

# Screening of Faba Bean (*Vicia faba* L.) for Resistance to *Aphis craccivora* Koch

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## Abstract

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A faba bean aphid screening program was started in the laboratory established at the Agricultural Research Center, Giza, Egypt, as part of the ICARDA/IFAD Nile Valley Project on faba bean. This laboratory is used as a center for screening faba bean lines (breeding lines, germplasm, pure lines, and populations) from Egypt, Sudan, Ethiopia, and ICARDA on a continuing basis. Studies were undertaken to develop a simple reliable method for screening. Growing faba bean seedlings under controlled conditions, artificially infesting them with one adult female *Aphis craccivora* Koch/seedling and counting the progeny 10 days after infestation

proved to be an effective and rapid technique. During a 4-year period, a total of 7156 faba bean lines were evaluated for aphid resistance of which 114 lines were rated resistant after retesting. Using the most promising, reconfirmed lines, a Regional Aphid Screening Nursery has been established and planted in the 3 countries. Selected resistant lines will be subject to further detailed biological studies.

**Key words:** Faba bean, Resistance, *Aphis craccivora*, Egypt.

## Introduction

In many of the faba bean growing areas of West Asia and North Africa the black bean aphid (*Aphis fabae* Scop.) and the cowpea aphid (*Aphis craccivora* Koch) are the main insect pests limiting faba bean yield. *A.fabae* is predominant in cooler regions, whereas in hot and dry climates *A. craccivora* predominates (6). In the Mediterranean region and West Asia both species often occur together, with *A.fabae* being the predominant species in Syria (8) and Tunisia (3) and *A. craccivora* in Morocco (3). In Egypt and Sudan, infestations consist almost exclusively of *A. craccivora*.

Although effective insecticides for aphid control are available, host plant resistance is preferable to reduce production costs and protect beneficial insects. Aphid resistance in faba beans has been studied for many years, but so far only a few faba bean cultivars having some level of resistance have been identified (7, 2, 4). Acceptable levels of resistance have been detected in a few faba bean landraces and in some wild *Vicia* species (2, 1, 5).

Since West Asia is the center of origin of *Vicia faba* L. the germplasm originating in this area should vary in its reaction to aphids. The International Center for Agricultural Research in the Dry Areas (ICARDA) has developed a large collection of faba bean germplasm from the ICARDA region and elsewhere. The collection is maintained in two forms, the ILB collection comprising original heterogeneous populations, and the BPL collection, a set of inbred lines developed from the ILB collection. The BPL collection is used in the breeding program of ICARDA and

national programs. ICARDA also operates a regional research program on faba bean improvement in collaboration with Egypt, Sudan, and Ethiopia, where a large number of breeding lines have been developed. It was, therefore, thought worthwhile to screen this material for aphid resistance over the last 4 years.

## Materials and Methods

Faba bean aphid screening started in 1985/86 with the establishment of «the aphid screening laboratory» at the Agricultural Research Center, Giza, Egypt as part of the Faba Bean Nile Valley Research Project. Mass aphid rearing and screening was conducted under controlled conditions in two separate rooms, both with a temperature of  $20^{\circ} \pm 2^{\circ}\text{C}$ , relative humidity of  $60\% \pm 5\%$  and a 16h photoperiod. Colonies of *A. craccivora* were reared on pot grown faba bean seedlings of the susceptible Egyptian variety Giza 402.

For the screening, 7 seeds of each of 7 faba bean genotypes were sown in metal trays (30cm × 60cm × 7cm) filled with a 3:1 mixture of soil and peat moss. Randomly allocated rows of Giza 402 served as susceptible check. Five days after emergence, leaf sections infested with approximately 5 adult aphids each were placed on each seedling. Two days after artificial infestation, plants were checked to ensure the presence of 5 aphids per seedling. Fifteen days after infestation, the total number of aphids per seedling was counted and used as an indication of the degree of resistance or susceptibility. Since one *A. craccivora* female produces a mean of 48 nymphs on a susceptible cultivar during

a 15-day period, faba bean lines having less than a mean of 20 aphid individuals per seedling were considered to have some degree of resistance. The rating scale developed was:

- 1 =  $\leq$  20 aphids/plant (resistant)
- 2 = 20 – 50 aphids/plant (tolerant)
- 3 = 50 – 100 aphids/plant (susceptible)
- 4 =  $>$  100 aphids/plant (highly susceptible)

However, based on the experience gained during the first 3 years, the screening methodology was modified as follows and has been in use since 1989/90 season: Five seeds of each genotype were sown in 3 pots (12cm diameter) Five days after emergence each seedling was artificially infested with a single adult female of *A. craccivora* using a fine camel-hair brush. Seedlings were covered with a lantern glass having a muslin top confining the aphids to the respective plants. Plants were examined for the presence of the aphid 2 days after infestation. Ten days after infestation, the total number of aphids per seedling was counted and the mean of 15 plants calculated. The infestation level of each genotype was rated according to the following scale:

- 1 =  $\leq$  5 aphids/plant (resistant)
- 2 = 6 – 20 aphids/plant (tolerant)
- 3 = 21 – 50 aphids/plant (susceptible)
- 4 =  $>$  50 aphids/plant (highly susceptible)

These modifications improved the screening methodology with regard to standardization, practicability, and reliability. The earlier infestation technique of placing infested

leaves on the seedlings gave uneven infestations, which were laborious to rectify. Also, the infestation rate of 5 adult aphids per seedling used in the initial screening technique resulted in enormous numbers of aphids on susceptible faba bean lines (the majority) and counting was relatively laborious and time consuming. The modified infestation method of placing 1 adult aphid per seedling results in sufficient numbers of progeny and permits easy identification of differences between lines. Besides the use of pots provides better growing conditions for the plants and excludes any effects of preference.

Comparison of screening the same lines by both methods showed no significant differences, thus the results were pooled from both techniques. Promising genotypes were retested in the laboratory and then tested in the field under natural infestation.

## Results and Discussion

During the first year (1986/87) a total of 2607 faba bean lines were screened in the laboratory. The ICARDA material included 840 pure lines (BPL), 653 germplasm accessions from yield trials and nurseries, and 126 breeding lines. Of these 12, 22, and 5 lines, respectively, were rated resistant, having fewer than 20 aphids per seedling 15 days after infestation (Table 1). Of the Egyptian faba bean lines, 3 of 115 selections of Giza 402 and 5 of 517 breeding lines were found resistant. From Sudan 356 lines of the Shambat 85 collection were evaluated and 18 rated resistant.

**Table 1.** Number and origin of faba bean lines evaluated and found promising (in parenthesis) for resistance to (*Aphis craccivora*) in the laboratory during four years of screening.

	1986/87	1987/88	1988/89	1989/90
ICARDA				
BPL	840 (12)	1253 (9)*	644 (19)	600 (7,25*)
Lines from yield trials, nurseries	653 (22)	454 (0)	154 (4)	-
Breeding lines	126 (5)	-	-	-
<b>Egypt</b>				
Giza 402 selections	115 (3)	256 (3)*	116 (5)	192 (0)
Breeding lines, F4	-	-	165 (11)	-
Breeding lines	517 (5)	242 (4)*	-	-
Segregating material	-	121 (4)*	-	-
<b>Ethiopia</b>				
Breeding lines	-	-	21 (3)	-
<b>Sudan</b>				
Shambat 85 breeding lines	356 (18)	-	-	-
Sudanese coll. 87/88	-	206 (1)*	-	-
Hudeiba breeding lines	-	125 (1)*	-	-
	2607	2657	1100	792

\* tolerant lines

In 1987/88 none of the newly tested 2657 faba bean lines including ICARDA pure lines and germplasm accessions, Egyptian breeding lines, segregating material and selections from Giza 402 as well as Sudanese lines, was rated resistant. Only 22 lines were found to be tolerant having a mean of 30 – 50 aphids per seedling.

The screening in 1988/89 involved a total of 1100 new faba bean lines, of which 644 were pure lines and 154 germplasm accessions from ICARDA yield trials, 165 breeding lines and 116 selections from Giza 402 from Egypt, and 21 lines from Ethiopia. Of the pure lines 19 were rated resistant, two of which had already been selected for *Botrytis* (B88123) and stem nematode (BPL 23) resistance. Four lines of the ICARDA yield trials, and 5 lines of the Giza 402 selections and 11 of the Egyptian breeding lines were promising, and 3 of the Ethiopian genotypes were rated resistant.

Of the 600 new ICARDA pure lines screened in 1989/90, 7 were found resistant and 25 tolerant. None of the 192 Egyptian selections from Giza 402 was rated resistant.

Thus, during the period of 4 years a total of 7156 faba bean lines from ICARDA, Egypt, Sudan, and Ethiopia have been evaluated, and a total of 114 lines have been rated resistant. All these promising lines have been screened twice and considered resistant only if showing consistently low numbers of aphids. The BPL's and breeding lines found resistant are identified in Table 2.

The laboratory screening method described above has provided an effective and rapid technique for screening large numbers of faba bean lines against aphids. Using the most promising reconfirmed lines a Regional Aphid Screening Nursery has been established consisting of 20 entries (8 from Egypt, 8 from Sudan, and 4 from Ethiopia) plus the

**Table 2.** Identification numbers of faba bean pure lines and breeding lines found resistant for *A. craccivora* in laboratory screening.

BPL	23, 132, 153, 542, 544, 547, 557, 558, 647, 804, 820, 1852, 1958, 2291, 2292, 2302, 2315, 2350, 2356, 2381, 2423, 2505, 2507, 2545, 2560, 2609, 2613, 2666, 2789, 2790, 3345, 3416, 3129, 3351, 3474, 3116, 3347, B 88123.
Breeding lines	
ICARDA	2269/86, 2493/86, 2526/86, 2570/86, 2575/86 S 83115-16-1-1, L 83149-75-6-1-1, S 822238-42-7-1-5-1, D 84081-7-1-1
Egypt	30/18/82, 373/600/83, 592/1782/86, 592/1809/86, 593/1919/86
Ethiopia	PGRC/E 207209, ALAD/25 (mc) – 3, NEB 207 × 74 TA 74 – 6D
Sudan	120002, 120003, 120005, 120008, 120009, 120010, 120011, 120013, 120014, 120015, 120016, 120066, 120067, 120085, 120150, 120419, 120420

respective local susceptible check. This nursery was planted in all the 3 countries in the 1990/91 season for the first time and will provide important information on the correlation between the resistance found in the laboratory and in the field in different countries. In the future, countries in North Africa will also be included and are planned to receive the Aphid Screening Nursery, as faba bean lines from Morocco are currently (1991) being screened in the laboratory. Selected resistant lines will be subject for further detailed studies on their effect on aphid development and reproduction and possible mechanisms of resistance.

## الملخص

الدفاوي، ج و ا. م. قنطيري وسوزان ويجاند وشعبان خليل. 1991. تقويم مدخلات من الفول لمقاومة المن *Aphis craccivora* Koch. مجلة وقاية النبات العربية 9 (2): 141 - 138.

حشرات المن *A. craccivora* / بادرة، وعد النسل بعد عشرة أيام من الإعداد طريقة فاعلة وسريعة. وقد تم على مدى أربع سنوات تقويم ما مجموعه 7156 سلالة، وتبين أن 114 منها كانت مقاومة بعد إعادة الاختبار. وقد تم بالاعتماد على السلالات المباشرة، إنشاء مشتل إقليمي للسلالات المقاومة، تمت زراعته في الدول الثلاثة. وستضع السلالات المقاومة لدراسات حياتية تفصيلية في المستقبل.

كلمات مفتاحية: الفول، مقاومة، *Aphis craccivora*، مصر.

بدأ برنامج تقويم مدخلات الفول لمقاومة المن في المختبر الذي أحدث في مركز البحوث الزراعية، بالجيزة - جمهورية مصر العربية كجزء من مشروع وادي النيل على الفول بالتعاون بين إيكاردا/ إيفاد. ويستخدم هذا المختبر كمركز لتقويم سلالات الفول (سلالات التربية، أصول وراثية، سلالات نقية، وعشائر) من مصر والسودان وإثيوبيا وإيكاردا على نحو مستمر. وقد أجريت دراسات لتطوير طريقة بسيطة ويعتمد عليها للتقويم. وقد تبين أن زراعة سلالات الفول تحت ظروف محكمة، وإعدادها اصطناعياً بمعدل بالغة من

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