DAMAGE AND QUANTITATIVE LOSS CAUSED BY *CALLOSOBRUCHUS MACULATUS* (COLEOPTERA : BRUCHIDAE) TO SOME COWPEA AND FABA BEAN VARIETIES

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Abstract

Infestation of cowpea seeds with *C. maculatus* resulted in 39.3 % to 58.5% damaged seeds according to seed variety. Kafr El-Sheikh-1 had 58.5% damaged seeds while this value lowered to 39.3% in seeds of Dokki 331. The percentages of damaged faba bean seeds ranged between 5.2 % and 17.4 % and the highest rate of damage seeds occurred in Giza 429.

The highest weight of cowpea seed loss was shown with Kafr El-Sheikh-1 variety (61.6 %) while the least percent loss (42 %) was found with Dokki 331. Faba bean seeds attacked by *C. maculatus*. Giza 843 suffered the least loss (8.3 %) while the maximum loss (28.3 %) occurred in the seeds of Giza 429.

Seed viability of cowpea and faba bean decreased to 4.6% and 7.2%, respectively, when seeds were infested with *C. maculatus* . In case of cowpea, the highest reduction rate of seed germination (94.9 %) was found in Dokki 331 and these values reduced to 94.3 % in the case of faba bean Giza 429.

INTRODUCTION

The cowpea beetle, *Collosobruchus maculatus* (Coleoptera : Bruchidae) is a major pest of cowpea and other pulses, where it causes substantial economic loss to stored leguminous seeds. The actual percentage of cowpea weight loss as estimated by El-Sawaf (1956) in Egypt was 51.3 % during a storage period of three months, however these value increased to 68% (Gerberg and Goldheim, 1957) and 10 % - 45 % in Nigeria depending upon the number of beetles infesting one gram of cowpea.

Losses in cowpea and other pulses seeds caused by *Bruchidius incarnatus* (Boh.) and *C. maculatus* were estimated based on mean developmental period, percentage of the eggs developed into adults and the quantity of food consumed (El-Banby and Mansour, 1970 and Nakhla 1988). Losses in different legume seeds were

expressed by estimating changes in moisture content, weight loss and percentage of seed germination (El-Banby *et al.*, 1985).

Infested seeds of Bengal gram (Chick pea), green gram (*Vigna radiata*) and red gram (*Pigeon peas*) exhibited significant changes in crude protein, true protein and the methionine when injured by *Collosobruchus chinensis* (L.) (Modgil and Melita 1993).

This work aims to assess damage, weight losses and biochemical changes occurred in some cowpeas and faba bean varieties incurred by *C. maculatus* under laboratory conditions.

MATERIALS AND METHODS

1. Effect of progeny of one pair of adult population Samples of cowpea varieties (Karim7, Dokki 331, local and Kafr El-Sheikh-1) and faba bean varieties (Giza 429, Giza 674, Giza 843 and Sakha-1) were obtained from Horticulture Research Institute and Field Crops Research Institute, Ministry of Agriculture and Land Reclamation. They were kept at 5 °C for two weeks, before the experiment, to kill any pests present.

Test samples containing 20 g of infestation-free cowpea and faba bean were kept in glass jars (100 g) covered with muslin for airation. One pair (♀ , ♂) of the cowpea beetle, *C. maculatus* of age 0 - 24 hr from the laboratory culture were released in each jar. The treatments representing the eight varieties were each replicated four times and kept in the rearing room at 28 ± 2 °C and 60 – 70 % R. H. The moisture content of all samples was determined before the start of the experiment.

Observations on adult longevity, developmental period, egg production, adult progeny and mortality of immatures were recorded for each treatment. In order to record percent seed damage in samples, all the sound seeds were separated and weighed and damage was determined by the following formula (Khattack *et al.*, 1987):

$$\% \text{ Damage} = \frac{\text{wt. of control sample} - \text{wt. of sound grain infest sample}}{\text{wt. of control sample}} \times 100$$

For determining weight loss, all the post-treatment samples were sieved. The dust passed through was discarded while the remaining sample which contained both

sound and damaged or holed seeds was weighed. The percent weight loss was calculated by the formula of Khattack *et al.* (1987) :

$$\% \text{ Loss} = \frac{\text{wt. of control sample} - (\text{wt. of sound} + \text{wt. damaged grain in test sample})}{\text{wt. of control sample}} \times 100$$

The data recorded for adult longevity, their progeny, developmental period, percent seed damage and weight loss of grains were subjected to statistical analysis by ANOVA. When a significant F ratio was obtained, Duncan's New Multiple Range Test (Duncan, 1955) was applied to the treatment means. The coefficient of correlation between variables was also determined.

Table 1. Grain weight and moisture content of different cowpea and faba bean varieties.

Crop	Varieties	100 grain weight (gm.)	% Moisture content
Cowpea	Karim 7	14.7	7.1
	Dokki 331	20.1	6.4
	Local	13.2	7.6
	Kafr El-Shikh-1	16.7	6.6
Faba bean	Giza 429	63.5	3.0
	Giza 674	56.2	3.4
	Giza 843	83.6	3.0
	Sakha- 1	79.8	2.6

2. Effect of initial adult density Sub samples of 20 g of each of the test varieties of cowpea and faba bean were weighed into ¼ L Kilner jars. Jars of each variety were infested with densities of 2, 4, 8, 16 and 20 pairs (♀ , ♂) 0 - 24 hr-old adults of C. M. After the jars were covered with muslin cloth, they were stored for 15 days in an incubator adjusted on 28 ± 2 °C and 60 - 70% R. H. At the end of the period of exposure, the beetles were removed and discarded, the seeds were returned to the jars and stored at 28 ± 2 °C and 60-70% R.H. Each density and variety was replicated four times and the experiment was set up in randomized complete block design. The total number of eggs laid on the seeds of each variety at each initial density of adults were counted. When the black windows of the future adult emergence appears on the

seeds, all jars were examined daily to record the first adult emergence. Number of emerged adults were recorded every two days. The counting of the emerged beetles was facilitated by anaesthing them separately with chloroform after separation. Data on the developmental period, number of emerged beetles, mortality, percentages of seeds damage and losses were collected and all were analyzed statistically and the mean values were separated by the Duncan's multiple-range test.

3. Effect of seed density Five different seed sets: 5, 10, 20, 40 and 80 conditioned cowpea or faba bean seeds of the different varieties were prepared, each set was placed in separate plastic tube of 3 x 5 cm One newly emerged and unmated female and two males were introduced to each seeds set. Tubes of different sets were covered with muslin cloth, fastened with rubber bands and kept in an incubator adjusted to 28 ± 2 °C and 60 - 70 % R. H. Each set density and variety was replicated 10 times. After an exposure period of 15 days, the beetles were removed and seeds were returned again to the plastic tubes and the total eggs laid, number of hatched eggs as well as eggs density per seed were counted and recorded.

As the black colour of the windows of the future adult emergence appears on the seeds, a daily examination of the different seed sets were conducted to record the developmental period, number of emerged beetles, adult mortality and percent of emerged beetles. Weight loss, percent of loss and percent of damage were estimated as mentioned before. All recorded data were subjected to statistical analysis and the mean values were separated by the Duncan's multiple-range test.

Growth index was estimated by dividing the natural logarithm of the percentage adult survival (Log. S) by the mean developmental period (T) according to Howe (1971) formula in order to compare the susceptibility of different faba bean and cowpea varieties to infestation by *C. maculatus* at different seed densities.

4. Effect of storage temperature This experiment was performed to study the effects of storage temperatures: 25, 30 and 35 °C ± 2 °C and laboratory fluctuated temperature on *C. maculatus* development and loss gained as a result of insect infestation to different varieties of cowpea and faba bean seeds. Samples of cowpea and faba bean seeds, each 20 g, representing cowpea varieties: (Karim 7, Dokki 331, local and Kafr El-Sheikh-1) and faba bean varieties: (Giza 429, Giza 674, Giza 843 and Sakha-1) were prepared. Seeds of each variety were placed in plastic tube 3 x 5 cm. Fifteen pairs of newly emerged beetles (0 - 24 hr-old) of *C. maculatus* were released in each tube, covered with muslin cloth and fastened with rubber bands. For each

variety, 3 sets of test tubes (10 tubes each) were prepared. Sets of each cowpea or faba bean varieties were incubated at constant temperatures of 25, 30 and 35 ± 2 °C and laboratory fluctuated temperature, respectively.

Tubes of each set were examined after one week, beetles were removed, the number of laid eggs was counted and seeds were returned back to the different temperatures. Seeds of the different sets were inspected daily until the emergence of the first adult. The following parameters were determined: the number of eggs laid, the number of L_1 having perforated the seed coat and reached the cotyledons, and number of adults emerging from the seeds. It was thus possible to determine the penetration rates (number of L_1 having penetrated/number of eggs laid) and the survival rates (number of emerging adults/total number of L_1 larvae having penetrated).

Rates of seed damage and weight of loss have been estimated as described before. Rates of penetration, survival rates, number of F_1 progeny, rate of damage and percent weight loss recorded were all analysed statistically and the mean values were separated by the Duncan's multiple-range test.

5. Effect of storage period Weight loss and seed viability were used as criteria for assessing quality loss of cowpea and faba bean seeds during different periods of storage. Sub-samples of test varieties of cowpea and faba bean each weighing 250 gr. were put in cotton bag and infested with 0 - 24 hr-old of *C. maculates*. Each sub-sample was infested with 32 beetles (unsexed) and stored on shelves under laboratory conditions. Four replications were prepared for each test variety at predetermined storage periods of 1, 2, 3, 4, 5 and 6 months. Laboratory temperature and relative humidity were recorded daily during storage periods. An uninfested bags of cowpea and faba bean were set as a control of each test variety at the various periods of storage. Twenty four treatments were thus prepared for each cowpea or faba bean of the varieties tested.

To assess weight loss of the cowpea and faba bean due to beetle infestation, cowpea and faba bean seeds were weighed prior to the introduction of the beetles. Then at each period of assessment, the beetles and all the dust they created were sifted and the infested seeds of cowpea and faba bean subsequently weighed. The uninfested cowpea or faba bean were similarly weighed, and the observed differences in weight between infested and uninfested samples were used to calculate loss in weight.

6. Seed viability Seed viability was assessed by the percentage of seeds germination and was determined by the filter paper method , using seeds of each cowpea or faba bean selected at random from the infested seeds at the different periods of storage. Germination percentage of the seeds was also determined before cowpea and faba bean were infested with beetles of *C. maculatus* .

7. Determination of chemical components of cowpea and faba bean seeds Random samples, 10 g each of cowpea and faba bean varieties (sound and infested seeds) were taken to assess their constituents of carbohydrates, protein, fats, tannins and vicine. Samples were chemically analysed by the Central Laboratory, Faculty of Agriculture, Cairo University .

The simple correlation and regression coefficients were calculated for the obtained results to clarify the relationship between the different levels of infestation, weight loss and chemical components.

RESULTS AND DISCUSSION

1. Weight loss of seeds Quantitative losses arising from the portions of cowpea consumed by the larval stages of the bruchid *C. maculatus* were assessed. This was obtained by finding the difference in the weights of the samples before and after infestation, after removing the frass and adjusting for moisture. In this part, the weight loss produced from 20 seeds of each cowpea and faba bean varieties due to the development of the total progeny of one female was determined.

Results in Table 2 indicate that cowpea suffered 42 - 61.6 % loss in general, however the highest seed loss was shown by Kafr El-Sheikh-1 variety which reached 61.6 % loss. On the other hand, the least weight loss 42 % was achieved by seeds of Dokki 331. Weight loss of Karim 7 and local varieties did not significanty differ than Dokki 331, these two varieties had 44.8 % and 49.2 % seed loss, respectively. These results infer that weight loss of cowpea seeds could be ranged between 42 % and 61.6 % as a result of seed attacked by *C. maculatus* during storage.

Weight loss in faba bean seeds due to *C. maculatus* infestation is greatly different than cowpea seed loss. Faba bean seeds attacked by the concerned insect pest lost 8.3 – 28.3 % with an average of 16.3 % and this obvious variation is regarded to seed varieties. As shown in Table 3, Giza 843 suffered the least loss 8.3 % while the maximum loss was shown in Giza 429 (28.3 %). Results also revealed enormous variation in weight loss among the tested varieties. There was significant

differences between Giza 429 on one hand and both Giza 843 and Giza 674 on the other hand.

Another parameter could be of considerable importance is the amount of food consumed by *C. maculatus* . Progeny of one pair of this beetle consumed 7.5 mg dry weight of cowpea seeds which is corresponding to a percentage of 49.1 of the total food introduced.

Table 2 . Comparison of the means of weight of food consumed, percent damage, percent weight loss and seed viability caused by *C. maculatus* bred in different cowpea varieties.

Cowpea varieties	Wt. Of food dry cons. (mg)	% Wt. Of food dry cons.	% Damage	Weight loss (mg)	% Weight loss	% Seed germination
Karim 7	6.7 ± 0.6 ^{a}	47.5 ± 3.6 ^{a}	42.5 ± 7 ^{ab}	0.45 ± 0.03	44.8 ± 3.3 ^{ab}	4.7 ^{a}
Dokki 331	9.3 ± 0.7 ^{a}	43 ± 1.9 ^{a}	39.3 ± 1 ^{b}	0.42 ± 0.01	42 ± 0.9 ^{b}	5.1 ^{a}
Local	5.8 ± 0.9 ^{a}	50.1 ± 7.8 ^{a}	46 ± 8 ^{ab}	0.49 ± 0.1	49.2 ± 7.2 ^{ab}	4.9 ^{a}
Kafr El-Shiekh 1	8.1 ± 0.3 ^{a}	55.8 ± 0.6 ^{a}	58.5 ± 2 ^{a}	0.62 ± 0.02	61.6 ± 1.6 ^{a}	3.6 ^{a}
Average	7.5 ± 0.8	49.1 ± 2.7	46.6 ± 4.2	0.5 ± 0.04	49.4 ± 4.3	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)]. varieties.

Table 3. Comparison of the means of weight of food consumed, percent damage, percent weight loss and seed viability caused by *C. maculatus* bred in different faba bean

Faba bean varieties	Wt. Of food dry cons. (mg)	% Wt. Of food dry cons.	% Damage	Weight loss (mg)	% Weight loss	% Seed germination
Giza 429	17.4 ± 3.8 ^{a}	24.8 ± 4.6 ^{a}	17.4 ± 1 ^{a}	0.28 ± 0.03	28.3 ± 3.2 ^{a}	8.3 ^{a}
Giza 674	4.8 ± 0.5 ^{b}	8.5 ± 0.6 ^{b}	7.9 ± 0.3 ^{c}	0.12 ± 0.01	12.1 ± 0.06 ^{bc}	5.7 ^{a}
Giza 843	8.1 ± 0.4 ^{b}	10.7 ± 0.1 ^{b}	5.2 ± 0.2 ^{d}	0.09 ± 0	8.3 ± 0.3 ^{c}	7.4 ^{a}
Sakha 1	7.5 ± 0.3 ^{b}	14 ± 1 ^{b}	11.2 ± 0.1 ^{b}	0.16 ± 0	16.3 ± 0.03 ^{b}	7.4 ^{a}
Average	9.5 ± 2.7	14.5 ± 3.6	10.4 ± 2.6	0.16 ± 0.04	16.3 ± 4.3	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)].

As shown in Table 2, amount of food consumption differed within varieties tested. Beetles consumed 55.8 % of the total food introduced of Kafr El-Sheikh-1 variety while this percentage dropped to 43 in seeds of Dokki 331. On the other hand, 47.5 % and 50.1 % of karim 7 and local seeds, respectively, were eaten by the progeny of one pair of *C. maculatus* during development.

Progeny of one pair *C. maculatus* developed in faba bean seeds consumed 9.5 mg dry weight which is corresponding to 14.5 % of the total food introduced. Similarly to cowpea, *C. maculatus* showed consumption variability from faba bean seeds belonging to different varieties. The greatest amount of food consumption was shown by Giza 429 followed by Sakha-1 while the smallest amount of food consumed was obtained by feeding on Giza 674 seeds (Table 3). Accordingly, percentages of food consumption could be arranged as following: 24.8, 14, 10.7 and 8.5 for Giza 429, Sakha-1, Giza 843 and Giza 674, respectively.

The forementioned results infer a positive correlation between damage and weight loss of cowpea ($r = 0.9975$) and faba bean ($r = 0.8455$). Other correlations between progeny and weight loss, progeny and damage, and weight loss and damage were highly significant and positive Tables 4 and 5. Similarly, adult longevity was positively correlated with progeny, weight loss, and damage, and weight loss and damage were positively correlated with developmental period. Likewise the correlation between percent moisture content and progeny, damage and weight loss were negative and significant. The correlation between adult longevity and moisture content was highly significant but negative while it was positive, and highly significant between developmental period and moisture content. Similar correlations were obtained by Khattack *et al.* (1987) which are greatly confirmed with our results.

Table 4. Correlation values (r) between parameters for susceptibility determination in cowpea .

Parameters		Progeny	Weight adult (mg)	Adult longivity (days)		Develop. period	Weight loss (mg)	% Weight loss	% Damage	% Moisture content
				Male	Female					
Progeny		1.0000	0.9884	0.9494	0.8391	0.4693	0.9167	0.4693	0.9349	-0.4707
Adult weight mg		0.9884	1.0000	0.9452	0.7606	0.4373	0.8479	0.8381	0.8735	-0.5539
Adult longivity (days)	Male	0.9494	0.9452	1.0000	0.8704	0.7068	0.8883	0.8818	0.9109	-0.2671
	Female	0.8391	0.7606	0.8704	1.0000	0.7345	0.9766	0.9789	0.9721	0.0689
Developmental period		0.4693	0.4373	0.7068	0.7345	1.0000	0.5948	0.5977	0.6032	0.4542
Weight loss mg		0.9167	0.8479	0.8883	0.9766	0.5948	1.0000	0.9998	0.9985	-0.1335
% Weight loss		0.9094	0.8381	0.8818	0.9789	0.5977	0.9998	1.0000	0.9975	-0.1179
% Damage		0.9349	0.8735	0.9109	0.9972	0.6032	0.9985	0.9975	1.0000	-0.1649
% Moisture content		-0.4707	-0.5539	-0.2671	0.0689	0.4542	-0.1335	-0.1179	-0.1649	1.0000

Table 5 . Correlation values (r) between parameters for susceptibility determination in faba bean.

Parameters		Progeny	Weight	Adult longivity (days)		Develop.	Weight	% Weight	%	% Moisture
			adult (mg)	Male	Female	period	loss (mg)	loss	Damage	content
Progeny		1.0000	0.3156	-0.1555	0.4027	-0.2774	-0.1270	-0.1366	-0.0727	-0.3204
Adult weight mg		0.3156	1.0000	0.4839	0.8713	-0.2424	0.8458	0.7981	0.4679	0.6008
Adult longevity (days)	Male	-0.1555	0.4839	1.0000	0.7614	0.7208	0.8165	0.8785	0.9949	0.8858
	Female	0.4027	0.8713	0.7614	1.0000	0.2071	0.8393	0.8489	0.7789	0.9136
Developmental period		-0.2774	-0.2424	0.7208	0.2071	0.2002	0.2002	0.3118	0.7789	0.7148
Weight loss mg		-0.1270	0.8458	0.8165	0.8393	0.3118	1.0000	0.9931	0.8455	-0.7712
% Weight loss		-0.1366	0.7981	0.8785	0.8489	1.0000	0.9931	1.0000	0.7431	-0.5707
% Damage		-0.0727	0.4697	0.9948	0.7789	0.7431	0.7789	0.8455	1.0000	-0.9206
% Moisture content		0.3204	0.6998	0.8858	0.0136	0.5707	0.7148	0.7712	0.82.6	1.0000

The cowpea beetle, *C. maculatus* was able to develop and produce progeny on cowpea and faba bean varieties. Generally, *C. maculatus* did better in cowpea than faba bean varieties.

Nakhla (1988) found that the highest percentage of weight loss was 35.06 % in the case of small-sized seeds lentils and the least was 3.92 % in the large-sized seeds as broad bean. El-Degwi and El-Orabi (1997) reported 6 - 20.6 % and 14.6 - 24.1 % losses of faba bean and cowpea, when infested with *C. maculatus* , under laboratory conditions. In our results, the percentages of damage and weight loss of faba bean (*Vicia faba*) averaged 63.5 % and 16% while these percentages increased to 77.5 and 49.4 in cowpea seeds. El-Shazly and El-Shabrawy (2000) recorded 12.15 % loss in cowpea seeds, while this percentage lowered to 8.63 , in case of faba bean seeds when attacked by *C. maculates* . Seed coat and the texture of seed coat, its hardness or presence of other toxic compounds could explain these results Desroches *et al.* (1995).

Differences in seed damage, weight losses and food consumption of different legume varieties attacked by *C. maculatus* were reported by El-Banby and Mansour (1970). Credland and Dick (1987) concluded that differences concerning these parameter among legume seeds were regarding due to the variations of tested varieties. Singh and Sharma (1984) conducted studies under fluctuating conditions in a laboratory in India and found that the grain damage and loss due to infestation by *C. maculatus* were significant in the mung bean varieties ML 5, G 65, and Shining Moon No. 1. Damage was 42.5 - 57.3 %. In our study, although different varieties of cowpea and faba bean were used, damage ranged from 39.3 to 58.5 % in cowpea varieties and from 7.9 to 17.4 % in case of faba bean varieties.

The results of the present investigation reveal that none of the cowpea or faba bean varieties were completely immune to C. maculatus , and their response to attack by this pest can be arranged on the basis of percent damage, percent weight loss, percent food consumption, progeny produced and adult longevity.

2. Loss in seed viability The initial seed viability of all cowpea and faba bean varieties ranged between 96 and 100 %. Seeds infested with *C. maculatus* resulted in significant decrease in seeds viability. Seed viability of cowpea and faba bean decreased as overall assessment to 4.6 % and 7.2 %, respectively (Tables 2 and 3). In case of cowpea, although seed viability in Dokki 331 was the highest, there were no significant differences between seed viability of the different tested varieties. The

same trend was shown in faba bean varieties as seed viability averaged 8.3 %, 5.7 %, 7.4 % and 7.4 % in Giza 429, Giza 674, Giza 843 and Sakha-1, respectively (Table 3). The considerable loss in seed viability of cowpea and faba bean varieties was therefore a reflection of the extent of damage caused to seeds by *C. maculatus* during storage. Mensah (1986) reported 80% loss in seed viability of cowpea cultivars during 8 months after being infested with *C. maculatus* . Our results demonstrate 95.4 % and 92.8 % loss in seeds of cowpea and faba bean varieties which seem to be somewhat higher than the previous rate.

3. Biochemical changes in cowpea and faba bean seeds infested by *C. maculatus* Chemical assessments of carbohydrates, lipids, proteins, tannins and vicine showed considerable variations between infested seeds of cowpea and faba bean varieties with *C. maculatus* and healthy seeds. These differences were also found among seeds of the various tested varieties (Tables 6 and 7). The amounts of tannins, proteins, lipids, carbohydrates and vicine averaged 1.68 %, 25.05 %, 1.05 %, 57.28 % and 0.79 % of the infested cowpea seeds dry matter, respectively, while these percentages were 3.11, 22.88, 1.27, 61.24 and 0.76 in uninfested seeds, respectively. These results indicate that infestation of cowpea seeds by *C. maculatus* resulted in 45.98 %, 9.48 %, 17.32 %, 6.47 % and 3.84 % loss in tannins, proteins, lipids, carbohydrates and vicine, respectively, (Table 6). Concerning changes in chemical constituents of cowpea seeds of the different tested varieties, it was found that Karim 7 had the least changes in chemical constituents (0.03 %) followed by local variety (3.42 %) while Dokki 331 showed the greatest loss in chemical components of infested seeds (Table 9).

Infestation of faba bean seeds by *C. maculatus* showed the same trend as cowpea. Insect infestation led to considerable changes in infested seeds components compared with uninfested seeds. In general, infested seeds lost 8.69 % of seed dry matter components (Table 11). Furthermore, loss in tannins, proteins, lipids, carbohydrates and vicine averaged 24 %, 4.12 %, 18.54 %, 12.77 % and 6.58 %, respectively (Table 7). Tested faba bean varieties also showed considerable changes in chemical components of infested seeds, as a result of which Sakha-1, Giza 843, Giza 429 and Giza 674 lost 6.03 %, 7.06 %, 9.14 % and 11.86% of total infested seed dry matter, respectively, (Table 11).

Reduction in seed contents of protein, lipids and carbohydrates may affect the development and mortality rate of *C. maculatus* . It was found that the presence of

tannins in faba bean seeds did not affect the perforation rate while larvae of *C. maculatus* were able to develop in seeds of *Vicia faba* poor in vicine and the presence of vicine with high rate in the seeds seemed to be the main mortality factor for *C. maculatus* larvae Desroches *et al.* (1995).

Table 6 . Percentages of losses in tannins, proteins, lipids, carbohydrated and vicine of cowpea seeds infested with *C. maculatus* .

Seed contents	Uninfested	Infested	% loss
Tannins	3.11	1.68	45.98
Proteins	22.88	25.05	9.48
Lipids	1.27	1.05	17.32
Carbohydrates	61.24	57.28	6.47
Vicine	0.76	0.79	3.84
Total	89.26	85.85	83.09

Table 7. Percentages of losses in tannins, proteins, lipids, carbohydrated and vicine of faba bean seeds infested with *C. maculatus* .

Seed contents	Uninfested	Infested	% loss
Tannins	4.75	3.61	24
Proteins	25.98	27.05	4.12
Lipids	1.51	1.23	18.54
Carbohydrates	60.5	52.76	12.77
Vicine	0.71	0.67	6.58
Total	93.45	85.32	66.01

Table 8. Infestation rates, susceptibility indices (SI) and germination percentages of cowpea varieties to infestation by *C. maculatus* .

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 9. Characteristic of the tested cowpea varieties of tannins, proteins, lipids, carbohydrated of uninfested and infested seeds with *C. maculatus* .

Seed contents % of seed dry matter	Karim 7		Dokki 331		Local		Kafr El-Sheikh-1		Average	
	Uninfested	Infested	Uninfested	Infested	Uninfested	Infested	Uninfested	Infested	Uninfested	Infested
Tannins	2.61	1.59	2.81	1.12	3.41	2.08	3.62	1.39	3.11	1.55
Proteins	22.6	24.8	21.6	23.5	23.2	26.1	24.1	25.8	22.88	25.05
Lipids	1.23	1.15	1.24	0.9	1.3	1.2	1.32	0.93	1.27	1.05
Carbohydrates	61.21	60	61.66	58.84	61.09	56.2	60.99	54.08	61.24	57.28
Vicine	0.82	0.91	0.85	0.86	0.67	0.72	0.68	0.65	0.76	0.79
Total	88.47	88.45	88.16	85.22	89.6	86.3	90.71	82.85	89.25	85.72
% loss	--	0.03	--	25.18	--	3.42	--	8.67	--	3.82

Table 10. Infestation rates, susceptibility indices (SI) and germination percentages of faba bean varieties to infestation by *C. maculates* .

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)].

Table 11. Characteristic of the tested faba bean varieties of tannins, proteins, lipids, carbohydrated of uninfested and infested seeds with *C. maculatus* .

Seed contents % of seed dry matter	Giza 429		Giza 674		Giza 843		Sakha-1		Average	
	Uninfested	Infested	Uninfested	Infested	Uninfested	Infested	Uninfested	Infested	Uninfested	Infested
Tannins	4.87	3.59	4.32	3.63	5.89	4.56	3.92	2.64	4.75	3.61
Proteins	26.4	28.2	24.6	25.8	26.8	27.3	26.1	26.9	25.98	27.05
Lipids	1.53	1.39	1.5	1.08	1.54	1.35	1.48	1.08	1.51	1.23
Carbohydrates	61.03	51.07	60.89	50.15	60	54.02	60.09	55.78	60.5	52.76
Vicine	0.48	0.66	0.96	0.67	0.44	0.76	0.97	0.59	0.71	0.67
Total	94.31	84.91	92.27	81.33	94.67	87.99	92.56	86.93	93.45	85.32
% loss	--	9.14	--	11.86	--	7.06	--	6.03	--	8.7

The relationship between seed contents of cowpea or faba bean in vicine on one hand and seed infestation with *C. maculatus* revealed that seed infestation is vicine reduction dependent factor.

The vicine in low rate in seed of cowpea or faba bean was accompanied with increase of seed infestation by *C. maculatus*. In cowpea seeds, it was found that the percentage of infestation averaged 13.2 in Dokki 331 seeds containing 0.86 % vicine, (Tables 8 and 9) while this rate significantly increased to 17.6 % in Kafr El-Sheikh-1 variety seeds containing 0.65 % vicine only.

Similarly, seeds of faba bean Giza 843 which contain 0.76 % vicine had 12.1 % infestation (Tables 10 and 11) and the decrease of this value to 0.59 % vicine resulted in the increase of seed infestation of Sakha-1 to 13.2 %. These results are in harmony with the results of Desroches *et al.* (1995) who stated that the presence of vicine in seed coat affects the perforation rate of insect larvae and seemed to be the main mortality factor. El-Banby *et al.* (1985) reported that *C. maculatus* caused the greatest loss of carbohydrates of soybean. While in the present results, *C. maculatus* caused 6.47 %, and 12.77 % loss of cowpea and faba bean carbohydrates, respectively, (Tables 6 and 7).

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تقدير الفاقد فى الوزن والتغيرات الكيماوية لبذور بعض أصناف اللوبيا والفول البلدى نتيجة الإصابة بخنفساء اللوبيا *COLLOSOBRUCHUS MACULATUS* (COLEOPTERA : BRUCHIDAE)

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أدت إصابة بذور اللوبيا والفول البلدى إلى تلف نحو ٣٩,٣ % – ٥٨,٥ % من بذور اللوبيا المعرضة للإصابة ، وكانت نسبة التالف من هذه البذور يتوقف أيضا على الصنف المعرض للإصابة، فلقد بلغت نسبة التالف فى بذور اللوبيا للصنف دقى ٣٣١ (٣٩,٣ %) بينما إرتفعت إلى ٥٨,٥ % فى بذور الصنف كفر الشيخ-١ ، أما فى حالة الفول البلدى فلقد تراوحت نسبة التالف فى البذور ٥,٢ % – ١٧,٤ % ، وكان أعلى معدل للتلف فى بذور الصنف جيزة ٤٢٩.

أدت إصابة كل من اللوبيا والفول البلدى بخنفساء اللوبيا إلى فقد واضح فى وزن البذور المصابة حيث بلغ معدل الفقد فى بذور اللوبيا ٤٢ – ٦١,٦ % بينما كان فى بذور الفول البلدى ٨,٣ – ٢٨,٣ %. أما بالنسبة لكمية الفاقد فى أصناف اللوبيا فلقد بلغ أعلى معدل فى الفقد فى وزن بذور اللوبيا فى الصنف كفر الشيخ-١ (٠,٦٢ مج / ٢٠ جم بذرة) وكذلك فى صنف الفول البلدى جيزة ٤٢٩ (٠,٢٨ مج / ٢٠ جم بذرة).

بلغت نسبة الحيوية فى بذور اللوبيا والفول البلدى الغير مصابة بين ٩٦% و١٠٠%، أدت إصابة بذور اللوبيا والفول البلدى بخنفساء اللوبيا إلى فقد واضح فى حيوية البذور عند الإنبات فلقد أوضحت نتائج هذه الدراسة إلى أن الإصابة بخنفساء اللوبيا أدت الى إنخفاض نسبة الإنبات فى البذور بمعدل ٩٤,٩ % لبذور اللوبيا، ٩٤,٣ % بالنسبة لبذور الفول البلدى، وقد سجل أعلى معدل فى فقد حيوية البذور بالنسبة لصنف اللوبيا دقى ٣٣١ ، وفى صنف الفول البلدى جيزة ٤٢٩.

أوضحت نتائج التحليل الكيماوى لبذور الأصناف السليمة والأصناف المصابة بخنفساء اللوبيا تغيرات واضحة فى المحتوى الكيماوى لكل منهما نتيجة للإصابة بخنفساء اللوبيا، فلقد أدى إصابة بذور اللوبيا بخنفساء اللوبيا إلى إنخفاض فى كل من التانينات، البروتينات، الدهون، الكربوهيدرات، الفيسين بنسب قدرها ٤٥,٩٨%، ٩,٤٨%، ١٧,٣٢%، ٦,٤٧%، ٣,٨٤% على التوالى بينما كانت معدلات الفقد فى هذه المحتويات الكيماوية فى بذور الفول البلدى المصابة هى ٢٤%، ٤,١٢%، ١٨,٥٤%، ١٢,٧٧% و٦,٥٨% لكل من التانينات، البروتينات، الدهون، الكربوهيدرات، الفيسين

على التوالى، كما أوضحت نتائج الدراسة أيضا الناتجة عن تحليل بذور الأصناف المصابة أن هناك علاقة عكسية بين نسبة الإصابة ومحتوى البذور من الفيسين وأن الإصابة تعتمد إعتمادا كبيرا على محتوى البـــذور من الفيسين، فصنف اللوبيـــا كفر الشيـــخ-١ والذى ثبت حساسيته العالية للإصابة (١٧,٦%) يحـــتوى على ٠,٦٥% فيسين، بينما الصنف دقى ٣٣١ الذى يتصف بالمقاومة للإصابة يحـــتوى على ٠,٨٦% فيسين، وبالمثل فلقد وجد أن صنف الفول البلدى سخا-١ يحتوى على ٠,٥٩ % فيســـين (نســـبة الإصابة ١٣,٢%) بينما يحتوى الصنف جيزة ٨٤٣ (معدل إصابته ١٢%) على ٠,٧٦% فيسين.