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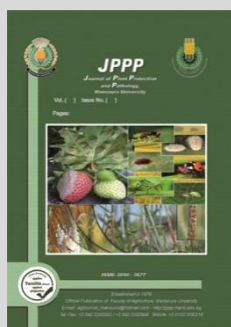
Effect of The Different Wheat Grain Varieties on some Biological Aspects of The Khapra Beetle *Trogoderma granarium* Everts (Dermestidae: Coleoptera)

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ABSTRACT

The Khapra grain beetle, *Trogoderma granarium* Everts is one of the serious primary insect pests attacking the stored wheat grains. The insect pest was reared on four wheat varieties to study their effects on the biological aspects as the immature stages, the ovipositional periods and the total number of egg-laying per the female. Giza 171 wheat variety showed a shortest duration of the larval stage and presented by 21.4 ± 0.4 days. Also, the shortest duration of the pupal stage was recorded at Giza 171 or Masir 2 wheat varieties and presented by 4.1 ± 0.2 days. The shortest oviposition period was recorded when reared the insect at Sakha 94 and presented by 10.5 ± 0.7 days. The wheat variety Giza 171 has to be considered the most favorable variety for *T. granarium* and gave the shortest development for immature stages (29.2 days), the highest oviposition (57.4 eggs/female), and the highest survival rate during the larval and pupal stage (96.0 %).

Keywords: Biology, egg-laying, survival rate, stored grain beetles

INTRODUCTION

During the process of storage, the different grains are exposed to attack by numerous species of insects, fungi and vertebrate pests from the time of the harvest to the consumption (Manickavasagan *et al.*, 2008). The insect pests, mainly beetles and weevils, play a great significant role in reducing the quantity and the quality of the stored grain and can be caused a loss of 75% in the yield in the developing countries (Nakakita, 1998; Papachristos and Stamopoulos, 2002). The consumption of the food commodities, additionally, contaminates the grains with faces, toxins, and shed skin of the insect pests (Arthur *et al.*, 2006).

The Khapra grain beetle, *Trogoderma granarium* Everts (Dermestidae: Coleoptera) consider a most destructive insect pest of stored grains worldwide (Gharib 2004). Several authors studied the biological aspects and the effect of different ecological factors on this insect pest. For example, Mahmood and Al-Azawi (1987) studied the effect of wheat and air moisture contents on the insect pest, Taheri (1988) studied the effect of various temperature degrees on the different stages, Aldryhim and Adam (1992) studied the biology in the central province of Saudi Arabia, Gharib (2004) evaluated the resistance of some wheat grain varieties to infestation with this insect pest, Awadalla *et al.* (2005) also studied the effect of different wheat varieties on the biological aspects of this insect, Sayed *et al.* (2006) studied the resistance of different stored wheat varieties to infestation by *T. granarium* and they found that wheat variety Mehran-89 hosted the lowest population, whereas Tj-0787 haboured the highest population of this insect, Abd El-Razik *et al.* (2016)

concluded that the Gemiza 7, Ben-swaif 4 and Sohag 3 were the most susceptible wheat varieties, whereas Giza 168 was the most tolerant variety to *T. granarium*, Athanassiou *et al.* (2016) studied the population growth of *T. granarium* on different commodities, Marani *et al.* (2017) also studied the effect of maize hybrid on the biology and life table parameters of *T. granarium* and they mentioned that the hybrid BC678 was unfavorable hybrid for population increase of the insect pest, Golizadeh and Abedi (2017) stated that, *T. granarium* larvae fed on barley cultivar Makuyi with higher values of relative consumption rates resulting in higher values of relative growth rates, and Mozghan and Hamzeh (2018) suggested that the larval food quality for *T. granarium* can affect the biological and physiological characteristics, and the supercooling point and cold hardiness of the insect pest.

Therefore, the present experiments aim to study the effect of the different wheat grain varieties on the biological aspects of the Khapra grain beetle *Trogoderma granarium* Everts (Dermestidae: Coleoptera) under laboratory conditions

MATERIALS AND METHODS

The present studies were carried out at the economic Entomology Department, Faculty of Agriculture, Damietta University under laboratory conditions of 30 ± 1 °C and $70 \pm 5\%$ RH. Culture was prepared by introducing batches of about 200 insect adults into 150 grams of wheat grains in plastic jars (20 × 10 cm) and covered with muslin and permitted to egg laying for two weeks and then removed. The new emerged adults were removed after ca. one week to obtain new culture of the insect under the

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same laboratory conditions. These adults were used to follow the biological aspects of their progeny.

Four wheat varieties were used in the experiments. These varieties were Sakha 94, Giza 168, Giza 171 and Masir 2. The grains were sterilized by subfreezing for two days to kill any hidden insect stages (El-Sabaay, 1998). All grains were maintained in the incubators at 30 ± 1 °C and 70 ± 5 % RH for two weeks to obtain equilibration moisture content with the relative humidity (Ezz, 1976). Small plastic jars (5×2 inches) were used in the present study and each contained 10 gram grains of the tested varieties. The jars were closed with a piece of muslin. Each wheat variety received 10 insect eggs for each replicate (five replicates for each variety). The incubation period, larval stage, pupal stage and ovipositional periods for the adult female as well as the adult male longevity were estimated at each wheat variety. Further, the total number of eggs laid by each female on each variety was counted. Data were analyzed using one-way ANOVA and means were separated by Duncan Multiple Range Test (Duncan, 1956).

RESULTS AND DISCUSSION

The obtained results in Table (1) represented the biological aspects of the Khapra grain beetle *Trogoderma granarium* Everts that reared on four different wheat varieties under laboratory conditions of 30 ± 1 °C and 70 ± 5 % RH. The incubation period of *T. granarium* was the same in all wheat varieties and lasted 3.6 ± 0.4 days. With regard to the larval stage, the longest duration was recorded on Giza 168 followed by Sakha 94 and represented by 23.1 ± 0.6 and 22.7 ± 0.8 days, respectively. Meanwhile, the shortest duration of the larval stage was recorded on Giza 171 and represented by 21.5 ± 0.4 days. Statistical analysis showed that there were significant differences between larval durations that reared on the four wheat varieties. In respect to pupal stage, it can be noticed that the pupal stage of *T. granarium* ranged between 4.1 ± 0.2 in Masir 2 or 4.1 ± 0.3 in Giza 171 and 4.4 ± 0.3 in Giza 168 without significant differences among wheat grain varieties.

Data arranged in Table (1) showed the ovipositional periods for *T. granarium* in different wheat varieties. It can be noticed that, the pre-oviposition periods were nearly similar and ranged between 3.9 ± 0.5 days in variety Masir 2 and 4.8 ± 0.6 days in variety Giza 168 without significant differences. Meanwhile the oviposition period was the longest in wheat variety Masir 2 and represented by 11.2 ± 0.7 days and the shortest oviposition period was in Sakha 94 and presented by 10.5 ± 0.7 days with significant differences. Moreover, the post-oviposition period ranged between 2.2 ± 0.2 days in Giza 168 and 2.4 ± 0.2 days in Masir 2 without significant differences.

The obtained data in Table (1) showed that the average number of eggs per female of *T. granarium* was the highest in wheat variety of Giza 171 (57.4 ± 1.1 eggs/female) followed by that in wheat variety of Masir 2 (54.3 ± 1.2 eggs/female), whereas the lowest number was recorded in wheat variety of Giza 168 (46.6 ± 1.2 eggs/female), with significant differences in total number of eggs in all varieties.

Table 1. Influence of the different wheat varieties on the biological aspects of the khapra grain beetle, *Trogoderma granarium* under laboratory conditions of 30 ± 1 °C and 70 ± 5 % RH.

Insect species	Wheat varieties			
	Sakha 94	Giza 168	Giza 171	Masir 2
Incubation period	3.6±0.4a	3.6±0.4a	3.6±0.4a	3.6±0.4a
Larval period	22.7±0.8a	23.1±0.6a	21.5±0.4b	21.7±0.5b
Pupal period	4.3±0.2a	4.4±0.3a	4.1±0.3a	4.1±0.2a
Egg- adult	30.6±0.7a	31.1±0.8a	29.2±0.6b	29.4±0.7b
Pre-oviposition period	4.5±0.5a	4.8±0.6a	3.7±0.4a	3.9±0.5a
Oviposition period	10.5±0.8b	10.6±0.8b	11.2±0.7a	11.5±0.6a
Post-oviposition period	2.3±0.1a	2.2±0.2a	2.3±0.3a	2.4±0.2a
Female longevity	17.3±0.6a	17.6±0.7a	17.2±0.5a	17.8±0.6a
Male longevity	15.1±0.8a	15.4±0.6a	15.9±0.6a	16.5±0.6a
No. eggs/female	49.3±0.9b	46.6±1.2b	57.4±1.1a	54.3±1.2a

Means followed by different letters within a raw are not significantly different at 5% probability level

Data arranged in Fig. (1) showed the effect of different wheat varieties on the total duration of the immature stages for the khapra beetle *T. granarium*. It can be noticed that the duration of the immature stage ranged between 29.2 days at Giza 171 and 31.1 days at Giza 168.

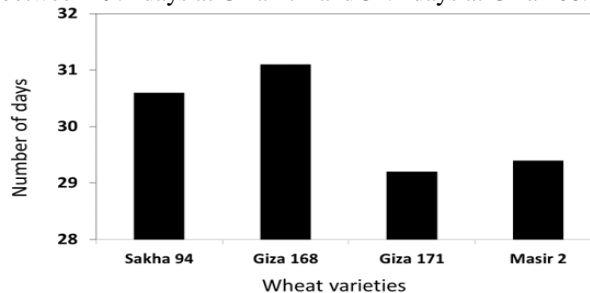


Fig. 1. Effect of different wheat varieties on the immature stages of the Khapra grain beetle, *Trogoderma granarium* under laboratory conditions of 30 ± 1 °C and 70 ± 5 % RH.

The obtained results in Fig, (2) showed the effect of the different wheat varieties on the adult male and female longevity for *T. granarium*. The adult female longevity was the longest at Masir 2 followed by Giza 168 and represented by 17.8 and 17.6 days, respectively. While, the shortest adult female longevity was recorded at Giza 171 with 17.2 days. On the other hand, the adult male longevity ranged between 15.1 days on wheat variety of Sakha 94 and 16.5 days on Masir 2. Statistical analysis revealed that a non-significant difference between the adult female longevity or adult male longevity at varying wheat varieties (Table 1).



Fig. 2. Effect of different wheat varieties on the adult male and female longevity of the Khapra grain beetle, *Trogoderma granarium* under laboratory conditions of 30 ± 1 °C and 70 ± 5 % RH.

Data illustrated in Fig (3) show the egg-laying behaviour by the Khapra grain beetle, *T. granarium* on the different wheat varieties under the laboratory conditions. It cleared that, the highest average number of eggs/female was recorded by insect females that reared on wheat variety Giza 171 followed by Masir 2 and represented by 57.4 and 54.3 eggs/female, respectively. On the other hand, Giza 168 wheat variety had the lowest average number of eggs by a female beetle and represented by 46.6 eggs/female.

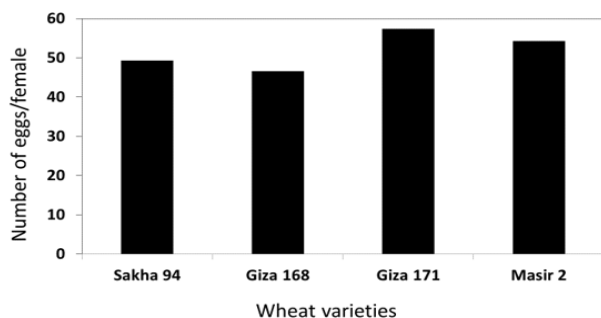


Fig. 3. Effect of different wheat varieties on the total egg-laying by female of the Khapra grain beetle, *Trogoderma granarium* under laboratory conditions of $30 \pm 1^\circ\text{C}$ and $70 \pm 5\%$ RH.

The obtained results demonstrated in Fig. (4) showed the egg hatchability percentage for the Khapra grain beetle, *T. granarium* when on reared on different wheat varieties. It can be noticed that, the egg hatchability percentage for the beetle ranged between 92% at Masir 2 and 95% at Giza 171.

The obtained results in Table (2) showed the survival rate of the Khapra grain beetle, *I. granarium* when on reared on different wheat varieties. The beetle exhibited the highest survival percentage during the larval and pupal stages on wheat variety Giza 171 which represented by 96 and 98.9%, respectively. Moreover, the lowest survival percentage of the beetle during both immature stages was on the wheat variety Giza 168 and represented by 93 and 96.8%, respectively.

As a conclusion, it cleared from the previous results that, the wheat variety Gisa 171 can be considered as the most favourable variety for *T. granarium*. On this variety, the beetle had the fastest immature stage development (29.2 days), the highest female fecundity (57.4 eggs), the highest egg fertility (95 %) and the highest survival percentage for the larval-pupal period (96.0 %).

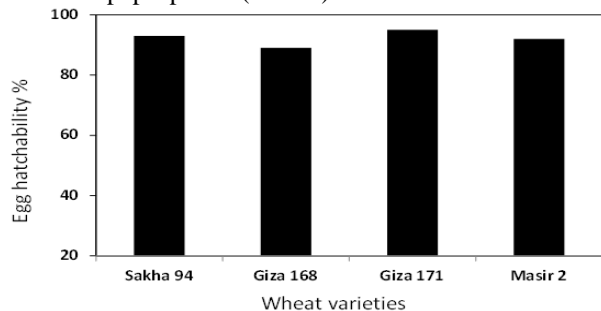


Fig. 4. Effect of different wheat varieties on the percentage of egg hatching of the Khapra grain beetle, *Trogoderma granarium* under laboratory conditions of $30 \pm 1^\circ\text{C}$ and $70 \pm 5\%$ RH.

Table 2. Influence of the different wheat varieties on the survival percentage of the khapra grain beetle, *Trogoderma granarium* under laboratory conditions of $30 \pm 1^\circ\text{C}$ and $70 \pm 5\%$ RH.

Wheat variety	Survival rates		
	Larval stage	Pupal stage	larval-adult stages
Sakha 94	95.0	97.9	93.0
Giza 168	93.0	96.8	90.0
Giza 171	97.0	99.0	96.0
Masir 2	96.0	98.9	95.0

These results are in agreement with these of Awadalla *et al.* (2005) who mentioned that the best preferable wheat varieties were Sakha 69 followed by Sakha 8 and Sakha 93 to the Khapra beetle, *T. granarium*. Sayed *et al.* (2006) suggested that Mehran wheat variety had the lowest population and Tj-0787 wheat variety had the highest population of the Khapra beetle, *I. granarium*. Moreover, Abd El-Razik *et al.* (2016) found that Ben-Swaif 4 and Gamiza 7 wheat varieties were the most susceptible varieties to *T. granarium*, whereas Gisa 168 was the most tolerant wheat variety to *I. granarium*.

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تأثير الأصناف المختلفة لحبوب القمح علي بعض الخصائص البيولوجية لخنفساء الخابرا *Trogoderma granarium* Everts

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تعتبر خنفساء الخابرا واحدة من أخطر الآفات الحشرية الأولية التي تهاجم حبوب القمح المخزونة. تم تربية الحشرة علي أربع أصناف من القمح لدراسة تأثيرها علي الخصائص البيولوجية مثل الأطوار غير الكاملة وفترات وضع البيض ومجموع البيض الكلي الموضوع لكل أنثي. وجد أن صنف القمح جيزة 171 سجل أقل فترة لطور اليرقة 0.4 ± 21.4 يوم، أيضا وجد ان أقل فترة لطور العذراء كان علي القمح صنف جيزة 171 أو مصر 2 حيث سجل 0.2 ± 4.1 يوم. كما وجد أن أقل فترة وضع بيض عندما تم تربية الحشرة علي صنف القمح سخا 94 حيث سجل متوسط 0.7 ± 10.5 يوم. وجد أن صنف القمح جيزة 171 يعتبر الصنف الأكثر تفضيلا للحشرة حيث أعطي أقصر فترة للأطوار غير الكاملة (29.2 يوم) والأكثر تشجيعا للانثي لوضع البيض حيث كان معدل وضع البيض (57.4 بيضة/أنثي) وحقت طوري اليرقة والعذراء اعلي معدل للبقاء علي هذا الصنف والذي بلغ 96.0%.