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POST HARVEST INFESTATION OF SOME EGYPTIAN BARLEY VARIETIES WITH *Trogoderma granarium* EVERTS BY

Gharib, M.S.A. and Abdel-Aziz, A.E.
Plant Protection Research Institute Dokki, Giza, 12618, Egypt

ABSTRACT

Two types of Egyptian barley grain varieties were screened to post-harvest insect infestation by Khapra beetle, *Trogoderma granarium* adults and larvae under laboratory conditions of 25– 34 °C and 40– 75 % RH.. The two types were: four old covered varieties (Giza 123, Giza 124, Giza 126 and Giza 2000) and three naked varieties (Giza 129, Giza 130 and Giza 131). Parameters of the evaluating the varietal susceptibility were progeny number, developmental period, growth and susceptibility indices, weight loss (%), damage (%) and grain viability (%). Infestation with five adult pairs and 10 pairs was done to samples of 10 g and 40 g weight respectively. Also, larval infestation to 20 g samples was investigated. Results showed significant differences in the tested parameters. With all weight levels, the naked varieties were more susceptible to *T. granarium* than the covered ones. Naked varieties were non-significantly different in the values of growth index and the same was found in covered varieties. At 10 gm samples, Giza 130 and Giza 129 were the most susceptible, while Giza 2000 was the least susceptible. Insect growth was of significantly shorter duration in the naked varieties and was significantly longer in the covered varieties. Also, more progeny number emerged from all naked varieties. The grain pericarp was found as strong physical barrier, since it increased adult mortality (%) and so reduced both oviposition period and larval development.

INTRODUCTION

The Khapra beetle, *Trogoderma granarium* Evers is 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). Its larvae attack grain embryos as well as attack other parts during heavy infestation (Pruthi and Singh, 1950). *Trogoderma granarium* shows signs of resistance to some common applied chemicals such as phosphine and Malathion (Borah and Chahal, 1979). Methyl bromide is currently the only treatment method with good control. However, methyl bromide is ozone depleting substance and its production and importation into the USA is prohibited in 2001 in accordance with the Clean Air Act. Current trends in stored product insect pest management demand the searching for other protective methods as plant seed resistance. Varietal resistance

of crop varieties to insect pests after harvest and during storage has been studied by many workers (Koura and El-Halfawy 1972a, Koura and El-Halfway 1972b, Koura *et al.*, 1972c and Khattack *et al.*, 1995, Gharib, 2004a, b, c). The present work determines the susceptibility of certain barely varieties to post harvest infestation by *T. granarium* under laboratory conditions.

MATERIALS AND METHODS

1. Stock insect cultures:

A culture of *T. granarium* was maintained in the Stored Grain Insects Res. Dept. Lab, Plant Protection Institute, Agric. Research Center, on a mixture of different barely varieties. Newly laid eggs of *T. granarium* were obtained by releasing a group of beetles in Petri dishes (7.5×2.5cm) containing broken barley grains for a definite time and removed. The grains were re-sieved again to separate eggs for starting new cultures. The latter could also start by releasing adult pairs in glass jars containing the grains at 32± 1°C and 60 ± 10% RH.

2. Barely varieties:

Seven barely grain varieties were purchased from the Barely Breeding Section of the Field Crops Research Institute, Agricultural Research Center, Ministry of Agriculture. The varieties were: three naked varieties (Giza 129, Giza 130 and Giza 131) and the other old four were of completely covered grains (Giza 123, Giza 124, Giza 126 and Giza 2000). All varieties were free from symptoms of insect's damage and then kept in a deep freezer for two weeks to kill any possible hidden infestation.

3. Susceptibility determination:

Three weight levels /variety were prepared (10 gm, 20 gm and 40 gm) for exploring effects of food (grain) availability on insect performance. This could be expected to reflex on the measured parameters of the susceptibility. Five replicates were of each variety/weight and a similar five-replicates/ variety left as control. Both weight groups of (10 gm and 40 gm) were infested with newly emerged adult pairs of 5 pairs and 10 pairs, respectively, thus each pair has 2 g as available food in case of 5 pairs and the second have 4 g of available food. Insects left to oviposit for four days only and then removed. Replicates left in the open conditions for 3 successive weeks, then examined daily for adult emergence, developmental period and counting the emerged adults. Values of growth index were calculated according to Howe (1971) as well as weight loss (%) was also calculated for comparison.

Weight samples of 20 g, each was infested with 40 newly hatched larvae and allowed to develop without disturbance until adult emergence. The previously biological parameters were also calculated except the growth index, was substituted by susceptibility index (SI) according to Dobie (1974) as follows:

$$SI = \frac{\log S}{T} x100$$

Where: S = % adult emergence, T = developmental period (days)

Grain damage (%) was calculated by withdrawing a random sample of one hundred grains/variety replicates after ceasing adult emergence, and grains with any insect feeding were counted. Those grains showing any signs of insect feeding were considered as damaged. Weight loss (%) was calculated from the weight difference after insect infestation and changed to dry weight loss (%) after subtracting the contained water, as follows:

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

Replicates of each variety were mixed together and viability (%) conducted by germination tests, in two replicates of 50 grains each, placed in two 9-cm diameter Petri dishes containing water moistened cotton pad. Number of the germinated grains was counted one week later. Data were statistically analyzed by ANOVA using SAS computer program and significant means were separated by Duncan's multiple range test, and standard errors were calculated.

RESULTS AND DISCUSSION

The obtained results of 10 gm and 40 gm seed samples/variety and infested by adult insects are presented in Tables 1 and 2. Weight loss (%) ranged from 7 for Giza 123 as covered variety to 18.34 for Giza 130 (as naked variety) at 10 g level samples. Progeny number ranged from 34.5 (Giza 124) to 167 (Giza 129). Grain damage (%) was 3.3 for Giza 124 and Giza 126 and 5.3 for Giza 2000 in the covered varieties, while it ranged from 44.7 for Giza 130 to 46.5 for Giza 129 and Giza 131. Results showed significant differences between all the naked grain varieties and all covered barley varieties in all parameters. Naked varieties showed the highest values of weight loss (%), progeny number, grain damage (%) and shorter developmental period, compared to the converse values in the covered varieties.

Under 10 g weight samples, the general mean of progeny, developmental period (MDP), growth index, weight loss (%), grain damage (%) and germination (%) (of the naked varieties that was infested with 5 pairs) were 158.2, 28.3, 8.06, 18.2, 45.6, and 70.7 while were 46.4, 41.5, 4.05, 8.05, 4.2, and 87.8 respectively in the covered varieties.

Under 40 g weight samples, the values of the previous parameters were: 279.6, 30.3, 8.14, 8.14, 32.9, and 56 %, respectively in the naked varieties while it reached 177, 32, 6.8, 5.3, 4.5, and 93.3 in covered varieties. The growth index as a parameter for measuring susceptibility and resistance was also significant between the naked varieties and covered varieties. Naked varieties (Giza 129, Giza 130 and Giza 131) showed non-significant values in the previous parameters mentioned before. The same was found among the covered varieties. Same results were found using a 40 gm seed samples/ variety and infested also by adults. Naked varieties were thus, much susceptible to *T. granarium* attack than the covered ones, at both weight levels. This was represented in a higher progeny number, with shorter developmental duration and higher calculated values of

growth index (Table 2). Significant differences were also found between the naked and covered varieties in the grain damage (%) and other studied parameters.

Larval infestation of 20 gm samples indicated non-significant differences in progeny number, weight loss (%) and adult emergence (%) between both groups. These results agree with the previous results and compatible with the previous results of adult infestation. Although, significant differences were found between the naked and covered varieties in respect to larval– pupal duration, grain damage (%) and the susceptibility index.

Table (1): Susceptibility of some barley varieties by *Trogoderma granarium* Everts (Five adult pairs) using 10 gm grain samples.

Variety type	Variety Name	Progeny No.	MDP (days)	Growth Index	Weight loss (%)	Grain Damage (%)	Germination (%)
Naked Varieties	Giza 129	167±8.8a	26.5±2.6c	8.64±1.1a	17.8±2.7a	46±4.6a	74±8.02b
	Giza 130	164.5±3.1a	25.8±2.8c	8.92±0.88a	18.34±2.3a	44.7±3.1a	65±9.03b
	Giza 131	143±6.6 a	32.5±1.2bc	6.61±0.1b	18.3±1.3a	46±5.6a	73±9.03b
	Mean	**158.2**	**28.3**	**8.06**	**18.15**	**45.6**	**70.7**
Covered Varieties	Giza 123	64±9.1b	39±4.6ab	4.73±0.43bc	7±0.82b	4.7±0.8b	85±7.02ab
	Giza 124	34.5±7.7b	37.5±2.8ab	4.1±0.41c	8.63±1.6b	3.3±0.6c	84±2.01ab
	Giza 126	46±3.8b	43.3±2.02a	3.86±0.24c	8.2±1.8b	3.3±0.6c	98±2.01a
	Giza 2000	41±5.5b	46.3±2.4a	3.5±0.3c	8.35±0.3b	5.3±1.5c	84±4.0ab
	Mean	**46.4**	**41.5**	**4.05**	**8.05**	**4.2**	**87.8**

*Data in the table were statistically analyzed by ANOVA test and means separated by Duncan's multiple range test, ** Vertical means with the same letters are not significantly different.

It is clear that naked varieties were more susceptible to post-harvest infestation than covered varieties even under the two levels of the provided weight. The general mean of the above studied parameters of the naked varieties(progeny no., MDP, SI, %weight loss, %damage, % germination and adult emergence, under larval infestation by 1st instar larvae of *T. granarium* were 36.3, 24.2, 8.2, 2.63, 23.1, and 73.7, although it was 36.7, 28.1, 7.01, 2.4, 4.2, and 94.8, in covered varieties. Non-significant differences were thus observed between both groups except SI, damage (%) and germination (%). Data indicated that a direct relation between susceptibility of a variety and emerged adult no.

developed on it. More adults that developed on a variety are considered more susceptible and so adult emergence was considered also as good criterion of susceptibility of barley grain to *T. granarium*. These differences could be due to the grain shell or testa, which full of hard hairs and spikes and these represent the main resistance physical factor of covered varieties. This could explain the differences between the two barley groups. Thus, shell reduces adult's life span and probably its fecundity as well as retards both larval penetration and feeding on the endosperm. While, the contrast in the naked varieties; these larvae are in direct contact with grain endosperm and so feed directly and easily.

Table (2): Susceptibility of some barley varieties by *Trogoderma granarium* Everts (Ten adult pairs) using 40 gm grain samples.

Variety type	Variety Name	Progeny no.	MDP (days)	Growth Index	Weight loss (%)	Grain Damage (%)	Germination (%)
Naked Varieties	Giza 129	287.3±11.9a	30±0.6a	8.2±0.2a	7.44±0.3ab	29.3±2.9a	65±3.01c
	Giza 130	287.5±5.14a	31±3.1a	8.1±0.8a	9.86±1.9a	35.3±7a	46±0.0d
	Giza 131	264±2.6ab	29.75±0.8a	8.13±0.1a	7.13±0.3bc	34±1.2a	57±1.0c
	Mean	**279.6**	**30.3**	**8.14**	**8.14**	**32.9**	**56**
Covered Varieties	Giza 123	164.8±3.9c	33±2.5a	6.67±3.9a	5.75±0.5bc	6.0±1.2b	86±4.01b
	Giza 124	186.5±5.8bc	35±2.5a	6.59±0.6a	4.56±0.4c	4.0±0.6b	95±3.01a
	Giza 126	191±8.8bc	33.5±3.1a	6.95±0.6a	5.53±0.2bc	4.0±0.6b	99±1.0a
	Giza 2000	166.8±4.3c	26.3±8.3a	7.11±1.1a	5.2±0.3bc	4±1.2b	93±3.01a
	Mean	**177**	**32**	**6.8**	**5.3**	**4.5**	**93.3**

*Data in the table were statistically analyzed by ANOVA test and means separated by Duncan's multiple range test. ** Vertical means with the same letters are not significantly different.

Results agree with those mentioned by Nwanze and Horber (1975) working on cowpea seed varieties with seed coats that resist the initial larval penetration of cowpea beetle and so limit the insect population increase. Wlliams and Mills (1980) and Locatelli and Limonite (1998) demonstrated that the undamaged pericarp of sorghum varieties represents the main resistant factor against damage by grain weevils and moths respectively, since the pericarp contain high amount of fibers. Other authors as Mabta (1987) showed also that, the seed coat could protect groundnut varieties from insect infestation. This study indicated that the naked varieties are highly susceptible to *T. granarium* Everts than the covered varieties under open infestations by either adults or 1ST instar

larvae. For a safe storage of the naked varieties, this needs other complementary protective methods, since they were more susceptible to post harvest infestation by *T. granarium*.

Table (3): Susceptibility of some barley varieties by *Trogoderma granarium* Everts larvae under 20 gm grain samples.

Variety type	Variety Name	Progeny no.	MDP (days)	Adult emergence (%)	Susceptibility Index (SI)	Weight loss (%)	Grain Damage (%)	Germination (%)
Naked Varieties	Giza 129	36± 3.4a	23.3± 1.3c	90± 5.9	8.43± 0.4a	2.44± 0.4ab	28.7± 5.2a	70± 10.03b
	Giza 130	37.5± 1.5a	23.8± 1.2c	93.8± 3.8	8.4± 0.4a	2.88± 0.13a	21.3± 1.8b	73± 7.02b
	Giza 131	35.3± 1.9a	25.5± 0.7bc	88.13± 4.7	7.64± 0.2ab	2.56± 0.1ab	19.3± 0.7b	78± 8.02ab
	Mean	**36.3**	**24.2**	**90.6**	**8.2**	**2.63**	**23.1**	**73.7**
Covered Varieties	Giza 123	36± 3.4a	25.8± 1.3bc	90± 8.4	7.59± 0.2bc	2.5± 0.2ab	6.0± 1.2c	95± 1a
	Giza 124	37.3± 1.7a	28.3± 0.5ab	93.1± 4.3	6.98± 0.2bc	2.0± 0.2b	2.7± 0.7c	94± 2.01a
	Giza 126	36.8± 1.9a	29± 0.0a	91.9± 4.7	6.76± 0.08bc	2.33± 0.14ab	3.3± 1.3c	96± 1.0a
	Giza 2000	36.5± 2.1a	29.3± 1a	91.3± 5.2	6.72± 0.8c	2.74± 0.3ab	4.7± 1.8c	94± 4.01a
	Mean	**36.7**	**28.1**	**91.6**	**7.01**	**2.4**	**4.2**	**94.8**

*Data in the table were statistically analyzed by ANOVA test and means separated by Duncan's multiple range test, ** Vertical means with the same letters are not significantly different.

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قابلية إصابة بعض أصناف الشعير المصرية بخنفساء الصعيد

محروس سليمان غريب ، عبد العزيز السيد عبد العزيز
معهد بحوث وقاية النبات – الدقي – جيزة – مصر

حشرة خنفساء الصعيد من أكثر حشرات الحبوب المخزونة مقاومة للوسائل العلاجية كغازات التبخير مثل الفوسفين والمبيدات كالملاثيون. وفي دراسة معملية تحت حرارة تراوحت بين ٢٥- ٣٤ درجة مئوية ، ورطوبة نسبية مقدارها ٤٠-٧٥%، تم دراسة حساسية سبعة أصناف من الشعير المصري (ثلاثة أصناف عارية وهي جيزة ١٢٩ وجيزة ١٣٠ وجيزة ١٣١ والأربعة الأخرى مغطاة الحبة أي بأغطية وهي جيزة١٢٣ وجيزة١٢٤ وجيزة١٢٦ وجيزة٢٠٠٠) للإصابة بهذه الحشرة خلال فترة تخزينها. ونفذت التجربة بإستخدام ثلاثة مستويات من الوزن / الصنف (١٠جم، ٢٠جم، ٤٠ جم) وتم إصابة ١٠جم وال٤٠جم بخمسة وعشرة أزواج من الحشرات الكاملة حديثة الخروج، بينما مستوي ٢٠جم تم إصابتها بعشرين يرقة حديثة الفقس. وقدرت النتائج بتحديد بعض الصفات البيولوجية للحشرة كعدد الحشرات الخارجة ومتوسط فترة التطور وقيمة دليل الحساسية (دليل النمو) ونسبة التلف ونسبة الفاقد في الوزن ونسبة الإنبات. من النتائج وجد أن الأصناف الثلاثة العارية كانت أكثر حساسية مقارنة بالأصناف مغطاة الحبة. وذلك عند كل مستويات الوزن المستخدم والمراحل الحشرية في الإصابة . وأظهرت النتائج اختلافات معنوية في كل الصفات المختبرة بين كل الأصناف العارية والأصناف المغطاة. عند مستوى ١٠جم و ٢٠جم وجد أن جيزة ١٣٠ كانت أكثر الأصناف حساسية بينما وجد أن جيزة ٢٠٠٠ كانت أكثر الأصناف مقاومة كما وجد أن جيزة ١٢٤ (عند مستوى ٤٠جم) كان الأكثر حساسية بناءا على قيم دليل النمو. وبالنسبة لفترة تطور الحشرة فوجد أنها تكون قصيرة في الأصناف العارية ومختلفة معنويا بين الأصناف العارية والأصناف المغطاة . وأظهرت النتائج أيضا خروج أعداد كبيرة من الذرية من الأصناف العارية مقارنة بالأصناف المغطاة. وبالنسبة للصفات الأخرى مثل النسبة المئوية للفقد في الوزن (%) وكل من نسبة التلف والإنبات فكانت مختلفة معنويا بين الأصناف العارية والأصناف مغطاة الحبة ، كما أنها غير معنوية داخل كل مجموعة. والنتائج تبين أن غلاف الحبة يمثل أكبر عائق ضد الإصابة بخنفساء الصعيد، لأنه يعمل على تعطيل وضع البيض و تأخير فترة النمو اليرقي، وقد ظهر ذلك في خروج أعداد قليلة من الحشرات من الأصناف المغطاة مقارنة بالأصناف العارية. كما تبين أن الأصناف العارية كانت أكثر حساسية وعرضة للإصابة بخنفساء الصعيد مقارنة بالأصناف المغطة للشعير.