 20 days after the insects were introduced. Insect culture was built to provide a sufficient number of insects at various ages for subsequent tests.

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Maize varieties: -

Five maize varieties of the most used maize verities in Egypt were used for the investigation Single cross 132 (S.C.132), Single cross 173 (S.C.173), Single cross 10 (S.C.10), Single cross 178 (S.C.178). Three ways cross 324(T.W.C 324).

Non-choice infestation test:

To evaluate the most suitable maize variety for the granary weevil a non-choice test done, by releasing 10 unsexed adults aged between 7 and 10 days of the granary weevil to a petri dish containing 10 g of maize kernels 5 replicates for each treatment (maize variety) where predetermined insects were carefully delivered into each jar., were placed into individual plastic jars. The insects were permitted to lay eggs on the grains for 7 days, then they were removed. The complete arrangement was thereafter placed in the laboratory, maintaining a temperature of 30±1°C and a relative humidity of 65±5%, until the initial adults of the F1 generation emerged. The number of emerged adults were counted daily across the period of 4 and 8 weeks until the complete emergence of all F1 offspring was anticipated.

Free choice infestation test:

The experiment involved determining the incidence and oviposition preference using the free choice test. A muslin-covered circular cage with a diameter of 17.5 cm and a thickness of 7.5 cm was used for this purpose. The interior of the cage was partitioned into five sections, with each section containing 5 grams of grains of each variety. The infestation was initiated by introducing 15 pairs of *S. granarius* (10 days old) into the central area of the cage. Subsequently, the upper part of the cage was covered. The insect was permitted to engage in oviposition for ten days. The grains were individually isolated, including mature insects, and stored in plastic jars weighing 250 g each. The treatments were conducted using a completely randomized design and were replicated five times. The number of attracted insects and weight loss evaluated after 72 h. while the number of emerged insects was assessed for each dish after 4 and 8 weeks. The weight loss % resulting from the weevil determined according to the following equation: -

$$\% \text{ weight loss} = \frac{\text{Initial Weight-Final Weight}}{\text{Initial weight}} \times 100$$

RESULTS AND DISCUSSION

non- choice infestation test: -

Data illustrated in Table (1) showed the average number of the emerged adults of S. granarius after four and eight weeks according to different maize varieties.

Table 1. the mean number of individuals of Sitophilus granarius on different certain varieties of Maize kernels

Maize varieties	Mean no. after 4 weeks	Mean No. after 8 weeks
S.C. 132	19.6 ± 0.98 c	24.2 ± 1.66 b
S.C. 173	26.4 ± 0.87 a	31.4 ± 0.87 a
S.C.10	18.2 ± 0.86 c	23.4 ± 1.78 b
S.C.187	14.6 ± 0.60 d	16.4 ± 0.81 c
T.W.C. 324	22.2 ± 0.86 b	26.8 ± 1.02 b

It can be noticed that, after four weeks (F1 progeny) ranged between 14.6 ±0.60 and 26.4 ± 0.87 indiv. while, after eight weeks (F2 progeny) ranged between 16.4 ± 0.81 and 31.4± 0.87 indiv. The most favorable variety was single cross (S.C173) 26.4 ± 0.87 and 31.4 ± 0.87 indiv. for F1 and F2 respectively. Followed by the variety three way cross 324 (T.W.C 324) 22.2 ± 0.86 and 26.8 ± 1.02 indiv. for F1 and F2 respectively. While the least number of emerged individuals was on the variety single cross 187 (S.C.178) and represented by 14.6 ± 0.60 and 16.4 ± 0.81 for F1 and F2 respectively.

Data obtained in Table (1) revealed that there were significant differences between the studied Maize varieties on the mean number of individuals emerged after 4 and 8 weeks.

The obtained data arranged in Fig. (1) showed the mean weight losses after four and eight weeks from infestation for different maize varieties. After four weeks (F1 progeny) the highest weight loss percentage was recorded on the maize variety S.C.173 (2.40%) followed by 2.10 % on maize varieties S.C.132 and T.W.C. 324. Meanwhile, the highest percentage of weight loss after eight weeks (F2 progeny) was recorded on maize variety S.C.173 followed by T.W.C 324 and S.C.132 maize varieties and presented by 2.9 and 2.6 %, respectively.

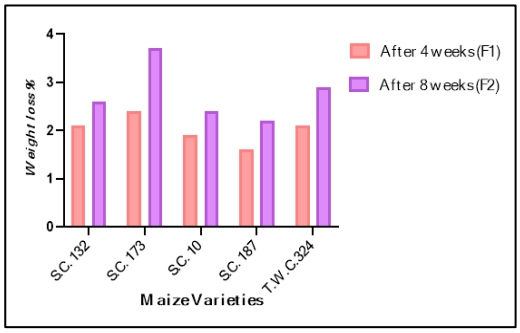

Fig 1. The percentage of maize varieties weight losses after F1 progeny and F2 progeny

The obtained results illustrated in Table 2 showed the average number of the drew individuals after 72 hours, the mean number of the individuals emerged after 4 weeks and after 8 weeks as F1 and F2 progeny on different maize varieties infested by the granary beetles *S. granarius*. The drew individuals from *S. granarius* for different maize varieties ranged between 7.40 ± 0.93 indiv. on maize variety S.C. 132 and 8.80 ± 1.07 indiv. on maize variety S.C.173. Statistical analysis revealed that non-significant differences were obtained between the different maize varieties according to the drew individuals of the granary beetle, *S. granarius*.

Table 2. The mean number of the attracted insect adults after 72h and the mean number of the emerged adults after four and eight weeks according to free choice test.

Maize varieties	No. of drew individuals after72h.	Mean no. of individuals emerged	
		After 4 weeks	After 8 weeks
S.C. 132	7.40 ± 0.93 a	16.2 ± 0.73 d	19.20 ± 1.02 d
S.C. 173	8.80 ± 1.07 a	29.60 ± 1.17 a	33.80 ± 1.77 a
S.C.10	7.80 ± 1.07 a	21.80 ± 1.07 c	24.20 ± 1.16 c
S.C.187	7.60 ± 0.93 a	12.80 ± 1.07 e	15.60 ± 0.81 d
T.W.C. 324	8.40 ± 0.60 a	25.20 ± 0.97 b	28.60 ± 1.17 b

Regarding the emerging adults of the insect *S. granarius*. After four weeks as F1 progeny from different maize varieties was the highest (29.60 ± 1.17 indiv.) was found on maize variety S.C.173 followed by T.W.C and S.C 10 varieties and presented by 25.20 ± 0.97 indiv. and 21.80 ± 1.07 indiv., respectively. The lowest average number of F1 progeny was found on S.C. 187 variety with an average of 12.80 ± 1.07 indiv. with significant differences (Table 2).

After 8 weeks, the emerged adults of the insect pest *S. granarius* as F2 progeny from different maize varieties was the highest (33.80 ± 1.77 indiv.) was found on maize variety S.C.173 followed by T.W.C and S.C 10 varieties and presented by 28.60 ± 1.17 indiv. and 24.20 ± 1.16 indiv., respectively. The lowest average number of F2 progeny was

found on S.C. 187 variety with an average of 15.60 ± 0.81 indiv. with significant differences. (Table 2).

The present data arranged in Table (3) showed the chemical analysis results of the tested maize varieties. Data revealed that, the maize variety S.C.173 had the highest moisture percentage, the protein percentage, the fat percentage as well as the lowest percentage of total phenol and the high percentage of oil followed by the maize variety S.C.10 and T.W.C. 324. While the maize variety S.C.132 had less moisture, Protein, fat and oil percentage and more percentage of the total phenol.

Table 3. the chemical analysis results of the tested maize varieties

Components	Maize Varieties				
	S.C. 132	S.C.173	S.C. 10	S.C. 187	T.W.C.324
Moisture %	11.85	12.97	11.98	11.36	12.19
Total carbohydrates %	72.93	73.81	73.24	72.51	93.12
Protein %	9.17	10.26	9.81	9.27	9.42
Fat %	3.22	3.96	3.34	3.43	3.52
Total Phenol %	162.47	160.22	161.19	162.71	161.07
Oil %	3.05	3.28	3.16	3.11	3.19

As a conclusion, the results arranged in Tables 1, 2 and 3 revealed that, the maize varieties S.C.173; S.C.10 and T.W.C.324 attracted the highest mean number as well as had the highest mean progeny (F1) and (F2) while the maize varieties S.C. 173 and S.C.187 had the lowest attracted mean number and the lowest mean progeny F1 and F2.

According to Schwartz and Burkolder (1991) the granary weevil S. granaries exhibited the lowest of the developmental rate on maize grains and the highest rate of development on rive grains and between these rates for maize and rice grains and between these rates for maize and rice came the developmental rate on barly, oats and wheat. Athanassiou *et al.* (2017) suggested that the population density of *S. oryzae* adults was significantly higher on rice grains than on maize grains and *S. granarius* exhibited the lowest adult's number on rice grains or maize grains. Kalsa *et al.* (2019) mentioned that, the percentage of insect damage kernels and grain weight loss by *S. granarius* infestation showed a negative correlation with kernel weight and hardness index and a positive correlation between kernel diameter and percentage of insect damaged kernels and grain weight loss. Also, they suggested that, kernel weight, hardness index and protein content have a significant role in wheat resistance to *S. granarius*. Nietupski *et al.* (2021) was strongly associated with the high concentration of saturated fatty acids (SFA) in the kernels. Fouad *et al.* (2024) mentioned that the host preference of *S. granarius* on cereal grains including polished rice, barley, wheat, maize, sorghum, rough rice and oats. They suggested that, wheat, sorghum and rough rice preferred grains for the granary weevil while barley and polished rice exhibited the lowest preferred grains to *S. granarius* infestation. Awadalla *et al.* (2024) found that wheat was the most preferred grain with both free- choice method or non-choice method for *S. oryzae*, while oats grains were the lowest preferred by the two methods. Also, they added that, F1 and F2 offspring the highest mean number of emerged adults were recorded on wheat grains followed by maize and rice grains.

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تأثير أصناف الذرة على الصفات البيولوجية لسوسة الحبوب *Sitophilus granarius* L.

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الملخص

سوسة الحبوب (سوسة القمح) تم تربيتها على أصناف الذرة المحلية حيث تم تنظيفها من أي إصابة حشرية وذلك تتحت ظروف المعمل حيث كانت درجة الحرارة 32 ± 2 م والرطوبة النسبية 65 ± 5 %. وقد اشارت النتائج المتحصل عليها وذلك بطريقة اختيار عدم الاختيارية لان صنف الذرة هجين فردي 173 كان أكثر الأصناف ملائمة حيث كان عدد الحشرات الكاملة المنبثقة 26.4 ±0.87 و31.4 ب 26.4 ±0.87 فرد يليه الصنف هجين ثلاثي 324 وذلك بعدد الحشرات الكاملة المنبثقة 22.4 ب 26.4 ±0.86 و26.8 ± 1.02 فرد وذلك لذرية الجيل الأول والجيل الثاني على التوالي. ومن جهة أجري وذلك بطريقة اختبار حرية الاختيارية وجد أيضا ان حبوب الذرة صنف هجين فردي 173 سجل أعلى معدل لجذب سوسة القمح واعلى متوسط للحشرات الكاملة المنبثقة من ذرية الجيل الأول والجيل الثاني حيث كانت 29.6 ± 1.17 و33.8 ± 1.77 فرد على التوالي. علاوة على ذلك جاء الصنف هجين ثلاثي 324 في المرتبة الثانية وسجلت 25.2 ± 0.97 و28.6 ± 1.17 فرد للجيل الأول والجيل الثاني على التوالي. أيضا سجل الصنف هجين فردي 173 أعلى نسبة فقد في الوزن بعد أربعة أسابيع وثمانية أسابيع حيث سجل فقد بنسبة 2.4 و3.7 % على التوالي.