Varietal susceptibility of certain wheat grains to infestation with khapra beetle, *Trogoderma granarium* (Everts) (Coleoptera: Dermestidae)

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ABSTRACT

Wheat is one of the most important cultivated crops in most of the world. The aim of this study was to the susceptibility of seven wheat varieties no-choice and free-choice methods to the khapra beetle, *Trogoderma granarium* (Everts) (Coleoptera: Dermestidae) infestation were evaluated under laboratory conditions of 30 ± 2°C, 65 ± 5% relative humidity. Results obtained indicated that there were significant differences at ($P < 0.05$) between mean percent weight losses or grain damage, Sakha 95 was the most susceptible oppositely, Sids 12 was the least susceptible. After three generation of infestation, the highest infestation (26.40 and 25.60%) recorded in Sakha 95 with 16.67 and 18.49 % weight loss, while the least percent infestation (16.40 and 12.80%) was in Sids 12 with 9.70 and 8.15% weight loss, in no-choice and free-choice methods, respectively. Also, chemical analysis of infested grains of showed after three generations percent fat and carbohydrate was found decreased (1.23 and 67.71%), while percent ash, protein, moisture and fiber content was found increased (3.49, 14.56, 10.40 and 2.61%) in Sids12, respectively. These varieties classified as the most sensitive and tolerant; the remaining varieties were moderately sensitive to weight loss and their response to pest infection. Therefore, we can use these resistant varieties against *T. granarium*.

Keywords: Khapra beetle; wheat; weight loss; damage; chemical constituents.

INTRODUCTION

Previous studies reported that losses in major food commodities are significant after harvest. Wheat (*Triticum aestivum* L.) of the Gramineae family is the main cereal crop and an important food in Egypt and all world (Aly *et al*., 2018). Insects which are the major post-harvest pests of concern from harvest to consumption affect the storability of grains (Manickavasagan *et al*., 2008). Due to storage pests, post-harvest losses reach 20% in developing countries and 9% in developed countries (Yadav *et al*., 2018). The Khapra beetle *Trogoderma granarium* (Everts) (Coleoptera: Dermestidae) is one of the pests that feed on a wide range of stored grains and their products. It also disquiet many grain producing and exporting countries and reduces the weight, quality and commercial value of grains (Athanassiou *et al*., 2019 and Myers, 2021). The economic loss resulting from Khapra beetle damage is significant in grain-producing countries (Özberk *et al*., 2017), it is classified as an A2 quarantine object for EPPO (Anonymous, 2007), one of the 100 most aggressive pests in the world (Lowe *et al*., 2000). The larvae tolerate starvation for about 3 years, and can survive on grains with very low moisture content. The adults are harmless, but the larvae cause losses in stored grain ranging 5% and 30%, and may reach 70% (Ahmedani *et al*., 2007). The feeding of the larvae causes the grains to empty, leaving only the husk. Thus, the infected grains are filled with skins and feces serious deterioration in the quality of the grains (Ahmedani *et al*., 2009). Grains are vulnerable to infection by pathogens and secondary nutrients when damage to the grain increases. Developing resistant and tolerant varieties is one of the different methods to prevent grain damage due to insects (Kumar *et al*., 2019). Studies indicate that increasing the storage period increases the damage resulting from storage pests (Ahmad *et al*., 2017). Reduced content of true protein, sugars, carbohydrates and crude fats; while it increases total protein, moisture content and crude fiber at infection levels of 75% in wheat and corn grains (Jood *et al*., 1993 and 1996). For types of insect pests, a significant positive correlation was observed between carbohydrate content, and there was a negative correlation between protein content in stored grains, grain weight loss, and insect damage (Khan *et al*., 2010). Previously, different wheat cultivars have been tested for either susceptibility or weight loss induced by *T. granarium*, for example; (Sayed *et al*., 2006; Ahmedani *et al*., 2011; Abd El-Razik *et al*., 2016; Ahmad *et al*., 2017 and Özberk *et al*., 2017). Therefore, current study aims to examine the infestation and quantitative losses caused by *T. granarium* to seven Egyptian wheat varieties during storage, in no-choice and free-choice methods under laboratory conditions.

MATERIALS AND METHODS

Experimental Design

The following wheat varieties were obtained from Filed Crops Research Institute, Agricultural Research Center (ARC), Giza, Egypt, for studying the relative susceptibility at laboratory at Plant Protection Department, Faculty of Agriculture, Al-Azhar University, Cairo, Egypt. Varieties of wheat tested for their relative susceptibility viz., Giza 171, Beny-Sewif 5, Gemmiza 12, Masr 3, Sakha 95, Sohag 5 and Sids 12. Manual separation and selection of only healthy and sound grains were for different wheat varieties. The grains were placed in the freezer at 5°C for 7 days to make them free of hidden infection (Koehler, 2003). The grains were conditioned for 7 days in an incubator at 30°C ± 2°C and 65±5% R.H. The beetles used in this study were obtained from the Plant Protection Institute, Ministry of Agriculture, Giza, Egypt.

To study susceptibility of seven wheat varieties against *T. granarium* in no-choice and free-choice methods: - In case of no-choice, plastic container (6.5 cm in diameter and 7 cm in height) was used contain 50g of each wheat variety (five replicates each variety). Introduced 5 pairs/replicate of *T. granarium* adults (0-24 hours old age), the containers were closed with a piece of muslin, as shown in Figure 1A. In case of free-choice, plastic container (30 cm in length, 20 cm in width and 10 cm in height) were used consist of 7 barriers contain each barrier contained 50g of each wheat variety, introduced 35 pairs of *T. granarium* adults in center of plastic container and covered with a muslin cloth and tightly held with a rubber band, as shown in Figure 1B. All containers were maintained in the incubators at 30 ± 2 °C and 65 ± 5% RH. Beetles were removed at the end of each generation and the grains in each container were examined and reweighted to determine weight loss or infestation for three generations. The % weight loss and % grain damage were determined using these equations as previously reported (Ogungbite et al., 2014) as;

% Weight loss= Initial weight- finalweight/ Initial weight* 100

% Grain damage = number of holed grain/total number of grain*100

In end experimental, chemical analysis was conducted using a near-infrared spectroscopy (model DA1650 e FOSS Corporation, Denmark). The estimated values of the major chemical constituents included: ash content, fat, protein, Moisture, fiber and carbohydrate content in a 50g sample of each variety in before infestation and after three generations infestation to *T. granarium* (Taha *et al*., 2016).

Using the statistical software (Statistix version 8.1), data collected for weight loss and grain damage was analyzed statistically, using Least Significant Difference (LSD) test the means of the treatments were compared and are shown as means ± SE.

RESULTS AND DISCUSSION

Data in Table 1 showed the mean percentage of weight loss and damaged grains of the wheat varieties caused by *T. granarium* in no-choice and free-choice methods after the first generation. All varieties had some degree of infestation by the pest. In case of no-choice, the highest weight loss percent recorded in Sakha 95 and Masr 3 were 5.29 and 5.21%, and the moderate weight loss percent was in Sohag 5, Gemmiza 12 and Giza 171 were 3.41, 3.96 and 4.60%, and the lowest weight loss percent was in Sids 12 and Beny-Sewif 5 were 2.28 and 3.29%, respectively. With regard to the grain damage, the lowest damage percent noticed in Sids 12 and Beny-Sewif 5 which were 4.40 and 5.20%, and the moderate damage percent was in Sohag 5 and Masr 3 were 6.00 and 6.40%, and the highest damage percent was in Giza 171, Sakha 95 and Gemmiza 12 with 9.20, 8.80 and 7.20%, respectively.

In case of free-choice, the lowest weight loss percent recorded in Sids 12 and Sohag 5 were 1.50 and 1.80%, and the moderate weight loss percent was in Beny-Sewif 5, Gemmiza 12 and Giza 171 were 2.42, 2.75 and 3.83%, and the highest weight loss percent was in Sakha 95 and Masr 3 were 6.23 and 5.15%, respectively. With regard to the grain damage, the highest damage percent noticed in Sakha 95 and Gemmiza 12 which were 8.00 and 7.20%, and the moderate damage percent was in Sohag 5 and Giza 171 were 6.00 and 5.60%, and the lowest damage percent was in Masr 3, Beny-Sewif 5 and Sids 12 with 4.40, 4.80 and 4.80%, respectively (Table 1).

Data presented in Table 2 showed the mean percentage of weight loss and damaged grains of the wheat varieties caused by *T. granarium* in no-choice and free-choice methods after the second generation. In case of no-choice method, the highest weight loss percent recorded in Sakha 95 was 10.93%, and the moderate weight loss percent was in Gemmiza 12, Masr 3, Giza 171, Beny-Sewif 5 and Sohag 5 were 8.81, 8.25, 8.14, 7.34 and 7.24%,

respectively, and the lowest weight loss percent was in Sids 12 was 5.70%. With regard to the grain damage, the lowest damage percent noticed in Sids 12 which was 9.20%, and the moderate damage percent was in Masr 3, Sohag 5, and Beny-Sewif 5 were 11.60, 12.40 and 12.80%, and the highest damage percent was in Sakha 95, Giza 171and Gemmiza 12 with 16.80, 14.80 and 14.40%, respectively.

In case of free-choice method, the lowest weight loss percent recorded in Sids 12 and Beny-Sewif 5 were 4.60 and 5.94%, and the moderate weight loss percent was in Sohag 5, Giza 171and Gemmiza 12 were 7.22, 7.98 and 8.36%, and the highest weight loss percent was in Sakha 95 and Masr 3 were 13.50 and 11.64%, respectively. With regard to the grain damage, the highest damage percent noticed in Sakha 95 was 18.40%, and the moderate damage percent was in Gemmiza 12, Giza 171, Beny-Sewif 5 and Sohag 5 were 13.20, 12.80, 11.20 and 11.20%, and the lowest damage percent was in Masr 3 and Sids 12 were 8.80 and 9.20%, respectively (Table 2).

Data in Table. 3 showed the mean percentage of weight loss and damaged grains of the wheat varieties caused by *T. granarium* in no-choice and free-choice methods after the third generation. In case of no-choice method, the highest weight loss percent

recorded in Sakha 95 was 16.67%, and the moderate weight loss percent was in Giza 171, Gemmiza 12, Masr 3, Beny-Sewif 5 and Sohag 5 were 13.06, 12.82, 12.54, 12.11 and 11.79%, and the lowest weight loss percent was in Sids 12 was 9.70%. With regard to the grain damage, the lowest damage percent noticed in Sids 12 which was 16.40%, and the moderate damage percent was in Beny-Sewif 5, Masr 3 and Sohag 5 was 18.00%, and the highest damage percent was in Sakha 95, Giza 171and Gemmiza 12 with 26.40, 21.20 and 20.80%, respectively.

In case of free-choice method, the lowest weight loss percent recorded in Sids 12, Sohag 5 and Beny-Sewif 5 were 8.15, 10.42 and 10.70%, and the moderate weight loss percent was in Gemmiza 12 and Giza 171 were 13.02 and 13.02%, and the highest weight loss percent was in Sakha 95 and Masr 3 were 18.49 and 15.75%, respectively. With regard to the grain damage, the highest damage percent noticed in Sakha 95 was 25.60%, and the moderate damage percent was in Gemmiza 12, Giza 171 and Beny-Sewif 5 were 19.20, 16.40 and 16.00%, and the lowest damage percent was in Sids 12, Masr 3 and Sohag 5 were 12.80, 14.80 and 15.60%, respectively (Table 3).

Results indicated that the highest infestation (26.40 and 25.60%) recorded in Sakha 95 with 16.67 and 18.49 % weight loss. The least percent infestation (16.40 and 12.80%) was in Sids 12 showing 9.70 and 8.15% weight loss in no-choice and free-choice methods after the third generation, respectively. Similarly, Sayed *et al*. (2006) found difference in infestation of *T. granarium* in varieties of wheat. Also, Jakhar et al. (2006) concluded that in the susceptible varieties highest grain damage and weight loss were recorded as evident in variety C-306 to infestation by *T. granarium*. Kumawat (2007) mentioned that the maximum weight loss in wheat grain ranged between 16 and 17% due to *T. granarium*. Ahmedani *et al*. (2011) revealed that significant increase in damaged grains and weight loss when infection levels increased of *T. granarium*. Mahmoud *et al*. (2011) noticed that the highest infection level of *Sitophilus granarius* (L) was in Gemmiza 7, while the lowest infection level was in Beny-sewif 4. Abd El-Razik *et al*. (2016) indicated that Giza 168 was the most tolerant variety to *T. granarium*, while Sohag 3 was the most susceptible wheat varieties. Ali et al. (2016) found variety AARI-11 was the most susceptible to *T. granarium*, while variety Punjab-11 was the least susceptible. Golizadeh and Abedi (2016) revealed that Kouhdasht and Gaskojen varieties are susceptible and resistant varieties for feeding of *T. granarium*. Hassan et al. (2017) reported that weight loss by *T. granarium* was more in wheat variety Fareed and minimum in variety Meraj. Özberk *et al*. (2017) concluded that there were response differences between wheat varieties to infestation with *T. granarium*. Ali *et al*. (2019) revealed that weight losses and damage grain in three wheat varieties viz., TD-1, Abadgar and Moomal due to *T. granarium* infestation. Hassan *et al*. (2021) observed that the maximum mean numbers of damaged grains were 80.50, and while percent weight loss was 2.89g, after 75 days infestation by *T. granarium*.

Data presented in Fig. 2 showed the percentages of ash content, fat, protein, moisture, fiber and carbohydrate of seven wheat varieties in before and after three generations infestation to *T. granarium*. In case of before infestation, the percent ash content was found higher (3.20%) in Sids12; whereas it was moderate (1.40, 1.28, 1.23 and 1.22%) in Sohag 5, Sakha 95, Masr 3 and Gemmiza 12, and while it was lower (1.11 and 1.13%) in

Giza171 and Beny-Sewif 5, respectively. In case of after infestation, the percent ash content was found lower (2.12%) in Giza171; it was moderate (2.65, 3.00, 3.24, 3.49 and 3.60%) in Sakha 95, Masr 3, Gemmiza 12, Sids12 and Sohag 5, and it was higher (3.65%) in Beny-Sewif 5, respectively (Fig. 2A). In case of before infestation, the percent fat content was found lower (1.25 and 1.32%) in Gemmiza 12 and Masr 3; while it was moderate (1.37, 1.40, 1.41 and 1.63%) in Sakha 95,Giza171, Beny-Sewif 5 and Sohag 5, and while it was higher (2.00 %) in Sids12, respectively. In case of after infestation, the percent fat content was found higher (1.26 and 1.23%) in Giza171 and Sids12; it was moderate (1.13, 1.01, 0.99 and 0.94%) in Sakha 95, Beny-Sewif 5, Sohag 5 and Masr 3, and it was lower (0.79%) in Gemmiza 12, respectively (Fig. 2B). In case of before infestation, the percent protein content was found higher (14.77 and 14.46%) in Gemmiza 12 and Sohag 5; whereas it was moderate (13.97, 13.96 and 13.04%) in Masr 3, Giza171 and Beny-Sewif 5, and while it was lower (12.71 and 12.83%) in Sids12 and Sakha 95, respectively. In case of after infestation, the percent protein content was found lower (10.05%) in Giza171; it was moderate (14.34, 14.34, 14.05, 13.21 and 12.20%) in Gemmiza 12, Sohag 5, Masr 3, Beny-Sewif 5 and Sakha 95 and it was higher (14.56%) in Sids12, respectively (Fig. 2C). In case of before infestation, the percent moisture content was found lower (7.31and 7.38 %) in Masr 3 and Sohag 5; while it was moderate (7.52, 7.70 and 7.76 %) in Giza171, Sids12 and Sakha 95, and while it was higher (7.99 and 7.85%) in Gemmiza 12 and Beny-Sewif 5, respectively. In case of after infestation, the percent moisture content was found higher (10.43, 10.40 and 10.36%) in Masr 3, Sids12 and Sakha 95; it was moderate (10.29, 10.06 and 9.56%) in Gemmiza 12, Sohag 5 and Beny-Sewif 5, and it was lower (8.66%) in Giza171, respectively (Fig. 2D). In case of before infestation, the percent fiber content was found higher (3.92 and 3.74%) in Masr 3 and Sakha 95; whereas it was moderate (3.53, 3.47 and 3.22 %) in Gemmiza 12, Sohag 5 and Beny Sewif 5, and while it was lower (2.56 and 3.02%) in Sids12 and Giza171, respectively. In case of after infestation, the percent fiber content was found lower (2.61and 2.89%) in Sids12 and Masr 3; it was moderate (3.20, 3.22, 3.27 and 3.32%) in Sohag 5 ,Sakha 95, Gemmiza 12 and Beny-Sewif 5, and it was higher (3.63%) in Giza171, respectively (Fig. 2E). In case of before infestation, the percent carbohydrate content was found lower (71.24 and 71.66%) in Gemmiza 12 and Sohag 5; while it was moderate (72.25, 72.53 and 72.99%) in Masr 3, Sids12 and Giza171, and while it was higher (73.35 and 73.07%) in Beny-Sewif 5 and Sakha 95, respectively. In case of after infestation, the percent carbohydrate content was found higher (74.28%) in Giza171; it was moderate (70.40, 69.25, 68.69 and 68.07%) in Sakha 95, Beny-Sewif 5, Masr 3 and Gemmiza 12, and it was lower (67.71 and 67.79%) in Sids12 and Sohag 5, respectively (Fig. 2F).

Chemical analysis of infested grains after three generations of showed the highest percent fat, fiber and carbohydrate content were 1.26, 3.63 and 74.28% in Giza171, and while highest percent ash and protein and moisture were 3.60, 14.56 and 10.43% in Sohag 5, Sids12 and Masr 3, respectively. Similarly, Khattak *et al*. (2000) revealed that during storage, varieties with a high percentage of protein, fiber, fat and ash protect them from insect infestation. Wakil *et al*. (2003) found that positive correlation between the content of fat and protein in grains and insect damage. Likewise, Arain *et al*. (2004) reported that the protein content and in wheat infested with the Khapra beetle was decreased compared to fumigated grain. However, the moisture content of infested grain higher than fumigated grain. Srivastava *et al*. (2005) observed that cultivars with higher protein contents showed greater susceptibility to *T. granarium*. Ash contents decreased in infested samples compared to control ones. Batta *et al*. (2007) mentioned that the lower and higher levels of carbohydrates and proteins were increase resistance of some wheat varieties against *Rhizopertha dominica* (F.), compared to that of sensitive varieties. Ahmedani *et al*. (2009) mentioned that the high damage grain due to increase protein, fat, fiber and ash contents. Ozkaya *et al*. (2009) found that increased in ash and protein contents and loss in weight to infestation by *R. dominica* and *Tribolium confusum* du val. Mebarkia *et al*. (2010) reported that low-resistant cultivars can be identified to grain pest attacks by low and high carbohydrate and protein contents. Saad *et al*. (2018) found chemical changes in wheat grains 3 months after infection with *S. oryzae* and *R. dominica*. Chatha *et al*. (2021) reported that the percent of ash and crude protein contents were measured after 90 days of *T. granarium* infestation. All the varieties sustained the low protein contents except KSK-434, Basmiti 385 and Shaheen basmati comparable to control.

CONCLUSION

The current study concluded that the wheat variety Sakha 95 was the most susceptible to *T. granarium* infestation, while the wheat variety Sids 12 was the least susceptible. Based on these results, most sensitive varieties couldn't stored for long periods. This study will also play a pivotal role in the selection of IPM-resistant varieties of the Khapra beetle.

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Table 1: Varietal susceptibility of wheat grains to the infestation with *T. granarium* in no- and free-choice methods, after the first generation.

Wheat variety	Mean ± SE			
	No-choice method		Free-choice method	
	Weight loss (%)	Grain damage (%)	Weight loss (%)	Grain damage (%)
Giza 171	4.60±0.54^{ab}	9.20±1.02^{a}	3.83±0.60^{b}	5.60±0.75^{ab}
Beny-Sewif 5	3.29±0.35^{bc}	5.20±10.20^{cd}	2.42±0.36^{cd}	4.80±1.02^{b}
Gemmiza 12	3.96±0.75^{ab}	7.20±1.36^{bc}	2.75±0.36^{bc}	7.20±1.02^{ab}
Masr 3	5.21±0.49^{a}	6.40±0.75B^{cd}	5.15±0.39^{a}	4.40±0.75^{b}
Sakha 95	5.29±0.18^{a}	8.80±1.02^{ab}	6.23±0.20^{a}	8.00±1.41^{a}
Sohag 5	3.41±0.21^{bc}	6.00±0.63^{cd}	1.80±0.38^{cd}	6.00±1.41^{ab}
Sids 12	2.28±0.49^{c}	4.40±0.40^{d}	1.50±0.39^{d}	4.80±1.02^{b}
F value	5.50	3.65	19.60	1.53

Means, in the same column, followed by the same letter are not significantly different at 0.05 level of probability (df = 6)

Table 2: Varietal susceptibility of wheat grains to the infestation with *T. granarium* in no- and free-choice methods, after the second generation.

Wheat variety	Mean ± SE			
	No-choice method		Free-choice method	
	Weight loss (%)	Grain damage (%)	Weight loss (%)	Grain damage (%)
Giza 171	8.14±0.46^{bc}	14.80±1.02^{ab}	7.98±0.25^{c}	12.80±1.36^{bc}
Beny-Sewif 5	7.34±0.16^{c}	12.80±1.62^{b}	5.94±0.45^{de}	11.20±0.80^{bcd}
Gemmiza 12	8.81±0.36^{b}	14.40±1.33^{ab}	8.36±0.31^{c}	13.20±1.86^{b}
Masr 3	8.25±0.63^{bc}	11.60±0.75^{bc}	11.64±0.82^{b}	8.80±1.20^{d}
Sakha 95	10.93±0.42^{a}	16.80±1.02^{a}	13.50±0.45^{a}	18.40±1.72^{a}
Sohag 5	7.24±0.43^{c}	12.40±1.16^{bc}	7.22±0.61^{cd}	11.20±1.36B^{cd}
Sids 12	5.70±0.53^{d}	9.20±1.50^{c}	4.60±0.52^{e}	9.20±1.02^{cd}
F value	12.80	3.98	36.10	5.51

Means, in the same column, followed by the same letter are not significantly different at 0.05 level of probability (df = 6).

Table 3: Varietal susceptibility of wheat grains to the infestation with *T. granarium* in no- and free - choice methods, after the third generation.

Wheat variety	Mean ± SE			
	No-choice method		Free-choice method	
	Weight loss (%)	Grain damage (%)	Weight loss (%)	Grain damage (%)
Giza 171	13.06±0.46^{b}	21.20±1.62^{b}	13.02±0.60^{c}	16.40±1.94^{bc}
Beny-Sewif 5	12.11±0.27^{b}	18.00±1.41^{bc}	10.70±0.60^{d}	16.00±1.41^{bc}
Gemmiza 12	12.82±0.34^{b}	20.80±2.06^{b}	13.02±0.48^{c}	19.20±1.74^{b}
Masr 3	12.54±0.34^{b}	18.00±1.41^{bc}	15.75±0.67^{b}	14.80±1.36^{c}
Sakha 95	16.67±0.53^{a}	26.40±1.16^{a}	18.49±0.62^{a}	25.60±1.04^{a}
Sohag 5	11.79±0.68^{b}	18.00±1.41^{bc}	10.42±0.74^{d}	15.60±0.75^{bc}
Sids 12	9.70±0.67^{c}	16.40±1.33^{c}	8.15±0.44^{e}	12.80±1.02^{c}
F value	14.30	4.94	33.50	8.45

Means, in the same column, followed by the same letter are not significantly different at 0.05 level of probability (df = 6).

Figure 1: (A) no-choice method and (B) free-choice method.

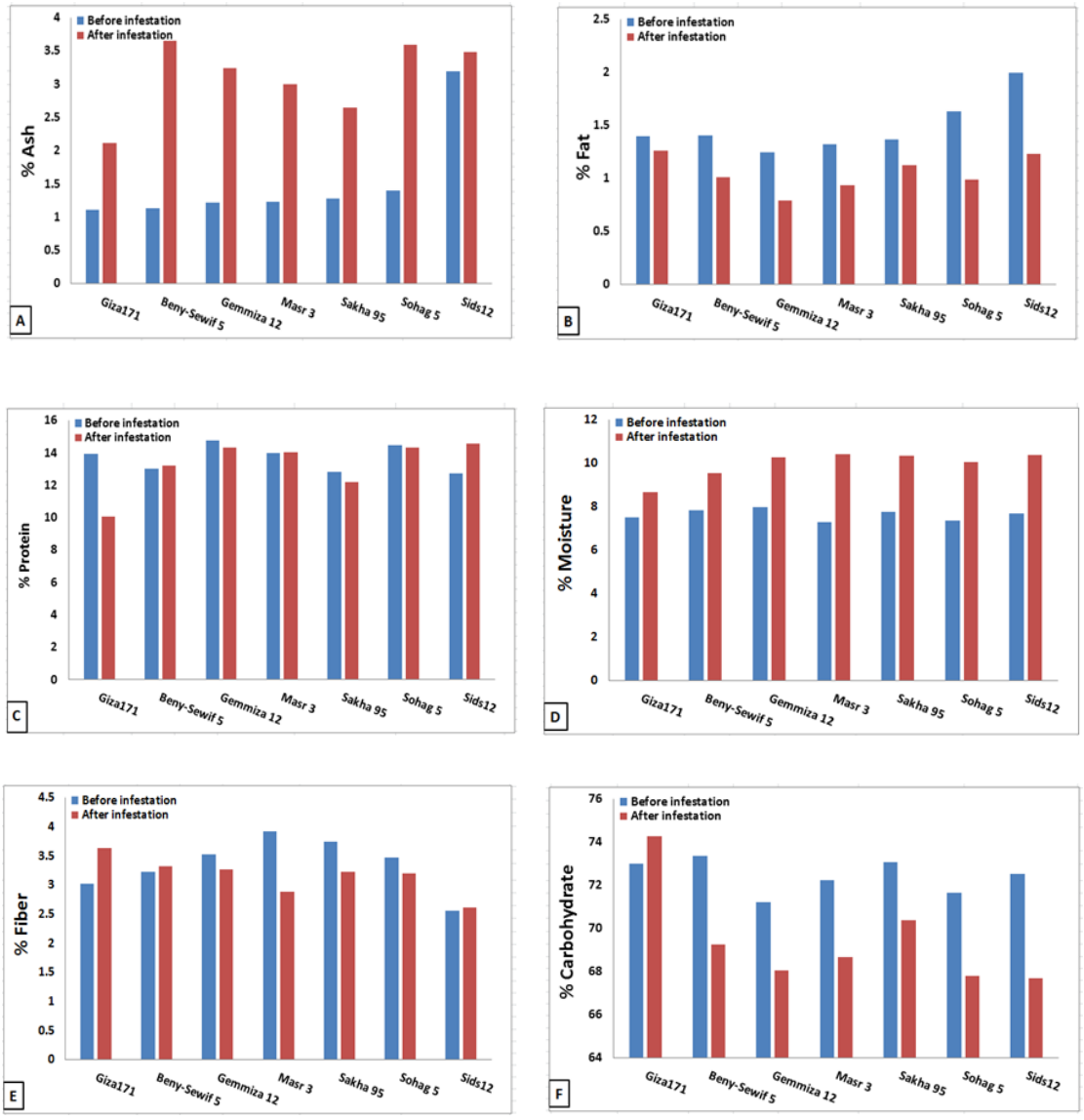

Figure 2: Effect of infestation on the quality of seven wheat varieties after the three generations; (A) ash; (B) fat; (C) protein; (D) moisture; (E) fiber; and (F) carbohydrate.

حساسية أصناف معينة من حبوب القمح للإصابة بخنفساء الخابرا(Everts) *Trogoderma granarium* (Coleoptera: Dermestidae)

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الملخص العربى

يعد القمح من أهم المحاصيل المزروعة في معظم أنحاء العالم. كان الهدف من هذه الدراسة هو تقييم حساسية سبعة أصناف من القمح بطرق عدم الاختيار أو الاختيار الحر للإصابة بخنفساء الخابرا *Trogoderma granarium* (Everts) (Coleoptera: Dermestidae) تحت ظروف مختبرية تبلغ 30 ± 2 درجة مئوية، 65 ± 5% رطوبة نسبية. أشارت النتائج التي تم الحصول عليها إلى وجود فروق معنوية عند مستوى ($P < 0.05$) بين متوسط نسبة الفقد فى الوزن أو الإصابة، وكان سخا 95 هو الأكثر حساسية وعكس من ذلك، كان سدس 12 هو الأقل حساسية. بعد ثلاثة أجيال من الإصابة، سجلت أعلى نسبة إصابة (26.40 و25.60%) في سخا 95 مع فقدان وزن 16.67 و 18.49%، بينما أقل نسبة إصابة (16.40 و 12.80%) كانت في سدس 12 مع فقدان وزن 9.70 و 8.15% في طريقتي عدم الاختيار والاختيار الحر، على التوالي. كما أظهر التحليل الكيميائي للحبوب المصابة بعد ثلاثة أجيال انخفاض نسبة الدهون والكربوهيدرات (1.23 و 67.71%)، في حين وجد زيادة في نسبة الرماد والبروتين والرطوبة والألياف (3.49 و14.56 و10.40 و2.61%) في سدس 12، على التوالى. صنيفت هذه الأصناف على أنها الأكثر حساسية وتحملاً، أما الأصناف المتبقية فكانت متوسطة الحساسية لفقدان الوزن واستجابتها للإصابة بالآفة. لذلك يمكن استخدام الأصناف المقاومة ضد *T. granarium*.

الكلمات الاسترشادية: خنفساء الخابرا، القمح، فقدان الوزن، الإصابة، المكونات الكيميائية.