

FIELD AND LABORATORY STUDIES TO EVALUATE FIVE SOYBEAN VARIETIES FOR THEIR RELATIVE SUSCEPTIBILITY TO THE TWO SPOTTED SPIDER MITE *TETRANCHUS URTICAE* KOCH INFESTATION (A CARINA : TETRANYCHIDAE : ACTENIDIDEA)

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Abstract

Field and laboratory studies were carried out to evaluate five soybean varieties, Giza21- Giza 22- Giza 35 Giza111 and Crawford, for their relative susceptibility to the two-spotted spider mite *Tetranychus urticae* as one of the main pests causing a great damage to soybeans. Obtained data cleared that the peak populations of spider mites occurred during mid of July or during the flowering and pod-formation according to each variety. Crawford & Giza 111 were highly susceptible, respectively. They aggregated 9985 & 8542 mites during the season 2006, while Giza 35 & Giza 21 were highly tolerant at the same trend, which harboring 3418 & 4140 mites, but Giza 22 was intermediate. Biological aspects of spider mites affected strongly by soybean varieties, as well as leaves phytochemical components, where as the average period from egg hatching to adult emergence which ranged from 5.9 to 9.6 days. Histological studies on leaves of soybean variety demonstrated that the more thickness of the cuticle epidermis especially that the lower surface could be considered as a physical tolerance factor against mechanism of spider mites, therefore, it could be recommended that adding potassium fertilizer necessary for different crops.

INTRODUCTION

Soybean is considered one of the relatively new crop introduced into the Egyptian agricultural which contribute in reducing food deficiency gap for high quality ratio of protein and oil contained in its seeds reaching up to 40% as well as approximately 20% of oil. The spider mite *Tetranychus urticae* Koch considered one of the main economic pests of soybean, which cause a great damage and severe losses Taha *et al* (1995). Sawires (1983) reported that spider mites infestation reduced soybean yield oil and protein. Zaher *et al* (1980), Sawires *et al* (1990) and Taha *et al.* (1995) stated that the spider mites population reached its peak during the flowering and pod-formation period which affected with different factors such as variety, sowing date and climatic factors. Taha *et al.* (1993) showed that soybean yield significantly decreases with spider mite infestation. Dahms (1972) identified 16 possible criteria to evaluate pest tolerance in plants among which are the number of motile stages of pest

attracted to plant when given a free choice, the length of developmental stages and fecundity or a number of eggs laid by female. In this study, field and laboratory studies : (Biology of spider mite *Tetranychus urticae* koch on different soybean varieties Phytochemical components analysis and histological studies of leaves) were carried out to evaluate five soybean varieties for their relative susceptibility to spider mite *T. urticae* infestation.

MATERIALS AND METHODS

Field and laboratory studies

I-field experiment design:-

To evaluate five soybean varieties: Giza 21, Giza 22, Giza35, Giza 111 and Crawford varieties for their relative susceptibility to spider mite infestation, an experiment of 0.5 feddan (2100 m²) was chosen at Marbles village, Nubaria region, prepared and divided into five plots each of 420 m² (30x 14m). This area divided into 20 ridges of 30 m long and 70 cm wide 15 cm between hills, the ridge had 200 hills, two plants for each hill 400 plants for each side, a ridge left unseeded as buffer between varieties. A normal agricultural practices were done during the season except using any pesticides.

Sampling for natural infestation rate estimation

Twenty five days post- plantation samples were collected weekly until the end of season (80 leaflets / variety) were taken and placed in paper bages. Then transferred to the lab. for examination using Stereomicroscope. Motile stages of spider mite *T. urticae* were counted on two sq. Inches / leaflet- lower surface.

II-laboratory studies

1-Biological studies :-

Biological studies of the two spotted spider mite *T. urticae* where it reared on five soybean varieties under laboratory conditions of 25 °C & 65% ±5 R.H. Pure culture of mites was propagated on sweet potato cuttings placed in glass jars filled with water. The colony was kept at room temp. and 24 h. illumination. Leaf discs of potato one inch in diameter were used. These were surrounded by tangle food which acts as a barrier and prevented the mite individuals from escaping. These discs were placed on pieces of moist cotton wool in petri-dishes of 10 cm diameter under constant conditions. The most are kept constant by adding few drops of water to the cotton wool. Biological developmental stages of mites and laid eggs by each female were recorded.

2- Phytochemical analysis of leaves five soybean varieties as a host plants

Samples of leaves of five soybean varieties were picked up during the vegetation period, cleaned and washed with distilled water, then dried in an oven at 70 °C for 48h., then grinded into fine powder. Powder of each variety divided into two parts, the first to determine the total nitrogen, phosphorus, potassium and sodium according the methods of Black (1965), Murphy & Riebly (1962) and Dewis & Freits (1970), while the second part to determine the total protein, total Carbohydrate and total lipids according to methods of knight et al (1972).

3- Histological studies of leaves for five soybean varieties

Samples for histological studies were prepared from soybean varieties originated from the season 2006. one leaflet from the first fully expanding trifoliate leaf was removed, washed with tap water and prepared for anatomical studies. Cross section were prepared according to method described by Kou-koung et al (1972). Using a microscope and a micrometric slide, the following were recorded : thickness of cuticle epidermis of the upper and lower surfces (u.m)

RESULTS AND DISCUSSION

To evaluate the relative susceptibility of five soybean varieties to the two spotted spider mite *T. urticae* infestation eight criteria were taken into consideration, the total number of motile stages of spider mites infesting each variety in the field during the season, five were concerred with biological aspects of spider mites reared on different soybean varieties, leaves constituents and histological studies of leaves for each variety.

I-Field studies

As shown in table (1) data and statistical analysis revealed that there were highly significant differences between soybean varieties in their relative susceptibility to spider mite *T. urticae* infestation during the season 2006 at Nubaria province, whereas population of mites started in few numbers after 25 dayes of sowing date on all tested varieties, with definite trend, whereby population increased gradually until reached its peak during mid of July or during the flowering and pod-formation according to each variety, after that number of mites decreased gradually until the end of season Crawford variety was the most susceptible to spider mite infestation, which received a total number of 9985 mites during the season (Mean number 10.4 mites / one sq. Inch) , while soybean variety Giza 35 was high tolerance than other varieties where it received 3418 mites (Mean number 3.5 mites / one sq. Inch). On the other hand Giza 111 was susceptible, while Giza 21 was tolerant, they recieved

(8524 & 4140 mites) with average (8.9 & 4.25 mites / one sq. inch) respectively, but Giza 22 variety was intermediate in its relative susceptibility to spider mite infestation, where it aggregated 6240 mites with average 6.5 mites / one sq. Inch. Table (1).

Table 1. population fluctuation of spider mite *Tetranychus urticae* Koch on different soybean varieties at Nubaria province during the season 2006.

Varieties	Average number of mites / 80 sq. Inches												Total
	14 June	21 June	28 June	5 July	12 July	19 July	26 July	2 Aug.	9 Aug.	16 Aug.	23 Aug.	30 Aug.	
Crawford	374	465	829	967	1864	1373	1115	974	662	562	442	358	9985
Giza 111	358	427	735	814	1602	1175	934	776	533	487	395	288	8524
Giza 22	281	398	629	990	765	678	534	501	473	414	346	213	6240
Giza 21	125	218	398	447	673	612	379	311	265	200	190	185	4104
Giza 35	112	214	281	514	423	421	417	315	277	198	164	82	3418
LSD 0.1%	184												
0.5%	138												

I- Laboratory studies

1- Biological studies

Five criteria concerned with biological aspects of spider mite *T. urticae* were studied, when it reared on five soybean varieties under laboratory condition of 25°C and 65 % R.H.

Total immature stages

obtained results in table (2) showed that the average period from egg hatching till the adult emergence ranged from 5.9 to 9.6 days when mites reared on Crawford variety and Giza 35 variety respectively. Therefore it could be mentioned that Crawford was highly susceptible to spider mites, while Giza 35 was highly resistant, but Giza 22 variety was intermediate (7.1 days) for its relative susceptibility.

Life cycle

Data presented in table (2) cleared that life cycle was affected by different soybean varieties, which lasted 9.1, 10.2, 10.7, 13.2 and 13.6 days when spider mites reared on Crawford, Giza 111, Giza 22, Giza 21 and Giza 35 respectively. These results agree with those obtained by Sawires *et al.* (1990) and Taha *et al.* (2006).

Generation period

As shown in table (2) data revealed that generation period lasted 11.4, 12.2, 12.2, 13.45 and 14.6 days when spider mites fed on Crawford, Giza 111, Giza 22, Giza21 and Giza 35 respectively.

Longevity

Female longevity of spider mite *T. urticae* connected strongly with different hosts, therefore it increased with susceptible varieties and the opposite obtained with resistant varieties, whereas, female longevity required 12.55, 10.75, 8.95, 7.75 and 6.95 days when mites reared on Crawford, Giza 111, Giza 22, Giza 21 and Giza 35 at the same pattern. These results agree with that obtained by Saweres *et al.* (1990) who mentioned that longevity increased with susceptible varieties Table (3).

Fecundity

Obtained data in table (3) showed that the relationship between female fecundity and plant hosts. The number of eggs which female deposited when it reared on the above mentioned varieties, without doubt female fecundity affected by different Soybean varieties, thus female deposited 64.8 eggs with a daily mean 7.6 eggs when reared on Crawford varieties, while with Giza 35 variety female laid 15 eggs, with a daily rate 3.0 eggs. Table (3).

Table 2 . Biological developmental stages of the spider mite *T. urticae* females when reared on different soybean varieties at 25±2 °C and 65± 5 R.H.

Varieties	Incub Period	Immature stages						T.imm stages	Life cycle	Ggene period	Life span
		Larval stage		Proto. Stage		Deuto. Stage					
Crawford	3.2	A1.8	Q 0.6	A1.5	Q0.5	A1.1	Q0.4	5.9	9.1	11.4	21.65
Giza111	3.5	2.1	0.8	1.8	0.5	1.2	0.3	6.7	10.2	12.2	20.95
Giza 22	3.6	2.2	1.0	1.1	0.9	1.3	0.6	7.1	10.7	12.2	19.65
Giza 21	3.9	3.0	1.0	2.1	0.9	1.5	0.8	9.3	13.2	13.45	20.95
Giza 35	4.0	3.2	1.0	2.1	0.8	1.6	0.9	9.6	13.6	14.6	20.56
LSD. 0.1%	0.135	0.135	0.4256	0.104	0.097	0.130	0.084	0.118	0.190	0.156	0.078
0.5%	0.097	0.97	0.305	0.075	0.069	0.093	0.060	0.085	0.137	0.112	0.056
Mean	3.64	2.46	0.88	1.707	0.727	$\frac{1034}{0}$	0.60	7.72	11.37	12.76	9.41
SD	0.329	0.579	0.208	0.394	0.206	0.228	0.251	1.523	1.823	1.179	2.109

Table 3. Effect of different soybean varieties on *T. urticae* females longevity and fecundity at 25±2 °C and 60± 5 R.H.

Varieties	Preoviposition	oviposition	Postoviposition	longevity	Fecundity
Crawford	2.3	8.5	1.75	12.55	64.8
Giza11	2.0	7.5	1.25	10.75	47.75
Giza 22	1.5	6.25	1.2	8.95	35.75
Giza 21	1.25	5.5	1.0	7.75	24.8
Giza 35	1.0	5.0	0.95	6.95	15.0
L.S.D 0.1%	0.092	0.165	0.054	0.110	0.348
0.5%	0.066	0.118	0.039	0.079	0.249
Mean	1.618	6.55	1.235	9.38	37.63
SD	0.499	1.339	0.292	2.110	18.06

2- Phytochemical analysis of leaves in relation to spider mite population and biological aspects

The phenomenon of plant tolerance to pests is quality that enables the plant to avoid, tolerate, or recover from the effect of pests that would cause greater damage

to other varieties of the same species under similar conditions. Phytochemical components the total carbohydrates, total protein, total lipids, nitrogen, potassium and sodium were estimated. As shown in table (4) data and statistical analysis cleared that the total Carbohydrates, ranged between 13.27 mg/gm dry weight for the most susceptible Crawford variety to 6.98 mg/gm dry wt. For the high tolerance Giza 35 variety, where, as Carbohydrates accelerate reproduction of spider mites (Henneberry, 1962a), therefore female total immatures and longevity period varied from (5.9 & 9.38) to (9.6 & 12.55) days Tables (2&3). The quantities of total protein and total lipids were small compare with that of total Carbohydrates, the smallest amounts of protein and lipids were found in leaves of Giza 35 and Giza 111 varieties (3.61 & 3.97) and (0.88 & 0.64) at the same trend. In addition to Crawford and Giza 35 have the same amounts of protein and lipids (3.83 & 3.61) and (0.87 & 0.88) ,receptivity. Table (4). These results agreement with Yokama (1978) who reported that population of spider mites increased even though the protein content of leaves was decreasing. The total nitrogen, phosphorus and potassium had a considerable role in developmental rate, fecundity and population density of spider mites, therefore, mites population, female longevity and fecundity increased as nitrogen and phosphorus increased, while the opposite occurred with potassium and sodium tables (1,2,3&4) these results coincided with Taha and El- Raies (1996) and Taha *et al* (1993).

Table 4. Phytochemical and biochemical analysis of leaves dry weight of five soybean varieties during season 2006

Soybean varieties	T.carbohydrates mg/gm	T.protein mg/gm	T.Lipids mg/gm	Nitrogen %	Phosphorus %	Potassium %	Sodium %
Crawford	13.27	3.83	.87	1.98	0.25	1.30	0.47
Giza111	12.93	3.97	0.642	1.60	0.45	1.42	0.39
Giza 22	9.49	4.26	1.25	1.45	0.58	1.5	0.58
Giza 21	8.88	4.56	1.13	1.26	0.72	1.8	0.71
Giza 35	6.98	3.61	0.88	1.1	0.95	2.2	0.65
L.S.D.0.1%	0.778	0.408	0.143	0.011	0.011	0.202	0.012
0.5%	0.558	0.292	0.102	0.008	0.008	0.145	0.008
Mean	10.312	4.0515	0.955	1.477	0.59	1.65	0.56
SD	20525	0.370	0.226	0.314	0.247	0.343	0.122

3- Histological studies on leaves of five soybean varieties

As shown in table (5) soybean variety have the higher thickness of cuticle epidermis of the upper leaves surfaces Giza 35(35.066 μ) Compared with Crawford variety (27.05415 μ), while Giza 21 variety have (33.844 μ) thickness of the cuticle

epidermis, followed by Giza 22 variety (32.2147 μ) and Giza 111 variety (28.68 μ). These results showed that there are significant differences in upper thickness cuticle epidermis, were as susceptible varieties Crawford and Giza 111 varieties had thinner layer than mite- resistant varieties Giza 35 and Giza 21. These results agree with that obtained by Zaher and Hanna (1980), Aggour *et al.* (2001) and Azouz (2005).

Lower cuticle epidermis also showed significantly less in thickness than upper cuticle epidermis, and resistant varieties possess thicker on either upper or lower leaf surfaces than susceptible ones. The more thickness of the cuticle epidermis especially that of the lower surface could be considered as a physical tolerance factor against feeding mechanisms of spider mite *T. urticae*, therefore Giza 35 variety (32.641 μ) negatively interfere with feeding mechanism of spider mites, while Crawford variety (25.071 μ) positively interfere with feeding mechanism of spider mite *T. urticae* Table (5).

Table 5. Measuring thickness of both upper and lower cuticle epidermis of five soybean varieties during vegetative stage season 2006

Soybean varieties	Cuticle thickness (μ) of upper leaf surface	Cuticle thickness (μ) of lower leaf surface
Crawford	27.05415	25.071
Giza 111	28.680	29.28
Giza 22	32.21472	28.931
Giza 21	33.844	31.15997
Giza 35	35.06638	32.641
L.S.D.01%	0.381	0.908
0.5%	0.276	0.663
Mean	3.074	2.88
SD	0.365	0.457

4- Correlation Coefficient between female developmental stages, fecundity of spider mite *T. urticae* and host plant leaves phytochemical constituents

Results presented in Table (6) showed that there is negative significant correlations between leaf contents of total carbohydrates, nitrogen, phosphorus and total immature stages. Furthermore, positive significant correlation between the above

mentioned materials and female preoviposition, oviposition and fecundity, which reflect on increasing fecundity, elongate female longevity and population of mites as well as damage to plants. On the other hand potassium and sodium were positive significant correlation with immature stages and negative significant correlation with female preoviposition, oviposition, postoviposition and fecundity as well as reducing female longevity and fecundity in consequence. Population of spider mites infesting plants.

Table 6. Correlation Coefficient (R) between phytochemical Components of leaves and biological aspects of spider mite *T. urticae* reared on different soybean varieties

Biology	T. carbohydrates	T. protein	T. lipids	N	P	K	Na
Incubation period	+0.682**	-0.533*	-0.643**	-0.816**	+0.904**	+0.878**	+0.762**
T. immatures	-0.843**	-0.522*	-0.770**	-0.926**	-0.946**	+0.927**	+0.854**
Life cycle	+0.835**	-0.533*	-0.759**	-0.937**	+0.953**	+0.928**	+0.844**
Generation period	+0.815**	Ns	-0.575*	-0.906**	+0.965**	+0.974**	+0.717**
Preoviposition	+0.620*	+0.769**	+0.809**	+0.969**	-0.953**	-0.860**	-0.847**
Oviposition	+0.626*	+0.765**	+0.789**	+0.983**	+0.961**	-0.862**	-0.832**
Postoviposition	-0.583*	+0.722**	+0.611*	+0.972**	+0.904**	-0.762*	-0.627**
Logevity	+0.626*	+0.765**	+0.773**	+0.989**	-0.964**	-0.863**	-0.819**
fecundity	+0.664**	+0.732**	+0.733**	+0.996**	+0.983**	-0.893**	-0.792**
L.S.D.	1% **						
	5% *						

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دراسات حقلية ومعملية لتقييم قابلية الإصابة لخمسة أصناف فول صويا للإصابة
بالاكاروس العنكبوتى ذى البقعين *Tetranychus urticae* koch
(Acarina : Tetranychidae : Actenididea)

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معهد بحوث وقاية النباتات - مركز البحوث الزراعية - دقى - جيزة

أجريت دراسات حقلية ومعملية لتقييم قابلية أصناف فول الصويا : جيزة ٢١- جيزة ٢٢ - جيزة ٣٥ - جيزة ١١١ الصنف كراوفورد للإصابة بالاكاروس العنكبوتى ذى البقعين حيث أجريت الدراسة الحقلية بقربة ماربلز بالنوبارية أوضحت الدراسة الحقلية أن أعلى معدل للإصابة (الذروة) كان في منتصف يوليو خلال مرحلة الأزهار والعقد تبعا للصنف كما أوضحت الدراسة أن الصنف كراوفورد حساس جدا للإصابة ٩٩٨٥ فرد بمتوسط ١٠,٤ فرد/بوصة^١ بينما الصنف جيزة ٣٥ أكثرها مقاومة للإصابة ٣٤١٨ فردا بمتوسط ٣,٥ فرد / بوصة^٢ في حين أن الصنف جيزة ٢٢ متوسط في قابليته للإصابة ٦٢٤٠ فرد بمتوسط ٦,٥ فرد / بوصة^٣ أجريت دراسات معملية بتربية العنكبوت الأحمر على أصناف فول الصويا لمعرفة تأثير العائل على تطور وخصوبة الإناث وكذلك تحليل فونوكيمائى لمعرفة محتوى الأوراق لهذه الأصناف من الكربوهيدرات والبروتين والليبيدات والنتروجين والفسفور والبوتاسيوم والصوديوم بالإضافة إلى الدراسات الهستولوجية لقطاعات من الأوراق لقياس طبقة الكيوتيكلى ابيديريم للسطح السفلى والعلوي لدراسة تأثيرها على مستوى الإصابة في الحقل وعلى بيولوجية وخصوبة العنكبوت الأحمر أوضحت هذه الدراسات أن هناك علاقة قوية بين العائل ومراحل التطور والخصوبة للأفة وبالتالي تعداد الأفة اى مستوى الإصابة للعائل حيث(محتوى الأوراق وسمك طبقة الكيوتيكلى) وجد أن زيادة التعداد وقصر فترة الأطوار الغير كاملة وطول فترة حياة الأنثى البالغة وزيادة معدل وضع البيض (الخصوبة) ارتبطت ايجابيا بزيادة الكربوهيدرات والنتروجين والفسفور وسليبا بزيادة البوتاسيوم والصوديوم ولا يوجد تأثير للبروتينات والليبيدات كما أن الدراسة الهستولوجية أوضحت أن سمك طبقة الكيوتيكلى وخاصة طبقة السطح السفلى والتي تعتبر من عوامل المقاومة الطبيعية ضد ميكانيكية التغذية للعنكبوت الأحمر العادي والآفات الثاقبة للآفات الأخرى لذا فان زيادة سمك طبقة الكيوتيكلى ابيديريم ارتبط ايجابيا بطول مرحلة الاطوار الغير كاملة وقصر الطور الكامل للأنثى ونقص معدل الخصوبة وبالتالي تعداد الأفة على العائل ولذا يمكن التوصية بالاعتدال في معدلات الأسمدة النتروجينية وضرورة إضافة الأسمدة البوتاسية والعناصر الصغرى لأنها تزيد من عوامل المقاومة في النبات ضد الآفات الثاقبة الماصة.