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Interaction between *Bruchidius incarnatus* (Boh.) and Certain Egyptian Faba Bean Varieties

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Abstract: The present study is carried out to scope the interaction between nine faba bean varieties and *Bruchidius incarnatus* (Boh.) in a non-choice and free-choice tests. The determined variables were: percentage of adult emergence, mean developmental period, susceptibility index and percentage of seed weight loss. The results in the no-choice and free-choice tests respectively for Giza 843 were as follow: the percentages of adult emergence were 85.0±1.52 and 76.66±1.15%, the mean developmental periods were 27.33±0.33 and 28.0±0.57 days, the susceptibility indexes were 5.09±0.08 and 4.03±0.01 and the percentages of weight loss were 3.68±0.08 and 2.79±0.0%; while the percentages of adult emergence were 48.02±1.76 and 35.70±0.33%, the mean developmental periods were 32.66±0.88 and 34.66±0.88 days, the susceptibility indexes were 2.75±0.02 and 2.14±0.0 and the percentages of weight loss were 1.43±0.05 and 0.66±0.04% for Giza 3. Generally, the study concluded that Giza 843 is the highest susceptible variety, whereas Giza 3 is the lowest susceptible variety to *B. incarnatus*.

Key words: *Bruchidius incarnatus* · Adult emergence · Faba bean varieties · Development · Weight loss

INTRODUCTION

Faba bean (*Vicia faba* L.) is widely grown throughout the world (covering 2.3 million hectares), though it is concentrated in temperate and subtropical climate [1]. With regard to its production, 43%, 35%, 7%, 6%, 5% and 2% occurs in Asia, Africa, South America, Europe, Australia and North and Central America, respectively [1]. It has long been a part of the human diet as a good source of protein and it is an important cash crop which comprises food for millions of people [2]. It contains protein, carbohydrates, fat, glucose, minerals, vitamins and a significant amount of crude fiber [3-4]. Faba bean is one of the most important leguminous crops widely grown in Egypt [5]. It is grown mainly for seeds or green pods as vegetables [6]. Faba bean seeds are subject to be attacked by many coleopteran insects of the family Bruchidae during storage [7-8]. Bruchid beetles attack the seeds of legumes and cause severe damage to the quality and quantity of the crop. It is the most preferred food to the small bean beetle, which they attack it before or during harvest as well as in storage [9]. *Bruchidius incarnatus* is an important pest of faba bean in Egypt [10]. It is the most important insect that attacks the stored bean and causes heavy losses in quantity, quality and germination rate of infested faba bean seeds [11-12].

The aim of the study is to scope the interaction between nine Egyptian faba bean varieties and faba bean beetle, *B. incarnatus* during a no-choice and free choice experiments.

MATERIALS AND METHODS

Culture of Insects: The beetles, which were used in the study were obtained from naturally infested faba bean seeds. Adults of *B. incarnatus* were cultured in an incubator at a constant temperature of 27±2°C and 65±5% R.H. in the Laboratory of the Department of Plant Protection, Faculty of Agriculture, Al-Azhar University, Assiut Governorate, Egypt. Stock culture was set up by two hundred adults of *B. incarnatus* which were introduced into the rearing bottles containing 500g seeds. The bottles were covered with muslin cloth and secured with rubber bands. The beetles were allowed to lay their eggs on sound faba bean local variety. Culture was sieved after four weeks; the older adults were removed and the newly emerged adults (0–24 hours old) were collected and used for the experiments.

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Preparation of Varieties: Nine varieties of faba bean seeds (Giza 3, Giza 40, Giza 429, Giza 716, Giza 843, Masr 1, May 3, Nobaria 3, Sakha 3) were obtained from the Agricultural Research Centre, Dokki, Giza, Egypt. They are all medium size, buff color and black hilum color. Their weight of 100 seeds ranged from 65-85 g according to [13]. Faba bean seeds were sieved to remove stones, dust, insects … etc and kept in a freezer at 5 °C for 7 days to kill all hidden infestations [14]. The sterilized seeds of each variety were then taken into a plastic container and stored at room temperature until their use.

Procedure, Experimental Design and Data Analysis: To study the interaction between nine varieties of faba bean seeds and *B. incarnatus*, two experiments were set up as follows: 1) A no-choice experiment; one hundred gram seeds of each variety were individually placed in a small plastic jar (250 ml) then five pairs of newly emerged beetles (less than 24 hrs. old) were put into each jar. The jars were covered with muslin cloth and wrapped with rubber bands. 2) A free-choice experiment; one hundred grams from each variety was kept in plastic jar. Those jars were placed in a plastic box (3 replicas x 9 varieties = 27 containers). A one hundred and thirty-five pairs of newly emerged beetles were released into the box and then it covered with a muslin cloth. All jars were kept in an incubator at a constant temperature of 27±2°C and 65±5% R.H. Ten days after infestation, released beetles were removed. The experiments were arranged in a completely randomized design (CRD) with three replicas. The experiments were continued for the first generation. Then, the adult emergence, the developmental period, the susceptibility index and the weight loss were calculated.

Collected data were subjected to the Analysis of Variance (ANOVA) using Statistical Analysis System (SAS) at 5% level of significance, while the mean differences were separated using Least Significant Difference (LSD). Data were depicted as means±SEM to show mean data deviation.

Examined Parameters

Adult Emergence: Observations for adult emergence started after three weeks of infestation. The seeds were observed daily for adult emergence till the end. Percent adult emergence was calculated using following formula [15]:

$$\text{Percent adult emergence} = \frac{\text{Number of adult emerged}}{\text{Number of eggs laid}} \times 100$$

Developmental Period: The number of days taken by the insect to complete its life cycle from the egg to the adult stage on each variety was calculated. It was estimated using the following formulae [15]:

$$\text{Mean developmental period} = \frac{D1\ A1 + D2\ A2 + D3\ A3 + \ldots\ldots\ldots + Dn\ An}{\text{Total number of adult emerged}}$$

where D_1 is the day at which adults started emerging (first day), A_1 is the number of adults emerged on $D1^{th}$ day.

Susceptibility Index: The total numbers of *B. incarnatus* adults that emerged and the mean developmental period were combined to calculate the susceptibility index for each variety using Dobie's formula [16]:

$$\text{Dobie's Susceptibility Index (SI)} = \frac{\text{Loge } F}{D} \times 100$$

where F is the total number of F1 emerged adults, D is the median development period (days).

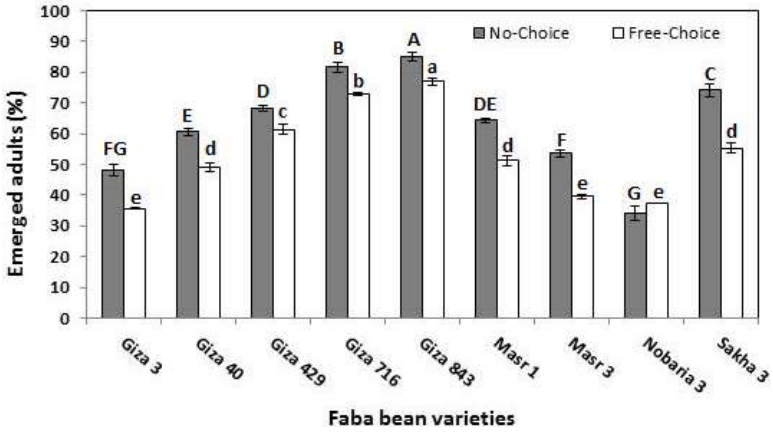
Based on the Dobie's susceptibility index, the faba bean varieties were grouped into four categories as resistant: SI 0 - 3; moderately resistant: SI 4 - 7; susceptible: SI 8 - 10; highly susceptible: SI > 11 [17].

Percentage of Weight Loss: To calculate weight loss percentage, the content of each container was sieved to remove frass and any insects present within the seeds. The seeds were re-weighed and the weight loss percentage was determined as the difference between the initial and the final weights of seeds in each replicate divided by the initial weight, then multiplied by 100 as described by [18].

$$\text{Weight loss (\%)} = \frac{\text{Difference in weight}}{\text{Initial weight}} \times \frac{100}{1}$$

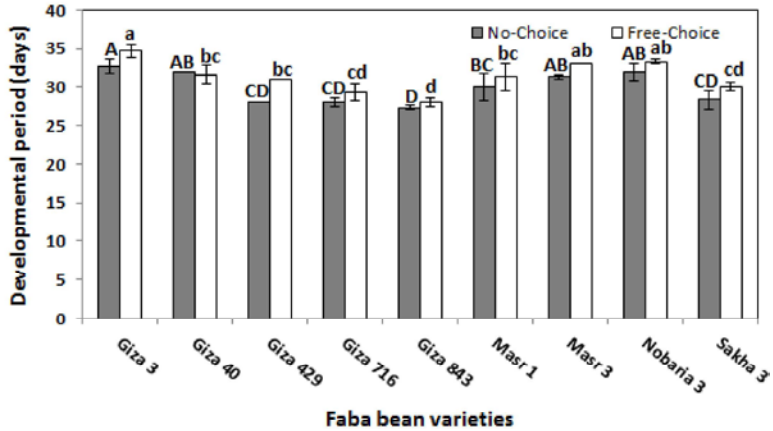
RESULTS AND DISCUSSION

Percentage of Adult Emergence: Data in Fig. 1 showed the mean percentage of adult emergence on faba bean varieties in no-choice and free-choice test. In case of no-choice test the lowest percentage of adult emergence was noticed in Nobaria 3, Giza 3 and Masr 3 (34.28±2.31, 48.02±1.76 and 53.50±1.20%, respectively). While the moderate percentage of adult emergence was recorded in



Values for each mean in the different columns, followed by the same capital or small letter, are not significantly different at P = 0.05

Fig. 1: Mean percentage of *B. incarnatus* F1 adult emerged after being reared on nine varieties of faba bean

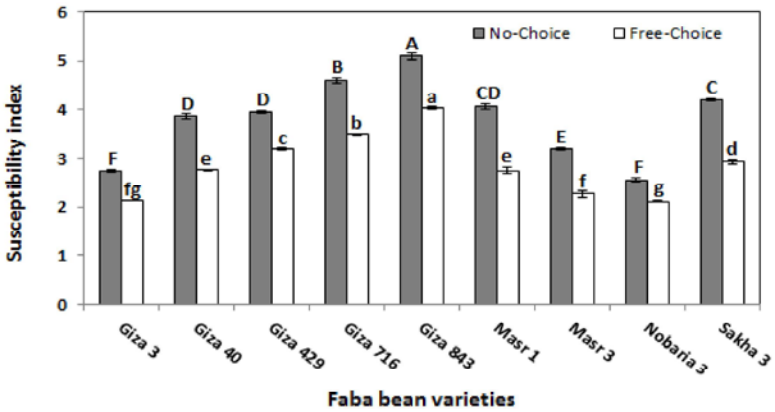


Values for each mean in the different columns, followed by the same capital or small letter, are not significantly different at P=0.05

Fig. 2: Mean development period of F1 adult *B. incarnatus* after reared on nine varieties of faba bean.

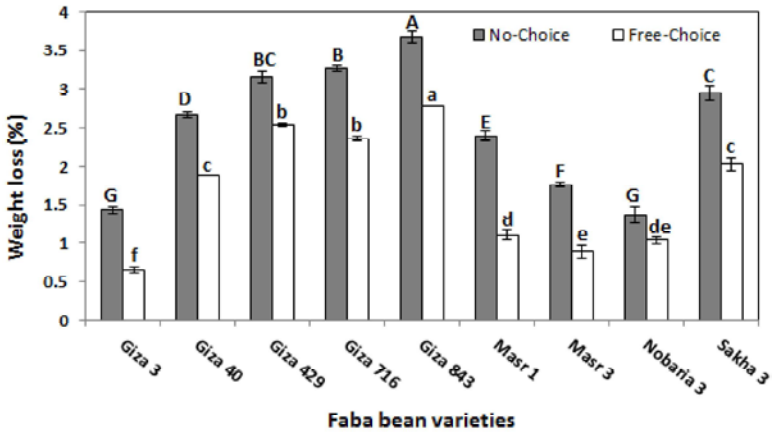
Giza 429, Masr 1 and Giza 40 (68.11±1.00, 64.24±0.66 and 60.70±1.15 %, respectively). Whereas the highest percentage of adult emergence was recorded in Giza 843, Giza 716 and Sakha 3 (85.0±1.52, 81.65±1.66 and 74.10±2.03%, respectively). In case of the free-choice test, the highest percentage of adult emergence was recorded in Giza 843, Giza 716 and Giza 429 (76.86±1.15, 72.97±0.57 and 61.37±1.75%, respectively). Whereas the moderate percentage of adult emergence was recorded in Sakha3, Masr 1 and Giza 40 (55.17±1.65, 51.17±1.76 and 48.86±1.45%, respectively). The lowest percentage of adult emergence was noticed in Giza 3, Nobaria 3 and Masr 3 (35.70±0.33, 37.51±0.0 and 39.62±0.66%, respectively).

Developmental Period: Data in Fig. 2 showed the mean number of *B. incarnatus* developmental period reared on the faba bean varieties in no-choice and free-choice tests. In case of no-choice test, the minimum developmental period was noticed in Giza 843, Giza 716, Giza 429 and Sakha 3 (27.33±0.33, 28.0±0.57, 28.0±0.0 and 28.33±1.20 days, respectively). While, the moderate developmental period was recorded in Masr 1 and Masr 3 (30.0±1.73 and 31.33±0.33 days, respectively).Whereas, maximum developmental period was recorded in Giza 3, Giza 40 and Nobaria 3 (32.66±0.88, 32.0±0.0 and 32.0±1.15 days, respectively). In case of free-choice test the maximum developmental period was recorded in Giza 3, Nobaria 3 and Masr 3 (34.66±0.88, 33.33±0.33 and 33.0±0.0 days,



Values for each mean in the different columns, followed by the same capital or small letter, are not significantly different at P=0.05

Fig. 3: Mean susceptibility index of nine varieties of faba bean infested with *B. **incarnatus***



Values for each mean in the different columns, followed by the same capital or small letter, are not significantly different at P=0.05

Fig. 4: Mean percentage of weight loss in faba bean varieties due to infestation by *B. incarnatus*

respectively). Whereas moderate developmental period was recorded in Giza 40, Masr 1 and Giza 429 (31.66±1.20, 31.33±1.76 and 31.0±0.0 days, respectively). The minimum developmental period was noticed in Giza 843, Giza 716 and Sakha 3 (28.0±0.57, 29.33±1.15 and 30.0±0.57 days, respectively).

Susceptibility Index: Data in Fig. 3 showed the mean susceptibility index of the faba bean varieties in no-choice and free-choice test to *B. incarnatus*. In case of no-choice test, the lowest susceptibility index was noticed in Nobaria 3, Giza 3 and Masr 3 (2.56±0.04, 2.75±0.02 and 3.19±0.03, respectively). While, the moderate susceptibility index was recorded in Masr 1, Giza 429 and Giza 40 (4.06±0.06, 3.95±0.02 and 3.86±0.05, respectively). Whereas the highest susceptibility index was recorded in Giza 843, Giza 716 and Sakha 3 (5.09±0.08, 4.60±0.05 and 4.21±0.03, respectively). In case free-choice test, the highest susceptibility index was recorded in Giza 843, Giza 716 and Giza 429 (4.03±0.03, 3.49±0.01 and 3.20±0.02, respectively). Whereas moderate susceptibility index was recorded in Sakha3, Giza 40 and Masr 1 (2.93±0.04, 2.77±0.01 and 2.75±0.07, respectively). While, The lowest susceptibility index was noticed in Nobaria 3, Giza 3 and Masr 3 (2.11±0.02, 2.14±0.0 and 2.26±0.08, respectively).

Percentage of Weight Loss: Data in Fig. 4 showed the mean percentage of weight loss of the faba bean varieties caused by *B. incarnatus* in no-choice and free-choice test. In case of no-choice test the lowest percentage of weight loss was noticed in Nobaria 3, Giza 3 and Masr 3 (1.37±0.10, 1.43±0.05 and 1.76±0.03%, respectively).

While the moderate percentage of weight loss was recorded in Sakha 3, Giza 40 and Masr 1 (2.95±0.10, 2.67±0.04 and 2.40±0.06%, respectively). Whereas the highest percentage of weight loss was recorded in Giza 843, Giza 716 and Giza 429 (3.68±0.08, 3.27±0.03 and 3.16±0.08%, respectively). In case of free-choice test, the highest percentage of weight loss was recorded in Giza 843, Giza 429 and Giza 716 (2.79±0.0, 2.54±0.02 and 2.36±0.03%, respectively). Whereas the moderate percentage of weight loss was recorded in Sakha 3, Giza 40 and Masr 1 (2.03±0.08, 1.88±0.00 and 1.11±0.06%, respectively). While, The lowest percentage of weight loss was noticed in Giza 3, Masr 3 and Nobaria 3 (0.66±0.04, 0.89±0.09 and 1.04±0.05%, respectively).

The development of *Callosobruchus maculatus* (F.) from egg to adult lasted 28 days on *V. faba* [19]. Sixteen varieties of seven species of some legumes for resistance to infestation by *Callosobruchus chinensis* L were tested. Results revealed that the greatest damage was observed on mung bean [*Vigna radiata* (L.) Wilcezk] and the least on lentil, broad bean (*V. faba*), cowpea (*Vigna unguiculata* L.) and chickpea (*Cicer arietinum* L.) [20]. The number of emerged adults of bruchid determines the extent of damage in cowpea and consequently more emerged adult; more extensive damage will be [21]. Also, faba bean varieties with lowest percent of emerging adults (17.4 %) among 35 tested varieties against *C. maculatus* (F.) were found [22]. The percentage of adult emergence of *B. incarnatus* and *C. maculatus* was not significantly different on seven seed legumes. Whereas cowpea was the most resistant to *B. incarnatus* and the pea was the most resistant to *C. maculatus*. Both insects failed to develop on haricot bean and lupin [23]. The weight loss is generally highly correlated with susceptibility index [24]. Interaction between ten faba bean varieties and *C. maculatus* was studied. Results showed an obvious variation in the percentage of emerged adults, while the developmental period did not vary significantly [25]. Also, Eight different varieties of mungbean were evaluated for their susceptibility to *C. chinensis* on the basis of duration of development, percentage adult emergence and weight loss. The varieties MB-2456 and Kanti were found to be highly susceptible, with 13.6 and 13.0% loss in the weight of seeds, respectively [26]. The susceptibility of four pulses, cowpea, faba bean and two varieties of *Phaseolus vulgaris* to *Callosobruchus phaseoli* (Gyll.) infestation using choice and non-choice tests was essayed. The beetle showed various responses to the seeds with regard to the number of adult emergence [27]. Sixteen seed varieties of broad bean were screened for their relative susceptibility to the infestation by two storage bruchids, *C. chinensis* and *C. maculatus*, under no-choice condition. Thier relative susceptibility was according to the mean developmental period (MDP), adult emergence (%), the values of susceptibility index (SI) and the weight loss. The results revealed that the seed varieties were more susceptible to infestation by *C. chinensis* than *C. maculatus* in respect to the values of the susceptibility index (SI) and weight loss [28]. The comparative susceptibility of ten legume seeds to infestation by *C. Maculatus* in choice and no-choice experiments was conducted. The results showed that cowpea, garden pea and pigeon pea seeds recorded the highest significantpercentage of adult emergence, the shortest developmental period, the highest susceptibility indices and the highest weight loss [29]. In Uganda, 45 genotypes of the common bean germplasm were evaluated for resistance to bean bruchids, *A. obtectus* and *Z. subfasciatus*. Outcomes showed that all 45 genotypes were susceptible as they severely damaged by bean bruchids [30].

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