Effect of Five Soybean Genotypes on the Induced Infestation and Fitness Components of *Callosobruchus chinensis* (Coleoptera: Bruchidae)

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ABSTRACT

All experiments were carried out in the Laboratory of Pests and Plant Protection Department, National Research Center, Dokki, Giza. These experiments were conducted to study the susceptibility of five soybean genotypes and the efficiency of soybean seed extracts on the biological activity of the cowpea beetle ***Callosobruchus chinensis*** (L.). The following points had been established and clarified:

1. Soybean Giza 111 was the most resistance genotype, whereas the lowest adult emergence percentage, slightly susceptible value and the highest mortality percentage for ***C. chinensis*** individuals inside the seeds.
2. The highest percentage of adult emergence and the lowest resistant to C. ***chinensis*** infestation was found on soybean genotype seeds H1 32.
3. Susceptibility Index (S.I.) values were 4.92, 5.22, 6.88, 6.98 and 8.90 for soybean genotypes Giza 111, H1 12, F5 H4, H1 10 and H1 32, respectively.
4. The vital of adult strains of soybean genotypes decreased when compared with the parent strain. However, the adults which were reared on the five soybean genotypes reducing the numbers of eggs, the percentages of adult emergences, the adult longevity and the developmental periods, when they were reared on cowpea seeds.
5. The interaction between low concentration of carbohydrate and low conjugated phenolic contents decreased the susceptibility to C. ***chinensis*** infestation.
6. Chloroform extract and soybean powder at 12.0% deterred the females at laying their eggs compared untreated seeds. Chloroform extract at 12.0% concentration was the highest effective in reduction percentage of progeny.
7. The minimum weight loss percentage in cowpea seeds was found in the cowpea seeds treatment at 12.0% concentration of Chloroform extract reached 2.15%.

Additional key words: Resistance, Carbohydrate, Phenolic component, powder and extracts.

INTRODUCTION

Grain legumes are among the important source of human dietary protein and calories in Egypt as well as many parts of the world. The cowpea (***Vigna unguiculata*** (L.) Walp.) and soybean (***Glycine max*** (L.) Merr.) are the principal legume grains of West Africa and the Northeast of South America. They are minor crops in Southern Asia, East Africa, the Caribbean and central North America (**Redden *et al.*, 1983; Bressani, 1985; Hashem and Risha, 1998 and Harminder and Ramzan, 2001**). Utilization of cowpea crops in many countries is reduced due to seeds destruction by larvae of both cowpea bruchid beetles i.e., ***Callosobruchus chinensis*** (L.) and ***C. maculatus*** (Fabr.) (**Gatehouse *et al.*, 1985 and Dick and Credland 1986 a, b**).

Infestations of bruchid beetles begin in the field and the populations expand rapidly in storage, which caused weight loss, decreased germination potentials and reduction in commercial values (**Messina and Renwick, 1985**).

In the meantime, bruchid beetle began to attack soybean seeds in the storage and caused considerable damage to seeds (**Suthama, 1982**). The widespread use of synthetic insecticides poses a serious hazard to both human and animals because of adverse effects on the environment and ecosystem. One solution to these problems might be to replace synthetic chemicals with compounds occur naturally in plants or environment (**Golob and Webley, 1980; Pereira, 1982** and **Keita *et al.*, 2001**). Several studies carried out to protect legume seeds by used soybean oil (**Choudhary, 1990; Begum and Quiniones, 1991** and **Risha *et al.*, 1993**).

Therefore, it seemed worthwhile to make an attempt to study and compare the susceptibility of five soybean genotypes to infestation with the cowpea pulse beetle, ***C. chinensis*** as long as their efficiency on its developmental periods under laboratory conditions. In addition, the influences of certain extractions of the most resistance soybean genotype to ***C. chinensis*** infestation on cowpea seeds were carried out.

MATERIALS AND METHODS

All experiments were carried out in the Laboratory of Pests and Plant Protection, National Research Center, Dokky, Giza, under laboratory conditions at 28.6 °C and 74.6% R.H.

1. Stock culture:

One or two days old adults of the cowpea pulse beetle, ***C. chinensis***, which were collected from laboratory culture maintained on cowpea seeds under the constant laboratory conditions.

2. Stock seeds:

The five soybean genotype seeds were obtained from Department of Legume Crops, Agricultural Research Center, Dokky, Giza. Samples of cowpea and five soybean genotype seeds were placed in polyethylene sacks and freezed for one week before treated to prevent any insects and/or mites infestation.

3. Susceptibility of five-soybean genotype seeds to *C. chinensis* infestation:

Five-soybean genotype seeds viz., H1 10, H1 32, H1 12, F5 H4 and Giza 111 were used to investigate the susceptibility to the cowpea pulse beetle infestation under the constant laboratory conditions.

3.1. Choice test:

An arena (3 cm high x 15.5 cm diameter) divided into five equal divisions was used. Five soybean seeds from each genotype were placed inside each room, seven pairs of newly emerged adults (1 – 2 days old) were introduced in the center of the arena and covered with arena's cap with four replicates. Seven days later the soybean genotype seeds with adhering eggs were removed and counted using a binocular microscope. Each genotype seeds was placed in a tube and incubated until adults emerging. The adults emergence were removed and recorded from each genotype seeds daily in order to prevent further mating and laying eggs. The count was continued till no adult emerging. Numbers of the adult mortality inside the seeds were recorded. The developmental periods were calculated from incubation period to the adult emergence for all different genotype seeds. However, Dobie's Index Formula was used to indicate the susceptibility of any soybean genotype to infestation (**Dobie, 1974**).

$$\text{Susceptibility Index (S.I.)} = \frac{\text{Log F1}}{D} \times 100$$

Where, F1 = Total number of emerging adults.

D = Mean of developmental periods (days).

All the obtained results were subjected to statistical analysis of variance by using "Microstate Program" a Computer Program for statistics.

3.2. Performance the breeding cowpea pulse beetle adults of five soybean genotypes to rear on cowpea seeds:

One pair of newly 1 – 2 days old female and male adults of ***C. chinensis***, which emerged from each soybean genotype seeds alone was confined in a Petri dish (7 cm diameter) containing 10 seeds of cowpea seeds till the adult dead. In the meantime, the same procedure was carried out on the cowpea pulse beetle adults, which reared previously on cowpea seeds as control. They were replicated four times. The number of settled eggs, incubation periods, the developmental periods till the adults emerged and the adult longevities were counted and recorded. In order to indicate the suitability of the cowpea seeds as host for the six rearing strains of cowpea pulse beetles; Howe's Index of Suitability for Development formula according to **Howe (1971)** was used as follows:

$$\text{Suitability for development} = \frac{\text{Log S}}{D}$$

Where, S = Percentage of insects reaching the adults.

D = The average duration of development.

3.3. Chemical analyses of different soybean genotypes:

The values of total carbohydrates were estimated according to **Thomas and Dutcher (1924)**, while to determine free, conjugated and total phenolic compounds the method mentioned by **Snell and Snell (1953)** was used.

3.4. Preparation of the powder, Chloroform and Methanol extracts of soybean Giza 111:

The present study was carried out under the laboratory conditions of 29.3 °C and 71.9% R.H. For preparation of soybean seeds Giza 111 powder an amount of 100 gm was ground by electric blender to fine powder and sieved.

For preparation the chemical extracts of seeds by Chloroform and/or Methanol the methods adopted by **Freedman *et al.* (1979)** and **Su and Horvat (1981)** were applied, respectively.

To determine efficacy of both extract solutions and fine powder of soybean seeds Giza 111 against the cowpea pulse beetle, series of volumes of each extract (i.e., 4, 6 and 12 ml) and series weights of powder (i.e., 4, 6, 12 gm) were mixed manually with 100 gm cowpea seeds. Each treatment was placed in a Petri dish (15.5 cm diameter). However, weights and concentrations were calculated as percentages. The treated seeds were left to dry using electric fan except, in case of powder treatments. Another untreated 100 gm cowpea seeds were used as control.

Thereafter, a number of twenty cowpea seeds from each treatment was weighted before infestation and placed in glass jar (200 ml). Two pairs (two females + two males) of newly emerged adults of cowpea pulse beetle were released in each jar containing the treatment cowpea seeds and covered with a fine nylon mesh, which was fixed with a rubber band. Four replicates were conducted for each treatment as well as for control treatment. Seven days later, the adults were removed and the numbers of deposited eggs by mated females were recorded and incubated till end emergence of the adults of the new generation. Then, the cowpea seeds were weighted to calculate the percentages of weight loss in each treatment seeds as follows:

$$\% \text{ of weight loss} = \frac{Wsbl - Wsal}{Wsbl} \times 100$$

Where, Wsbl = Weight of seeds before infestation.

Wsal = Weight of seeds after infestation.

To determine the oviposition deterrency of the tested extracts of ***C. chinensis*** adults, the oviposition deterrent index (O.D.I.) (**Lundgreen, 1975**) was used as follows:

$$O.D.I. = \frac{B - A}{B + A} \times 100$$

Where, A and B are the number of eggs laid on treated and untreated seeds, respectively, 100% represent complete deterrency and zero means that equal number of eggs are distributed on the untreated and treated seeds.

The percentage of reduction in progeny was calculated as:

$$\% \text{ of Reduction} = \frac{C - T}{C} \times 100$$

Where, C = number of adults emerged in untreated seeds.

T = number of adults emerged in treated seeds.

All experiment data were statistical analyses by Microstat Program to obtain F "values" and L.S.D. and Duncan's Multiple Range Test according to **Duncan (1955)** was used.

RESULTS AND DISCUSSION

Analysis of variances confirmed that there were significantly differences among the five soybean genotypes in their effective on the egg numbers, percentages of adult emergences, adult longevities and developmental periods in all experiments.

1. Susceptibility of five soybean genotype seeds to the cowpea pulse beetle infestation using the choice test:

Data summarized in **Table 1** showed definite performance to susceptibility infestation by ***C. chinensis*** to certain soybean genotype seeds later seven days of the choice test; it could be arranged in descendingly order as ranks. In this respect, results indicated that soybean seeds H1 32 (1st rank) have the highest attractant to the adult females of the cowpea pulse beetle to lay their eggs followed by soybean seeds H1 10 (2nd rank), Giza 111(3rd rank), H1 12 (4th rank) and F5 H4 (5th rank), consecutively. Where, the mean numbers of laying eggs were 68.25, 60.50, 44.50, 40.00 and 39.25 eggs, respectively. They were high significantly differences among the different soybean genotype seeds in their susceptibility to the cowpea pulse beetle infestation, except for soybean genotype seeds H1 12 and F5 H4 there was no significantly difference between them.

As shown in **Table 1**, soybean genotype seeds significantly affected the numbers of larvae and pupae reached to adult stage. The highest percentage of adult emergence was found on soybean genotype seeds H1 32 (13.20% adults), while the lowest percentage was noticed on soybean genotype seeds Giza 111 (4.50% adults). There was no significantly difference either between the percentage of adult emerged from soybean genotype seeds of H1 32 (the 1st rank) and F5 H4 (the 2nd rank) or between soybean seeds H1 10 (the 3rd rank) and H1 12 (the 4th rank). Meanwhile, the percentage of adult emerged from soybean seeds Giza 111 (the 5th rank) had high significant differences with the percentages of four remaining tested soybean seeds.

On the other hand, soybean Giza 111 appeared the highest resistance soybean genotype to ***C. chinensis*** infestation, while the soybean H1 32 was the lowest resistant one. Where, the percent of adult mortality inside the soybean seeds Giza 111 and H1 32 was 57.0 and 30.18%, successively.

Regard to data of developmental periods of cowpea pulse beetles in **Table 1,** it could be estimated that the bruchid beetles on soybean seeds H1 12 had the 1st rank with the longest period (50.5 days) followed by soybean H1 10 the 2nd rank (44.25 days), while soybean seeds H1 32 had the shortest period the 5th rank (40.25 days). There were high significantly differences between the developmental period of ***C. chinensis*** on soybean H1 12 and the developmental period on each of the four resting soybean genotypes.

Based on susceptibility index (S.I.) values in **Table 1**, the susceptibility of soybean genotypes were identified to three criteria as follows:

a- Slightly susceptible genotype: Giza 111 and H1 12, where (S.I.) were 4.92 and 5.22, respectively.

b- Moderately susceptible genotype: F5 H4 and H1 10, where (S.I.) were 6.88 and 6.98, consecutively.

c- Susceptible genotype: H1 32, where (S.I.) was 8.9.

Consequently, obtained data confirmed that soybean Giza 111 was the most resistance genotype, whereas the lowest adult emergence percentage, slightly susceptible value and the highest mortality percentage for ***C. chinensis*** individuals inside the seeds.

Many investigators reported that soybean seeds are generally considered to be relatively resistant to infest by some bruchid beetle species. However, **El-Sawaf (1956)** indicated that when ***C. maculatus*** was reared on soybean its survival was poor and its development was low. Similarly, **Yoshida (1958)** reared ***C. chinensis*** on soybean seeds but found it to be a poor food. **Applebaum *et al.*, (1965)** mentioned that ***Callosobruchus*** species have occasionally been recorded on this commodity, but never as serious pests.

As indicated by **Suthama (1982)** the development and damage caused by the Indonesian bruchid beetle, ***Callosobruchus analis*** (Fabr.) on four varieties of white soya, the varieties differed in their susceptibility to attack but the bruchids developed successfully on the whole beans of the four varieties and caused significant damage.

Dick and Credland (1986 a, b) observed that three strains of ***C. maculatus*** from Brazil, Nigeria and Yemen Arab Republic, did not survive well or develop at the same rate in a resistance cultivar of cowpea. In all beetle strains, fewer larvae survived to produce adults, and the duration of development was extended,. in the resistance cowpea cultivar.

2. Biology and efficacy of *C. chinensis* adults resulted from different soybean genotypes on cowpea seeds:

Some biological aspects of ***C. chinensis***, which were previously bred on the five soybean genotypes and cowpea seeds (as parent strains of cowpea pulse beetles on each soybean genotype seed) to rear one generation over on cowpea seeds were studied and discussed.

2.1. Numbers of deposited eggs:

The exhibited results in **Table 2** revealed that the vital of the adult strains of soybean genotypes decreased compared with the parents strain as aforementioned data in **Table 1**. The highest mean number of laying eggs was 36.0 eggs on cowpea seeds obtained from the beetle adult females of strain reared on soybean genotype H1 32. Compared with mean number of 75.75 eggs, which were laid by the adult females of pure strain on cowpea seeds. While, the lowest mean number of deposited eggs 13.5 eggs on cowpea seeds was scored from the adult females bred on soybean seeds F5 H4. There were high significantly differences between the mean number of laying eggs of ***C.***

chinensis from parents strain of cowpea seeds and the numbers of five beetle strains reared on five soybean genotypes, when they were reared on cowpea seeds.

2.2. Percentages of adults emergence:

As shown in **Table 2**, it could be noticed that the mean number of adult emergence from cowpea seeds was higher in strain beetles reared on pure cowpea seeds (parents) than that of five strain beetles reared on the five soybean genotypes (parents), when they were reared on cowpea seeds. High significant differences were observed between the mean number of adult collected from pure cowpea and the means of adults collected from the five soybean genotypes, when they were reared and emerged from cowpea seeds.

On the other hand, the percentages of adult emergences were in this descendingly order cowpea, soybeans of H1 10, H1 32, H1 12, F5 H4 and Giza 111, respectively. Where, the percents were 71.6%, 65.85%, 62.5%, 60.6%, 59.25% and 44.4%, successively.

2.3. Adult longevity:

The included data in **Table 2** elucidated that the five strains of adult beetles decreased the adult longevities on cowpea seeds. In this respect, the five rearing pulse beetle strains of the five soybean genotypes shorted the adult longevity periods in comparison to the cowpea strain (16.38 days). The longest period was recorded by adult strain of soybean Giza 111 followed by strains of H1 32, F5 H4, H1 10 and H1 12, consecutively. Where the longevity periods were 9.0, 8.25, 6.5, 6.5 and 6.0 days, respectively. On the other hand, there were highly significant differences between cowpea seeds pure strain and the five strains of the five soybean genotypes.

2.4. Developmental period:

The induced data in **Table 2** inferred that the developmental periods of the different strains of beetles were affected during the life cycles on cowpea seeds. Relatively the longest developmental period was calculated from beetles strain of soybean H1 32 (34.9 days), while the shortest period was recorded in strain of cowpea seeds (23.5 days). However, there were highly significant differences between the developmental period of beetles resulted from soybean H1 32 and the five resting strains of cowpea pulse weevil, when they were reared on cowpea seeds.

Although the developmental periods of the five weevil strains were longer than that of cowpea seeds strain, in comparison these developmental periods were shorter than those of the five weevil strains of the five soybean genotypes as data given in **Tables 1** and **2**.

Obtained data in **Table 2** showed the values of Howe's Index for the six-cowpea weevil strains. In this calculation of Howe's Index, the shortest developmental period produced the highest value, which in turn indicated the greater suitability of the host seeds. However, Howe's Index elucidated that the pure strain of ***C. chinensis*** adults found the host preference (cowpea seeds) more suitable for development, where the Index value was 0.073. Meanwhile, the soybean strains showed lower Index values in this descendingly order H1 12, H1 10, Giza 111, H1 32 and F5 H4, respectively, where the Index values were 0.042, 0.040, 0.039, 0.038 and 0.029, successively.

From the above-cited results, it could be noticed that the soybean strains did not survive equally well or develop at the same rate in the susceptible of cowpea seeds. Consequently, the adults of five strains of ***C. chinensis***, which were reared on the five soybean genotypes have high efficacy in reducing the numbers of eggs, the percentages of adult emergences, the adult longevity and the developmental periods, when they were reared on cowpea seeds.

Our data are in line with those of **Dick and Credland (1986 a** and **b)** who reported that the bruchid beetles resistance expressed in cowpea, TVu 2027 and its progeny was unlikely to remain effective for very long. If host plant resistance is to contribute to the reduction in cowpea losses caused by ***C. maculatus***, then plant breeders well need to remain at least one step ahead of insect pest. Breeding of the Yemen and Nigerian strains on TVu 2027 for three generations demonstrated that the performance of the beetles rapidly improves in terms of both survival and developmental rate.

Lale and Mustapha (2000) mentioned that the number of eggs that hatch and the number of first instar larvae that are able to penetrate the cotyledons of pulse seeds determined successful infestation by species of Bruchidae.

3. Relationship between resistance of soybean genotype and certain chemical components:

The exhibited data in **Table 3** show the chemical analysis of the five soybean genotype seeds i.e., total carbohydrates and phenolic compounds (mg/g fresh weight). Comparison between the susceptibility of the five soybean genotypes to ***C. chinensis*** infestation and the chemical compounds (**Tables 1** and **3**) were conducted. Whereby, the slightly susceptible genotypes and/or the resistance soybean genotypes viz., Giza 111 and H1 12 have low concentration of total carbohydrates and the least concentration of conjugated phenolic compounds as well as the total phenolic compounds. The moderately susceptible genotypes were F5 H4 and H1 10, where they have high concentrations of total carbohydrates, free phenol and moderate concentrations of conjugated phenol as well as the total phenolic compounds. The susceptible genotype was H1 32, where it has relatively low concentration of total carbohydrates, the highest concentration of conjugated phenol as well as the highest concentration of total phenolic contents.

On the other words, there was a positive relationship between the high concentration of conjugated phenolic compound as well as the total phenolic compounds and the high level of susceptibility to infestation by the cowpea pulse beetles. The opposite was true in resistance soybean genotype to the cowpea pulse weevil infestation. In our opinion the interaction between low concentration of carbohydrate and low conjugated phenolic contents decreased the susceptibility to C. ***chinensis*** infestation.

Data in **Table 4** indicated the statistical correlation analyses between the carbohydrate, phenolic contents and some biological aspects. There were highly significant positively correlated with both chemical components and emergences of adults of all cowpea pulse beetle strains, except for the carbohydrates and adult emergence on soybean genotype F5 H4 and Giza 111, where there was insignificant correlation at the 5% level of probability. In the resistance soybean genotype Giza 111, there was highly significant positively correlated between either the carbohydrate or phenolic components and adult mortality percentage. Also, there was highly significant negatively correlated between both the carbohydrate or phenolic components and the developmental period. In susceptible soybean genotype H1 32, there was highly significant negatively correlated with either the adult mortality percentage or developmental period and the carbohydrate content. While there was insignificant correlation with either the adult mortality percentage or developmental period and the phenolic components.

Torres *et al.* (1996) mentioned that the resistant varieties to the ***Sitophilus oryzae*** L. differed significantly with the S.I. and grains weight loss, and there were significant positive correlations between these two parameters.

Ramputh *et al.* (1999) found significant inverse linear relationships were between resistance parameters such as weight loss of grain, the Doble's Index of susceptibility, number of eggs laid and progeny emerged and the phenolic content of the grain. They suggested that the soluble phenolic content could be used as an indicator of resistance.

Harmindor and Ramzan (2001) observed that the soybean cultivars received less number of eggs because of their shiny and convex seed surface and creamy seed coat.

Wang and Luo (2001) indicated that the resistance of soybean varieties to pod borer, ***Leguminivora glycinivorella*** were highly significant positively correlated with seed weight and sugar content of the husk, and highly significant negatively correlated with cellulose content, hardness and colour of the husk.

4. Effective of powder, Chloroform and Methanol extracts of soybean Giza 111 on *C. chinensis*:

Data presented in **Table 5** showed that the effects of Chloroform extract and soybean Giza 111 powder on oviposition eggs increased with increasing the concentration. Chloroform extract and soybean powder at 12.0% deterred the females from laying their eggs and the mean numbers of eggs laid were 22.25 and 23.5 eggs, respectively, compared with 115.25 eggs in untreated seeds. The oviposition deterrent index (O.D.I.) reached 67.63 and 66.13% with mixing the seed by Chloroform extract and soybean powder at 12.0% concentration.

Methanol extract at 12.0% concentration was not effective as deterrent oviposition to females, where the mean numbers of eggs laid were 51.0 eggs compared with Chloroform extract and powder at the same concentration. Chloroform extract and powder at 12.0% concentration were highly effective as oviposition deterrent and protected the seed from infestation. The remaining extracts and powder concentrations did not effective as oviposition deterrent index.

There was no significantly difference between Chloroform and powder at 12.0% concentration in mean numbers of eggs laid. While, significant differences were found between them and the other treatments.

Chloroform extract at 12.0% concentration was the highest effective in reduction percentage of progeny (98.35%) followed by the powder (86.57%) and Methanol extract (74.79%). The developmental periods were prolonged in all treatments and elapsed between 30.83 and 32.2 days; compared with 21.76 days in untreated one (as control).

The minimum weight loss percentage in cowpea seeds was found in the cowpea seeds treatment at 12.0% concentration of Chloroform extract reached 2.15%. This followed by treatment cowpea seeds at 12.0% concentration of powder and treatment cowpea seeds at 12.0% concentration of Methanol extract, where the weight losses reached 14.35% and 16.57%, respectively.

Finally, results indicated that the treatment of cowpea seeds with 12.0% concentration of Chloroform extract had the least weight loss in seeds; this due to the highly effective in the protection of cowpea seeds against the cowpea pulse beetles.

Ran *et al.* (1988) extracted mechanically oil from soybean seeds and applied at 3ml/kg grain seeds. They found that the oil was very effective in controlling ***S. oryzae*** and reducing the damage caused.

The previous results are in harmony with those of **Choudhary (1990)** who reported that soybean oil was effective in reducing damage caused by ***C. chinensis*** at 10 ml/100g of chickpea seeds.

Giga and Munetsi (1990) found that the soybean and castor oils reduced oviposition and egg hatching of the bruchid weevil, ***Callosobruchus rhodesianus*** (Fabr.) more than citrus oil. The oils tested were equally effective at rates of 5 ml/kg seeds or higher in reducing survivor ship of eggs. They suggested that the mortality be caused by a general physical property of the oil coating rather than a specific chemical action.

Sharma and Norris (1994) elucidated that methanol (60%) in water and benzene/ethyl acetate/methanol (in the ratio 4:3:3) extracts of soybean genotype PI 227687 leaves were highly antifeedant activity to third instar larvae of ***Trichoplusia ni***. Plant extracts are widely known to cause significant mortality of the first instar larvae when used to protect against infestation (**Boughdad *et al.*, 1987** and **Lale and Mustapha, 2000**). **Hoffmann *et al.* (2001)** found that ethanolic extracts of soybean genotype PI 227687 and three purified fraction were effective in feeding deterrence and as an antibiotic, appeared to account for the adverse effect of PI 22768 on the physiology of ***T. ni***.

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Table 1. Susceptibility of five soybean genotypes to *C. chinensis* infestation, some biological aspects and susceptible indices (S.I.) using the choice test.

Soybean genotype	Mean numbers and percentages of *C. chinensis* infestation					(S.I.)
	Eggs	Adults emergence	Adults emergence %	Adults mortality inside seeds %	Developmental period (days)	
H1 10	60.50 b	5.5	9.10 b	42.25 b	44.25 b	**
H1 32	68.25 a	9.0	13.20 a	30.18 d	40.25 c	***
H1 12	40.00 d	3.5	8.75 b	31.00 d	50.50 a	*
F5 H4	39.25 d	5.0	12.74 a	39.00 c	43.50 b	**
Giza 111	44.50 c	2.0	4.50 c	57.00 a	42.25 bc	*
L.S.D.	4.23		2.59	2.14	2.86	

* = Slightly susceptible genotype, ** = Moderately susceptible genotype and *** = Susceptible one.
In a column, means followed by the same letter are not significantly different at the 5% level by DMRT.

Table 2. Efficiency of *C. chinensis* reared on the five soybean genotypes and some biological aspects when reared over one generation on cowpea seeds under laboratory conditions.

Parent of *C. chinensis* seeds	Mean numbers and some biological aspects of *C. chinensis* reared on cowpea seeds					Howe's Index
	Eggs	Adult emergence	% of Adult emergence	Adult longevity (days)	Developmental periods (days)	
H1 10	20.50 cd	13.50 cd	65.85	6.50 c	28.20 c	0.040
H1 32	36.00 b	22.50 b	62.50	8.25 b	34.90 a	0.038
H1 12	33.00 b	20.00 bc	60.60	6.00 c	30.80 b	0.042
F5 H4	13.50 d	3.00 d	59.25	6.50 c	30.80 b	0.029
Giza 111	27.00 bc	12.00 cd	44.40	9.00 b	27.50 c	0.039
Cowpea	75.75 a	54.25 a	71.60	16.38 a	23.50 d	0.073
L.S.D.	11.12	8.84		1.93	1.34	

In a column, means followed by the same letter are not significantly different at the 5% level by DMRT.

Table 3. Chemical analysis of the main constituents in five soybean genotypes.

Soybean genotypes	Total carbohydrates (mg/g fresh weight)	Phenolic compounds (mg/g fresh weight)		
		Conjugated	Free	Total
H1 10	82.61 a	0.272 a	0.125 a	0.397 bc
H1 32	66.93 c	0.310 a	0.093 bc	0.403 a
H1 12	73.55 b	0.172 c	0.114 a	0.286 c
F5 H4	84.29 a	0.279 a	0.082 c	0.361 ab
Giza 111	66.47 c	0.226 b	0.095 bc	0.321 bc
L.S.D.	2.576	0.044	0.019	0.062

In a column, means followed by the same letter are not significantly different at the 5% level by DMRT.

Table 4. Simple correlation coefficient between carbohydrates and phenolic contents of soybean genotypes and percentages of adults emergence, adult mortality and developmental period.

Soybean genotypes	Chemical component	Adult emergence %	Adult mortality %	Developmental period
H1 10	Carbohydrate	0.993 **	0.549 ns	0.829 **
	Phenolic	0.698 **	0.561 *	0.618 **
H1 32	Carbohydrate	0.978 **	- 0.791 **	- 0.860 **
	Phenolic	0.787 **	- 0.365 ns	0.423 ns
H1 12	Carbohydrate	0.590 **	0.352 ns	0.658 **
	Phenolic	0.88.9 **	0.848 **	0.867 **
F5 H4	Carbohydrate	0.187 ns	- 0.459 ns	0.398 ns
	Phenolic	0.800 **	0.826 **	0.680 **
Giza 111	Carbohydrate	0.279 ns	0.998 **	- 0.965 **
	Phenolic	0.679 **	0.828 **	- 0.799 **

* = Significant at 5%, ** = Significant at 1% and ns = Not significant.

Table 5. Effective of two extracts and powder of soybean Giza 111 on the biology of *C. chinensis* reared on cowpea seeds and oviposition deterrent Index (O.D.I.).

Extract types *	Conc. %	Mean no. of Eggs	O. D. I.	Mean no. of adult emergence	Progeny reduction %	Developmental period (days)	Weight loss %
Methanol	4.0	115.00 a	0.10	68.00 b	25.47	31.25 bc	54.77 a
	6.0	113.00 a	0.98	57.00 c	37.53	31.60 ab	51.67 ab
	12.0	51.00 e	38.64	23.00 g	74.79	30.60 e	16.57 d
Chloroform	4.0	91.25 b	11.62	48.75 d	46.57	30.90 bc	52.82 ab
	6.0	76.50 d	20.20	32.50 f	64.38	32.20 a	33.77 c
	12.0	22.25 f	67.63	1.50 i	98.36	31.50 ab	2.15 e
Powder	4.0	81.50 bc	17.15	48.50 d	46.84	31.50 ab	47.49 ab
	6.0	67.75 d	25.95	38.25 e	58.08	30.83 bc	45.49 b
	12.0	23.50 f	66.13	12.25 h	86.57	31.30 bc	14.35 d
Untreated	-	115.25 a	-	91.25 a	-	21.76 d	55.54 a
L.D.S.		12.65		5.23		0.76	8.58

* Conc. = Concentration; in case of Methanol and Chloroform were prepared as (ml/100gm) and the powder was as (gm/100gm)

In a column, means followed by the same letter are not significantly different at the 5% level by DMRT.

الملخص العربى

تأثير خمسة أصناف من فول الصويا على مستوى الإصابة ومكونات الموائمة بخنفساء اللوبيا (غمدية الأجنحة: عائلة الخنافس)

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أجريت التجارب تحت الظروف المعملية فى معمل قسم آفات ووقاية النبات- المركز القومى للبحوث ، الدقى ، الجيزة . حيث تم اختبار حساسية بذور خمسة تراكيب وراثية (أصناف) من فول الصويا هى Giza 111, H1 10, H1 12, H1 32, F5 H4 للإصابة بخنفساء اللوبيا ، كذلك دراسة كفاءة مستخلص بذور فول الصويا ومسحوق بذور فول الصويا فى مكافحة خنفساء اللوبيا على بذور اللوبيا ولقد أظهرت النتائج:

١- أن صنف فول الصويا جيزة ١١١ كان الأعلى مقاومة ، حيث كان له قابلية ضعيفة للإصابة وأدى إلى أقل نسبة مئوية للخنافس الناتجة وأعلى نسبة موت لخنافس اللوبيا داخل بذوره.

٢- كان فول الصويا H1 32 هو الأقل مقاومة للإصابة بخنفساء اللوبيا وسجل أعلى نسبة مئوية للحشرات الكاملة المنطلقة من طور العذارى.

٣- قلت حيوية سلالات الخنفساء المرباة على أصناف فول الصويا بالمقارنة مع سلالة الآباء.

٤- خنافس اللوبيا الناتجة من التربية على بذور الخمس أصناف فول الصويا عند تربيتها على بذور اللوبيا قلت أعداد البيض بشدة ونسب خروج الخنافس وطول فترة نموها وطول فترة حياة الحشرة الكاملة.

٥- لوحظ وجود السكريات والفينول المرتبط بتركيزات منخفضة فى صنف فول الصويا جيزة ١١١ الذى تميز بقابلية منخفضة للإصابة بخنفساء اللوبيا.

٦- عند استخدام الكلوروفورم كمستخلص لبذور فول الصويا جيزة ١١١ ومسحوق فول الصويا جيزة ١١١ بتركيز ١٢% كان لهما أعلى تأثير فى تقليل نسب الخلفة الناتجة من خنفساء اللوبيا على بذور اللوبيا .

٧- وجد أن أقل فقد فى وزن بذور اللوبيا كان فى المعاملة بمستخلص الكلوروفورم حيث وصل الفقد فى الوزن إلى ٢,١٥%.