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INFLUENCE OF DIFFERENT MAIZE VARIETIES ON THE RICE WEEVIL *Sitophilus oryzae* (L) INFESTATION UNDER LABORATORY CONDITIONS.

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ABSTRACT

Choice and non-choice tests were carried out to determine the influence of certain maize varieties on the rice weevil, *Sitophilus oryzae* (L) infestation under laboratory conditions. Regarding to non-choice tests on different maize varieties, data revealed that, Tri-Hybrid 353 yellow variety was the highest weight after damage. while Tri-Hybrid 311 white variety was the highest percentage weight loss and lowest weight after damage. In addition, Tri-Hybrid 353 yellow variety was the longest total developmental period and lowest number of F1 while Tri-Hybrid 311 white variety was the shorter total developmental period and highest number of F1 progeny. In respect to free choice on different maize varieties, data revealed that, Tri-Hybrid 353 yellow variety was the highest weight after damage, while Tri-Hybrid 311 white variety was the highest percentage weight loss and lowest weight after damage. On the other hand, the index of susceptibility (IS) among the varieties tested showed that Tri-Hybrid 311 white was moderately susceptible for different maize grains varieties and other varieties were moderately resistant.

INTRODUCTION

Maize, *Zea mays* L., is the second most produced cereal after wheat in the world. It is cosmopolitan in distribution and widely consumed by man and his animals (Makate, 2010). About 50 maize species exist and grains vary in colour, texture, shape and size. Maize grains are rich in Vitamins A, C and E, carbohydrates, essential minerals and protein. Worldwide production of maize in 2011 was 883,460,240 tonnes with the largest producer, the United States, producing 35.5%. Africa produces 7.4% and the second largest African producer (after South Africa) was Nigeria with 9,180,270 tonnes (FAO, 2013).

During post-harvest storage, maize grains are vulnerable to many insects. Among those, Angoumois grain moth, *Sitotroga cerealella* (Olivier), lesser grain borer *Rhyzopertha dominica* (F.), weevils complex *Sitophlilus* spp., Khapra beetle *Trogoderma granarium* Everts and red flour beetle , *Tribolium castaneum* (Herbst) are very important (Lohar *et al.*, 1997; Ebeling, 2002). But most damage is done during storage. Damaged grains have reduced nutritional values, low percent germination and reduced weight and market values, respectively. Worldwide seed losses ranging from 20 to 90% have been reported for untreated maize due to the maize weevil , *S. zemais* (Giga *et al.,* 1991).

The rice weevil, *Sitophilus oryzae* (L.), is a cosmopolitan pest which is considered to be one of the most destructive species in stored grain. It is classified as a primary pest, which can easily infest sound seeds, enabling

other species (the secondary pests), which are not capable of breeding on intact grains, to cause additional damage (Hill, 1990; Rees, 1995). Since its larvae develop in the internal part of the kernels, the infestation is not visible at the first stages. Moreover, *S. oryzae* has developed a considerable level of resistance, to many traditional residual protectants (Arthur, 1996). For instance, the rice weevil is considered to be one of the most resistant stored-product insect species to pyrethroids, and usually cannot be controlled by application rates that are effective against most other stored-grain beetle species (Samson and Parker, 1989; Arthur, 1992, 1994, 1999).
Therefore, the aim of the present work is to study the influence of different maize varieties on the rice weevil S.*oryzae* infestation.

MATERIALS AND METHODS

Relative susceptibility of some maize varieties to *S.oryzae* was carried out under laboratory conditions at stored product pest laboratory, Sakha Agricultural Research Station.

The rice weevil *S.oryzae* was raised on a susceptible local maize variety in the laboratory. The maize grains were initially stored for two weeks at -4 °C to eliminate different stages of storage pests that might be present in the kernels and remove seeds with visible damage symptoms. Grains were then transferred into transparent plastic buckets and kept in a rearing room for two weeks to attain stable environmental conditions. Small windows (10 cm × 10 cm) were created on the lid and side of the buckets and covered with nylon mesh for proper ventilation. Newly emerged *S.oryzae* was introduced into the buckets containing the dis-infested maize. Ten days after introduction, adults were removed from each bucket and the containers were observed beginning from 20 days after the insect's introduction for emergence of offspring. The insect's culture was established to supply adequate number of the insects of similar age for the experiments.

The susceptibility experiments were carried out on four varieties of maize namely Tri-Hybrid 311 white, Tri-Hybrid 353 yellow, Single-Hybrid 10 white and Single-Hybrid 173 yellow. All are obtained from the Crop Research Institute, Sakha Agricultural Research Station, Kafr -El-Sheikh, Ministry of agriculture.
Enough samples of maize grains were firstly sieved to remove stone, dust and insects. The grains were then sterilized by freezing for 24:48 h at -18:-22°C to be assured freedom from any insect infestation. All grains were maintained in an incubator at a constant temperature of 29 ± 1 °C and 65 ± 5% R.H. for two weeks to obtain equilibration moisture content with this R.H. (Ezz, 1976). To evaluate the relative susceptibility of the tested maize varieties, two sets of experiments were applied. The first was a free choice infestation test and the other was a non-choice infestation test.

1. Non-choice infestation test:

Non-choice test method in which pre-determined the insects were introduced to each jar was used for the study (Abebe *et al.,* 2009). Twenty grams of each variety was weighed into plastic Petri dishes in three replicates. The plastic material allowed ventilation and prevented insects from escaping. Twenty emerged unsexed adult insects aged between 0 and 5 days were then introduced into the Petri dishes containing the grains. The insects were allowed to lay eggs on the grains for 10 days after which they were removed and checked for adult mortality. The insects that were dead and those that were alive were counted and recorded separately for each dish. The entire set up was then left in the laboratory at 26 °C and 75% RH until the first adults of the F1 generation emerged.The total number of F1 adults was determined on each maize variety and median development time (MDT) was calculated as the time (days) from the middle of oviposition period to the emergence of 50% of these adults. The data was used to calculate the index of susceptibility.
To assess each maize variety seed damage (seeds with hole (s)) and grain weight loss. Seed damage was expressed as a proportion of the total number of seeds sampled (Abebe *et al.,* 2009). The count and weight method of Gwinner *et al.* (1996) was used to determine seed weight loss using the formula:

$$W(\%) = \frac{(Wu\ X\ Nd) - (Wd\ X\ Nu)}{Wu\ X\ (Nu + Nu)}\ X\ 100$$

Where, W is the weight loss (%), Wu is the Weight of undamaged seed, Nu is the number of undamaged seed, Wd is the weight of damaged seed and Nd is the number of damaged seed.

2. Choice infestation test:-

In this experiment, glass jars accommodates four varieties of maize grain (with three replicates) for *S.oryzae* was used as choice chamber. Twelve Petri dishes (9 cm diameter) each contains 20 gm of a variety was used. Three hundred adults of each tested insect (150 pairs 10 day old) were placed in the center part of each jar to give the insects a free choice to oviposit on any variety. The experiment was conducted at the conditions of (27 °C and 70 % R.H.). The parents were removed after ten days of treatment. After 60 days, the percent of damage and grain loss was estimated. Analysis of variance and Duncan's multiple range tests (1955) were performed to rank the varieties according to their susceptibility to the insect.

3. Index of susceptibility:

The Dobie index of susceptibility was used as the criterion to separate varieties into different resistance groups (Dobie, 1974). The index of susceptibility is given by the formula:

$$IS = \frac{\text{LogeX}}{\text{MDP}} \times 100$$

Where, IS is the Dobie's index of susceptibility, Log_e^x is the natural logarithm of the total number of F1 progeny emerged and MDP is the Median development period.

The Dobie Index was used to classify the maize varieties into susceptibility groups following the scales as follows : scale index of ≤ 4 was classified as resistant; scale index of 4.1-6.0 as moderately resistant; scale index of 6.1-8.0 as moderately susceptible; scale index of 8.1-10 as susceptible; and scale index of >10 was classified as highly susceptible.

4. Data analysis:

All data collected were subjected to analysis of variance (ANOVA) procedures (SAS, 2008). Tukey test were used to detect mean differences between treatments. Data with regard to percent adult mortality, seed damage and weight loss were subjected to angular-transformation while numbers of F1 progenies were log transformed in order to ensure assumptions of ANOVA before analysis. Then, the transformed data were analyzed using one-way ANOVA. Tukey standardized "Honestly Significant Difference" (HSD) tests were used to differentia.

RESULTS AND DISCUSSION

Choice and non-choice tests were carried out to determine the preferred maize varieties for *S.oryzae* under laboratory conditions. Some biological parameters for both insects were used as an indicator of the insect preference. These parameters were weight after damage, number of emerged progeny the percentage of weight loss, adult mortality and median development period (MDP) or F_1 longevity.

1.Non-choice test:

1.1. Influence of different varieties of maize on adult mortality, F_1 progeny and median development:

Date presented in Table (1) showed the influence of different varieties of maize on biological parameters of *S.oryzae*. In respect to the percentage of adult mortality, F_1 emerged progeny and median development period. Maximum and the highest weevil's adult mortality was recorded from Tri-Hybrid 353 yellow (3.7 ± 0.3 %) followed by Single-Hybrid 173 yellow (3.3 ± 0.3 %), Single-Hybrid 10 white (2.3 ± 0.3 %) and Tri-Hybrid 311 white (1.3 ± 0.3 %).

Among all the maize varieties tested, Maximum and the numbers of progenies was emerged from Tri-Hybrid 311 white (224 ± 0.87) and Single-Hybrid 10 white (195 ± 1.45) while the lowest numbers of progenies was emerged from Tri-Hybrid 353 yellow (129 ± 1.2).

Table 1: Adult mortality, F_1 progeny and median development period (MDP) of *S.oryzae* on different maize varieties caused by *S.oryzae according* to non-choice test.

Maize Varieties	MEAN ± SE		
	Adult mortality %	F1 progeny	median development period (MDP)
Tri-Hybrid 311 white	1.3 ± 0.33 b	224 ± 0.87 a	37.7 ± 0.33 b
Single-Hybrid 10 white	2.3 ± 0.3 ab	195 ± 1.45 ab	38.7 ± 0.3 ab
Single-Hybrid 173 yellow	3.3 ± 0.3 a	161.33 ± 1.45 b	39.7 ± 0.8 ab
Tri-Hybrid 353 yellow	3.7 ± 0.3 a	129.61 ± 1.21 c	40.7 ± 0.6 a

In the same column, means followed by the same letter are not significantly different according to DMRT at 0.05 level of probability.

The median development period (MDP) ranged from 37.7 ± 0.33 days for Tri-Hybrid 311 white to 40.7 ± 0.6 days for Tri-Hybrid 353 yellow. Shorter median development period was recorded on variety Tri-Hybrid 311 white 37.7 ± 0.33 days. Generally, as the median development period increases the F_1 progeny emergency decrease were as the percentage adult weevil mortality increase. Varieties with high F_1 progeny emergency tended to have shorter median development period and very minimum percentage adult mortality.

1.2. Influence of different varieties of maize on the percentage of weight after damage and the percentage of weight loss.

Data presented in Table (2) showed the influence of different varieties of maize on the weight after damage and percentage of weight loss caused by *S.oryzae* reared on different maize grains varieties under laboratory conditions according to non-choice test. Regarding to the weight after damage, Tri-Hybrid 353 yellow was the highest weight after damage (19.2 ± 0.12) followed by Single-Hybrid 173 yellow (19.1 ± 0.08), Single-Hybrid 10 white (18.9 ± 0.12) and Tri-Hybrid 311 white (18.3 ± 0.19).

Where weight before damage = 20 gm.

Table 2: Influence of different maize varieties on the weight after damage and the percentage of weight loss caused by *S.oryzae according* to non-choice test.

Maize Varieties	Mean of weight after damage	Mean weight loss % ± SE
Tri-Hybrid 311 white	18.3 ± 0.19 a	8.5 ± 0.99
Single-Hybrid 10 white	18.9 ± 0.12 a	5.5 ± 0.57
Single-Hybrid 173 yellow	19.1 ± 0.08 a	4.67 ± 0.43
Tri-Hybrid 353 yellow	19.2 ± 0.12 a	3.83 ± 0.6

In the same column, means followed by the same letter are not significantly different according to DMRT at 0.05 level of probability.

Moreover, there were non-significant differences between the different maize varieties according to the mean weight after damage.

On the contrary, the highest percentage weight loss was observed in Tri-Hybrid 311 white (8.5 ± 0.99%) followed by Single-Hybrid 10 white (5.5 ± 0.57%), Single-Hybrid 173 yellow (4.67 ± 0.43%) and Tri-Hybrid 353 yellow (3.83 ± 0.6%).

2. Free choice test:

Data presented in Table (3) showed the influence of different varieties of maize on the weight after damage and percentage of weight loss caused by *S.oryzae* reared on different maize grains varieties under laboratory conditions according to free choice test. Regarding to the weight after damage, Tri-Hybrid 353 yellow was the highest weight after damage (18.9 ± 0.12) followed by Single-Hybrid 173 yellow (18.3 ± 0.19), Single-Hybrid 10 white (17.9 ± 0.06) and Tri-Hybrid 311 white (17.3 ± 0.08).

On the contrary, the highest percentage weight loss was observed in Tri-Hybrid 311 white (13.67 ± 0.43) followed by Single-Hybrid 10 white (10.67 ± 0.33), Single-Hybrid 173 yellow (8.5 ± 0.99) and Tri-Hybrid 353 yellow (5.5 ± 0.57).

Where weight before damage = 20 gm.

In the same columm, means followed by the same letter are not significantly different according to DMRT at 0.05 level of probability.

These results are in agreement with those of Tadesse (1991) and Tefera *et al.* (2011) indicated that the extent of damage during storage depends on the number of emerging adults during each generation and the duration of each life cycle and varieties permitting more rapid and higher levels of adult emergence are more seriously damaged. Differential reaction of maize varieties to maize weevil have been reported by several authors (Giga et al., 1991; Arnason *et al.,* 1993). Similarly, Garcia-Lara *et al.* (2004) indicated that progeny emergency tended to be higher in susceptible genotypes than in resistant ones.

Index of susceptibility (IS):

Table 3: Influence of different maize varieties on the weight after damage and the percentage of weight loss caused by *S.oryzae* according to Free Choice test.

Maize Varieties	**Mean of weight after damage**	**Mean weight loss % ± SE**
Tri-Hybrid 311 white	17.3 ± 0.08 b	13.67 ± 0.76
Single-Hybrid 10 white	17.9 ± 0.06 ab	10.67 ± 0.33
Single-Hybrid 173 yellow	18.3 ± 0.19 ab	8.5 ± 0.99
Tri-Hybrid 353 yellow	18.9 ± 0.12 a	5.5 ± 0.57

Table 4: Index of susceptibility (IS) of maize varieties to rice weevil *S.oryzae*:

Maize Varieties	**Dobie's IS**	**Classification**
Tri-Hybrid 311 white	6.23	Moderately susceptible
Single-Hybrid 10 white	5.92	Moderately resistance
Single-Hybrid 173 yellow	5.2	Moderately resistance
Tri-Hybrid 353 yellow	5.56	Moderately resistance

Significantly differences ($p < 0.05$) were observed in the index of susceptibility (IS) among the varieties tested (Table 4). The IS in *S.oryzae* were 5.2, 5.56, 5.92 and 6.23 for Single-Hybrid 173 yellow , Tri-Hybrid 353 yellow , Single-Hybrid 10 white and Tri-Hybrid 311 white , respectively. Whereas , Tri-Hybrid 311 white was moderately susceptible for different maize grains varieties and other varieties were moderately resistant.

These results are in agreement with those of according to Horber (1988). The index of susceptibility is based on the assumption that the more F_1 progeny and the shorter the duration of the development, the more susceptible the seeds would be. Abraham (1991) indicated that the extent of damage during storage depends upon the number of emerging adults during each generation and the duration of each life cycle and seeds permitting more rapid and higher levels of adult emergence will be more seriously damaged. Several maize varieties, including local land races, have been characterized as sources of resistance to *S. zeamais* (Giga and Mazarura, 1991; Arnason et al. 2004) and some sources of resistance have been incorporated into elite maize lines.

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تأثير أصناف الذره المختلفه على الاصابه بحشرة سوسة الارز Sitophilus oryzae (L) تحت الظروف المعمليه

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أجريت هذه الدراسه لمعرفة مدى تأثير أصناف الذره المختلفه على الاصابه بسوسة الارز تحت ظروف المعمل , وذلك بأجراء أختبارين الاول يوفر للحشره حرية أختيار الغذاء المفضل والثانى لا يوفر هذه الحريه . وأشارت النتائج الى انه بالنسبه للاختبار الثانى , فأن الصنف الهجين الثلاثى 353 الأصفر كان أكثر وزنا بعد الاصابه والاقل فقد فى الوزن بعد الاصابه , فى حين كان الصنف الثلاثى 311 الأبيض الاقل وزنا بعد الاصابه والاكثر فقد فى الوزن بعد الاصابه , كما ان الصنف الهجين الثلاثى 353 الاصفر كان الاطول فى مده الاطوار غير الكامله والاقل فى النسل , بالمقابل كان الصنف الهجين الثلاثى 311 الابيض الاقصر فى مدة التطور والاعلى نسلا . أما فيما يتعلق بالاختبار الاول , فأن الصنف الهجين الثلاثى 353 الاصفر كان الاكثر وزنا بعد الاصابه والاقل فقد فى الوزن بعد الاصابه , فى حين كان الصنف الثلاثى 311 الابيض الاقل وزنا بعد الاصابه والاكثر فقد فى الوزن بعد الاصابه . من ناحيه أخرى فان مؤشر الحساسيه للاصناف تحت الاختبار أظهر ان الصنف هجين ثلاثى 311 أبيض كان متوسط الحساسيه بينما الاصناف الاخرى كانت متوسطة المقاومه .

قام بتحكيم البحث

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