

**EFFECT OF POPULATION DENSITY ON SOME  
BIOLOGICAL ASPECTS AND WEIGHT LOSS OF  
*CALLOSOBRUCHUS MACULATUS* (F.), REARED  
ON THREE LEGUMINOUS SEEDS**

**Metwaly, S.M., M.A. El-Deeb, Zeinab A. Mohamed and  
Habeba M.O. Abou El-Enien**

**Plant Protection Dept., Fac. of Agric., Zagazig Univ., Egypt.**

*Accepted 2 / 8 / 2006*

**ABSTRACT :** The effect of four population densities, i.e., 1, 2, 4, 8 pairs on some biological aspects of the cowpea seeds beetle, *Callosobruchus maculatus* (F.), and weight loss of three leguminous seeds, namely cowpea, broad bean and lentil was studied. The obtained results can be summarized as follows :

- 1. The population density levels of cowpea beetle had significant effects on female fecundity, penetrated larvae and emerged adult, where they were decreased by increasing densities.**
- 2. The average number of deposited eggs per female was 68.05, 53.62 and 35.49 eggs on cowpea, broad bean and lentil seeds, respectively.**
- 3. The average number of penetrated larvae per female was 57.75, 32.76 and 31.77 on cowpea, broad bean and lentil seeds, respectively.**
- 4. Sex ratio (% of males) of emerged adults in F<sub>1</sub> generation averaged 49.71%, 45.95% and 55.22% on cowpea, broad bean and lentil, respectively.**
- 5. The three tested leguminous seeds could be arranged desendingly according to adults emergence as follows : 72.93%, 29.40% and 15.33% on cowpea, broad bean and lentil, successively.**
- 6. The longest mean period (in days) of generation (34.26) was recorded on lentil seeds followed by broad bean (23.01) and cowpea (20.75 days).**

7. The highest loss was achieved by the highest density and decreased gradually by decreasing densities, where they were 30.25% and 3.37% by 8 and 1 pair / 10 gram, respectively.

**Key words :** Population densities, weight loss, cowpea beetle, *Callosobruchus maculatus* (F.), leguminous seeds.

## INTRODUCTION

The cowpea beetle, *Callosobruchus maculatus* (F.) is an important insect pest attacking stored leguminous seeds (e.g., cowpea, broad bean, lentil, pea and chick-pea) causing serious damage during the storage period.

The effect of population densities on the biological changes of *Callosobruchus* species, on different leguminous seeds and their loss during the storage were studied by many investigators such as Helaly (1973), Salama, Shadia (1984), Nakhla (1988), Shahein *et al.* (1991), Rashed, Salwa *et al.* (1996) and Abdel-Galil *et al.* (2000).

The present work aims to study the following points :

1. Biological effects of four population densities of *C. maculatus* reared on three leguminous seeds.
2. The percentage of weight loss of three tested leguminous seeds

namely, cowpea, broad bean and lentil artificially infested with four densities under  $27 \pm 0.5$  °C and  $75 \pm 5\%$  R.H.

## MATERIALS AND METHODS

### I. Insect Culture Technique

Three leguminous seeds, namely, cowpea (var. Karem 7), broad bean (var. Englesy) and lentil (var. Balady) were used as a rearing hosts for cowpea beetle, *C. maculatus* (F.) reared for many generations under controlled conditions at  $27 \pm 0.5$  °C and  $75 \pm 5\%$  R.H. in rearing chamber of Plant Protection Department, Faculty of Agriculture, Zagazig University.

### II. Experiments

#### A. Effect of different densities on some biological aspects of *C. maculatus*

Different densities (one, two, four and eight pairs) of newly emerged adults were placed in plastic tubes (3.5 cm. in diameter ×

7.5 cm. in length), each containing ten grams of seeds. Ten replicates of each were used.

Treatments were kept in an electrical heating and cooling incubator running at  $27 \pm 0.5$  °C and  $75 \pm 5\%$  R.H. for one generation. These tubes were examined daily, the emerged adults were counted and sexed according to El-Sawaf (1956). In each density, the following biological aspects were determined : fecundity (number of deposited eggs/female), number of penetrated larvae, number of emerged adults, sex ratio (% of males), percentage of adult emergence and period (in days) of generation.

#### **B. Weight loss**

After adults emergence of F<sub>1</sub> generation, all adults were sexed, counted and removed daily. Seeds were cleaned carefully, the weight loss were estimated at the end of generation to calculate the percentage of loss in each density.

Data were statistically analyzed using MSTAT-C V.2.10 computer program (1988).

## **RESULTS AND DISCUSSION**

### **Fecundity (Number of Deposited Eggs/Female)**

Data recorded in Table 1 revealed generally, that female fecundity was affected significantly by host, where the highest number of eggs was recorded on cowpea 68.05 eggs/female and decreased to (53.62) and (35.49) on broad bean and lentil seeds, respectively.

The interaction between densities and seed type cleared that, the highest number of deposited eggs (77.10) was recorded on cowpea seed on one pair density, where the lowest (31.40) was observed on lentil at the same density.

These results are in agreement with Helaly (1973) and Shahein *et al.* (1991) the first author found that the adult population density of *C. maculatus* had a significant effect on the mean number of eggs per female and the highest number of 45.25 eggs was recorded at the density of one pair and it was decreased to 32.45 by increasing the population density to ten pairs. The second authors noticed that there was a negative correspondence

**Table 1 . Effect of four densities of *Callosobruchus maculatus* (F.) adults on fecundity and larval penetration when reared on three hosts of cowpea, broad bean and lentil seeds at constant conditions of  $27 \pm 0.5^\circ\text{C}$  and  $75 \pm 5\%$  R.H.**

Densities	Cowpea		Broad bean		Lentil		Average irrespective of hosts	
	Mean no. of eggs/female	Mean no. of penetrated larvae/female	Mean no. of eggs/female	Mean no. of penetrated larvae/female	Mean no. of eggs/female	Mean no. of penetrated larvae/female	No. of eggs/female	No. of penetrated larvae/female
1	77.10 a	62.0 a	62.80 b	37.80 d	31.40 e	26.10 ef	57.10	41.97
2	68.85 ab	58.70 ab	65.10 ab	41.25 cd	37.65 de	32.10 de	57.20	44.02
4	68.78 ab	60.47 a	46.30 cd	32.88 de	36.40 de	34.30 de	50.49	42.55
8	57.45 bc	49.82 bc	40.29 de	19.10 f	36.50 de	34.59 de	44.75	34.50
<b>Average irrespective of densities</b>	68.05	57.75	53.62	32.76	35.49	31.77	52.39	40.76
L.S.D. <sub>hosts</sub>	2.135	5.213						
L.S.D. <sub>densities</sub>	2.465	5.734						

in the average of deposited eggs when density of *C. chinensis* adults increased.

### **Number of Penetrated Larvae/Female**

Data presented in Table 1 show that the number of penetrated larvae was significantly affected by the population density, where the highest average number of penetrated larvae per female (44.02) was recorded at the density of two pairs and it was decreased to 34.50 at the density of eight pairs. The number of penetrated larvae was the highest on cowpea seeds (57.75), followed by broad bean (32.76) then (31.77) on lentil seeds.

In general, the highest mean number of penetrated larvae on cowpea seeds with one pair density was 62.0 and the lowest number of 19.10 was recorded in case of the density eight pairs on broad bean seeds.

### **Number of Emerged Adults/Female**

The data compiled in Table 2 indicate that the number of emerged adults per female differed significantly from one density to another, where it was gradually decreased by increasing densities

from 23.00 to 12.22 adults by increasing densities from one pair to eight pairs, respectively. Also, the highest number of emerged adults was 42.61 adults/female on cowpea seeds, followed by broad bean (9.38) where the lowest of 4.39 was recorded on lentil seeds. These results may be due to the differences in size and weight of tested seeds (Nakhla, 1988). Generally, the highest mean number of emerged adults of 54.50 was noticed on cowpea with one pair, and the lowest one (2.15) was obtained at the density of four pairs on lentil seeds.

### **Sex Ratio (% of Males)**

The results given in Table 2 show that male percentage ranged between 48.55% and 52.41% at the four tested densities. The highest percentage (55.22%) was observed on lentil seeds followed by cowpea (49.71%) and the lowest percentage (45.95%) recorded on broad bean seeds.

Generally, the highest percentage of adult emergence (58.24%) was recorded on lentil with four pairs density, where the lowest (43.24) on broad bean with two pairs density.

The obtained results are in agreement with Shahein *et al.* (1991) who found that the number



of *C. chinensis* males was higher than females in all densities used.

### Percentage of Adult Emergence

Data presented in Table 2 refer to an inverse relationship between the population density and percent of adult emergence. In case of cowpea seeds, the highest percentage was 88.14% at one pair density and regularly decreased to 50.82% at eight pairs density. On the other hand, the data disagree with Shahein *et al.* (1991) who indicated that there was a slight decrease in adult emergence in the population densities 1, 5 and 10 pairs, especially at the density of 80 pairs, and a significant influence was recorded in the densities 20, 40 and 80 pairs, especially at the density of 80 pairs.

In addition, the highest percentage of emerged adults was 72.93% recorded on cowpea followed by broad bean (29.40%) and the lowest one was 15.33% on lentil seeds.

The present results clearly show that the highest percentage of emerged adults (88.14%) occurred at the density of one pair on cowpea seeds and the lowest one was 7.33% on lentil seeds at the density of four pairs.

### Mean Period (in Days) of Generation

The data given in Table 2 reveal that mean period of generation differed according to densities and leguminous hosts, where the longest period of 26.85 days was recorded with four pairs and decreased to 25.17 days at two pairs. Also, lentil had the longest period (34.26 days) while the shortest period of 20.75 days was recorded on cowpea seeds.

Generally, the longest generation period of 36.52 days was recorded on lentil seeds at the density of four pairs and the shortest one was 18.50 days on cowpea seeds with the density of two pairs. This means that the cowpea seeds are the most preferable host for *C. maculatus*.

### The Percentage of Weight Loss

The results presented in Table 3 indicate that weight loss increased by increasing population density. Severe increase in weight loss was recorded in the three tested hosts. The highest average percentage of weight loss was 15.68% recorded at the density of eight pairs and decreased to 5.42% at one pair. Also, the highest percentage of

weight loss was 17.33% recorded on cowpea seeds followed by broad bean (7.24%) and the least one (4.25%) on lentil seeds.

Generally, the density of eight pairs of adults on cowpea seeds resulted in the highest mean percentage of weight loss (30.25%) while, broad bean seeds recorded the lowest one (3.37%) at the density of one pair.

These results disagree with Nakhla (1988) who found that the highest percentage of weight loss (35.06%) was recorded on lentil seeds and the lowest percentage (3.92%) was recorded on broad bean seeds, also the percentages of loss in the black eyed cowpeas, mountain chickpeas and pea seeds were 19.71, 8.26 and 5.21%, respectively. Author added that, the weight loss was related to the initial larval population, finally the black eyed cowpea seeds were the most susceptible to cowpea beetle followed by broad beans.

Credland *et al.* (1986) found that males and females differed significantly in the amount of cowpea consumed during development; females always required more food than males.

Generally, the tested leguminous seeds of cowpea,

broad bean and lentil differed significantly in various studied biological aspects as shown in Tables 1 and 2.

The obtained results cleared that the highest number of eggs per female (77.10 eggs) was recorded on cowpea seeds and the lowest number (31.40) was obtained on lentil seeds, in case of one pair population density.

Also, cowpea was the suitable host recording the highest number of penetrated larvae with an average of 62.00 larvae with one pair, while broad bean recorded the lowest number of 19.10 larvae with eight pairs.

The sex ratio shows that the number of males was higher than females on lentil seeds at different densities from one to eight pairs. This incompatibility may be due to the difference in size and weight.

The percentage of emerged adults shows that there were highly significant differences between the tested leguminous seeds and the cowpea seeds recorded the highest number of emerged adults and the percentage of adult emergence (54.50 adult, 88.14%, respectively) with one pair, but the lentil seeds



**Table 3. Effect of four densities of *C. maculatus* (F.) adults on the mean percentage of weight loss, reared on cowpea, broad bean and lentil seeds at constant conditions of  $27 \pm 0.5^\circ\text{C}$  and  $75 \pm 5\%$  R.H.**

Densities	Hosts	Cowpea	Broad bean	Lentil	Average irrespective of hosts
1		8.980 d	3.37 e	3.90 e	5.42
2		14.13 b	6.43 d	3.58 e	8.04
4		15.98 b	7.90 d	4.02 de	9.30
8		30.25 a	11.27 c	5.52 d	15.68
<b>Average irrespective of densities</b>		17.33	7.24	4.25	
L.S.D. <sub>hosts</sub>		0.457			
L.S.D. <sub>densities</sub>		0.528			

recorded the lowest values (2.15 adults and 7.33%, respectively) in case of the population density of four pairs.

Also, the longest period of generation was 36.52 days with the population density of four pairs on lentil seeds, while the shortest period was 18.50 days on cowpea seeds with two pairs.

Cowpea seeds showed the highest percentage of loss in weight with a mean of 30.25% in case of eight pairs while broad bean seeds recorded the lowest percentage of 3.37% at the density of one pair.

These differences can be attributed to the tolerance degree of each leguminous seed.

Finally, the tested pulse seeds significantly differed in their susceptibility toward infestation with *C. maculatus* (F.), and the seeds of cowpea were the most susceptible followed by broad bean and then lentil seeds.

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تأثير الكثافة العددية على بعض النواحي البيولوجية والفقد في الوزن الناتج  
عن خنفساء اللوبيا (*Callosobruchus maculatus* (F.) المرماه  
على ثلاثة بذور من البقوليات

السيد مجاهد متولى - محمد على الديب - زينب عبد الله محمد -

حبيبة محمد عمر أبو العينين

قسم وقاية النبات - كلية الزراعة - جامعة الزقازيق - مصر

تم دراسة تأثير العدوى الصناعية بخنفساء اللوبيا لكل من بذور اللوبيا والفول البلدى والعدس بأربعة كثافات عددية مختلفة (١، ٢، ٤، ٨ زوج من الحشرات وكل زوج مكون من ذكر وأنثى) على بعض النواحي البيولوجية لتلك الحشرة والفقد الناتج منها تحت درجة حرارة ثابتة  $27 \pm 0.5$  م° و  $75 \pm 5$ % رطوبة نسبية وقد أظهرت هذه الدراسة النتائج التالية:

١- تبين أن لكثافة الحشرة تأثير معنوى على معدل وضع البيض للأثنى الواحدة وعدد اليرقات المخترقة وعدد الحشرات الخارجة والفقد في الوزن وذلك على العوائل البقولية الثلاثة المختبرة، ولقد وجد أنه بزيادة كثافة الحشرة يقل عدد البيض الموضوع للأثنى الواحدة وعدد الحشرات الخارجة للأثنى الواحدة ولكن يزداد الفقد في الوزن مع زيادة الكثافة.

٢- وجود اختلافات معنوية بين متوسط عدد البيض الموضوع لكل أنثى على البذور البقولية الثلاثة حيث سجل  $68.05$  بيضة لبذور اللوبيا،  $53.62$  بيضة للفول البلدى،  $35.49$  بيضة بالنسبة للعدس.

٣- كما كانت أعلى نسبة لخروج الحشرات الكاملة فى حالة بذور اللوبيا بمعدل  $72.93$ %، يليها الفول البلدى بمعدل  $29.4$ % ثم العدس بمعدل  $15.33$ %.

٤- كذلك وجدت اختلافات معنوية بين عدد اليرقات المخترقة بالإضافة لعدد الحشرات الخارجة، كما اختلفت فترة الجيل بين الأنواع الثلاثة من البذور وكانت أطول فترة فى حالة بذور العدس ( $34.26$  يوم) يليها الفول البلدى ( $23.01$  يوم) ثم اللوبيا ( $20.75$  يوم).

٥- كما سُجلت أعلى نسبة فقد فى وزن البذور والتي بلغت  $17.33$ % فى حالة بذور اللوبيا يليه الفول البلدى ( $7.24$ %) ثم بذور العدس حيث سجل أقل نسبة فقد بمقدار