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DETERMINATION OF RESISTANCE OF EXPERIMENTAL SOYBEANS TO THE LIMA BEAN POD BORER *ETIELLA ZINCKENELLA* TREITSCHKE AND THE WHITEFLY *BEMISIA TABACI* GENNADIUS AT DAKHLA OASES, NEW VALLEY, EGYPT

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ABSTRACT:

Three soybean varieties and two cultivars have been planted in an isolated and closed agro-desert ecosystem in Dakhla Oases, New Valley Governorate. The resistance status of the selected soybeans against the lima bean pod borer *Etiella zinckenella* and the whitefly *Bemisia tabaci* has been determined. In respect to *E. zinckenella* the obtained results indicated that the tested soybean varieties Clark, Giza22 and Tono equipped higher infestation by this insect pest with an average 4.30, 3.54 and 9.13% respectively, than the tested cultivars Hagen32 and S5 by 2.38 and 3.21%, respectively. Similar results were obtained by calculating the damaged soybean seeds. The highest damage percentage appeared on Tono variety by 9.30% while, the lowest one appeared on Hagon32 cultivar by 1.97%. Also, results showed no variations between the influences of the analyzed soybean seed components on the yield consumption by *E. zinckenella*, whereas (r) values were nonsignificant. High compatibility is recorded between the resistance status of the tested soybeans and the mean numbers of *E. zinckenella* individuals attacking the developing pods. The newly produced cultivars Hagen32 and S5 presented some sort of resistance and appeared as moderately resistant cultivars. However, the soybean varieties Clark, Giza22 and Tono appeared as relatively resistant, susceptible and highly susceptible varieties, respectively.

Concerning the whitefly *B. tabaci*, results indicated a distinct compatibility between the nymphal incidence and the degree of resistance. Although, the tested varieties and cultivars exist different degrees of resistance, the newly produced cultivar S5 appeared as a resistant cultivar against *B. tabaci* infestation.

Consequently, plant breeders must be select soybean cultivars that have a desirable resistance levels for breeding purpose with serious trials to transfer gene(s) responsible for these phenomenon to the newly produced soybean varieties.

INTRODUCTION:

Soybean *Glycine max* (L.) Merr. is a major legume crop in tropical and subtropical areas all over the world. It received a great attention because its value as an animal feed crop and for its edible and industrialises. Its meal is the protein choice fore livestock and poultry producers worldwide. Irwin (1978) reported that the total production of soybean in north America in 1975 was 41,406,000 tonnes. He mentioned that the Soybean Insect Research Information Center (SIRIC) has on file well over 14000 articles on soybean associated arthropods. Amongst the destructive pests that attack this crop, is the Lima Bean Pod Borer (LBPB) *Etiella zinckenella* Treitschke. The obvious sign of its infestation is the tine hole where the larvae escaped after the damage already has been done, whereas one larva can destroy most of the pod seeds (Semeada *et al.*, 2001 and Tohamy and El-Hafez, 2005).

On the other hand, the whiteflies were reported as severe insect pests in tropics and subtropics on several crops. The damage is done by sucking the sap from the leaves. However, fungus often grows on its honeydew (Borror and Delong, 1979). Information about the susceptibility of legume crops to *Bemisia tabaci* Gennadius are scarce. In Egypt, very few investigators concerned with the susceptibility of beans to *B. tabaci* (Faris *et al.*, 1991; Nosser, 1996; Amro, 1999 and Mohamed *et al.*, 2000).

No attempts to identify and breed soybean varieties resistant to the aforementioned pests have been done in the Egyptian Oases. Therefore, the present investigation was initiated with the aim to measure the infestation, the damage percentages and the yield loss caused by the lima bean pod borer *E. zinckenella* to three experimented soybean varieties and two cultivars that cultivated in Dakhla Oases. Also, to determine the resistance status of soybean to *E. zinckenella* and *B. tabaci* in this isolated area.

MATERIAL AND METHODS:

Field experiments were conducted throughout two successive soybean growing seasons (2004 and 2005) at Dakhla Oases, New Valley Governorate, western desert, Egypt, to evaluate the resistance status of three experimental soybean varieties and two cultivars against the infestation of the (LBPB) *E. zinckenella* and the whitefly *B. tabaci.* The experimental soybeans were supplied by agronomy Institute, Agricultural Research Center.

The experimental area:

An area of about ¼ feddan was divided into plots 3x3.5 meters (1/400 feddan) for each. The experimented soybeans were cultivated at the last week of May in a completely randomized block design and each variety and/or cultivar replicated 4 times.

1-Infestation, damage percentages and yield loss caused by the (LBPB) *E. zinckenella*:

Weekly samples were taken by picking up 25 green pods in addition to 25 dry pods from each plot after soybean pod sitting at 1st August till collecting the yield at the end of September.

1-1-Infestation percentages of soybean pods:

The mean numbers of the larval escaping holes on the green and dry soybean pods is considered as an indicator of the infestation percentage caused by *E. zinckenella*. The infestation percentage was calculated according to the following equation as recorded by Amro (2004) in the case of the green and dry pods.

Infested pods (%) =

$$\frac{\text{No. collected pods - No. undamaged pods}}{\text{No. collected pods}} \times 100$$

1-2-Damage percentages of soybean seeds:

The collected pods were dissected to calculate the damaged and undamaged green and dry seeds. The damage percentage was calculated according to the equation used by Compton *et al*., (1998) with simple modification as follows:

Damage (%) =

$$\frac{\text{No. collected seeds - No. undamaged seeds}}{\text{No. collected seeds}} \times 100$$

1-3-Yield loss:

The yield loss caused by this pod borer was calculated after harvest by using 25 gm. of dry soybean seeds (replicated four times). The aforementioned equation was used to calculate the yield loss percentage as follows :

Yield loss (%) =

$$\frac{\text{Initial weight - Undamaged weight}}{\text{Initial weight}} \times 100$$

By using additional 25 gm. dry soybean seeds (replicated four times), the correlation value (r) between the yield loss percentage and the percentage of each analyzed component was determined. Analysis of soybean components was established by the specialists in the National Research Center.

2-The resistance status of the tested soybeans:

2-1-The lima bean pod borer *E. zinckenella*:

The resistance status of the tested soybean varieties and cultivars dependent on the mean number (MN) of individuals (larvae+bores) and the amount of change (UC) from one susceptibility degree to another. Where:

UC (Range of Change) =

$$\frac{\text{Maximum mean number - Minimum mean number}}{4}$$

By using these parameters the equation applied by Nosser (1996) succeed to classify the tested soybeans into five categories. Varieties and cultivars that had mean numbers of individuals more than (MN+UC) considered highly susceptible (HS); between MN and (MN+UC), susceptible (S); less than MN to (MN-UC), relatively resistant (RR); ranging from <(MN-UC) to (MN-2UC), moderately resistant (MR) and less than (MN-2UC) were considered resistant (R).

2-2-The whitefly *B. tabaci*:

The resistance status of the tested soybeans to *B. tabaci* dependent on the mean numbers of the nymphal stage individuals calculated on soybean leaves. Five trifoliate soybean leaves were picked up weekly from each plot and transferred to the laboratory in muslin bags, mean numbers of the nymphal instars of the whitefly were calculated by using stereomicroscope. The above-mentioned equation was used to determine the resistance status of each variety to this pest.

Data obtained were statistically analyzed by using F test. The means were compared according to Duncan's multiple range test (Snedecor and Cochran, 1971).

RESULTS AND DISCUSSION:

1-Infestation, damage percentages and yield loss caused by the (LBPB) *E. zinckenella*:

1-1-Infestation percentages of soybean pods:

The mean percentage of the infested soybean pods by the (LBPB) *E. zinckenella* is shown in Table (1). Statistical analysis of the data revealed highly significant differences between the infestation percentages of the tested soybeans (F=66.27**). The obtained results in the two successive years are quietly similar. The soybean varieties Clark, Giza22 and Tono equipped higher infestation by 4.30; 3.54 and 9.13% respectively, than the soybean cultivars Hagen32 and S5 by 2.38 and 3.21%, respectively. These newly experimented cultivars may be used as promising varieties because their low infestation. In this respect Semeada *et al.*, (2001) determined the damage caused by the (LBPB) *E. zinckenella* to soybean according to the different levels of infestation by this insect pest.

1-2-Damage percentages of soybean seeds:

Because the (LBPB) *E. zinckenella* spends its destructive larval stage inside the developing legume pods and feeds on developing seeds before leaving the pod through an escape hole, results in (Table 2) dependent on this behavior to measure the damage percentage caused by this insect pest on the tested soybean seeds. Tabulated data showed highly significant differences between the tested soybean seeds (F=84.44**). Similar, results have been obtained during each of the two studied years. The damage percentage is quietly high on soybean varieties than on soybean cultivars. The highest damage percentage appeared on Tono variety and represented by 9.30%, while the lowest one appeared on the soybean cultivar Hagen32 by 1.97% throughout the studied period. Segarra-Carmona and Barbosa (1990) dependent on this parameter to evaluate the herbivory levels by *E. zinckenella* on *Glycine max* and *Crotalaria pallida.*

1-3-Yield loss:

Data presented in Table (3) exhibit the percentages of the yield loss after harvest. Highly significant differences between the tested soybeans (F=7.02**) were recorded. Although, the soybean varieties Tono, Giza22 and Clark showed high yield loss by 4.05, 3.21 and 2.39% respectively, the tested cultivars S5 and Hagen32 showed low yield loss by 0.94 and 0.83%, respectively. In this approach similar results have been reported by Amro (2004) by using different cowpea cultivars. On the other hand, the analysis of the available soybean components (Protein, Fibers, Ash and Relative humidity%) was represented in Table (3). This approach have been conducted to find what component responsible about the low populations compared with the high populations of *E. zinckenella.* Results showed no variations between the influences of the analyzed soybean components on the yield loss, whereas (r) values were nonsignificant in all cases. Therefore, factors responsible for soybean resistance to *E. zinckenella* need more studies in the future.

Table (1): The mean percentage of the infested green and dry soybean pods by *Etiella zinckenella* during 2004 and 2005 growing seasons

Varieties and cultivars	2004 growing season			2005 growing season			General mean ± SD
	Green pods	Dry pods	Mean ± SD	Green pods	Dry pods	Mean±SD	
Clark	3.17b	6.00b	4.59±1.9b	3.00b	5.00b	4.00±1.3b	4.30±1.5b

Giza22	3.00b	3.00cd	3.00±0.6cd	2.83b	5.33b	4.08±1.5b	3.54±1.2c
Tono	5.50a	11.66a	8.58±3.5a	9.00a	10.33a	9.67±1.3a	9.13±2.6a
Hagen32	2.66b	2.66d	2.66±0.4d	1.50b	2.67c	2.09±0.8c	2.38±0.7d
S5	2.83b	4.33c	3.58±0.9c	2.33b	3.33c	2.83±0.9bc	3.21±1.0c
Mean	3.43	5.53	4.48	3.73	5.33	4.58	4.51
F. value	70.70**	75.81**	80.07**	40.33**	44.05**	56.57**	66.27**

Based on 25 soybean pods/each replicate
Means in each column followed with the same letter are not significantly different at 0.05 level of probability.
**** Highly significant at 0.05 level of probability.**

Table (2): The mean percentage of the damaged green and dry soybean seeds infested by *Etiella zinckenella* during 2004 and 2005 growing seasons

Varieties and cultivars	2004 growing season			2005 growing season			General mean ± SD
	Green seeds	Dry seeds	Mean±SD	Green seeds	Dry seeds	Mean±SD	
Clark	3.29ab	2.81b	3.05±0.9b	2.91b	4.66b	3.79±1.2b	3.42±1.1b
Giza22	3.44ab	2.59b	3.02±1.0b	3.42b	4.06b	3.74±0.6b	3.38±0.9b
Tono	4.95a	10.06a	7.51±3.0a	10.61a	11.57a	11.09±2.3a	9.30±3.2a
Hagen32	2.12b	2.24b	2.18±0.6b	1.56b	1.96b	1.76±0.4c	1.97±0.5c
S5	2.26b	2.37b	2.32±0.9b	2.21b	3.11b	2.66±1.1bc	2.49±1.0c
Mean	3.21	4.01	3.62	4.14	5.07	4.61	4.11
F. value	5.04*	23.59**	56.18**	23.52**	20.29**	56.54**	84.44**

Based on 25 soybean pods/each replicate.
Means in each column followed with the same letter are not significantly different at 0.05 level of probability.
*** Significant at 0.05 level of probability,** Highly significant at 0.01 level of probability.**

Table (3): Relationship between certain soybean components and the yield loss caused by *Etiella zinckenella*

Varieties and cultivars	Protein (%)	Fibers (%)	Ash (%)	RH (%)	Yield loss (%)
Clark	35.84	13.47	4.75	6.67	2.39 ab
(r) value	0.751	0.918	- 0.751	0.013	-
Giza 22	36.19	12.76	4.38	6.61	3.21 a
(r) value	- 0.068	0.426	0.426	- 0.629	-
Tono	35.25	14.47	4.63	6.61	4.05 a
(r) value	0.321	0.241	0.321	- 0.893	-
Hagen 32	36.27	12.10	4.51	6.84	0.83 b
(r) value	0.607	0.607	- 0.618	- 0.607	-
S5	33.41	8.82	4.67	6.35	0.94 b
(r) value	0.037	0.011	- 0.720	0.581	-
LSD	0.88	0.58	0.05	ns	-
F. value	17.10**	130.45**	63.06**	1.92^{ns}	7.02**

Based on 25 gm. dry soybean seeds.
Means followed by the same letter are not significantly different at 0.05 level of probability.
ns= non significant.
**** Highly significant at 0.01 level of probability.**

2-The resistance status of the tested soybeans:

2-1-The Lima bean pod borer *E. zinckenella* :

The tiny holes (Bores) refer to the escape larvae before sampling. So, the number of these bores in addition to the number of larvae inside the developing pods expressed about the number of individuals (Bores+larvae). Results presented

in Table (4) summarizes the mean numbers of individuals in the dissected green and dry pods and the resistance status of soybean varieties and cultivars. Data revealed highly significant differences between the tested soybeans (F=84.25). The soybean varieties Tono, Giza32 and Clark harbored mean numbers of individuals higher than the soybean cultivars S5 and Hagen32 by mean numbers 2.42, 1.32, 0.93 and 0.60, 0.47, respectively.**

Although, some of the tested soybeans showed some sort of resistance, no one appeared immune to the pod borer infestation. Regarding the resistance status throughout the two successive growing seasons, the soybean varieties Tono, Giza22 and Clark appeared as Highly Susceptible (HS), Susceptible (S) and Relatively resistant (RR) varieties. However, the soybean cultivars Hagen32 and S5 exist some sort of resistance and appeared as Moderately resistant (MR) cultivars. Similar results have been reported by Talekar and Chen (1983) and Talekar and Lin (1994) who identified sources of resistance to the (LBPB) in soybean. In general, the obtained results may be consider the newly produced soybean cultivars as a promising varieties that can be use as resistant varieties to this insect pest in the future.

Table (4): Resistance status of soybean varieties and cultivars to the lima bean pod borer *Etiella zinckenella*

Varieties and cultivars	Mean No. of (bores+larvae)						General mean± SD	Resistance status
	2004 growing season			2005 growing season				
	Green pods	Dry pods	Mean±SD	Green pods	Dry pods	Mean±SD		
Clark	0.50b	1.66b	1.08±0.8b	0.54b	1.00b	0.77±0.3b	0.93±0.6c	RR
Giza22	0.38b	3.00a	1.69±1.8a	0.79b	1.08b	0.94±0.3b	1.32±1.3b	S
Tono	1.29a	3.16a	2.23±1.2a	2.71a	2.50a	2.61±0.5a	2.42±0.9a	HS
Hagen32	0.25b	0.75bc	0.50±0.3bc	0.29b	0.58b	0.44±0.4b	0.47±0.3d	MR
S5	0.59b	0.33c	0.46±0.3c	0.62b	0.83b	0.73±0.3b	0.60±0.3d	MR
Mean	0.60	1.78	1.19	0.99	1.20	1.09	1.14	
F. value	11.18**	15.38**	17.55**	11.99**	16.94**	31.72**	84.25**	

Based on 25 soybean pods/each replicate.
Means in each column followed with the same letter are not significantly different at 0.05 level of probability.
**** Highly significant at 0.01 level of probability.**
HS =Highly susceptiblele, S = Susceptible, RR = Relatively resistant, MR = Moderately resistant.

2-2-The whitefly *B. tabaci*:

Data presented in Table (5) exhibit the nymphal average numbers and the resistance status of the tested soybeans to the whitefly *B. tabaci* during the period of study. Statistical analysis of the data revealed significant differences between the tested cultivars (F= 4.76*). The tested soybeans were arranged descendingly according to the nymphal infestation as follows: Tono by 39.93 > Hagen32 by 34.47>Clark by 31.57>Giza22 by 28.23>S5 by 22.85 mean numbers, respectively.

The obtained results indicated a distinct compatibility between the nymphal incidence and the degree of resistance. By using the aforementioned equation, Tono variety appeared as a highly susceptible (HS) variety. However, Clark and Hagen32 appeared as susceptible(S) soybeans. In contrast, Giza22 and S5 exhibit some sort of resistance and appeared as relatively resistant (RR) and resistant (R) soybeans, respectively. So, it is of importance to point out herein to the soybean cultivar S5 as a moderately resistant (MR) and resistant (R) cultivar against both of *E. zinckenella* and *B. tabaci*, respectively. The resistance mechanism of this newly produced cultivar against *E. zinckenella* may be due to appearance of

antibiosis phenomenon which needs more studies in the future. However, its resistance mechanism against *B. tabaci* could be due to the hooked-trichomes density which can deter the adult ovipositor from reaching to the leaf surface as reported by Pillemer and Tingey (1976). Therefore, it can be concluded that the newly produced soybean cultivar (S5) must be take great attention in the future to be used as resistant (R) variety against the LBPB *E. zinckenella* and the whitefly *B. tabaci.*

Table (5): Resistance status of soybean varieties and cultivars to the whitefly *Bemisia tabaci*

Varieties and cultivars	Mean No. of nymphs/5 trifoliate leaves			Resistance status
	2004 growing season	2005 growing season	Mean ± SD	
Clark	32.95ab	30.19ab	31.57±4.7abc	S
Giza22	30.14ab	26.33bc	28.23±7.2bc	RR
Tono	44.62a	35.24a	39.93±6.4a	HS
Hagen32	36.81ab	32.14ab	34.47±4.4ab	S
S5	25.09b	20.62c	22.85±4.5c	R
Mean	32.92	28.90	30.91	
F. value	3.02 ^{NS}	10.15**	4.76*	

Based on 5 trifoliate leaves/each replicate.
Means in each column followed with the same letter are not significantly different at 0.05 level of probability.
NS, non significant,* Significant at 0.05 level of probability, Highly significant at 0.01 level of probability.**
HS= Highly susceptible, S = Susceptible, RR = Relatively resistantt, R = Resistant.

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تقدير درجات مقاومة أنواع تجريبية من فول الصويا لدودة قرون اللوبيا والذبابة البيضاء في الواحات الداخلة بمحافظة الوادي الجديد, مصر

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أجريت الدراسة بزراعة ثلاث أصناف وسلالتين من فول الصويا في منطقة منعزلة شبه صحراوية بالواحات الداخلة بمحافظة الوادي الجديد. وقد تم تقدير درجات مقاومة هذه الأصناف والسلالات للإصابة بدودة قرون اللوبيا *Etiella zinckenella* Treitschke، والذبابة البيضاء *Bemisia tabaci* (Gennadius).

وقد أظهرت النتائج أن النسبة المئوية لإصابة قرون فول الصويا بدودة قرون اللوبيا كانت 4.30، 3.54، 9.13% للأصناف كلارك وجيزة 22 وتونو على التوالى. بينما كانت النسبة المئوية لإصابة سلالات فول الصويا هجين 32 وسلالة 5 هي 2.38، 3.21% على التوالي. وقد بدت نتائج تقدير النسبة المئوية للضرر الذي تحدثه يرقات هذه الآفة للبذور الخضراء والجافة مماثلة للنتائج السابقة. فقد سجلت أعلى نسبة للضرر على بذور الصنف تونو بمقدار 9.30% بينما سجلت أقل نسبة للضرر على السلالة هجين 32 بمقدار 1.97%. أظهرت النتائج أيضا عدم وجود اختلافات بين تأثيرات بعض مكونات بذور فول الصويا على استهلاك دودة قرون اللوبيا, حيث كان معامل الارتباط غير معنوي في كل الحالات. كما دلت النتائج على وجود توافق كبير بين درجة مقاومة أصناف وسلالات فول الصويا المختبرة وبين أعداد يرقات دودة قرون اللوبيا التي تهاجم القرون النامية, حيث بدت كل من سلالتي فول الصويا هجين 32 و س 5 كسلالتين متوسطتي المقاومة للآفة بينما بدت الأصناف كلارك وجيزة 22 وتونو كأصناف أقل مقاومة وحساسة وعالية الحساسية للآفة على التوالي.

وباعتبار أن متوسط أعداد حوريات الذبابة البيضاء التي تهاجم أوراق فول الصويا تعبر عن حالة مقاومة النبات للآفة فقد أظهرت النتائج توافق كبير بين متوسط أعداد الحوريات على الأوراق ودرجة حساسية الأصناف المختبرة للآفة. وبالرغم من ظهور درجات مختلفة من الحساسية للآفة بين الأصناف والسلالات المختبرة إلا أن السلالة س 5 ظهرت كسلالة مقاومة للذبابة البيضاء.

وبناءً على ذلك يمكن توجيه مربي النباتات إلى اختيار السلالات والأصناف التي تحمل مستويات مرغوبة من المقاومة لكلٍ من دودة قرون اللوبيا والذبابة البيضاء في برامج التربية مع عمل محاولات جادة لنقل الجينات المسئولة عن هذه الصفات للأصناف المنتجة حديثاً .