INFESTATION POTENTIAL OF *COLLOSOBRUCHUS MACULATUS* (F.) ON SOME COWPEA AND FABA BEAN VARIETIES

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Abstract

The vulnerability of the tested varieties of cowpea and faba bean seeds to post-harvest infestation by *Collosobruchus maculatus* (F.) revealed that Karim 7 was the least susceptible cowpea variety while Kafr El-Sheikh-1 was the most susceptible. For faba bean varieties, Giza 429 was the most infested and Giza 674 proved to be the least susceptible. These results were based on duration of *C. maculatus* (F.) reared on these varieties, survival rates, rate of emerged beetles and female fecundity.

INTRODUCTION

Cowpea, *Vigna unguiculata* Walp. and faba bean, *Vicia faba* L. are important and widely consumed grain legumes in different subtropics and tropical parts of the world. They provide more than half the plant protein in human diets and they are a key source of protein for the poorest sector of many developing countries.

Species of the genus *Collosobruchus* (Coleoptera: Bruchidae) are very damaging pests of stored legumes. A part from the most widely distributed species such as *Collosobruchus maculatus* (F.) and *Collosobruchus chinensis* (L.). According to Shomar (1963), *Collosobruchus maculatus* (F.) is polyvaltine occurring all over Egypt during June – August and develops in black eyed cowpeas, broad beans and peas.

Development, mortality and oviposition of several species of Bruchidae bred on stored pulses were studied (Howe and Currie 1964 and El-Banby and Mansour 1970). The effect of host availability on the reproduction performance and development in *C. maculatus* (F.) usually depended upon number of the cowpeas to which they had sole access (Credland 1986) while insect development was greatly affected by kind of legume food and environmental temperature (Giga and Smith, 1987).

The present paper deals with development, egg production and survival rate of *C. maculatus* bred on different seeds of cowpea and faba bean varieties in order to shed light on the susceptibility of different commercial varieties of both cowpea and faba bean to insect infestation.

MATERIALS AND METHODS

1.The development of *Callosobruchus maculatus* (F.) on cowpea and faba bean seeds:

To determine the developmental time, mortality, egg production and adult longevity of *C. maculatus* on cowpea and faba bean, five replicates from each seed variety (100 seeds each) were collected. Seeds of each replicate were kept in a plastic tube (2 x 1/inche). Each replicate of one pair (♀ and ♂) of newly emerged beetles, 0 - 24 hrs-old, was confined on seeds previously conditioned at 28 ± 2 °C and 60 - 70 % R. H. The 25 tubes of each experimental series were covered with muslin secured by rubber bands and were kept in an incubator at 28 ± 2°C and 60 – 70 % R.H. Two weeks after the starting of the experiment, dead and alive beetles were removed and the total eggs deposited by each female was counted. Number of hatched eggs and egg density per seed were also recorded. Daily observations were conducted and developmental periods were estimated as the black colour of emergence windows appear on the seeds. Number of newly-emerged beetles per day, percent adult emergence and adult survival were estimated and recorded until three consecutive days pass without adult emergence. Also the growth index reported by Howe (1971) was applied [Log S/T x 100, where S is the percentage progeny and T is the mean developmental period] to compare the suitability of cowpea and faba beans to insect infestation. Similarly, the rate of adult population growth in the various pulse seeds was also calculated according to the following formula (El-Lakwah, 1978):

$$r = \frac{\text{Log } N/N_o}{\text{Log } e/t}$$

where :

r = Rate of population growth

N = Number of beetles after certain time

t = Time

N_o = Number of beetles at the beginning of the experiment

e = Basic of natural logarithm = 2.7

2.The relative susceptibility of different cowpea and faba bean varieties to *Callosobruchus maculatus* (F.) infestation:

a- Source of experimental insects A laboratory culture of *C. maculatus* was started from infested cowpea obtained from local market. The colony was maintained in incubator at 28 ± 2 °C and 60 – 70 % R. H. *C. maculatus* was reared separately on both cowpea and faba bean local varieties which are known to be very susceptible to bruchids. This was done to ensure that F_1 adults used in the investigation had the same background.

b- Source of cowpea and faba bean varieties Four cowpea as well as four faba bean varieties were used in this study. These included pure germplasm line and local varieties which are known to be moderately resistant to *C. maculatus* (F.). Cowpea varieties were obtained from the Horticulture Research Institute, ARC, Ministry of Agriculture and Land Reclamation, Giza, Egypt.

Cowpea varieties included Karim7, Dokki 331, Kafr El-Sheikh-1 and CLV (cowpea local variety). On the other hand, faba bean varieties were obtained from the Field Crops Research Institute, ARC, Ministry of Agriculture and Land Reclamation, Giza, Egypt. Faba bean varieties were Giza 429, Giza 674, Giza 843 and Sakha-1.

c- Mean developmental period and mortality Sound seeds with intact testa were selected from the cowpea and faba bean seeds supplied. These were heated at 60°C in a fan-ventilated oven for 6 hrs. to kill all insects and mites that might be present in them. Each variety batch had 20 seeds selected randomly and dissected to ascertain that the seeds were free from internally developing beetles.

Five grams of each variety were added into small glass jar (100 ml) in replicates of four. A total of 40 jars (20 jars of cowpea and 20 jars of faba bean) were used. Jars were infested with 0 - 24 hrs-old adults of *C. maculatus* taken from laboratory stock cultures . A total of 120 weevils of 40 females and 80 males were used, one female and two males per each jar. The jars were then covered with muslin cloth, secured in place with rubber bands, and stored in an incubator adjusted at 28 ± 2 °C and 60 – 70 % R. H.

After 15 days of continuos exposure to the cowpea and faba beans in a no-choice situation, the weevils were removed and discarded. Jars were daily examined until the emergence of the new adults. Daily counts of F_1 progeny were taken until no more progeny emerged.

Total number of deposited eggs on each variety, developmental period, mortality and total number of emerged beetles were assessed. Susceptibility of the cowpea and faba bean varieties to *C. maculatus* (F.) was assessed according to the method developed by Howe (1971) and Dobie (1974):

Index of susceptibility = Log F_1 / D x 100

Where:

(F_1) is the total number of emerging adults

(D) is the median developmental period.

The susceptibility indices were compared among the varieties and separated by the Duncan's multiple-range test (Duncan, 1955).

RESULTS AND DISCUSSION

1. Cowpea varieties The vulnerability of the tested varieties to post-harvest infestation by *Callosobruchus maculatus* (F.) is given in Tables 1 and 2. There were significant differences (P = 0.01) between varieties on the development and emergence of F_1 progeny.

Larvae developed in cowpea seed varieties required 24.3, 23.1, 30.5 and 28.5 days for Karim 7, Dokki 331, local and Kafr El-Sheikh-1 varieties, respectively. These results may clear that Dokki 331 enhanced larvae to develop faster than other varieties while local seeds opposed immatures development, therefore, they required longer time period (30.5 days) to complete development.

Concerning mortality rates of immaturs, particulary larval stage, data in table showed great variability. However the developmental period of larvae in seeds of Dokki 331 was the shortest (23.1 days), larvae suffered high mortality (44.8 %), while the lowest mortality (25.3 %) was shown by larvae developed in the seeds of the local variety which required longer time (30.5 days) to complete development. The non-linear correlation between developmental time and mortality ratios of the different test varieties could be due to variation of the ability of the newly hatched larvae to penetrate the coatlyed of the seeds successfully.

Table 1. Means of eggs production, percent of hatchability, mortality of immature and percent of adult emergence of *Callosobruchus maculatus* (F.) developed in different cowpea varieties.

Cowpea varieties	No. of eggs per female	No. of eggs per seed	% Hatchability	Developmental period (days)	% Mortality of immature	No. of emerged adults	% Adult emergence	Adult longevity (days)	
								Male	Female
Karim 7	67.8 ± 13.7 ^{a}	6.8 ± 1.4 ^{a}	90 ± 3.5 ^{a}	24.3 ± 0.4 ^{b}	48.3 ± 13.2 ^{a}	27.8 ± 4.8 ^{b}	51.7 ± 13.2 ^{a}	6.8 ± 0.3 ^{b}	9.8 ± 1.1 ^{c}
Dokki 331	76 ± 6 ^{a}	7.6 ± 0.6 ^{a}	87 ± 4.7 ^{a}	23.1 ± 0.3 ^{b}	44.8 ± 4.2 ^{a}	38.3 ± 5.5 ^{b}	55.2 ± 4.2 ^{a}	7 ± 0.4 ^{b}	10.5 ± 0.6 ^{bc}
Local	63.3 ± 16.2 ^{a}	6.3 ± 1.5 ^{a}	87.8 ± 7.9 ^{a}	30.5 ± 1.2 ^{a}	25.3 ± 10.8 ^{a}	39 ± 9.1 ^{b}	44.7 ± 10.8 ^{a}	8.8 ± 0.3 ^{a}	13.3 ± 0.5 ^{a}
Kafr El-Shiekh 1	97 ± 5.2 ^{a}	9.8 ± 0.6 ^{a}	90.8 ± 1.1 ^{a}	28.5 ± 0.2 ^{a}	30.3 ± 1.9 ^{a}	61.3 ± 3.1 ^{a}	69.7 ± 1.9 ^{a}	8 ± 0.8 ^{ab}	12.3 ± 0.5 ^{ab}
Average	76 ± 7.5	7.6 ± 0.8	88.9 ± 0.9	26.6 ± 1.7	37.2 ± 5.6	41.6 ± 7	62.8 ± 5.6	7.7 ± 0.5	11.5 ± 0.7

Means followed by the same letter in a column are not significantly different [P = 0.05, Duncan's multiple range test (1955)].

There was a wide variability between the varieties on the mean number of F_1 adults that emerged, which thus reflects the inherentability of a particular variety to resist pest attack. Breeding on Kafr El-Sheikh-1 seeds gave the highest number of progeny (61.3 adults) followed by local variety (39 adults) while the lowest progeny production was achieved by breeding on Karim 7 seeds (27.8 adults). Based on these results, Kafr El-Sheikh-1 variety seems to be the most susceptible to post-harvest infestation, followed by Local and Dokki 331 varieties. The lowest susceptible variety was Karim 7 ($P = 0.05$).

Assessment of infestation rates of the different cowpea varieties with *C. maculatus* as shown in Table 2 ensured the brevious derived results. Infestation percentages averaged 13.6 %, 16.8 %, 13.2 % and 17.6 % for the varieties Karim 7, Dokki 331, Local and Kafr El-Sheikh-1, respectively. These results also prove that Karim 7 and local varieties were the lowest infested while Kafr El-Sheikh-1 was highly infested with *C. maculatus* .

As shown in Table 2, *C. maculates* infestation drastically affected by cowpea seed viability. Germination percent of cowpea healthy seeds ranged between 89 % and 100%. Infested seeds of the different cowpea varieties exhibited enormus reduction in seed viability which ranged from 3.6 to 5.1 %. However seed germination of infested varieties did not show significant variations.

On the basis of index of susceptibility, only local variety exhibited some degree of tolerance to infestation by *Callosobruchus maculatus* (F.) while Kafr El-Sheikh-1 variety seems to be highly susceptible Table 2. The index of susceptibility, loss in seed quality and number of adult progeny emerged were used to assess the vulnerability of the cowpea varieties to post-harvest infestation (Mensah, 1986; Khattack *et al.,* 1987, Manoha and Yadav 1990 and Mbata, 1993).

Adults of *C. maculatus* (F.) oviposit freely on the seeds. Once the eggs have hatched, subsequent development would depends upon the ability of the larvae to penetrate into the seed and the available nutrients being able to support growth and development of the larvae into adults. Dobie (1974) has demonstrated that grain hardness, total protein and reducing sugars have significant effect on the inherent susceptibility of some maize varieties to post-harvest infestation by the maize weevil, *Sitophilus zeamais* and the angoumois grain moth, *Sitotroga cerealella.* High susceptibility of Kafr El-Sheikh-1 variety could be attributed to physical and chemical nature of the various types of cowpea seeds as well as the presence or absence of

certain nutrients which are some of the factors contributing to the differences in susceptibility of the varieties to the beetle attack.

2. Faba bean varieties The results of the multiple comparison of means of developmental period, larval mortality, number of emerged beetles and adult longevity of *C. maculatus* (F.) reared in different faba bean varieties Tables 3 and 4 indicated that larval mortality, adult progeny and adult longevity were significantly differed among the tested varieties. Progeny numbers were lowest in Giza 674 followed by Sakha-1 and increasing significantly in Giza 429. As would expected, mortality of larvae was the lowest in Giza 429 and increased significantly in Sakha-1 to amount 67.3%. However, these significant differences among faba bean tested varieties, insect developed was faster in Giza 429 (25.8 days), followed by Giza 674 (29 days). There were no significant differences between Giza 674, Giza 843 and Sakha-1 concerning developmental time of this insect species. Developmental period was significantly prolonged in Giza 843 as compared with Giza 429. Similarly, progeny developed in Giza 843 lived longer than in Giza 429, Giza 674 and Sakha-1. However, no significant differences were denoted (Table 3).

Table 2. Infestation rates, susceptibility indices (SI) and germination percentages of cowpea varieties to infestation by *C. maculatus* (F.).

Cowpea varieties	No. of test seeds	No. of holed seeds	% Infestation	Indices of susceptibility (SI)	% Germination
Karim 7	50	6.8 [a]	13.6 [a]	5.7 [a]	4.7 [a]
Dokki 331	50	8.4 [a]	16.8 [a]	6.1 [a]	5.1 [a]
Local	50	6.6 [a]	13.2 [a]	5.2 [a]	4.9 [a]
Kafr El-Shiekh 1	50	8.8 [a]	17.6 [a]	6.3 [a]	3.6 [a]
Average	50 ± 0	7.7 ± 0.6	15.3 ± 1	5.8 ± 0.2	4.6 ± 0.3

Means followed by the same letter in a column are not significantly different [P = 0.05, Duncan,s multiple range test (1955)].

Table 3. Means of eggs production, percent of hatchability, mortality of immature and percent of adult emergence of *Callosobruchus maculatus* (F.) developed in different faba bean varieties.

Faba bean varieties	No. of eggs per female	No. of eggs per seed	% Hatchability	Developmental period (days)	% Mortality of immature	No. of emerged adults	% Adult emergence	Adult longevity (days)	
								Male	Female
Giza 429	72 ± 9.5 [a]	7.3 ± 1.1 [a]	85.5 ± 4.9 [a]	25.8 ± 0.8 [b]	40.5 ± 7 [b]	36.3 ± 5.3 [a]	59.5 ± 7 [a]	6.8 ± 0.3 b	12.3 ± 0.5 a
Giza 674	57.3 ± 11.2 [a]	7.3 ± 1.7 [a]	81 ± 5.7 [a]	29 ± 1 [a]	69.8 ± 5 [a]	14.3 ± 4.9 [b]	30.3 ± 5 [b]	9.3 ± 0.5 a	13.5 ± 1.7 a
Giza 843	69.5 ± 10.6 [a]	7.3 ± 1 [a]	84.3 ± 4.3 [a]	31.3 ± 0.9 [a]	53.8 ± 3.2 [ab]	26 ± 2.3 [ab]	46.3 ± 3.2 [ab]	10 ± 0.7 a	13.3 ± 1.5 a
Sakha 1	70.3 ± 1.9 [a]	7 ± 0 [a]	91.3 ± 1.7 [a]	29.8 ± 1 [a]	67.3 ± 8.5 [a]	20.8 ± 5.1 [b]	32.8 ± 8.5 [b]	9 ± 0.6 a	12.8 ± 2.3 a
Average	67.3 ± 3.4	7.2 ± 0.1	85.5 ± 2.1	29 ± 1.2	57.9 ± 6.8	24.4 ± 4.6	42.2 ± 6.7	8.8 ± 0.7	13 ± 0.3

Means followed by the same letter in a column are not significantly different [P = 0.05, Duncan,s multiple range test (1955)].

Concerning the number of deposited eggs per female, it was found that females emerged from Giza 429 laid the maximum number of eggs (72 eggs/female) and the lowest (57.3 eggs/female) was deposited by females emerged from Giza 674. Females developed in Giza 843 and Sakha-1 laid approximately equal number of eggs Table 3. Although, there were some differences among seed size of the different varieties tested, the number of eggs per seed was nearly the same .

Based on developmental period, survival rate, number of emerged beetles and female fecundity, it can be stated that Giza 429 was the most susceptible variety for *C. mculatus* followed by Giza 843 while Giza 674 was the least susceptible variety.

Table 4 presents the results of the viability of faba bean test varieties to *C. maculatus* attack and its effect on the viability of infested seeds. It is evident that all tested varieties were liable to insect infestation with no significant variations . Infestation ratios ranged between 12.1 % and 13.2 %, however Giza 843 was the least attacked variety while Giza 429 and Sakha-1 had the same rate of infestation (13.2 %). Susceptibility indices of faba bean varieties showed the same trend and were resemble to infestation ratios.

Seed infestation of faba bean varieties with *C. maculatus* was also influenced. Germination percentages of infested seeds were significantly and drastically dropped. Seed viability of all faba bean varieties ranged between 98 % and 100 %, but when exposed to *C. maculatus* attack, this ratio significantly decreased to 5.7 – 8.3 % (Table 4). Seed germination of infested varieties averaged 8.3 %, 5.7 %, 7.4 % and 7.4 % for Giza 429, Giza 674, Giza 843 and Sakha-1 without significant differences.

The susceptibility of the tested legume varieties depends upon many factors. Some of the important factors are variety, seed size, species and environment (Govindarajan and Balasubramanian, 1983 and Khattack *et al.,* 1987). Of the four tested faba bean varieties, Giza 429 was the most susceptible based on the differences in number of emerged beetles and developmental period. These results are confirmed with these of Fam and Ahmed (1985) who reported that the percentage of emerged adults developed in 35 faba bean varieties varied considerably between the varieties and it was lowest in the variety 379 which is recommended as source of resistance in the breeding against *C. maculates* (F.).

The results of the present investigation reveal that none of the faba bean varieties was completely immune to *Callosobruchus maculatus* (F.) and their response to attack by this pest can be arranged in the following order, Giza 429, Giza 843, Sakha-1 and Giza 674, respectively.

Table 4. Infestation rates, susceptibility indices (SI) and germination percentages of faba bean varieties to infestation by *C. maculatus* (F.).

Faba bean varieties	No. of test seeds	No. of holed seeds	% Infestation	Indices of susceptibility (SI)	% Germination
Giza 429	50	6.6 [a]	13.2 [a]	5.8 [a]	8.3 [a]
Giza674	50	6.2 [a]	12.4 [a]	3.8 [a]	5.7 [b]
Giza 843	50	6.1 [a]	12.1 [a]	4.7 [a]	7.4 [a]
Sakha 1	50	6.6 [a]	13.2 [a]	4.3 [a]	7.4 [a]
Average	50 ± 0	6.4 ± 0.2	12.7 ± 0.3	4.7 ± 0.4	7.2 ± 0.5

Means followed by the same letter in a column are not significantly different [P = 0.05, Duncan,s multiple range test (1955)].

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إمكانية إصابة بعض أصناف اللوبيا والفول البلدى بخنفساء اللوبيا *Collosobruchus* (Coleoptera : Bruchidae) *maculatus* (F.)

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كـان لتغذية خنفساء اللوبيا على بذور اللوبيا والفول البلدى تأثيرا معنويا على معدلات النمو وفـترة الـنمو والتكاثر ومعدل وفيات الأطوار غير الكاملة حيث أثبتت نتائج التجارب وجود فروق واضـحة بين كل من اللوبيا والفول البلدى على النواحى الحياتية للحشرة . بلغت فترة النمو للأطوار غير الكاملة ٢٨ – ٣٤ يوما بمتوسط عام ٣٠,٥ يوما عند التغذية على بذور اللوبيا ، بينما بلغت ٢٨ – ٣٦ يومـا بمتوسـط عام ٣١ يوما عند التغذية على بذور الفول البلدى . أدى تغذية الأطوار غير الكاملة على بذور اللوبيا إلى وفاة ٢٥% من مجموع اليرقات والعذارى بينما إرتفعت هذه النسبة الى ٥٤% فى حالة التغذية على بذور الفول، بلغ عدد البيض الناتج من الإناث المغذاة على اللوبيا ٤٩ – ١٠٠ بيضـة للأنـثى الواحدة بينما كان ٤٦ – ٨٨ بيضة / أنثى ناتجة من التغذية على بذور الفول البلدى، كما أن معدل النمو فى اللوبيا بلغ ٢٦,٦ يوما، وفى الفول البلدى ٢٩ يوما.

ومـن حيـث قابلية بعض أصناف اللوبيا والفول البلدى للإصابة فقد تم إختيار بذور أربعة أصناف من اللوبيا هى : كريم ٧ ، دقى ٣٣١ ، المحلى ، كفر الشيخ-١ ، وكذلك بذور أربعة أصناف مـن الفـول البلدى هى : جيزة ٤٢٩ ، جيزة ٦٧٤ ، جيزة ٨٤٣ ، سخا-١ لإختبار مدى حساسيتها للإصـابة بخنفساء اللوبيا أثناء التخزين من عدمه بالمخزن، وقد أوضحت النتائج أن الصنف كريم ٧ كـان أقل أصناف اللوبيا إصابة بالحشرة حيث بلغ متوسط الإصابة خلال فترة تخزينه ١٣,٦% بينما كان الصنف كفر الشيخ-١ أعلى الأصناف إصابة بالحشرة حيث سجلت نسبة إصابة قدرها ١٧,٦% ، أما بالنسبة للفول البلدى فلقد كان الصنف سخا-١ أكثر الأصناف إصابة (١٣,٢%) بينما كان أقلها إصابة الصنف جيزة ٨٤٣ (١٢,١%).