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REPELLENCY OF SOME SUCKING INSECTS ON SOYABEANS BY SESAME AND MUNGBEANS

By

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ABSTRACT

There is ample evidence to show that the plant kingdom is a vast store-house of chemical substances manufactured and used by plants in their own defense from attack by insects. Due to the intensive application of insecticides the present work was planned to use a cheaper alternative and a much safer way to control the sucking pests, *Aphis gossypii*, *Tetranychus urticae* and *Emposca lybica* by growing either sesame or mungbean as plant traps within the soyabean field. The population density of *A. gossypii*, *E. lybica* and *T. urticae* were much lower in soyabean polyculture; soyabean-mungbean or soyabean-sesame than in soyabean monoculture during the two successive years 1995 and 1996. The least degree of infestation occured by *A. gossypii* in the soyabean plants surrounded by mungbean during two successive years 1995 and 1996 (19% and 17.7%, respectively) followed by soyabean surrounded by sesame (24% and 21%, respectively) while the highest level of infestation occurred in the plots of soyabean monoculture (45% and 39%, respectively). The resistance mechanisms of sesame and mungbean were attributed to the presence of natural toxic chemical components. The plant contents of alkaloids, flavonoids, saponins and triterpenes are suggested to be responsible for repelling insects from sesame plants while flavonoids are expected to repell insects away from mungbean. In addition, the presence of dense growths and trichomes of mungbean leaves may help plants to deter insects feeding and adult oviposition. Chemical analysis of the leaves showed low content of some nutrients in mungbean such as protein, N, Mn, Na, Fe, Zn and Pb with an increase in K, Mg, Cu, Cr, Co, Ni and Cd. The sesame leaves showed less marked content of protein, N, Mg, Mn, Zn and Cr with an increase in Na, Fe, Ni, Co, Cu, Pb and Cd. The correlation between chemical constituents and susceptibility to pest infestation of *Aphis gossypii*, *Tetranychus urticae* and *Emposca lybica* was investigated.

INTRODUCTION

The soyabean, *Glycin max* (L.) Merril, is one of the economic field crops in Egypt. *Aphis*, *Tetranychus* and *Emposca* spp. are among the major pests attacking soyabean. These pests could be controlled by different synthetic pesticides but because of the ecological problems resulting from using them, resistant plants to pests can be used which are cheaper and do not require the extensive use of the toxic hazardous chemicals to humans and the environment. The present work was conducted to evaluate the resistance which occurs when a normally susceptible plant is grown in association with a resistant plant which provides protection from insect infestation (Smith, 1989). Associational resistance indicates that the delaying actions of mixtures of plant species can help slow the development of insect biotypes that overcome insect - resistant cultivars (Heinrichs *et al.*, 1986). Taman *et al.* (1996) found that the population density of *Spodoptera littoralis* (Boisd.), is much lower in soyabean polyculture (soyabean - sesame - mungbean) than in soyabean monoculture. The population density of *Diaphania hyalinata* (L.), a lepidopteran pest of cucurbit crops in Mexico, is much lower in squash polyculture (squash - maize - cowpea) than in squash monoculture (Letourneau, 1986). Burris *et al.* (1983) found that high fruiting strains of cotton, planted in combination with cultivars not preferred for oviposition have been used to attract and hold boll weevil infestations away from commercial plantings of cotton.

Chemical analysis of the leaves of the tested plants, (sesame, mungbean and soyabean) at the time of maximum infestation was determined to show the effect of nutrient contents and bioactive plant constituents in an attempt to find the correlation between these chemicals and the resistance of plants to the sucking insects infestation.

MATERIALS AND METHODS

I . Field Experiment :

A field (2100 m^2) was chosen at the Agricultural Research Experiment Station Sabahia, Alexandria. This area was divided into 15 plots. Five treatments (3 plots each), were cultivated with : A, sesame (Giza 32) ; B, mungbean (V.C. 1000) ; C, soyabean (Clark) ; D, sesame was sown around soyabean ; E, mungbean was sown around soyabean. All plots were sown on 15 April 1995 and 1996, and received the normally recommended agricultural practices.

1- Population density of the sucking insects :

For studing the population density of the sucking insects, *Aphis gossypii*, *Tetranychus urticae* and *Emposca lybica* on soyabean plants, 100 soyabean plants were inspected atrandom at weekly intervals throughout 1995 and 1996 seasons.

2- Degree of infestation caused by *A. gossypii* insects :

The degree of infestation caused by *A. gossypii* insect was evaluated for each treatment in which 100 soyabean leaves samples were randomly collected. Each leaf was thoroughly inspected and ranked in one of four infestation categories as suggested by Habib and El-Kady (1961) which was slightly modified as follows:- clean (no aphids are visible), slight (1-10% infested leaves), moderate (11-50%) and severe (>50%). The degree of infestation was estimated according to the following formula :

$$P = \frac{\text{Sum of } n \times v}{ZN} \quad \text{(Kasopers, 1965)}$$

where; P = degree of infestation ,
n = number of leaves in each category ,
v = Score of each category ,
Z = Score of the highest category (5) and
N = total number of inspected leaves

II . Phytochemical Screening :

The collected samples of plant leaves were air dried at room temperature and then ground in a willey mill to a fine powder. Chemical analysis of the leaves of each plant (sesame, mungbean and soyabean) was carried out to determine the following :

a) The nutrient contents in the leaves at the period of highest attack, such as protein, nitrogen, potassium, sodium, copper, iron, zinc, manganese, magnesium, nickel, chromium, cobalt, lead and cadmium contents were determined in the Central lab. of the Faculty of Science Laboratory, Alexandria University.

b) The leaves powder of each plant was tested for the presence of alkaloids, flavonoids, saponins and triterpenes according to Peach and Tracy (1955).

III. Statistical analysis :

The data were statistically analyzed to determine the significant differences by calculating the analysis of variance and the L.S.D. values (Snedecor and Cochron, 1971).

RESULTS AND DISCUSSION

I . Population density of the *Aphis gossypii*, *Tetranychus urticae* and *Emposca lybica* on soyabean plants :

The levels of infestation with the *A. gossypii*, *T. urticae* and *E. lybica* are shown in Tables (1 and 2). Analysis of variance of the data obtained during the 1995 and 1996 seasons indicated the presence of high significant differences between the means (L.S.D. 32.72 and 29.64, respectively) for *A. gossypii*, (L.S.D. 37.5 and 33.4, respectively) for *T. urticae* and (L.S.D. 12 and 20 respectively) for *E. lybica*. The total number of insects of *A. gossypii*, *T. urticae* and *E. lybica* collected on soyabean plants surrounded by sesame or mungbean (883 and 312, 3581 and 2321, and 47 and 40/100 plant, respectively) during the season 1995 while they were (190 and 64, 4841 and 2492 and 106 and 84 / 100 plant, respectively during the season 1996. The previous treatments showed higher significant decrease than that of the soybean plants alone (3814, 11684 and 207 / 100 plant, respectively) during the season 1995, while they were 3635, 14468 and 207 / 100 plant, respectively) during the season 1996.

Table (1) : Population density of the *A. gossypii*, *T. urtica* and *E. lybica* on soybean different treatments (1995 season).

Date of inspection	*Aphis gossypii*					*T. urtica*					*E. lybica*				
	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
June 27/6/1995	---	---	1588	431	210	---	---	25	---	---	---	---	10	---	---
July 4/7	---	---	220	---	---	---	---	6223	2460	1926	---	---	60	---	---
11/7	---	---	25	---	---	---	---	4030	380	135	---	---	40	---	---
18/7	---	---	120	25	8	---	---	892	189	56	---	---	55	15	12
25/7	---	---	130	35	8	---	---	2163	320	91	---	---	50	11	10
4/8	---	---	72	---	---	---	---	350	65	22	---	---	40	9	8
11/8	---	---	250	90	35	---	---	540	112	51	---	---	45	5	4
18/8	---	---	200	70	21	---	---	88	21	12	---	---	20	5	4
25/8	---	---	550	80	18	---	---	123	26	20	---	---	12	2	2
1/9	---	---	265	72	12	---	---	17	4	4	---	---	---	---	---
8/9	---	---	215	---	---	---	---	17	4	4	---	---	---	---	---
15/9	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Total	---	---	3635	883	312	---	---	14468	3581	2321	---	---	332	47	40
Mean	---	---	302 ± 23.7	73 ± 10.4	28 ± 3.6	---	---	1315 ± 61.5	325.5 ± 23.5	211 ± 20.5	---	---	38 ± 4.1	4.3 ± 0.5	3.6 ± 0.4
L.S.D.	32.72 *					37.5 *					12 *				
F value between C , D	8.9 **					10.5 **					9.6 **				
t value between C , D	3.9 *					4.3 *					4.1 *				
F value between C , E	9.2 **					12.7 **					11.1 **				
t value between C , E	4.1 *					3.2 *					3.0 *				

A = Sesame B = Mungbean C = Soybean D = Soybean surrounded by sesame
E = Soybean surrounded by mungbean

Table (2): Population density of the *A. gossypii*, *T. urtica* and *E. lybica* on soybean different treatments (1996 season).

Date of	*Aphis gossypii*					*T. urtica*					*E. lybica*				
inspection	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
June 27/6/1995	---	---	24	---	---	---	---	8	2	---	---	---	---	---	---
July 4/7	---	---	24	---	---	---	---	5316	1329	1224	---	---	---	---	---
11/7	---	---	24	---	---	---	---	3236	2612	809	---	---	---	---	---
18/7	---	---	124	---	12	---	---	568	212	142	---	---	---	---	---
25/7	---	---	32	---	4	---	---	1768	442	196	---	---	---	---	---
4/8	---	---	32	---	---	---	---	224	56	28	---	---	---	---	---
11/8	---	---	2084	112	12	---	---	448	120	52	---	---	120	76	70
18/8	---	---	---	---	---	---	---	30	24	8	---	---	24	10	4
25/8	---	---	1230	---	---	---	---	70	36	25	---	---	55	16	10
1/9	---	---	68	18	8	---	---	4	4	4	---	---	8	4	---
8/9	---	---	116	48	28	---	---	12	4	4	---	---	---	---	---
15/9	---	---	56	12	---	---	---	---	---	---	---	---	---	---	---
Total	---	---	3814	190	64	---	---	11684	4841	2492	---	---	207	106	84
Mean	---	---	317.8 ± 24.1	15.8 ± 1.4	5.3 ± 0.8	---	---	974 ± 52.4	403 ± 40.5	208 ± 24.2	---	---	17.25 ± 1.2	8.8 ± 0.9	7 ± 0.7
L.S.D.			29.64 *					33.4 *					20 *		
F value between C , D			10.1 **					7.8 **					7.2 **		
t value between C , D			6.5 *					6.1 *					4.5 *		
F value between C , E			12.8 **					8.6 **					8.1 **		
t value between C , E			7.5 *					6.5 *					5.2 *		

A = Sesame B = Mungbean C = Soybean D = Soybean surrounded by sesame
E = Soybean surrounded by mungbean

The results indicated that the population density of *A. gossypii*, *T. urtica* and *E. lybica* on soyabean plants was much lower in soyabean polyculture (soyabean - sesame - mungbean) than in soyabean monoculture, which may be attributed to the repellent effect of the combined plant species which can help ininsect biotypes that overcome insect resistant cultivars (Smith, 1989). These results are in agreement with those obtained by Taman *et al.*(1996), Letourneau (1986) and Burris *et al.*(1983).

II . Degree of infestation caused by *A. gossypii* :

The data in Table (3) show the degree of infestation caused by the *A. gossypii* in different treatments. It also indicates that higher infestation occurred to soyabean in plots grown with soyabean alone, than with soyabean surrounded by either sesame or mungbean.

The plots cultivated with either sesame or mungbean alone showed almost no infestation with the previous sucking pests. This may be due to the effect of the secondary plant chemicals repellant to these pests. These results are in agreement with those obtained by Taman *et al.*(1996) who found the same results on cotton leafworm. Also the results are in agreement with those obtained by Fraenkel (1959) who determined the relationships between the feeding habits of insects and the host-plant by studying the effect of secondary plant chemicals acting as attractants or repellents on locomotion, ovipositional and feeding behaviour of these sucking pests.

III . The role of secondary plant chemicals in plant leaves :

Table (4) shows the reported allelochemical compounds which may be responsible for causing deterrence effect against *Aphis*, *Tetranycus* and *Emposca* sucking pests particularly the alkaloids, flavonoids, saponins and triterpenes which were found at higher levels in the leaves of sesame and mungbean compared with the soyabean leaves. The present results indicated that sesame`s leaves contain all thebiologically active components, while soyabean had no detectable alkaloids. The resistance of sesame to sucking pests infestation may be due to the presence of these alkaloids. These results are in accordance with those reported by Sinden *et al.* (1986) and Cantot & Lapinean (1983).

Table (3) : The degree of infestation caused by *Aphis gossypii* under different treatment during 1995 and 1996.

Sampling Date	% degree of foliage infestation by *A. gossypii* insect					
	1995			1996		
	A	B	C	A	B	C
June 27/6	65.0	48.7	36.5	52.2	40.0	36.0
July 4/7	59.7	0.0	0.0	56.8	20.0	17.0
11/7	31.0	0.0	0.0	28.0	7.5	8.0
18/7	57.5	41	31.5	55.5	31.7	22.0
25/7	42.5	38.7	31	46.4	35.0	29.0
4/8	37.5	0.0	0.0	32.0	0.0	0.0
11/8	50.0	37.5	25.0	38.5	25.0	25.0
18/8	55.0	35.0	34.2	46.3	27.0	33.8
25/8	61	50.0	45.0	48.8	40.2	32.0
1/9	46	32.0	24.0	39.0	27.5	10.4
8/9	30	0.0	0.0	28.0	0.0	0.0
15/9	---	---	---	---	---	---
Total	535.2	282.9	227.2	471.5	253.9	213.2
Mean	44.6 ± 0.48	23.57 ± 0.17	19 ± 1.3	39 ± 4.5	21.1 ± 0.11	17.7 ± 1.21

L.S.D. (0.05 level) for varieties = 3.5 * L.S.D. (0.05 level) for varieties = 3.0 *

A = Soybean B = Soybean surrounded by sesame C = Soybean surrounded by mungbe

Table (4) Phytochemical examination for the presence of natural constituents in various plant leaves.

Plant	Natural constituents					Saponins
	Alkaloids		Flavonoids		Triterpenes	
	Wagner test	Dragedorff test	Na oH test	Amyl alcohol test	Liebermann & Burchard test	
Sesame	+	+	+	+	+	+
Soybean	–	–	+	+	+	+
Mungbean	–	–	+	+	–	–

+ = Present   – = Absent

The leaves of mungbean have only flavonoid compounds. Therefore, the high resistance of mungbean to the sucking pests may be due to flavonoids deterrent effect, which agree with the results obtained by Meisner *et al.*(1981), Van-Etten (1973) and Waiss *et al.*(1979). In addition, the presence of dense growths of trichomes on mungbean leaves may also help the plant to deter insect feeding and oviposition. These results are in accordance with those reported by Taman *et al.*(1996). They found that mungbean showed no infestation with sucking insects, which may be due to pubscence of its leaves. Also Abdel-Barry *et al.*(1968) found that Bahtim 101 which is one of the hairy cotton varieties, showed low infestation with thrips, which may be attributed to heavy pubescence of its leaves. Besides, Broersm *et al.*(1972) studied the effect of pubescence of soyabean varieties on populations of the potato leafhopper. They found that pubescence is responsible for differences in resistance to leafhopper.

Evaluation of the impact of certain nutrients in plant leaves on the susceptebility to sucking pests infestation :

The determination of certain nutrients, namely macro and micro elements was carried out to correlate the degree of infestation by the sucking pests with the amount of these nutrients is soyabean, sesame, and mungbean.Table (5) shows the concentrations of various macro and micronutrients, in the leaves of the three plants. These concentrations were expressed as mg/kg (ppm) while the protein and nitrogen contents were expressed as percentage. The concentrations of protein were 16.4%, 15.5% and 14.5% in soyabean, sesame and mungbean leaves successively, while the respective concentrations of the total nitrogen were 2.63%, 2.49% and 2.33% .The previous data showed that the concentrations were expressed as mg/kg (ppm) while the protein and nitrogen contents were expressed as percentage. The concentrations of protein were 16.4%, 15.5% and 14.5% in soyabean, sesame and mungbean leaves successively, while the respective concentrations of the total nitrogen were 2.63%, 2.49% and 2.33%. The previous data showed that the concentrations of protein and N were higher in susceptible soyabean followed by the resistant sesame and mungbean plants. However the differences were not significant. The data also showed that the concentrations of Zn and Mn were 74, 45.6 and 41 ppm & 111.75 and 61.5 ppm in soyabean, mungbean

Table (5) : level of nutrients in the leaves of soybean, sesame and mungbean.

Plants	Concentrations													
	%		Mg / kg (ppm)											
	Protein	N	K	Mg	Na	Fe	Mn	Zn	Cr	Pb	Cu	Co	Ni	Cd
Soybean	16.4	2.63	3.2	2737	603	530	111	74	1.8	12	20	1.7	5	0.5
Mungbean	14.5	2.33	5.5	3216	498	420	75	45.6	3	9.9	38	1.8	6.8	2
Sesame	15.5	2.49	5.5	2566	1044	1250	61.5	41	1.1	12.7	28	2.7	7.8	1

and sesame, respectively. The same results were obtained by Taman *et al.*(1996) and Abdel-Rahman (1995). They pointed out that the concentrations of Zn and Mn were much higher in soyabean and cotton leaves which are susceptible to the infestation with *S. littoralis* and *Tetranychus* spp. compared with the resistant varieties.

The concentrations of Cu, Ni, Co and Cd were higher in the resistant plants of mungbean (38, 6.8, 1.8 and 2 ppm) respectively, while in the susceptible soyabean these concentrations were 20, 5, 1.7 and 0.5 ppm. Thus the increase of those elements may explain the observed relative resistance of mungbean and sesame to the sucking pests. The present results are in agreement with those obtained by Taman *et al.*, (1996). They observed a reduction in the resistance of soyabean to cotton leaf worm which may be due to the reduction of the previous elements. Also the present results coincide with those obtained by Abdel Aal and Abdel-Nasser (1995). They reported a reduction in the leaf blade area in maize in the presence of Cd^{2+} at the concentrations higher than 25 uM. However, the growth reduction in maize induced by Cd^{2+} is probably due to the interference of these cations with different biochemical processes such as inhibition of photosynthesis and transpiration (Stiborova *et al.*, 1986), as well as depression of cell growth and cell division which may reduce the leaf area (Barcelo *et al.*, 1988) and reduce growth of both root and shoots (Tofl *et al.*, 1981).

The data suggests the economic importance of using belts of repellent plants such as sesame or mungbeans as biological traps to divert the invading insects and pests such as aphids. The data are very promising for future large scale application of such measure in the frame of the Integrated Crop Management, which is now a global policy to maintain crop protection and minimize the use of synthetic pesticidal chemicals. This will help in achieving environmental and human health.

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الملخص العربى

زراعة نباتات السمسم والمانجوبين كنباتات طاردة لبعض الحشرات الثاقبة الماصة فى حقول فول الصويا

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الهدف من هذا البحث هو إستخدام أحد الطرق الغير تقليدية لمكافحة حشرات المن والجاسيد والعنكبوت الأحمر تكون أكثر أمان وأقل تكلفة للحد من إستخدام المبيدات والحفاظ على البيئة وذلك بزراعة مصائد نباتية لا تفضلها الحشرة كعائل لها مثل زراعة نباتات السمسم والعدس الصيفى (المانجوبين) داخل حقول فول الصويا.

وقد أثبتت النتائج لموسمى ١٩٩٥ و ١٩٩٦ أن أقل إصابة بحشرة المن كانت فى حقول فول الصويا المحاطة بالمانجوبين (١٩٪ ، ١٨٪) على التوالى يليها فى الإصابة حقول فول الصويا المحاطة بنباتات السمسم (٢٤٪ ، ٢١٪) على التوالى ، بينما سجلت

الحقول المنزرعة فول الصويا فقط أعلـى إصابـة (٤٥٪ ، ٣٩٪) علـى التوالـى ، وقد أظهـرت النتائج علـى حشـرتىّ الجاسيد والعنكبـوت الأحمـر نفس الإتجـاه. ولمحاولـة تفسير ميكانيكيـة مقاومة نباتات السمسم والمانجوبين للإصابة بالحشرات السابقة تم تحليل أوراق النباتـات حيث تبين أن أوراق السمسم تحتوى على مواد سامة كيماوية مثل الألكالويدز والفلافونيد والصابونين والتراى تربينز والتى ربما تكون هى المسئولة عن طرد الآفة عن النبات .. كذلك وجدت مـواد فلافونيد فى أوراق نبات المانجوبين بالإضافة إلـى الزغـب الكثيـف الـذى يغطـى أوراق النبـات والذى يعوق تواجد الحشرة على النبات ويقلل من إمتصاصها للعصارة كما يعوق الحشرات من وضع البيض.

بالإضافة إلى ذلك فقد تم تحليل أوراق النباتات فى الوقت الـذى ظهـرت فيـه الإصابـة بشدة لمعرفة محتويات الأوراق لبعض العناصر الكـبرى والعنـاصر الصـغرى لمحاولـة دراسـة دورها فى زيادة مقاومـة النبـات للإصابـة . وقد أظهـرت النتـائج زيـادة فـى عنـاصر الكوبلـت والنيكل وزيادة واضحة فى عنـاصر النحـاس والكـادميوم فـى أوراق النباتـات المقاومـة وكـانت أوراق المانجوبين (١,٨، ٦,٦، ٣٨، ٢ جزء فى المليون) على التوالى بينمـا كـانت فـى أوراق السمسم (٢,٧، ٧,٨، ٢٨، ١ جزء فى المليـون) علـى التوالـى .. بينمـا كـانت فـى أوراق فـول الصويا الحساس للإصابة (١,٧، ٢٠، ٥، ٠,٥ جزء فى المليون) على التوالى.

وبذلك يتضح من هذه النتائج أهمية تشجيع زراعة النباتات الطاردة لبعـض الحشـرات الثاقبة الماصة داخل الحقول المنزرعة بنباتات قابلة للإصابة بهذه الآفات كأحد وسائل المكافحـة المتكاملة وذلك للحد من إستخدام المبيدات والحفاظ على التـوازن الطبيعـى بيـن الآفـة والأعـداء الطبيعية.