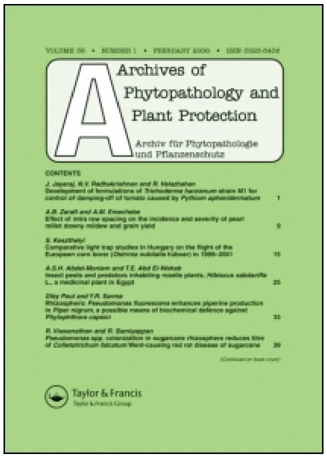

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Influence of certain agricultural practices on the cowpea aphid, **Aphis craccivora** Koch, infesting broad bean crops and the relation between the infestation and yield of plants in upper Egypt

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Influence of certain agricultural practices on the cowpea aphid, *Aphis craccivora* Koch, infesting broad bean crops and the relation between the infestation and yield of plants in upper Egypt

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Abstract
The effect of certain agriculture practices such as susceptibility of six broad bean varieties, space of planting, nitrogen fertilization levels, first irrigation and farmyard manure on the infestation of broad bean crop with the *Aphis craccivora* Koch was studied at El-Kawsar region, Sohag Governorate (about 495 km south of Cairo, Egypt) throughout the 2003/2004 and 2004/2005 seasons. The results obtained revealed that *A. craccivora* appeared from November until the second week of April. Also, the faba bean varieties were different in their susceptibility to the infestation with *A. craccivora*, dividing into three groups: the first one which was susceptible included Giza 674 and Giza Blanka; the second had low resistance and included Giza 843, Giza 2 and Giza 40; and the third group was moderate including Giza 429. The numbers of *A. craccivora* was significantly increased at 70 kg chemical nitrogen plus farmyard manure than at 40 or 55 units/feddan of chemical nitrogen during the two seasons. The population density of *A. craccivora* was significantly higher when decreasing the planting space. The population density of *A. craccivora* increased significantly with an increase of nitrogen fertilization levels during both seasons. The broad bean plants sown on 10 cm and which received N at a rate of 90 kg/fed. harboured the highest numbers of *A. craccivora* as compared with the other treatment (20 and 30 cm). The results show also that the broad bean plants which were irrigated at 56 and 63 days as a first irrigation harboured highly significant numbers of *A. craccivora* compared with the plants irrigated at 14, 21 and 28 days. These results also show significant negative correlation between the infestation of *A. craccivora* and the yield of broad bean plants.

Keywords: *Cowpea aphid,* Aphis craccivora*, agriculture practices, broad bean cultivars*

Introduction

Faba bean, *Vicia faba* L. is among the most important crops that supply Egyptian people with protein. Moreover, it is essential for the feeding of livestock (Mannaa et al. 1999). One of the reasons which may explain the decreased yield in the crop is the cowpea aphid, *Aphis*

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craccivora Koch. The pest causes economic damage by direct feeding and it is also known as a virus disease vector responsible for the dissemination of about 30 plant virus diseases (Gutierrez et al. 1971; Basky & Nasser 1989). Recently, up to 85% yield loss was recorded in the commonly cultivated cultivar, Giza 2 (El-Defrawi et al. 1994). Way (1967) concluded that the loss of *V. faba* yield caused by aphids ranged from 53 – 100%. Also, Blackman and Eastop (1985) reported that the cowpea aphid, *A. craccivora* koch (Aphididae) is one of the key pests which attacks broad bean causing severe damage to plants and yield in addition to transmitting plant viruses. Many authors have completed interesting work upon the use of cultural measures to manipulate the aphid populations. Khalil et al. (1974) studied the susceptibility of faba bean varieties to the infestation with the insect pests. Haseman (1946) showed that nitrogen, phosphorus, potassium, calcium, iron, zinc and magnesium are the main factors affecting plant attack by insects. Wearing (1968) mentioned that the fecundity of *Brevicoryne brassicae* increased with water shortage, Helaly et al. (1994) indicated that the abundance of *Aphis gossypii* Glover and *Tetranychus* spp. was significantly affected by space of planting.

The objective of the present work is to study the incidence of leguminous aphid, *Aphis craccivora* on six broad bean varieties, evaluate the response of *Aphis craccivora* Koch to the susceptibility of six broad bean varieties, farmyard manure, space of planting, nitrogen fertilization levels and the first irrigation.

Material and methods

Susceptibility of certain broad bean varieties to Aphis craccivora *infestation*

The present investigation was carried out at the Experimental farm of Faculty of Agriculture, Sohag, South Valley University (about 495 km south of Cairo, Egypt) during two successive seasons of 2003/2004 and 2004/2005. Six faba bean varieties namely Giza 674, Giza 40, Giza 843, Giza 429, Giza 2 and Giza Blanka were sown in October 20, during both seasons. A complete randomized block design was used. The size of each experimental plot (replicate) was 1/400 feddan. Normal agriculture practices were applied without pesticides treatment. The obtained results were statistically analysed according to the complete randomized block design. The proper 'F' and LSD values were calculated according Fisher (1950) and Snedecor (1957). The faba bean varieties were divided into three groups according to their sensitivity and resistance to the infestations with aphids, as described by Chiang and Talekar (1980).

Those with insect numbers less than $\bar{X} - 2SD$ were considered to be highly resistant (HR); between $\bar{X} - ISD$ to $\bar{X} - 2SD$ were moderately resistant (MR); between $\bar{X}$ and $\bar{X} - ISD$ were low resistant (LR); between $\bar{X}$ and $\bar{X} + 2SD$ were susceptible and more than $\bar{X} + 2SD$ were highly susceptible (HS).

$$(\mathrm{SD} = 6^2/n - 1; \quad \overline{X} = \overline{X}_1 + \overline{X}_2 + \overline{X}_3 \ldots /n)$$

Sampling

All morphs of *A. craccivora* were counted as soon as the appearance of aphids and continued until its disappearance. Ten faba bean branches per treatment (10 branches/replicate) were visually examined *in situ* according to Dewar et al. (1982), every 3 – 4 days two samples (week).

Faba bean yield of each plot (1/400 feddan) was determined at the harvesting time. The regression and correlation coefficient values were calculated between the mean number of aphids/10 branches and the yield as kg of grains/plot (Fisher 1950).

Effect of farmyard manure on the infestation of faba bean by A. craccivora

This experiment included five treatments of farmyard manure; farmyard manure plus 40 kg N urea (46.5%); farmyard manure + 55 kg N urea; farmyard manure + 70 kg N urea; and 70 kg N urea, designed in a complete randomized block design with four replicates. The plot size was 10.5 m^2. Seeds were sown on 20 October during both seasons, broad bean variety Giza 2 at a seed rate recommended per feddan. Farmyard manure was applied during soil preparation at a recommended rate (20 m^3/feddan). Chemical nitrogen fertilizer was added in the form of urea (46.5%) and applied in three equal doses before the first, second and third irrigation times. Normal recommended cultural practices were followed uniformly, and insecticides were entirely avoided. For each considered treatment, ten random branches were visually examined every 3–4 days. Faba bean yield of each treatment was determined at the harvesting time. The regression and correlation coefficient values were calculated between the mean number of aphid/10 branches and yield as kg of grains/plot.

Effect of space of planting and nitrogen fertilization levels on the population density of A. craccivora *infesting broad bean plants*

The experiment was laid out in a split-plot design with four replicates. Each plot was 10.5 m^2 in size. During the two successive seasons 2003/2004 and 2004/2005, two seeds of Giza 2 were sown on both sides of the ridge at 10, 20 and 30 cm hill spacing (main plots) seeds were sown on October 20 during both seasons. The three rates of nitrogen levels 50, 70 and 90 kg N/feddan as sub plots. Nitrogen fertilizer was used in the form of urea (46.5%) and applied in three equal doses before the first, second and third irrigation times. Normal recommended cultural practices were followed uniformly and no insecticides treatments were used. Ten broad bean plants were randomly, visually examined every 3–4 days. Yield of each treatment was determined at the harvest time. The regression and correlation coefficient values were made between the mean number of aphids/10 branches and yield as kg of grains/plot.

Effect of the first irrigation in the population density of A. craccivora *infesting broad bean plants*

The experiment was laid out in a complete randomized blocks design with four replicates. Each plot size was 10.5 m^2. The planting dates were 20 October during two growing seasons. Giza 2 broad bean variety was used. All regular recommend cultural practices were followed except for the first irrigation. Eight randomly times of first irrigation (14, 21, 28, 35, 42, 49, 56 and 63 days) were used. No pesticide treatments were applied. For each treatment 10 branches were randomly chosen at 3–4 days intervals and the numbers of aphids were counted. The data obtained were statistically analysed using F test means were compared using LSD at 5% level of probability. The regression and correlation coefficient values were calculated between the mean number of aphids/10 branches and the yield as kg of grains/plot.

Results and discussion

Susceptibility of certain broad bean varieties to Aphis craccivora *infestation*

Data presented in Table I show that the average number of *A. craccivora* increased from November until March then decreased gradually until the second half of April. The aphid numbered 62.42, 123.04, 187.96, 210.38, 301.08 and 62.58 per branches during November, December, January, February, March, and April, (2003/2004) season, while the numbers

Table I. Susceptibility of faba bean varieties to *Aphis craccivora* Koch infestation during 2003/2004 and 2004/2005 seasons.

	No. of *A. craccivora*/10 branches 2003/2004							No. of *A. craccivora*/10 branches 2004/2005								Yield/kg/10.5 m^2	
Varieties	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	Total mean	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	Total mean	Means of both seasons	2003/ 2004	2004/ 2005
Giza 674	96.5	184.5	185.25	329.5	442.0	85.5	1323.25a	102.75	189.75	190.75	336.25	449.25	92.75	1361.5a	1342.38 (S)	1.93c	1.75c
Giza Blanca	73.25	178.75	235.5	290.5	372.0	74.5	1224.5b	95.0	185.25	248.0	291.5	386.5	76.75	1283b	1253.75 (S)	2.13c	2.0c
Giza 843	54.0	120.75	207.0	195.75	291.25	61.25	930.0c	62.25	123.0	215.0	197.25	294.75	70.25	962.5c	946.25 (LR)	2.63b	2.50b
Giza 2	63.0	100.5	226.5	181.25	262.5	65.0	898.75d	74.0	110.75	213.0	173.75	270.0	74.0	915.5d	907.13 (LR)	3.0b	2.83b
Giza 40	50.5	93.25	131.5	143.5	254.75	50.75	724.25e	52.0	100.5	104.0	147.25	265.25	57.5	726.5e	725.38 (LR)	3.63a	3.50a
Giza 429	37.25	60.5	142.0	121.75	184.0	38.5	584.0f	45.0	73.0	141.5	122.75	190.75	46.25	619.25f	601.63 (MR)	3.88a	3.75a
Average mean	62.42	123.04	187.96	210.38	301.08	62.58		71.83	130.37	185.38	211.46	309.42	69.58				
F value																26.75	46.68
LSD at 0.05							13.57							7.16		0.4596	0.3535

Means followed by the same letter are not significantly different at 0.05 level of probability; *r* value between the cowpea aphid densities and vs. the yield = −0.98** during 2003/2004; *r* value between the cowpea aphid densities and vs. the yield = −0.99** during 2004/2005; SD = 288.99; X = 964.2; S, Susceptible; LR, Low resistance; MR, Moderate resistance.

were 71.83, 130.37, 185.38, 211.46, 309.42 and 69.58 during November, December, January, February, March, and April, (2004/2005) season. Data also show that the aphid number increased to reach its maximum 301.08 and 309.42 individuals/10 branches during March through two seasons. The results indicate that the population density of aphid during the second season was markedly higher than that of the first season. High population densities of aphids during the second season (2004/2005) are probably due to climatic conditions, particular temperature. These results are in agreement with those of (Saleh et al. 1974; Saleh & Guirguis 1976; Ali & Rizk 1980; Salem 1998; Mannaa et al. 1999; Mohamed & Slman 2001) who found that the initial infestation began to appear in the field at the beginning of the vegetative stage and increased gradually to reach its maximum level during the pod development stage (March) and diminished when the crop was nearly mature. It is clear that the maximum number of *A. craccivora* occurred in March during both seasons; this may be attributed to the broad bean varieties which during this month are in the suitable development stage for feeding for this aphid. Also the weather factors prevailing in Sohag during this month are within the preferred range for their multiplication (Prasad et al. 1984; Mohamed 1986; Sharma & Yadav 1994; Hassanein et al. 1995; Salem 1998). After that month, the population declined and this may be due to the effect of natural enemies. The six varieties of broad bean tested were harboured by *A. craccivora* infestation with different degrees as shown in Table I. Statistical analysis between the tested broad bean varieties of two seasons yielded significant 'F' values thus revealing the presence of significant differences among the broad bean varieties. When the broad bean varieties were arranged descendingly according to the mean number of *A. craccivora* and LSD value, it appeared that variety Giza 674 received 1323.25 and 1361.5 individuals/10 branches during (2003/2004) and (2004/2005) seasons, while Giza Blanca received 1224.5 and 1283.0 individuals/10 branches. On the other hand Giza 843, Giza 2, Giza 40 received 930.0, 962.5, 898.75, 915.5; 724.25 and 726.5 individuals/10 branches during two seasons, respectively. Meanwhile, Giza 429 received the fewest number of aphid individuals – 584.0 and 601.25/10 branches during both seasons, respectively.

These results partially disagree with those of Saleh et al. (1974) who found that Giza 2 was the least susceptible to aphid infestation. On other hand, the present results agree with those reported by Mohamed and Slman (2001) who found that Giza 429 harboured the less number of aphid individuals. According to Chiang and Talekar (1980), the six broad bean varieties can be divided into three groups of sensitivity (Table I). The first one includes Giza 674 and Giza Blanka, and this group was susceptible to *A. craccivora* infestation; the second group had low resistance and included three varieties (Giza 843, Giza 2 and Giza 40); while the third group included Giza 429 which moderately resisted *A. craccivora*. These results are in agreement with those of Mohamed and Slman (2001) who found that variety Giza 429 was moderate to aphid infestation. It is be concluded as a general discussion to plant resistance for pests, certain environmental conditions influence fundamental physiological processes of the plant as well as the pest, thus a variety that exhibits resistance in one locality or environment may be susceptible in another (Kumar 1984). Also, plant resistance to insects generally derives from certain biochemical and/or morphological characteristics of plants which affect the behavior and/or the metabolism of insects as to influence the relative degrees of damage caused by these insects (Metcalf & William 1975). Yield of broad bean varieties increased with the decrease in cowpea aphid *A. craccivora* population density (Table I). Analysis of data revealed a significant negative correlation between the mean numbers of cowpea aphid and the yield. The highest yield was obtained in the case of Giza 429, Giza 40 and Giza 2 varieties that were slightly infested by *A. craccivora*.

Effect of farmyard manure on A. craccivora *infestation of broad bean*

Data presented in Table II show that the effect of farmyard manure on the infestation of broad bean plants (Giza 2) and yield by *A. craccivora*. Results indicated that population density of *A. craccivora* was significantly higher on fertilized plants with farmyard manure plus 70 kg N (urea 46.5%) than plants fertilized only with farmyard manure or 70 kg N (urea 46.5%) during the two seasons. The infestation of *A. craccivora* was increased significantly at a rate of 70 kg N (urea 46.5%) plus farmyard manure as compared to other chemical nitrogens added to farmyard manure throughout the two seasons. The treatment 70 kg N (urea 46.5%) plus farmyard manure showed the increasing with *A. craccivora* during both seasons, with an average of (258.8 and 285.8 individuals per 10 branches). These results coincide with those obtained by Broadbent et al. (1952) who found that the highest populations of aphids on potato plants were achieved by dung, ammonium sulphate and superphosphate. Boguleanu et al. (1977) and Slman (2002a) mentioned that the greenbug, *Schizaphis graminum* on wheat plants was found to be most abundant on the plants fertilized by chemical nitrogen fertilizer plus farmyard manure. Data also in Table II show negative correlation between the mean number of *A. craccivora* and the yield of treatment. Treatment with 70 kg N (urea 46.5%) gave the highest yield (2.88 and 2.63 kg/10.5 m^2) and the lowest numbers of *A. craccivora*. Treatment with farmyard manure plus 70 kg N gave the smallest yield (1.38 and 1.33 kg/ 10.5 m^2) and harboured the highest numbers of *A. craccivora* during the two seasons, respectively.

Effect of planting space and nitrogen fertilization levels on the population density of A. craccivora *during 2003/2004 and 2004/2005 seasons*

Planting space. Data in Table III represent the effect of the planting space on the population density of *A. craccivora* and yield of broad bean plants (Giza 2), during two seasons (Avg. no./ 10 branches on the three different planting space 10, 20 and 30 cm.) Results show that the

Table II. Effect of farmyard manure on the infestation of broad bean plants by *Aphis craccivora* Koch during 2003/ 2004 and 2004/2005 seasons.

	Avg. no. *A. carccivora*/10 branches		Yield/kg/0.5 m^2	
Treatments	2003/2004	2004/2005	2003/2004	2004/2005
Farmyard manure	196.3d	202.8d	1.50c	1.53c
Farmyard manure + 40 kg N	208.3c	216.5c	2.25b	2.13b
Farmyard manure + 55 kg N	240.0b	267.5b	1.45c	1.33c
Farmyard manure + 70 kg N	258.8a	285.8a	1.38c	1.33c
70 kg N	197.3d	206.3d	2.88a	2.63a
LSD at 0.05%	4.447	6.285	0.3043	0.3836

Means followed by the same letter are not significantly different at 5% probability level; *r* value between the cowpea aphid densities and vs. the yield = −0.63* during 2003/2004; *r* value between the cowpea aphid densities and vs. the yield = −0.69* during 2004/2005; F between varieties for *A. gossypii* population = 1.54, probability = 0.2649**; F between varieties *B. tabaci* population = 0.73, probability = 0.5093**; F between varieties *Empoasca* sp. population = 0.82, probability = 0.4704**; F between varieties *M. hirsutus* population = 4.23, probability = 0.0506**; CV between *A. gossypii* population and farmyard manure during 2003/2004 = 1.31%; CV between *A. gossypii* population and farmyard manure during 2004/2005 = 1.73%; CV between *A. gossypii* population and yield during 2003/2004 = 10.42%; CV between *A. gossypii* population and yield during 2004/2005 = 13.95%.

Table III. Effect of planting space and nitrogen fertilization levels on number of *Aphis craccivora* Koch infesting broad bean during 2003/2004 and 2004/2005 seasons.

		Avg. no. of aphid/10 branches		Yield/kg/10.5 m^2	
Planting space (cm)	Nitrogen levels (kg/fed.)	2003/2004	2004/2005	2003/2004	2004/2005
10	50	222.5f	225.5e	2.14bc	2.03b
	70	292.8b	296.5b	1.38e	1.25de
	90	322.8a	327.5a	1.63de	1.50cd
	Mean	279.4a	283.2a	1.72b	1.59b
20	50	195.8g	202.5f	2.63a	2.50a
	70	234.5d	239.8de	2.38ab	2.25ab
	90	259.5**c**	269.8c	1.63de	1.50cd
	Mean	229.9b	237.3b	2.21a	2.08a
30	50	164.3h	174.8g	1.86cd	1.73c
	70	218.3f	229.3e	1.36e	1.23e
	90	227.5e	259.0cd	1.50e	1.38de
	Mean	203.3c	221.0b	1.58b	1.45c
All average	50	194.2	200.93	2.21	2.09
N-levels	70	248.53	255.2	1.71	1.58
(Urea 46.5)	90	269.93	285.43	1.59	1.46
LSD 0.05%	Planting space	2.289	17.69	0.1747	0.1223
	N. levels	2.678	12.36	0.2067	0.1582
Planting space × N – levels		4.639	21.41	0.3025	0.2739

Means followed by the same letter are not significantly different at 0.05% probability level; $r = -0.99^{**}$ and -0.98^{**} during 2003/2004 and 2004/2005, respectively between the cowpea aphid densities versus the yield; CV between *A. gossypii* during 2003/2004 and 2003/2004 were 1.31% and 5.83%; CV between *A. gossypii* population and yield during 2003/2004 = 19.38%; CV between *A. gossypii* population and yield during 2004/2005 = 10.78%.

population density of *A. craccivora* on broad bean plants was highly significant when using 10 and 20 cm planting spaces (the average numbers were 279.4 and 229.9 individuals/10 branches) during 2003/2004 season and (283.2 and 237.3 individuals/10 branches) during 2004/2005 season compared with 30 cm) planting space during both seasons. These results are in agreement with results of Way and Heathcote (1966) who indicated that increasing broad bean plants per unit area led to the increase of *Aphis faba* number. Slman (2002b) also found that the density of aphids was significantly increased when decreasing the planting space.

Effect of nitrogen fertilization levels. Table III also showed the response of *A. craccivora* infestation to nitrogen fertilization during two seasons. It appeared that the population density of *A. craccivora* increased progressively with an increase of nitrogen rate. For both seasons, the infestation was significantly lower on plants which received 50 and 70 kg N/feddan compared with those which received 90 kg N/feddan. For that, the increase of aphid infestation with increasing nitrogen fertilization rates found in the present study may be attributed to the increase of soluble nitrogen level in the plant sap, since Banks (1965) found that increasing nitrogen supply increases nitrogen uptake and nitrate accumulation in the plant. The previous results inferred that infestation was markedly affected by increasing nitrogen rate and was accompanied by an obvious increase of *A. craccivora*. Such results reflected that the broad bean which absorbed high amounts of nitrogen containing higher amounts of specific amino acids in the phloem sap, consequently increased the development of aphid population. Also, the highest nitrogen rate prolongs the vegetation period and inhibits senescence so that plants are much longer convenient host plants for the aphids (Hansen 1986). These results are in agreement with Singh and Painter (1965); Waghray (1965), Vereijken (1979), Hanisch (1981), Honek (1991), Li et al. (1992), Moon et al. (1995), Ali and Ahmed (1996), Gash et al. (1996), Duffield et al. (1997) and Slman (2002a), who reported that an increase in aphid multiplication was almost proportional with the units of nitrogen applied.

Interaction between space of planting and nitrogen fertilization level on the infestation of broad bean plant by A. craccivora

As shown in Table III results revealed that there was a significant interaction between space of planting and nitrogen fertilization level during both seasons of 2003/2004 and 2004/2005. It is obvious that broad bean plants sown at 10 cm and receiving N at a rate of 90 kg/fed. harboured the highest numbers of *A. craccivora* during both seasons (avg. no. 322.8 and 327.5 individuals/10 branches) as compared with other treatments (20 and 30 cm).

Generally it can be concluded from the previous results that the high density of broad bean plants and high rate of nitrogen fertilization were responsible for the significant increase of the population of *A. craccivora*. Such an increase was much pronounced when using 10 cm planting space and 90 units/feddan of nitrogen fertilization. There is considerable evidence that the reproduction of *A. craccivora* increase by the high levels of soluble nitrogen in the phloem (Van Emden et al. 1969; Van Emden 1996; Ettay & Moshe 2001). Increase of soluble nitrogen was also recorded by Goodall and Gregory (1947). The descent of nitrogen accumulation in plants due to low rate of fertilization leads to the suppression of aphid fecundity and reproduction and minimizes the aphid infestation.

Broad bean yield (kg/10.5 m^2). Data in Table III also show negative correlation between the mean infestation by the *A. craccivora* and the yield of broad bean plants ($r = -0.99$ and -0.98) during 2003/2004 and 2004/2005 seasons, respectively. The broad bean plants gave the highest yield (2.21 and 2.08 kg/10.5 m^2 when using 20 cm planting space and when fertilized with a rate 70 kg, N/feddan as compared with 10 and 30 cm planting space (1.72, 1.5 and 1.50, 1.38 kg/10.5 m^2) when using a rate of 50 and 90 kg N/feddan, respectively during both seasons. Way (1967) concluded that the loss of *V. faba* yield caused by aphids ranged from 53 – 100%. Also, El-Defrawi et al. (1994) reported that recently, up to 85% yield loss was recorded in the commonly cultivated cultivar.

Effect of the first irrigation on the population density of cowpea aphid, A. craccivora *infesting broad bean plants during 2003/2004 and 2004/2005 seasons*

Statistical analysis of the data presented in Table IV showed that population density of *A. craccivora* was significantly affected by prolonging the first irrigation in both seasons. The highest numbers of *A. craccivora* were recorded at 56 and 63 days (223.8 – 239.0 and 231.5 – 250.0 individuals/10 branches) during both seasons. This may be attributed to the increase of the essential amino acids in the plants at this stage that leads to an increase in the infestation of broad bean plants with *A. craccivora*. The lowest numbers of *A. craccivora* were recorded at 14 and 21 days (144.3 – 150.0 and 149.8 – 160.0 individuals/10 branches) during both seasons. These results coincided with those obtained by Wearing (1968) who mentioned that the fecundity of cabbage aphid, *B. brassicae* increased with water shortage as a result of the enrichment of phloem sap with nitrogen compound.

Table IV. Impact of the first irrigation on the infestation of broad bean plants with *Aphis craccivora* Koch during 2003/2004 and 2004/2005 seasons.

	Avg. no. aphid/10 branches		Yield/kg/10.5 m^2	
First irrigation (days)	2003/2004	2004/2005	2003/2004	2004/2005
14	144.3h	149.8h	3.0a	2.75a
21	150.0g	160.0g	2.75a	2.25b
28	162.5f	176.5f	2.0b	1.75c
35	178.0e	194.8e	1.63bc	1.40d
42	194.8d	204.0d	1.33cd	1.13de
49	207.3c	222.8c	1.20cde	1.00ef
56	223.8b	231.5b	1.00e	0.83f
63	239.0a	250.0a	0.88e	0.75f
LSD at 0.05%	4.381*	3.521*	0.4412*	0.2867**

Means followed by the same letter are not significantly different at 5% probability level; *r* value between the cowpea aphid densities and vs. the yield = −0.94** during 2003/2004; *r* value between the cowpea aphid densities and versus the yield = −0.96** during 2004/2005.

Data also in Table IV show a negative correlation between the mean number of *A. craccivora* and yield of broad bean. The highest yield was recorded at 14 and 21 days (3.0–2.75 and 2.75–2.25 kg/10.5 m^2) as compared with 56 and 63 days (1.0–0.88 and 0.83–0.75 kg/10.5 m^2) respectively during both seasons.

Generally, the population density of *A. craccivora* was variable according to broad bean resistance, planting space, nitrogen fertilization levels, first irrigation and farmyard manure.

Generally, thus, it could be recommended that using resistant varieties, 20 cm planting space, 70 kg nitrogen fertilization level, first irrigation at 14 or 28 days from planting date and preventing crowding of the plants should minimize aphid infestation in broad bean plants.

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