INFESTATION POTENTIAL OF *CALLOSOBRUCHUS CHINENSIS* AND *C. MACUATUS* ON CERTAIN BROADBEAN SEED VARIETIES

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Abstract

Sixteen seed varieties of broadbean crop were screened for their relative susceptibility or resistance against infestation by the two storage bruchids, *Callosobruchus chinensis* and *C. maculatus* in a non-choice condition. Many biological parameters were studied as fecundity, eggs hatching (%), mean developmental period (MDP days), adult emergence (%) and the values of growth index or susceptibility index (SI). The resultant weight loss was also calculated on the dry weight basis. All tested parameters were found in a vulnerable level but 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.

INTRODUCTION

The family Bruchidae consists of approximately 1300 species, grouped into 56 genera placed within 5 subfamilies. They exist in every continent especially in tropical regions of Asia, Africa and central and South America except Antarctica (Southgate, 1979). Some of the bruchid species have showed high specificity to one or more species of host plant while others are capable to feed and breed on a wide range of hosts (Johnson, 1981). Among storage bruchids, the pulse beetle, *C. chinensis* and the cowpea beetle, *C. maculatus* are considered serious pests, causing immense damage every year to many varieties of the pulse seeds. They able to generate exceedingly high levels of infestation even when they were passed only one or two generations on the host. *C. chinensis* and *C. maculatus* are cosmopolitan and polyvoltine species attacking seeds of different pulses in storage during warm season in Egypt (Shomar, 1963). The larvae of both bruchids feed on the pulse seed contents, reducing their degree of usefulness unfit to become either for planting or for human consumption. They have showed great variations in their behavior, ecology and morphology (Avidov *et al.,* 1965, Yadav and Pant, 1978 and Chun and Ryo, 1992).

Now there has been a move between plant breeders and entomologists to improve grain legume crops by breeding varieties that gives higher yields and are resistant to the pests that devastate the current varieties. Faba bean is important food crop in Egypt and represents the main focus of ICARDA Food Legume program. Faba bean seeds are liable to attack during storage by several insect pests. Studies of crop resistance against insect pests are of great important tool in insect control because of the different varieties of fababean seeds have some variations in their susceptibilities to bruchid infestation (Mahgoub and Khalifa, 1993). It is clear that no comparative and available study is found to determine the susceptibility of faba bean varieties. Lack of researches on the susceptibility of new seed varieties of broad bean to both *Callosobruchus spp.* Infestation in Egypt is found. So the present work is an attempt to study the susceptibility of 16 seed varieties of brodbean, now are commonly cultivated in Egypt.

MATERIALS AND METHODS

1. Insect cultures: The pulse beetle, *C. chinensis* and the cowpea beetle, *C. maculatus* previously reared on a commercial variety of broad bean seed were used in the present work. The two sexes of the beetles were easily distinguished and identified according to the key of Southgate (1958) and Shomar (1963).

2. The tested seed varieties: 16 varieties of the broadbean seeds developed by Food Legume Research section of the Field Crop Research Institute were used in the present study. The varieties were cleaned by washing in ether and left to dry at room temperature and then stored in refrigerator until use.

3. Infestation procedure and measured criteria: Groups of five grams seeds of the different varieties were distributed in a small tubes. At least ten replicates were made from each variety; five ones were used for each insect species. The glass tubes with weighed seeds were incubated at 28 ±1 °C_and 60±5 % R.H. for a week for equilibrium conditioning. Each replicate was infested with a pair of newly emerged adults and left to oviposit, then removed after dying. The tubes were kept in the same conditions for a further week. The deposited eggs and the hatched ones were counted followed by daily check for adult emergence. The emerged adults were counted from each tube and the developmental period was estimated from the time of eggs laying up to the appearance of first adult.

4. Susceptibility Index (SI): The total number of emerged adults was counted and the percentage of adult emergence was calculated in relation to the number of hatched larvae. The developmental period of the immature stages was taken as criteria for calculating the susceptibility indices according to Howe (1971) and Dobie (1974) as follows:

$$\text{Susceptibility index (SI)} = \frac{\text{Log } S}{T} \times 100$$

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

The values of susceptibility indices were categorized into five ranks according to Mensah (1986) as following:

A. The values between 0.0 - 2.5 are considered resistant variety **(R)**.

B. Those between 2.6 - 5.0 are considered moderately resistant variety **(MR).**

C. The values between, 5.1- 7.5 are considered moderately susceptible variety **(MS).**

D. The values between (7.6– 10.0) are considered susceptible variety **(S).**

E. Those > 10.0 are considered highly susceptible variety **(HS).**

5. Weight loss (%) : The used seeds after adult emergence were reweigh. Quantitative losses arising from the portion of seeds consumed by the larval stages of the bruchids were estimated by finding the differences in the weight of the replicates before (5 g) and after infestation. The frass and all dusts were carefully removed and the moisture content was adjusted before reweighing. The weight loss (%) was calculated as follows:

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

On the basis of the quantitative losses, Khare and Johari (1984) provided a category to the obtained values into the following:

A. The values of weight loss (%) between 8.4 to 16.3 %, are considered least susceptible variety **(LS).**

B. The values of weight loss (%) between 16.3 to 24.3 %, are considered moderately susceptible variety **(MS).**

C. The values of weight loss (%) above 24.3 % are considered highly susceptible variety **(HS).**

3. Statistical analysis: The obtained data were statistically analyzed using the analysis of variance (ANOVA) test using a computer program (Costat). Means were detected and compared by Duncan multiple range test at 0.05% probability level .Standard error was also calculated. This to compare the species behavior and its response to infest and damage the different pulse seeds and determining the most and the least susceptible / or the resistant pulse for each species.

RESULTS AND DISCUSSION

Susceptibility of sixteen seed varieties of the broadbean, *Vicia faba* to *C. chinensis* and *C. maculatus* infestation are shown in the Tables 1 and 2. The oviposition rate of the two bruchids reared on sixteen varieties under a non-choice condition showed significant variations to the species and the tested variety. Giza Blanka variety and G. 461 have received the highest number of eggs by *C. chinensis* and *C. maculatus*, respectively, while G. 717 and Saka 40 showed smaller numbers of eggs by both *C. chinensis* and *C. maculatus*. However, the varieties in general received moderate numbers of eggs by *C. maculatus* and *C. chinensis*. Taking the percentages of larval penetration and development into consideration, the maximum grubs penetration was achieved on G. 429 variety by *C. chinensis* and on G .462 varieties by *C. maculatus*. The remaining varieties are also of high values, although showed insignificant variations. Mean developmental period (MDP) of *C. chinensis* larvae ranged from 25.0 to 27.3 days and that of *C. maculatus* was ranged from 31.3

to 35.0 days. Percentages of adult emergence of the two bruchids are significant. Giza 402 and G. 462 produced lower percentages of adults while G. 43 and T.W variety gave the highest production of adults for *C. chinensis* and *C. maculatus*. It is evident that the above results concerning eggs production, larval penetration, MDP, and adult emergence are always inconsistent indicating that resistance is most likely lying within the seed testa. The varieties received more eggs from *C. maculatus* than *C. chinensis* and vice versa for adult emergence. Regarding to the SI values, the varieties are considered susceptible to moderately susceptible to *C. chinensis* infestation Table 1, while most of them are considered moderately resistant to *C. maculatus* infestation Table 2. Moreover, most of the varieties sustained, suffered from moderate to fairly weight loss Table 3. Janzen (1977) analyzed the perforation capacity of *C. maculatus* larvae in seeds of 73 species of leguminousae and demonstrated the importance of the seed coat in the relationships between the bruchids and their host plants. The thick seed coat prevents the penetration of the larvae in 69.5 % of the tested seeds. Once again the texture of the seed coat, its thickness and its chemical composition may explain these results. The susceptibility of sixteen seed varieties of broadbean, *Vicia faba* (L.) to bruchid infestation showed that egg production, larval penetration, MDP, and adult emergence are inconsistent parameters; this indicated that resistance is most likely lies within the seed testa. All the tested varieties received more eggs from *C. maculatus* than *C. chinensis* while the opposite was occurred in respect to adult emergence. The obtained calculated susceptibility indices indicated that the tested broadbean varieties are considered moderately resistant (MR) to *C. maculatus* infestation while the tested varieties were moderately susceptible (MS) to *C. chinensis* attack.

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Table 1. Susceptibility of the broadbean seed varieties to *C. chinensis* infestation.

Seed variety	Fecundity (eggs no.)	Larval penetration (%)	MDP (Days)	Adult emergence (%)	Susceptibility Index (SI)
Giza 461	57.5±5.2bc	95.03±1.1ab	26.3±0.48abc	84.0±3.01ab	7.33± 0.13abc (MS)
G. 462	55.8±1.93bc	92.8±1.48ab	26.8t±0.48ab	78.5±4.7abc	7.10±0.2abc (MS)
G. 402	62.3±4.3b	94.4±0.4bab	25.3±0.48cd	61.3±9.1c	6.95± 0.4c (MS)
G. Blanka	75.3±4.5a	95.1±44ab	26.8±0.63ab	77.85±4.17a bc	7.14± 0.19abc (MS)
G. 714	52.0±5.1bc	95.5±0.8ab	27.3±0.3a	76.6±4.9abc	6.90± 0.19c (MS)
G. 716	52.5±5.72bc	93.5±2.91ab	26.25±0.25abc	67.6±5.4bc	6.95± 0.1c (MS)
G. 717	44.5 ±0.3 c	95.1±1.7ab	26.0±0.44bcd	75.2±3.6abc	7.20± 0.12abc (MS)
G. 429	62.5±3.3b	96.8±0.16a	26.75±0.25ab	79.3±5.8ab	7.08± 0.17bc (MS)
G. 643	50.5±4.8bc	94.0±1.43ab	26.3±0.49abc	85.83±2.3a	7.40± 0.15abc (MS)
G. 667	53.5±9.2bc	91.7±1.6b	26.25±0.25abc	80.3±2.3ab	7.25± 0.06abc (MS)
G. 674	55.8±2.4bc	93.5±1.9ab	26.5±0.29ab	71.9±8.5abc	6.98± 0.27C(MS)
G. 2	48.5±4.35	92.1±2.1ab	26.3±0.25abc	85.4 ±4.2a	7.35± 0.19abc (MS)
G. 3	47.0±3.3c	92.7±0.9ab	25.3±0.3cd	83.2±2.7ab	7.63± 0.19ab (S)
Saka 40	48.5±3.07bc	92.6±1.5ab	25.0±0.0D	85.1±5.06a	7.70± 0.11a (S)
Pakistani	54.5±2.6bc	96.3±0.75ab	27.0± o.0ab	79.9±5.2ab	6.98± 0.16c (MS)
T. W	52.5±4.4bc	95.2±0.6ab	26.3±0.3abc	84.4±1.97ab	7.35± 0.06abc (MS)
F- value	3.01	NS	3.2	1.85	1.87
LSD- 5%	12.17	-	1.01	14.09	0.5

Means within a column followed by a same letter(s) are not significantly different at 5% level of significance. S= susceptible, MS= moderately susceptible.
G= Giza

Table 2. Susceptibility of the broadbean seeds varieties to *C. maculatus* infestation.

Seed variety	Fecundity (eggs no.)	Larval penetration (%)	MDP (Days)	Adult emergence (%)	Susceptibility Index (SI)
Giza 461	91.5±4.4a	95.4±0.5a	31.3±0.8e	42.1±6.2b	5.20±0.3abc (MS)
G. 462	74.3±6.16abc	97.3±0.3a	34.8±0.63ab	21.2±2.6c	3.70±0.25e (MR)
G. 402	80.3±3.84ab	94.7±1.5ab	32.3±0.3cde	43.5±3.6b	5.10±0.1abc (MS)
G. Blanka	75.0±3.1abc	95.6±0.8a	34.0±0.71abc	45.4±5.9b	4.80±0.21 bcd (MR)
Giza 714	80.5±6.7abc	93.9±0.5ab	33.0± 0.41xd	43.5±5.1b	4.80±0.4bcd (MR)
G. 716	87.0±4.7ab	95.5±0.86a	33.0± 0.41bcd	43.2±5.3b	4.95± 0.21abcd (MR)
G. 717	74.3±3.1abc	93.6±1.4b	31.8±0.63de	47.2±4.7b	5.30± 0.17b (MS)
G. 429	75.8±4.5abc	93.6± 1.29ab	33.0± 0.41bcd	48.5± 4.1b	5.10± 0.05abc (MS)
G. 643	84.5±7.01ab	94.5± 0.6ab	33.5± 0.3abcd	46.4± 4.1b	4.96± 0.1abcd (MR)
G. 667	85.5± 5.5ab	93.9±1.7ab	33.3±0.48bcd	44.5±6.3b	4.93± 0.3abcd (MR)
G. 674	73.5± 8.1bc	94.6±1.13ab	33.5± 0.65 abcd	45.8±5.4b	4.95± 0.3abcd (MR)
G. 2	77.3±4.03abc	92.8±1.4ab	35.0±0.6a	32.9±7.1bc	4.3±0.28de (MR)
G. 3	70.8± 4.4bc	92.6±1.4ab	33± 0.41bcd	45.8±6.01b	5.01± 0.09abcd (MR)
Saka 40	64.3± 3.04bc	92.1±1.5ab	33.3± 0.3bcd	41.8±2.7b	4.89± 0.1abcd (MR)
Pakistani	80.3±7.4cbc	94.7±1.2ab	34.3±0.5ab	32.7± 4.1bc	4.4±0.2cd (MR)
T. w	80.3± 7.4abc	93.9±1.8ab	32.3± 0.8cde	64.3±6.8a	5.63±0.3a (MS)
F- value	1.75	NS	3.66	2.46	3.7
LSD- 5%	14.9	-	1.51	11.8	0.65

Means within a column followed by the same letter(s) are not significantly different from each other at 5% level of significance. MS= moderately susceptible, MR= moderately resistant.
G= Giza

Table 3. Weight loss (%) in different broadbean seed varieties caused by *C.chinensis* and *C. maculatus* (F.) infestation.

Seed Variety	Weight loss (%)	
	C.chinensis	*C.maculates*
Giza. 461	14.7±1.7bcde (LS)	20.6±2.5a (MS)
G. 462	17.3±0.6b (MS)	8.6±0.96c (LS)
G. 402	16.5±1.1b (MS)	19.8±1.9a (MS)
G. Blanka	20.15±0.45a (MS)	16.3± 0ab (MS)
G. 714	12.03±1.2ef (LS)	14.7±2.4ab (LS)
G. 716	13.10±0.49cdef (LS)	15.5±2.98ab (LS)
G. 717	10.83±0.57f (LS)	17.4± 0.84ab (MS)
G. 429	15.80±0.6bcd (LS)	15.6± 1.42ab(LS)
G. 643	14.73±1.48bcde (LS)	17.5± 1.3ab (MS)
G. 667	14.80±1.4bcde (LS)	16.1± 1.52ab (LS)
G. 674	16.4±0.91bc (MS)	16.7± 0.97ab (MS)
G. 2	14.9±1.3bcde (LS)	12.9± 2.4bc (LS)
G. 3	12.7±0.86 (LS)	9.68± 0.9ab (LS)
Saka 40	13.7±0.7bcdef (LS)	12.4± 1.17bc (LS)
Pakistani	11.98±1.1ef (LS)	13.1±3.0bc (LS)
T. W	12.95±0.90cdef (LS)	17.3±1.8ab (MS)
F- value	4.89	2.3
LSD- 5%	1.89	3.5

Means within a column followed by the same letter(s) are not significantly different from each other at 5% level of significance, MS=moderately susceptible and LS=Least susceptible.

درجات الإصابة بحشرتى خنفساء البقول وخنفساء اللوبيا على بذور أصناف الفول البلدى

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فـــى هذة الدراسة تم أختبار وتقدير حساسية بذور ستة عشر صنفا من أصناف الفول البلدى للإصـــابة بحشـــرتين من أخطر خنافس البقول عند الخزن وهما حشرتى خنفساء اللوبيا و خنفساء الـــبقول بطريقة عدم الاختيار (أو عدم التفضيل) حيث تم فى الدراسة تحديد سلوك ونمو الحشرتين بتقدير العديد من الصفات البيولوجية للحشرتين على بذور كل صنف مثل عدد البيض الكلى ونسبة الفقس ومتوسط فترة التكوين أو التطور وكذلك حساب كل من قيم دليل الحساسية ونسبة الفقد فى الوزن على أساس الوزن الجاف عند ظروف معملية من حرارة ٢٨ ±٢ درجه مئوية ورطوبة نسبية ٦٠± ٥ %.وقــد أظهــرت النتائج أن كل الأصناف المختبرة كانت حساسة للإصابة بكلا الحشرتين بدرجـــات مـــتفاوتة ولم يتواجد آي صنف منيع تماما للإصابة بأي من الحشرتين حيث أظهرت قيم دلـــيل الحساسية لمعظم الأصناف شدة حساسيتها للإصابة بحشرة خنفساء البقول بدرجة أكبر من حشـــرة خنفساء اللوبيا بينما وجد العكس صحيح فى حالة نسبة الفقد فى الوزن حيث وجد أيضا أن كل الأصناف المختبرة حدث بها خسائر فى الوزن بدرجات متفاوتة وكان جيزة ٧١٧ أقل الاصناف بيـــنما أكثرها جيزة بلانكا نتيجة الإصابة بحشرة خنفساء البقول .وبالنسبة لحشرة خنفساء اللوبيا كان الصنف جيزة ٤٦١ أكثرها حساسية بينما وجد أن الصنف ٤٦٢ أقلها-إصابة. وقد أظهرت الدراسة أيضا آن الاصناف المختلفة كانت أكثر حساسية للإصابة بحشرة خنفساء البقول بينما لوحظ درجات متفاوتة ومنخفضة من دليل الحساسية لحشرة خنفساء اللوبيا مع طول فترة النمو كان أكبر دليل على وجود بعض المقاومة ضد الإصابة بهذه الحشرة.