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SUSCEPTIBILITY OF SOME EGYPTIAN WHEAT VARIETIES TO THE INFESTATION WITH THE GRANARY WEEVIL, *Sitophilus granarius* (L). (COLEOPTERA: CURCULIONIDAE).

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ABSTRACT

The present investigation was carried out to evaluate the relative susceptibility of ten Egyptian wheat varieties to the infestation with the granary weevil, *Sitophilus granarius* (L). The loss in grain weight and the percentage of infested grains were determined in choice and force infestation tests. The obtained results, either in the choice or non-choice infestation tests, indicated that non of the tested varieties were completely resistant against the attack by the insect pest; but their susceptibility to the infestation varied considerably. Variety Gemmiza 7 was the most susceptible with an average infestation level of 18.33% and a maximum weight loss of 6.41 g/100 g grains. Oppositely, variety Beny-sewif 4 was the least susceptible with an infestation level of 3.00% and minimum weight loss of 1.64 g/100 gm. A significant positive correlation was found between the infestation of grains and weight loss (r= 0.86-0. 95**).

Keywords: Stored grain pests, wheat varieties, *Sitophilus granarius*, susceptibility.

INTRODUCTION

Storage insect pests cause considerable and variable losses in many developing countries. The granary weevil, *Sitophilus granarius* (L.) is considered among the most important pests in Upper Egypt. It attacks mature grains in the storage which are the major source of dietary protein for humans. The mean annual production in the world (2001-2005) of all cereals exceeded 2100 million tones (Shewry, 2007). Cereal grain losses during storage can reach 50% of total harvest in some countries, a worldwide loss quality of grains is caused by insects (Fornal *et al.*, 2007), as they have become cosmopolitan since humans began harvesting and storing (Padin *et al.*, 2002). Many variables affect grain storability (Maier *et al.*, 1997), noted that, the primary post-harvest pests of concern are insects and fungi, both of which develop as a function of temperature, moisture content and time. Stored grains are an ideal food source for stored product insect pests, providing the essential elements required for continued growth and development. The levels of carbohydrates, proteins, lipids and required vitamins varies with the species concerned (Mason *et al.*, 1997).

Managing insect populations that infest stored commodities is a greater challenge today than previously because pesticide usage becomes more restricted. The search for environmentally safe alternatives is the focus of research in many laboratories around the world (Silhacek and Murphy, 2006). Therefore, we are seeking new approaches based upon the insect's

behavior. Sarin and Sharma (1983) have revealed that all the stored grain pests exhibit the phenomenon of preference / non-preference for the grains of different varieties. Subsequently, different wheat varieties have been tested to either susceptibility or weight loss caused by *S. granarius* e.g. Rodrigues *et al.* (1990); Bekon and Fleurat- Lessard (1992) and Mebarkia *et al.* (2010). Keeping in view the importance of pesticide problems, the aim of this work is to test various varieties of Egyptian wheat for their susceptibility to the insect pest *S. granarius.*

MATERIALS AND METHODS

The present investigation was carried out to study the relative Susceptibility of some Egyptian wheat varieties to the granary weevil, *Sitophilus granarius.* Wheat grains were firstly sieved to remove stones, dust, insects ... etc, and then frozen for 7 days to eliminate mites and insects. The grain was tempered 2 weeks at 27±2°C and 70±5% R.H. (Russell and Cogburn, 1977). The tested wheat varieties were: (Beny-sewif 4, Gemmiza 7, Gemmiza 9, Giza 168, Sakha 94, Sakha 95, Shandwil 1, Sids 1, Sohag 2, Sohag 3). These varieties were obtained from Egyptian National research Center. Two tests were done, the first was a choice infestation test and the second one was a non- choice or force infestation test.

The first experiment (choice infestation test):-

To study the susceptibility of the different wheat varieties to the granary weevil (*S. granarius*), the standard weight of the samples was 100 gram. Three samples of each variety were counted and weighted on an analytical balance accurate to 0.01 g. and each sample was kept in plastic container (8 cm. height and 4.5 cm. diameter). These containers (3 samples x 10 varieties = 30 containers) were placed in a wooden box (65 x 65 x 8 cm.). Batches of about 300 couple aduit granary weevils were released into the box. All samples were kept under laboratory conditions during the period from November to January (temperature 27 ± 2 ° C and 70 ± 5% relative humidity), 2010/2011 season. Samples were examined at the end of each generation. The experiment has been continued for two generations. In each generation, after the insects had been removed, the grains in each container were checked and reweighed to determine the infestation or damage grain and weight loss.

Percent of damage grain was calculated using the following formula:

Damage grains (%) = $\frac{\text{No. of damage grain}}{\text{Total no. grain}}$ X 100; and weight loss was calculated according to the method of Mebarkia *et al.* (2010): **WL = Wh – Wd;** where

WL = Weight loss.
Wh = Weight healthy grains before infestation.
Wd = Weight damaged grains after infestation.

The second experiment (non- choice infestation test):-

Adults of *S. granarius* were collected from a mass rearing under experimental conditions of temperature 27 ± 2°C and 70 ± 5% relative humidity. In each box, 20 Adults of *S. granarius* were placed on 100 g grains and each sample was kept in plastic container (8 cm. height and 4.5 cm. diameter) and allowed to lay eggs for 7 days and then removed. The jars were covered with muslin held in place with rubber bands and kept at 27 ± 2°C and 70 ± 5% R.H. until the new adults started to emerge. The experiment was continued under laboratory conditions until the emergence of adult granary weevil stopped. This experiment was also continued for two generations. Percentage of infested grains and weight loss were calculated.

RESULTS AND DISCUSSION

Choice-infestation test:

Data in Table 1 show the percentages of the damaged grains and the progressive loss in weight of each wheat variety caused by the granary weevil *S. granarius* after the first generation. All varieties had some degree of infestation by the pest. On the base of percentage of damaged grains, the wheat varieties Beny-sewif 4, Sakha 94 and Sakha 95 were the least susceptible, whereas Sohag 3, Gemmiza 9 and , Gemmiza 7 were the highly susceptible varieties.

On the other hand, when these varieties were arranged according to the weight loss, it is clear that the varieties Beny-sewif 4, Sakha 94 and Sakha 95 were the least damaged, whereas, Gemmiza 7 was the highly damaged variety. There is a significant positive correlation existed between the percentage of damaged grains and weight loss (r= 0.93**). After two generations, infestation percentage and loss values seemed to be greater than those recorded after the second generation (Table2). A significant positive correlation was also existed between the number of damaged grains and weight loss (r= 0.95**).

Table (1): Susceptibility of some wheat varieties to the infestation with *S. granarius* – choice- infestation test, after one generation.

Wheat varies	Infestation ± SE (%)	Loss ± SE (g/100g)
Beny-sewif 4	1.00 ± 0.47 e	0.90 ± 0.06 h
Gemmiza 7	13.00 ± 0.47 a	4.23 ± 0.04 a
Gemmiza 9	10.66 ± 0.72 b	3.94 ± 0.04 b
Giza 168	7.33 ± 0.54 c	2.25 ± 0.07 de
Sakha 94	1.66 ± 0.27 e	1.23 ± 0.09 g
Sakha 95	3.00 ± 0.47 de	1.33 ± 0.04 fg
Shandwil1	8.00 ± 0.94 c	3.64 ± 0.04 c
Sids 1	5.00 ± 0.47 d	2.03 ± 0.07 e
Sohag 2	4.33 ± 0.72 d	1.48± 0.07 f
Sohag3	9.33 ± 0.72 bc	2.41± 0.03 d

Means, in the same column, followed by the same letter are not significantly different.

Table(2): Susceptibility of some wheat varieties to the infestation with *S. granarius* – choice- infestation test, after two generations.

Wheat varies	Infestation ± SE (%)	Loss ± SE (g/100g)
Beny-sewif 4	3.00 ± 0.81 g	1.64 ± 0.05 h
Gemmiza 7	18.33 ± 0.72 a	6.41 ± 0.06 a
Gemmiza 9	15.66 ±0.27 b	5.24 ± 0.05 b
Giza 168	10.33 ±0.98 d	3.14 ± 0.04 de
Sakha 94	4.00 ± 0.0 fg	2.13 ± 0.04 g
Sakha 95	6.33 ± 0.27 ef	2.26 ± 0.06 g
Shandwil1	13.66 ± 0.72 bc	3.99 ± 0.06 c
Sids 1	9.66 ±1.18 d	3.02 ± 0.05 e
Sohag 2	7.00 ± 0.47 e	2.68 ± 0.06 f
Sohag3	13.00 ± 0.81 c	3.29 ± 0.06 d

Means, in the same column, followed by the same letter are not significantly different.

According to both parameters, Beny-sewif 4 was the least susceptible and damaged variety (with an infestation percentage of 3.00 % and a loss of 1.64 g / 100 g.), whereas Gemmiza 7 was the highly susceptible one (with an infestation level of 18.33% and a loss of 1.64 g / 100 g).

Non- choice (force) infestation test:

Data in Table 3 show the relative susceptibility of the 10 chosen wheat varieties to infestation with the granary weevil after the first generation. It is clear that, the larvae completed their development inside all tested wheat varieties. In respect to the percentages of infestation, there were clear significant differences between some varieties. According to the weight loss, the adult had not caused loss greater than 2.19 g/100g grains. Beny-sewif 4 appeared to be the least damaged variety with an average weight loss 0.54 g/100 g. and Gemmiza 7 was the most damaged variety with an average weight loss of 2.19 g /100 g. There was a significant positive correlation between the number of damaged grains and weight loss (r = 0.86**).

After two generations, the granary weevil was damaging some varieties more severely than others. As shown in Table 4 Beny-sewif 4 and Sakha 94 were the least susceptible varieties to the pest with an infestation level of 0.33% and minimum weight loss 0.97g/100g. On the other hand, Gemmiza 7 was the most susceptible one with a maximum infestation level of 4.33% and weight loss of about 2.76g/100g. A significant positive correlation was also observed between the number of damaged grains and weight loss (r= 0.95 **).

The obtained results, either from the choice or in non-choice infestation tests, indicate that non of the tested varieties were completely resistant to attack by the granary weevil but their susceptibility to the infestation varied considerably. These results are in agreement with those of (Ali *et al.*, 2001); it could be generally concluded that Gemmiza 7 was the most susceptible wheat variety to the granary weevil and if stored in an area where this pest is common, the variety can be heavily damaged by the pest. Oppositely, Beny-sewif 4 was the least susceptible variety. The rest of wheat varieties as indicated in Tables 2 and/or 4 appeared to be moderately susceptible wheat varieties. The differential damage reported in this study is directly related to infestability among wheat varieties that genetically diverse. Thus the value of

developing wheat varieties that are resistant to stored-product pests is doubly confirmed.

Table(3): Susceptibility of some wheat varieties to the infestation with *S. granarius* – non-choice infestation test, after one generation.

Wheat varies	Infestation ± SE (%)	Loss ± SE (g/100g)
Beny-sewif 4	0.00 ± 0.00 d	0.54 ± 0.03 f
Gemmiza 7	2.66 ± 0.54 a	2.19 ± 0.05 a
Gemmiza 9	2.00 ± 0.47 ab	2.15 ± 0.007 a
Giza 168	1.00 ± 0.66 bcd	1.06 ± 0.04 c
Sakha 94	0.66 ± 0.27 bcd	0.56 ± 0.03 f
Sakha 95	0.33 ± 0.30 cd	0.74 ± 0.02 e
Shandwil1	2.00 ± 0.47 ab	1.24 ± 0.009 b
Sids 1	1.66 ±0.27 abc	0.92 ± 0.01 d
Sohag 2	0.66 ± 0.16 bcd	0.81 ± 0.06 de
Sohag3	1.66 ± 0.54 abc	1.30 ± 0.03 b

Means, in the same column, followed by the same letter are not significantly different.

Table(4): Susceptibility of some wheat varieties to the infestation with *S. granarius* – non-choice infestation test, after two generations.

Wheat varies	Infestation ± SE (%)	Loss ± SE (g/100g)
Beny-sewif 4	0.33 ± 0.27 f	0.97 ± 0.05 f
Gemmiza 7	4.33 ± 0.27 a	2.76 ± 0.03 a
Gemmiza 9	3.33 ± 0.27 ab	2.43 ± 0.03 b
Giza 168	2.00 ± 0.47 cde	1.54 ± 0.03 d
Sakha 94	0.66 ± 0.27 f	0.97 ± 0.04 f
Sakha 95	1.00 ± 0.47 ef	1.03 ± 0.04 f
Shandwil1	3.33 ± 0.54 ab	1.78 ± 0.04 c
Sids 1	2.33 ± 0.30 bcd	1.46 ± 0.02 d
Sohag 2	1.33 ± 0.27 def	1.20 ± 0.03 e
Sohag3	2.66 ± 0.37 bc	1.82 ± 0.04 c

Means, in the same column, followed by the same letter are not significantly different.

To endorse the previous obtained results; the proteins, carbohydrates and moisture content were assessed in the ten tested wheat varieties as shown in Table 5. Statistical analysis shows there is a significant difference between all tested varieties in the triple checked characters. Beny-sewif 4 has the least content of proteins (12.66 %), moisture (10.03 %) and the most content of carbohydrates (73.42 %) where these results came as it was expected as the variety was the most resistant one. Consequently, the proteins, moisture content and carbohydrates of Gemmiza 7 were 16.54, 11.82 and 69.29 %, respectively which makes it the most susceptible variety.

The relationship between proteins, moisture content, carbohydrates and infestation and loss percentages were statistically analyzed in both tests (choice and non-choice tests) and for both generations; the correlation values ranged from (0.81^{**} - 0.94^{**}), (0.87^{**} - 0.94^{**}) and (-0.83^{**} -0.95^{**}), respectively.

As indicated above, the values and trends of correlation coefficients give more supports to the obtained results in this study.

Table (5): Mean Percentages of Proteins, Carbohydrates and Moisture content of wheat variety-grains.

Wheat Variety	Protein ± SE (%)	Carbohydrate ± SE (%)	Moisture content ± SE (%)
Beny-sewif 4	12.66 ± 0.054 i	73.43 ± 0 .063 a	10.03 ± 0.021 h
Gemmiza 7	16.54 ± 0.035 a	69.29 ± 0.030 j	11.82 ± 0.023 b
Gemmiza 9	16.48 ± 0.063 ab	69.53 ± 0.047 i	12.00 ± 0.023 a
Giza 168	15.91 ± 0.021 d	70.15 ± 0.028 f	10.69 ± 0.032 d
Sakha 94	13.56 ± 0.029 h	72.54 ± 0.033 b	10.24 ± 0.017fg
Sakha 95	14.24 ± 0.033 g	71.61 ± 0.066 c	10.18 ± 0.009 g
Shandwil 1	16.37± 0.057 b	69.72 ± 0.042 h	11.37 ± 0.063c
Sids 1	15.35 ± 0.019 e	70.62 ± 0.033 e	10.51 ± 0.007 e
Sohag 2	14.67 ± 0.037 f	71.25 ± 0.035 d	10.33 ± 0.014 f
Sohag 3	16.20 ± 0.012 c	69.90 ± 0.016 g	11.75 ± 0.021 b

Means, in the same column, followed by the same letter are not significantly different.

Our outcome to assess the susceptibility of the ten wheat varieties is that all stored grains exhibit the phenomenon of preference / non-preference for the grains of different varieties. This phenomenon is due in the structure and composition of wheat such as, starchs, carbohydrates, enzymes (Evers *et al.*, 2001); proteins (Gupta *et al.*, 2000). In addition, Hardness of the grains was found to be the probable factor of resistance of some cereal varieties to the stored product insects (Singh *et al.*, 1968; Karan-Singh and Girish, 1973; Nwanze and Harber, 1975; Williams and Mills, 1980 and Shazali, 1987). It was also found that nutritional and chemical contents play more important role encouraging the oviposition and development rate of insects in different varieties of cereals beside the physical nature of grains. Cogburn (1974) attributed resistance in "Dawn" rice variety to antibiosis, due to composition of the bran coat of that variety which caused high mortality in the infesting insects. Khokhar and Gupta (1974) added that high protein content and high grain moisture were linked to susceptibility to the stored-product insects. Batta *et al.* (2007), suggested that resistance of some varieties to *Rhyzopertha dominica* F. can be attributed to the low protein and high carbohydrates compared to susceptible varieties. Also, Matthew *et al.* (1990) showed that it is attributed to the genetic factors genetic between different varieties of wheat.

Recently, Giacinto *et al.* (2008) showed that the antennae of adults of *S. granarius*, detecting a wide variety of compounds such as aliphatic alcohols, aldehydes, ketones and aromas mixed with the smell of various cereal grains. This character can play a very important role in detecting and choosing suitable variety for the insect.

From the abovementioned, we can deduce that the differences in biochemical constituents and hardness among the tested varieties of wheat that will allow or prevent this pest and it may act as repellents and/or biochemical inhibitors. These results imply that stored grain managers should be aware of potential differences in susceptibility, attributable to wheat varieties, to *S. granarius* infestation to be easy for them to choose the right wheat variety for use.

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حساسيه بعض أصناف القمح المصرى للاصابه بسوسه المخزن

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أجريت الدراسه الحاليه لتقييم الحساسية النسبية لعشرة أصناف من القمح المصرى للإصابة بسوسه المخزن . حيث تم حساب كلا من الفقد الحادث فى وزن الحبوب وكذا النسبة المئوية للحبوب المصابة فى اختبارين أحدهما إختيارى والآخر غير إختيارى للحشرة تحت الدراسة. أوضحت النتائج المتحصل عليها بأنه لا يوجد صنف من أصناف القمح المختبرة مقاوم ضد حشرة سوسة المخزن ، ولكن جميع الأصناف إختلفت بدرجة معنوية من حيث حساسية إصابتها لسوسة المخزن . كما أوضحت الدراسة أيضا أن الصنف جميزة ٧ كان اكثر الأصناف حساسية للإصابة بهذه الآفه حيث كان متوسط الإصابة ١٨.٣٣% بينما كان الفقد الحادث فى وزن الحبوب ٦.٤١جرام /١٠٠جرام حبوب. وعلى النقيض من ذلك وجد ان الصنف بنى سويف ٤ كان من اقل الأصناف المختبرة حساسية للإصابة حيث كانت درجة إصابته ٣% وكذا أقل فقد فى وزن الحبوب ١.٦٤ جرام /١٠٠جرام من الحبوب. أوضح التحليل الإحصائى ان هناك علاقات تلازم موجبة تتراوح ما بين ٨٦الى٩٥ % بين كلا من درجات الإصابة والفقد الحادث فى الحبوب.

قام بتحكيم البحث

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