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Evaluation of Some Faba Bean *Vicia faba* L. Cultivars for Tolerance to the Black Bean Aphid, *Aphis craccivora* (Koch.)

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ABSTRACT

The present work based on field and laboratory screening to detect the tolerance of 5 Egyptian bean cultivars (local, Romy, Giza blanca, Giza-643 and Giza-3) towards aphid infestation (*Aphis craccivora*) for two successive seasons (2002 and 2003). Under field experiment, the results obtained with regard to the index values indicated that Giza blanca and Giza-3 were more susceptible cultivars to aphid infestation. In spite of the fact that Giza blanca is susceptible to aphid infestation but this cultivar possess a tolerant factor represented by the high yield obtained in comparison to other tested cultivars. In laboratory tests, the relative growth rate and the degree of distribution and settlement of the aphid on different cultivars after 24 and 48 hours, clarified that the population of aphid on Giza blanca and Giza-3 were more and above the equilibrium position and represented by positive departure. The local bean proved to be the least susceptible cultivar to aphid infestation.

Key Words: *Aphis craccivora*, Index value, Relative growth rate, Tolerance.

INTRODUCTION

The resistant of plant cultivars to insect pests is one of the most promising methods for controlling these insect pests. The concept of developing plants that are resistance to insects capitalizes on the natural defence mechanisms acquired by plant species during their evaluation against various herbivorous pests (Wiseman and Widstrom, 1992). The planned development of resistant cultivars is important, not only to plant resistance research program, but also to the overall success of integrated pest management (Reese, 1981).

Regarding to the faba bean, *Vicia faba* is one of the most important leguminous crops as a source of plant protein in Egypt. This crop is highly susceptible to the infestation with the leguminous aphid, *Aphis craccivora* Koch.. Many authors studied the susceptibility of some faba bean cultivars to *A. craccivora* infestation under Egyptian field conditions (Metwally *et al.,* 1997 and Mohamed and Slman, 2001) and in Syria (Mustafa and Samara, 1999). Investigation of genetically determined tolerance of faba beans for *Aphis fabae* was mentioned by Bohnke *et al.,* (1992) and Powell and Hardie, (2000).

The present work based on field and laboratory screening methods to detect the tolerance of five Egyptian faba bean cultivars towards *A. craccivora* infestation in an attempt to develop a host-plant resistant program against this aphid species; the major pest of bean in Egypt.

MATERIAL AND METHODS

1- Field experiments

An experiment was conducted at the Agricultural Research Station of the National Research Centre (Shalakan, Kalubia Governorate) in an area of 250m^2 during the last week of October 2002 and 2003. Five bean cultivars inbred under Egyptian conditions namely local bean, broad bean, Giza Blanca, Giza-3 and Giza-643 were sown. The area was divided into plots, each of 1/100 feddan and the seeds were sown in complete randomized blocks with four replicates per each cultivar. Agronomic practices such as cultivation, fertilization and weed control were done in all plots without insecticidal treatments throughout the growing seasons.

To determine the population of aphids on the different cultivars, randomized samples of ten tillers were taken weekly from each cultivar. Examination started 40 days after cultivation and continued till end of season. The average number of aphids/ tiller was calculated and tabulated in table (1). At harvest, the average numbers of pods and seeds per plant were also calculated. A visual rating scale and index system given by Mansour *et al.* (2000) was used as a criterion to evaluate resistance (Long *et al.,* 1977). This visual rating scale was as follows: No infestation (0 aphid/tiller), light infestation (1-5 aphid/tiller), moderate infestation (6-15 aphid/tiller) and heavily infestation (more than 15 aphid/ tiller). Index values for each cultivar were calculated by adding the weighed percentage of each class of infestation as follows: Percentage of no infestation (X1), % light infestation (X2), % moderate infestation (X3) and heavy infestation (X4).

Statistical analysis was carried out using analysis of variance (F-test) according to Hayslett (1970).

2- Laboratory experiments

a- Suitability of cultivars to growth

To estimate the influence of the different cultivars on growth rate of aphids, the five faba bean cultivars were sown in plastic pots 15cm in diameter, each was replicated five times. After ten days, each pot was artificially infested with five adult aphids and covered with chimney cage covered from above by muslin. The number of aphids on each seedling was counted daily, the average number of aphid on each cultivar was calculated and reported in table (2). The growth rate of aphid population was calculated daily according to the following equation and tabulated in table (3):-

$$R = \frac{P2 - P1}{P1} X\ 100$$

Where: R= population growth rate (natality).
P1= aphid number of the first count.
P2= aphid number of the second count.

b- Choice of aphid settlement

The relative susceptibility of the different bean cultivars to aphid settlement was conducted under laboratory conditions by growing the five faba bean cultivars in plastic pots 15cm in diameter. Plants were tested at a height of 15-20cm (6-8 leaf stage) which represented an age of 4 to 6 weeks. Four pots per each cultivar were arranged alternatively in a large wooden cage. The top of pots were covered with cardboard with 20 holes in order to permit the stock of the plant to grow normally, and the twenty pots to prevent the loss of aphids during the experimental period. Fifty newly emerged adult aphids were released above the centre of the cardboard and the cage was covered with muslin lid and left for 48 hours. The number of aphid settled on each cultivar after 24 and 48 hours were counted. Ten replicates were conducted. The percentage of distribution was calculated during the two intervals. The average number of aphids on each cultivar was estimated. The general mean was calculated using the following equation:

$$XU = \frac{X1 + X2 + X3 + X4 + X5}{5 \text{ (number of tested cultivars)}}$$

Where: XU = the general mean (steady point).
X1+X2+X3+X4+X5 = mean number of aphids per each cultivar. The departure from the general mean/cultivar was calculated and represented as positive and negative departure from the general mean.

The departure from the general mean clarified the susceptibility of settlement of aphids on the different cultivars which represented in table (4) and figure (1).

RESULTS AND DISCUSSION

1- Field experiments

Under field conditions, the five cultivars of faba bean tested were harboured by *A. craccivora* at different levels of infestation (Table 1). Regarding to the infestation index value, the data obtained showed that Giza blanca and Giza-3 represented the highest infestation index (163.48 and 103.16, respectively). This result is in agreement with the findings of Metwally *et al.* (1997) and Mohamed and Slman (2001), who found that Giza-3 and Giza blanca were the more susceptible cultivars to aphid infestation. In the contrary, Reina Blanca (Giza blanca) was found to be the less susceptible cultivar than Giza-3 towards *A. craccivora* during 1985/1986 season at Bani Sweif Governorate (El-Gentiry *et al.*, 1994). These results may be attributed to the difference in geographical and climatic conditions.

Table (1): Mean number of aphids/tiller infesting the five tested bean cultivars and the corresponding seed yield

Plant cultivar	Mean number of Aphids/tiller	Infestation Index value	Plant yield		
			Number of pods/plant	Number of seeds/plant	% of yield
Local bean	3.0±0.08b	11.92	1.6±0.2^{B}	6.40±0.44^{C}	11.72
Romy	8.7±1.5ab^{C}	51.78	1.6±0.2^{B}	6.72±0.50^{C}	12.31
Giza Blanca	20.6±6.6^{A}	163.48	3.4±0.37^{A}	22.44±0.74^{A}	41.10
Giza-643	5.1±0.95^{BC}	30.36	1.9±0.22^{B}	7.60±0.55^{C}	13.92
Giza-3	13.0±5.6^{AB}	103.16	2.2±0.41^{B}	11.44±0.65^{B}	20.95
F-value	2.9*		9.2**	3.8*	
L.S.D. at 5%	12.70		0.68	1.60	

Means in column followed by the same letter (s) are not significantly different at 5% level.

According to the index values of infestation, the tested five cultivars can be divided into three categories according to their tolerance tendency to aphid infestation, local beans (11.92) proved to be more resistant to aphid infestation; Romy and Giza-643 were moderate, while Giza blanca and Giza-3 were highly susceptible (Table 1). In spite of the susceptibility of Giza blanca to aphid infestation, this cultivar possessed a tolerant factor represented by the high yield in comparison to the other tested cultivars (Table 1).

Statistically, there was no significant difference among the yields of the following four cultivars: local, Romy, Giza-643 and Giza-3 (Table 1).

2- Population dynamics of *A. craccivora*

To emphasis the results of field experiments, a laboratory test was conducted to clarify the population dynamics of aphids on the different faba bean cultivars. The data obtained in table (2) magnify the highest susceptibility of Giza blanca. Two days after artificial infestation, the relative growth rate of aphids on this cultivar was 684 in comparison to Giza-643 which reached only 276 (Table 3). These results may be attributed to the higher content of essential and non-essential free amino acids in Giza blanca than other cultivars under test (Cichocka *et al.*, 2002). Regarding to the other experimental cultivars, there was no significant difference between the relative growth rates of aphids on local bean, Romy and Giza-3 2 days after the artificial infestation (Table 3). At the same time, the local bean still proved to be not suitable for aphid growth. The slope of growth rate decreased after the 3rd day of the artificial infestation. The degradation of aphid colonies was occurred five days after infestation. Jiallingii (2004) showed that the fast fatal reaction of the infested plants may be to the salivary components of aphid species.

Aphid settlement

It is well known that aphid distribution differ from cultivar to another due to the bio-chemical constituents of the plant especially amino acids (Cichocka *et al.*, 2002). Thus, it is important to measure the degree of distribution and settlement on the different faba bean cultivars with regard to the equilibrium position of aphids on the same experimental time and age of the plant. The data obtained in table (4) and figure (1) showed that the equilibrium position of aphids (general mean) on the different cultivars after 24 and 48 hours were 27.48 and 45.07 aphids/ seedling, respectively. The data present in figure (1) represented the departure of aphids (positive or negative) with regard to the faba bean cultivars after 24 hours from aphid distribution. The data obtained clarified negative) with regard to the faba bean cultivars after 24 hours from aphid distribution. The data obtained clarified that aphid population on Giza-3 and Giza blanca

Table (2): Population dynamics of *Aphis craccivora* Koch. on different bean cultivars under laboratory conditions

Plant cultivar	Number of aphids/plant seedling after the following days from artificial infestation					F-value	L.S.D. at 5%
	2nd	3rd	4th	5th	6th		
Local bean	16.4±2.8	14.0±1.7	12.8±1.8	11.2±3.1	2.8±1.7	5.78**	9.11
Romy	18.0±4.9	19.8±2.9	18.8±2.6	11.8±3.0	3.4±2.1	6.48**	11.00
Giza Blanca	39.2±1.2	70.4±2.4	30.2±1.8	25.4±1.7	14.0±4.1	75.97**	10.00
Giza-643	18.8±2.1	19.6±5.2	22.4±6.3	11.6±3.0	3.4±2.1	2.72 NS	--
Giza-3	19.2±2.1	32.8±3.8	38.8±2.7	31.4±1.3	26.4±3.5	7.35**	11.00
F-value	9.49**	44.78**	7.8**	12.98**	12.78**		
L.S.D. at 5%	12.00	13.00	14.00	10.00	11.00		

**= highly significant at 5% level of probability.
NS= not significant.

Table (3): Relative growth rate (natality) of *Aphis craccivora* Koch. on different bean cultivars

Plant cultivars	Growth rate of aphids after the following days from artificial infestation				
	2nd	3rd	4th	5th	6th
Local bean	288.00	- 13.41	- 8.57	- 12.50	- 75.00
Romy	260.00	36.00	- 5.05	- 37.20	- 69.79
Giza Blanca	684.00	79.59	- 57.12	- 15.90	- 44.88
Giza-643	276.00	9.57	14.29	- 48.21	- 70.69
Giza-3	284.00	70.83	18.29	- 19.07	- 15.92

R = ((P2-P1)/P1) * 100
Where: R = population growth rate P1= aphid number at 1st count P2= aphid number at 2nd count

Table (4): Distribution of *Aphis craccivora* Koch. on the five cultivars of *Vicia faba* (Choice test)

Plant cultivars	After 24 hours				After 48 hours			
	Number of aphids/ seedling	% Distribution	Departure from equilibrium position		Number of aphids/ seedling	% Distribution	Departure from equilibrium position	
			+ ve departure	-ve departure			+ ve departure	-ve departure
Local bean	14.0±1.70	10.18	---	- 13.48	16.40± 2.8	7.27	---	- 28.67
Romy	11.8±3.00	8.60	---	- 15.68	18.00± 4.9	7.99	---	- 27.07
Giza Blanca	38.0±2.50	27.65	10.52	---	74.67± 3.5	33.13	29.6	---
Giza-643	10.3±0.84	7.50	---	- 17.18	29.50± 9.5	13.00	---	- 15.77
Giza-3	63.3±4.51	46.07	35.82	---	87.00±11.0	38.61	41.93	---
Mean	27.48				45.07			
F-value	0.77 NS				1.95 NS			
L.S.D. at 5%	---				---			

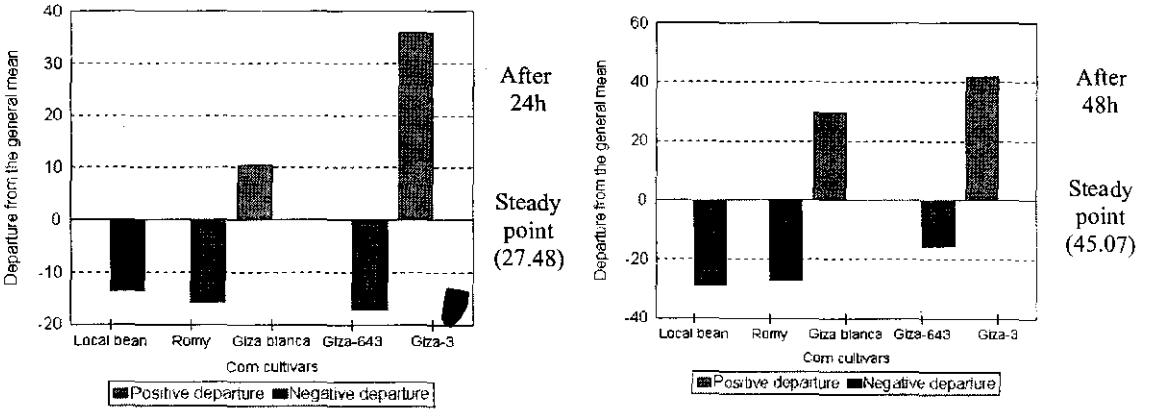

Fig. (1): Departures from the general mean (steady point) of *Aphis craccivora* infestation of five faba bean cultivars.

was above the equilibrium position and represented by a positive departure of 35.82 and 10.52, respectively. The number of aphids on the other three cultivars was below the equilibrium position. Local bean still proved to be the least susceptible cultivar to aphid infestation. This cultivar was similar to the Syrian local cultivar (Aquadulee), possibly to its nitrogen and protein contents in the plant leaves and stems (Mustafa and Samara, 1999).

Figure (1) represents the settlement of aphids on the five cultivars 48 hours after aphid release. It is obvious that the same response was found as regard to the settlement after 24 hours.

Local bean still the least attractive cultivar for aphid settlement being 28.67 (Table 4 and Fig. 1), while Giza-3 and Giza blanca proved to be suitable for the settlement of aphids on it.

REFERENCES

Bohnke, B.; E. C. Oerke; C.P.W. Zebitz and F. J. Schonbeck 1992. Allocation of assimilates in two cultivars of faba bean (*Vicia faba* L. var *minor*) differing in tolerance of *Aphis fabae*. Plant Path. Plant Protec. (Germany), 99 (2): 196-200.

Cichocka, E.; A. Ciepiela and W. Goszczynski 2002. Effect of amino acid contents on the acceptance of broad bean cultivars to black aphid. Prog. Plant Protec., Poznan, Poland 42 (2): 662-665.

El-Gentiry, A. M.; M. A. El-Hariry; S. F. Moussa; I. A. Marzouk and A. T. Abd El-Salam. 1994. Susceptibility of broad bean, *Vicia faba* L. varieties and breeding lines to infestation with *Aphis craccivora* Koch. under field condition in Egypt. Egypt. J. App. Sci., 9 (1): 358-364.

Hayslett, H. T. 1970. Statistics, Made Simple. Made Simple Books. W. H. Allen & Co., Ltd., London, W.C.2., pp 251.

Jiallingii, W. F. 2004. What is a host plant? Aphid-plant interactions in three *Vicia faba* exploiting aphids. Nat. Rech. Agron., Paris, 513-519.

Long, B. J.; G. M. Dunn; J. S. Bowman and D. G. Routley 1997. Relationship of hydroxamic acid content in corn and resistance to the corn leaf aphid. Crop Sci., 17: 55-58.

Mansour, H.; S. A. Ahmed; N. Y. Salem and A. R. Ramadan 2000. Evaluation of the susceptibility of different corn varieties towards aphid, *Rhopalosiphum maidis* (Fitch) infestation. Bull. Ent. Soc. Egypt, 78: 205-216.

Metwally, M. M.; E. M. E. Khalafalla; H. A. Helal; A. S. El-Khouly and A. B. El-Mezaien 1997. Susceptibility of some faba beans varieties and breeding lines to infestation with *Aphis craccivora* (Koch.) and *Empoasca* spp. under field conditions at Kafer El-Sheikh Governorate, Egypt. Egypt. J. Agric. Res., 75 (3): 579-586.

Mohamed, A. M. and F. A. A. Slman 2001. Susceptibility of some broad bean varieties to natural infestation with *Aphis craccivora* (Koch.) and *Liriomyza trifolii* (Burgess) at upper Egypt. Assiut J. Agric. Sci., 32 (1): 167-173.

Mustafa, T. and R. Samara 1999. Reproduction potential and susceptibility of certain broad bean (*Vicia faba* L.) to black bean aphid (*Aphis fabae* Scopli)(Homoptera: Aphididae). Arab J. Plant Protection, 17 (1): 41-44.

Powell, G. and J. Hardie 2000. Host selection behaviour by genetically identical aphids with different plant preferences. Physiol. Entom., 25 (1): 54-62.

Reese, J. C. 1981. Current topics in insect endocrinology and mutation. Edited by Bhaskaran, G.; Friedman, S. and Rodriguez, J. G. New York, 10013.

Wiseman, B. R. and N. W. Widstrom 1992. Resistance of corn inbreds to larvae of the corn earworm (Lepid.: Noctuidae). J. Econ. Entomol., 85: 289-292.