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SCREENING SUSCEPTIBILITY/RESISTANCE OF SOME WHEAT GRAIN VARIETIES TO *RHIZOPERTHA DOMINICA* (F.) AND *TROGODERMA GRANARIUM* (EVERTS) INFESTATION

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Abstract

The present work aims to study the susceptibility of thirteen Egyptian wheat grain varieties to infestation by the lesser grain borer, *Rhizopertha dominica* F. and khapra beetle, *Trogoderma granarium* Everts. Basis of evaluation were growth index, percent weight loss, damage and germination (%). The obtained results showed significant differences among the tested varieties. In respect to *R.dominica* eight varieties: Sakha 69, BeniSwaif 1, Sohag 3, Gemmiza 7, Giza 164, Soahag 2, Sids 1 and Beni Swaif 3 were found to be the least susceptible based on growth index. The other varieties were found to be the most susceptible (Giza167, Sohag Durum1, Giza 163, Giza 168, Sakha 93). Germination (%) and weight loss (%) were 59% and 31.1% in the least susceptible variety (Sakha 69) respectively, while reached 6.0% and 42% in the most susceptible variety (Sakha 93). In case of *T.granarium*, eleven varieties were the most susceptible (Gemmiza 7, Sohag 3, Sohag Durum1, Beni Swaif 3, Giza 168, Sakha 69, Beni Swaif 1, Sohag 2, Sids 1, Giza 164, Giza 167) varieties based on values of the susceptibility index. The other two varieties (Sakha 93 and Giza 163) were the least susceptible or moderately resistant and differ significantly. The study showed that none of the 13 varieties was completely immune to both pests since all the varieties reacted significantly with insect growth. Further studies are still needed to explain factors and reasons of resistance or susceptibility. Other complementary methods of control for safe grain storage are also needed.

INTRODUCTION

Stored grains are subjected to losses of variable and complex factors, and the accurate determination of their magnitude is of well-known importance (Koura and EL-Halafawy, 1972). Among the stored grain pests, insects are considered to be one of the most serious threats and 50% of the annual losses to cereals could be attributable to insects (FAO, 1948). The lesser grain borer, *Rhizopertha dominica* F. belongs to a family of beetles named bostrichidae. The adult is one of the smallest beetles that represent a major pest of stored cereals in tropical and subtropical regions of the world

(Tiwari, 1994) and spread through commerce to all parts of the world. Both beetles and larvae cause serious damage in warm climates by attacking a great variety of grains making the kernels thoroughly riddled and devoured.

The khapra beetle, *Trogodema granarium* Everts is primarily a major pest of cereal grains and their products of stores in tropical and subtropical regions of Asia and Africa (Atwal, 1976, Salunkhe *et al.* 1985 and Viljoen, 1990). Larvae typically attack the embryo point or weak place in the pericarb or seed, and also will attack other parts during heavy infestation (Pruthi and Singh 1950). *Trogoderma granarium* Everts is among the most serious pests and of widest occurrence because it shows signs of resistance to some common chemicals such as phosphine and malathion (Borah and Chahal, 1979), methyl bromide is currently the only treatment method and provides good control in a variety of commodities. However, methyl bromide is an ozone depleting substance and its production and importation into the USA is prohibited begining January 2001 in accordance with the Clean Air ACT. This demands the search for other control methods such as plant seed resistance against infestation and damage.

Resistance of crop varieties to the important insect pests during storage has been studied by number of workers (Koura and EL-Halafawy 1972a, Koura and EL- Halafawy 1972b, Koura *et al.* 1972c and Khattack *et al.* 1995). But, the definite determination of the relative susceptibility of the recent wheat grain varieties, grown these days to important insect storage pests is not available.

So, the aim of the present work is undertaking to screen the relative susceptibility of 13 important and promising new wheat varieties to *R. dominica* and *T. granarium* infestation, under a controlled laboratory conditions and to estimate the resultant losses in weight and damage (%) under a non-choice condition.

MATERIALS AND METHODS

1. Stock culture of the test insects: A culture of the lesser grain borer, *R. dominica* F. (Coleoptera, Bostrichidae) and *Trogoderma granaium* (Coleoptera, Dermestidae) were maintained in the Stored Grain Res. Dept. Lab., Plant Protection Res. Institute. *R.dominica* was reared on mixed broken kernels of wheat which represents the op-

timum environment. Their adults and larvae prefer a hard surface to oviposit and breed (Kapoor Santosh, 1964) at 28 ± 1°C and 60±5 % RH. *Trogoderma granaium* was maintained on a mixture of the different wheat varieties used in the present investigation. Newly laid eggs of *T.granarium* was obtained by releasing a group of beetles in Petri dishes (7.5 X 2.5 cm) containing broken wheat grains for a definite time and removed. The grains were resieved again to separate the eggs and to start the cultures. The latter could also started by releasing adult pairs in glass jars containing the diet at 32 ± 1°C and 60 ± 5 % RH

2. Source of wheat varieties: Thirteen tested wheat grains varieties were obtained from the Wheat breeding Section of the Field Crop Research Institute, ARC, MOA. All the varieties were washed with tape water and left to dry under lab. conditions. Samples required for testing were conditioned within an incubator for two weeks at 28 ± 1°C and 60±5 % RH to equilibrate their moisture content.

3. Method of testing susceptibility

A. In case of *R. dominica*: Ten replicates, each of one hundred seeds, were taken from each variety and weighed. This weighed number of grains were put in small glass tubes, five replicates were infested with about 25 unsexed adults that are newly emerged and of one week old. The adult insects were left to oviposit for two weeks, then removed. The tubes were re-incubated again inside the incubator, covered with muslin cloth and held by rubber bands. After four weeks, the tubes were inspected daily for the adult emergence to record date of the first adult emergence and counting the number of emerged adults. Determination of susceptibility/ resistance of the tested varieties was determined and calculated by assessing the suitability of each diet (variety) according to the method described by Howe (1971) and known as Howe growth index or environmental index as follows:

$$\text{Growth Index} = \frac{\text{Log N}}{\text{T}} \; 100$$

Where: N = number of the emerged adults and T = mean developmental period.

Also, after ceasing the adult emergence, the seeds were re-weighed again, to calculate the weight loss incurred. The percent damage was also determined by recording number of infested grains in a randomly selected sample of 50 grains/variety/

replicate. Those grains showing any signs of feeding were also considered as damaged. The seed replicates of each variety were mixed together and viability of a random selected seed sample / variety was conducted by germination tests, in two replicates of 50 grains each, placed in two 9-cm diameter Petri dishes containing water-moistened cotton pad. The number of germinated grains was recorded after one week to calculate percentage germination. The other replicates left as control.

B. In case of *T. granarium*: Ten replicates of 10 g each, were taken from each variety. Five replicates were infested with the insect, while the other left as control. The infestation of each replicate was done by releasing twenty newly hatched larvae of 0-1 day old in each tube, secured by rubber bands and incubated until adult emergence. Emergence date, number of emerged adults, percentage of damaged kernels in each replication as well as the weight loss (%) was calculated as mentioned before. The susceptibility index was calculated by the method developed by Dobie (1974). The germination (%) was not conducted at the end of the test because all grains were seriously damaged.

4. The statistical analysis: The data were statistically analyzed by analysis of variance test and means were separated by Duncan multiple range test, using a computer program of SAS Institute methods as well as the standard error of the means was calculated.

RESULTS AND DISCUSSION

The obtained results pertaining the susceptibility of the Egyptian wheat grain varieties to *R.dominica* infestation are shown in Table 1. The data showed significant differences among the varieties in all the determined characters. Eight varieties (Sakha 69, BeniSwaif 1, Sohag 3, Gemmiza 7, Giza 164, Sohag 2, Sids 1 and Beni Swaif 3) were the least susceptible varieties, since it produced a lower number of progeny and a longer developmental period, resulting smaller values of the Howe growth index. These were considered to have some factors of resistance that may retard the insect development. On the other hand, Sakha 93 was the most susceptible since it has higher value of growth index (4.93) and with higher damage (72.8%) and weight loss (42.0%). The last four varieties have intermediate values of the growth index. The percentage of

the germination which basically depends on the amount of the damage incurred was the highest in Sakha 69 (59%) which was previously the least susceptible variety, while it was of a lowest value in Saka 93 (6%) and Giza 163 (11%). These two varieties were considered the most susceptible.

The study also proved that all the tested varieties were infested with this dangerous insect borer, but with variable degrees and no variety was completely immune and resistant. This differences could be due to a gradation in the nutritive values of variety, with the most susceptible is the most nutritive while the less susceptible varieties are the less nutritive (Kapoor Santosh 1964).

The obtained results of *T. granarium* are shown in Table 2. All the tested varieties were susceptible to *Trogoderma granarium* infestation. Based on values of the susceptibility index(SI), the varieties could be subdivided into three main groups: the first included eleven susceptible varieties (Gemmiza 7, Sohag 3, Sohag Durum 1, Beni Swaif 3, Giza 168, Sakha 69, Beni Swaif 1, Sohag 2, Sids 1, Giza 164 and Giza 167). The second group was the least susceptible varieties (Saka 93 followed by Giza 163). The longest duration for Giza 163 was 45.8 days and for Sakha 93 was 42.0 days) and both were considered to be moderately resistant. While, the shortest period was for Sohag Durum 1 (38.3 days) and considered the most susceptible. In respect to weight loss, Sohag3 suffered the greatest amount (4.33%) followed by Giza 167 (3.88abc).

The present study showed that a definite insect preference for certain varieties, in respect of studied parameters, depending on the type of food and its nutritional composition. In other words, some varieties are more suitable for insect growth than others. These findings agree with those of Ismail *et al.*1988 , Atwal and Dhaliwal 1971). In conclusion, the present wheat varieties could arrange ascedingly as follows (based on values of the growth index) to the *Rhizopertha dominica* infestation as: Sakha 69 > BeniSwaif 1 > Sohag 3 > Gemmiza 7 > Giza 164 > Sohag 2 > Sids1 > BeniSwaif 3 > Giza 167 > SohagDurum 1 > Giza 163 > Giza 168 > Sakha 93. And for *Trogoderma granarium* as follows: Gemmiza 7 > Sohag 3 > Sohag Durum 1 > Beni Swaif 3 > Giza 168 > Sakha 69 > Beni Swaif 1 > Sohag 2 > Sids 1 > Giza 164 > Giza 167 > Sakha 93 > Giza 163.

Table 1. Growth and damage of *Rhizopertha dominica* (F.) on grains of thirteen wheat varieties at 28±1°C and 60±5%RH.

Variety	Progeny number	MDP (days)	Growth Index	% weight loss	% Grain damage	% Germination
Sakha 69	46.2±4.6d	45.6+0.5abc	3.63+0.1e	31.1+3.1bc	47.6+4.6def	30 bcd
Beni Swaif 1	47.4±1.9d	46+0.3abc	3.64+0.05e	17.8+1.3f	32.4+7.3f	42b
Sohag 3	63.8±0.5cd	49+0.3a	3.67+0.1e	22.3+0.9def	52.2+3.2cdef	35bc
Gemmiza 7	60.6±7.6cd	46.8+0.7ab	3.78+0.12e	23.9+3.4cdef	51.4+5.8def	13efg
Giza 164	57.8±7.8	45.6+0.5abc	3.86+0.1de	23.1+1.2cdef	59.8+6.2bcde	23cdef
Sohag 2	62.6±7.2cd	46.2+0.4abc	3.86+0.13de	20.6+1.78ef	48.8+5.9def	59a
Sids 1	52.8±8.1cd	43.6+0.7bcd	3.89+0.2de	21.9+0.9def	45.2+7.2ef	26 cde
Beni Swaif 3	93.6±7.1a	48+0.7a	4.1+0.06cde	32.6+1.3b	70.8+4.1ab	14efg
Giza 167	69.8±3.8bc	43.2+2.1bcd	4.32+0.3bcd	27.7+1.2bcde	61.2+3.2bcd	17def
Sohag Durum 1	86±8.7ab	44.2+0.6bcd	4.36+0.1bcd	33.5+1.9b	84.8+3.1a	13efg
Giza 163	85.8±9.4ab	42.6+2.01cd	4.57+0.4abc	31.1+3.3bc	75.2+5.7ab	11fg
Giza 168	86.8±8.4ab	41.8+1.9de	4.65+0.2ab	34.4+5.1bcd	67+6.5bc	26cde
Sakha 93	85±3.6ab	39+1.2e	4.93+0.2a	42+1.5a	72.8+1.7ab	6g

Table 2. Growth and damage of *Trogoderma granaarium Everts* (F.) on grains of thirteen wheat varieties at 32±1°C and 60 ± 5%RH.

Variety	Progeny number	MDP (days)	Susceptibility index	% weight loss	% Grain damage
Sakha 93	4.25b	42.0bc	2.83c	1.73h	5.0e
Giza 163	16.25a	45.8a	4.15b	3.08cdef	19.0bcd
Giza 167	18.80a	43.3ab	4.55ab	3.88abc	20.8bc
Sohag 2	18.75a	41.8bcd	4.58ab	3.35bcde	24.5b
Giza 164	16.25a	41.0bcde	4.63ab	3.15bcdef	14.0cd
Sids 1	15.30a	40.3bcde	4.63ab	3.95abc	20.0bc
Beni Swaif 1	17.50a	41.8bcd	4.68ab	2.13gh	12.3cd
Sakha 69	16.00a	39.3cde	4.83a	3.70abcd	14.8cd
Giza 168	17.75a	40.0cde	4.85a	4.08ab	26.5b
Beni Swaif 3	16.25a	38.8de	4.90a	2.50efgh	20.0bc
Sohag Durum 1	16.50a	38.3e	4.98a	2.38fgh	44.3a
Sohag 3	17.90a	39.3cde	4.98a	4.33a	25.5b
Gemmiza 7	16.70a	38.3e	5.03a	2.78defg	14.5cd

- Data was analyzed statistically by analysis of variance and means separated by Duncans multiple range test. Different symbols after standard indicates a significant difference.

MDP = Mean developmental period

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حساسية حبوب بعض أصناف القمح المصرية للإصابة بحشرتى ثاقبة الحبوب الصغرى وخنفساء الصعيد

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يهدف البحث إلى تقييم حساسية ثلاث عشرا صنفا من القمح المصري للإصابة بحشرتى ثاقبة الحبوب الصغرى وخنفساء الصعيد وكلاهما حشرات خطيرة وهامة لأنهما حشرات أولية وبالتالي لهما القدرة على إصابة الحبوب السليمة في الحقل والمخزن . وتم فى هذا البحث تقييم حساسية الأصناف على أساس عدد من الصفات البيولوجية للحشرة ومنها قيمة دليل النمو وعدد الحشرات الخارجة، وفترة التكوين وكل من نسبة الفاقد فى الوزن والتلف الحادث نتيجة تغذية الحشرات الكاملة وأطوارها غير الكاملة ثم في نهاية التجربة، تم تقدير الإنبات للبذور المصابة بهذه الحشرة لمعرفة تأثير هذه الإصابة على حيوية الجنين. وأظهرت النتائج وجود فروق معنوية واضحة في الصفات المذكورة لكلا الحشرتين. وبالنسبة لثاقبة الحبوب الصغرى وجد ثمانية أصناف ضعيفة الحساسة للإصابة على أساس قيمة دليل النمو (سخا٦٩، بنى سويف١، سوهاج٣، جميزة٧، جيزة١٦٤، سوهاج٢، سدس١، بنى سويف٢). بينما كانت الأصناف سوهاج٩٣ وجيزة١٦٨ حساسة جدا للإصابة . وبالنسبة لدرجة الإنبات والتى تعتمد على كمية الإصابة الحشرية الحادثة فكان الصنف سخا٦٩ من أكثر الأصناف مقاومة (نسبة الإنبات ٥٩٪) وكان أقلهم سخا٩٣ (٦٪) ويليه جيزة١٦٣(١١٪). وبالنسبة لخنفساء الصعيد وجد إحدى عشرا صنفا حساسة للإصابة وهى مرتبة تنازليا (جميزة٧، سوهاج٣، سوهاج ديورم١، بنى سويف٣، جيزة١٦٨ سخا٦٩، بنى سويف١، سوهاج٢، سدس١، جيزة ١٦٤ وجيزة١٦٧) بينما كانت الأصناف سخا٩٣ وجيزة ١٦٣ المقاومة للإصابة . ولم تظهر أصناف منيعة تماما لكلا الحشرتين، وتوصى الدراسة الحالية بعمل دراسات أخرى مكملة تتعلق بالتحليل الكيمائى للأصناف الحساسة والمقاومة لمعرفة أسبابهما بجانب إستخدام طرق تكميلية أخرى للمكافحة لحفظ الحبوب المخزنة بطريقة أمنة.