

The Influence of Infestation With The Black Legume Aphid, *Aphis craccivora* Koch on Some Biological Parameters of Faba Bean, *Vicia faba* L.

Somaia E. Aly and Mohamed E. Tawfeek

Department of Applied Entomology, Faculty of Agriculture, University of Alexandria, Alexandria, Egypt

Received on: 4 /7/2010

Accepted: 29/7/ 2010

ABSTRACT

The influence of the black legume aphid, *Aphis craccivora* Koch (Homoptera : Aphididae) infestation on faba bean plants was studied. The obtained results indicated that the surface area of the leaves, length of the plant, weight of the leaves were decreased significantly in comparison with those of the normal plants, while the percentage of chlorophyll was increased with the aphid infestation. Analysis of free amino acids showed significant reduction in amino acids concentration in the infested plants. Meanwhile, the concentrations of especially 14 amino acids were decreased as well as reducing sugars Glucose. This reduction leads to a drop in the nutrition values of the plant.

Key words: Faba bean, *Aphis craccivora*, plant growth, amino acids, sugars.

INTRODUCTION

Faba bean *Vicia faba* L. is one of the most popular vegetable crops in Egypt. Green broad beans, freshly shelled, rank the highest in protein contents among the fresh vegetables.

The estimated area planted with broad bean in Egypt is 350,000 to 400,000 feddans (Saker, 1952 and Eid, 1998). The decrease in the local production of faba bean plants in recent years by the competition from the other winter crops, such as wheat and clover, has led to import more supplementary quantities from Ethiopia, Poland, Morocco, England and Canada. These imports are expensive and, in some years, sources of faba bean have been difficult to find at any price (Sexena and Stewart, 1983). With less land being allotted to the crop, it has become more important than ever that researchers should find ways to raise the yield of the crop.

The faba bean crop is liable to attack by several insect pests, right from the early stage of growth through the late development to the post harvest stage. Many insects, belonging to the orders Lepidoptera, Diptera, Hemiptera, Homoptera, Heteroptera, Thysanura and Coleoptera, are known as pests attacking faba bean. However, the most important field insect pests are leaf miners and some aphid species.

Certain aphid species are common as major pests of economic crop plants. For instance, the cowpea aphid, *Aphis craccivora*, (Homoptera: Aphididae) is a polyphagous pest species of plants such as fruit trees and crop plants especially Leguminosae and is also found in small colonies on many other plant families. It damages the infested

plants by absorbing the sap. It is also known as a vector of about 30 plant virus diseases. (Blackman and Eastop, 1984; Sanz *et al.*, 2001; Tawfeek, 2001, El-Hawary and Abd El-salam, 2005).

Most aphids feed on the plant sap, which consists of an aqueous sugar sucrose and other organic substances. A few aphids feed on cells of parenchymatic tissues. The food of aphids is rich in carbohydrates but poor in low-grade amino acids. They obtain sufficient amino nitrogen by processing several times their body weight of phloem sap every day (Heie, 1980; Darwish, 1991; Dixon 1997 and Knäbe and Dixon, 1998).

The females and larvae feed mainly on the lower surface of the leaves around the mid-rib, leaf stalk, flower buds and pods. Sooty moulds develop on the honeydew secretion of the aphids and make a dull blackish film on the contaminated surfaces. The feeding of aphids causes leaves curling and rosette of the plant foliage associated with dwarfs of the plants (El-Komy, 1999).

The objective of the present study is to investigate the influence of black legume aphid infestation on some biological parameters of faba bean plants.

MATERIALS AND METHODS

Faba bean seeds were planted in pots with three replicates each of five pots. Every pot had four plants. Five pots were used as for control. Two weeks later, the faba bean plants were infested with aphids. Each pot was infested with 30 aphid individuals, while the control pots were not infested, as they were covered with white sheet fixed by rubber to avoid the entrance of aphids. *A. craccivora* individuals used in the present experiments were

obtained from the Farm of the Faculty of Agriculture, Shebin El-Kom Menoufia University. Samples of infested bean plants with colonies of this aphid species were transported from the field colonies to the bean plants, which were cultivated in pots under semi-field conditions at the Department of Applied Entomology, Faculty of Agriculture in Alexandria. The aphids were reared for several generations.

To evaluate the effect of *A. craccivora* on faba bean, some biological parameters such as the area of infested leaves, length of the infested plant, weight of the infested leaves were recorded. The percentage of the chlorophyll in the infested leaves was also secured by using Spadmeter (1mg/cm² spad unite). Recording weight of the infested leaves in the control after drying leaves at 50°C for 24hrs.

All these parameters in the treatments and in the control were measured after 48, 96, 168 and 240 hrs post infestation.

In addition, to assay free amino acids, 0.5 gm dried sample (leaves) + 20ml 5% sulpho salicylic acid (S.S.A.), shaken well for one hour at room temperature then centrifuged at 5,000 rpm for 15 min or filter supernatant or filtrate, store at 4°C. Using amino acid analyzer for free A.A. Estimate Carbohydrates (Sugars): Extract 2.0gm dried sample (leaves) + 25 ml 70% Ethyl alcohol, incubate with shaking at 50°C. Filter or centrifuge at 5,000 rpm for 15 min., supernatant or filtrate for sugars determination.

The data were statistically analyzed to check the significant differences between treatments by using F test and L.S.D. test.

RESULTS AND DISCUSSION

Faba bean plants were infested with aphids two weeks after planting. The biological parameters, surface area of the leaves, length of the plant, weight of the leaves, percentages of the chlorophyll in the leaves, and estimated amino acids and Sugars were studied after 48, 96, 168 and 240 hrs after infestation. The obtained results on the surface area of the leaves, (Figure 1) showed that there were significant differences between the measurements of the leaves area, which averaged 4.1 ± 0.4 , 3.3 ± 0.6 , 5.05 ± 0.4 , 6.0 ± 1.1 Cm² respectively, while those of healthy leaves were 11.6 ± 1.4 , 15.35 ± 1.5 , 20.15 ± 1.8 and 20.4 ± 1.1 Cm², successively.

The length of the plant is shown in Figure 2. It may be clear that its measurements were significantly shorter in the infested plants, 5.0 ± 0.7 , 5.5 ± 0.8 , 7.1 ± 0.8 and 8.30 ± 0.9 Cm, compared with healthy plants which, were 12.5 ± 1.7 , 16.6 ± 0.9 , 22.2 ± 0.9 and 30.1 ± 0.9 Cm after 2, 4, 7 and 10 days, respectively.

Figure 3 revealed the effect of *A. craccivora* on the weight of the leaves after 2, 4, 7 and 10 days. There were significant differences between the weight of the infested leaves and the controls. The average weights were 0.018 ± 0.002 , 0.016 ± 0.002 ,

0.027 ± 0.002 and 0.030 ± 0.003 gm, successfully, versus 0.037 ± 0.002 , 0.041 ± 0.002 , 0.053 ± 0.003 and 0.055 ± 0.003 gm in control ones, respectively

Figure 4 shows that the effect of infestation with *A. craccivora* on the percentage of the chlorophyll in faba bean leaves after 2, 4, 7 and 10 days. The increase in the percentage of chlorophyll was slight during the early days of infestation. The percentage of chlorophyll in infested plant (leaves), averaged 45.22 ± 1.9 , 45.46 ± 1.9 , 42.06 ± 1.2 and 35.9 ± 1.2 respectively, versus 42.2 ± 2.07 , 38.6 ± 1.2 , 35.2 ± 1.4 and 34.4 ± 1.2 mg/cm² in the control leaves. The obtained results of increase of the percentage of chlorophyll in the infested leaves may be refer to dwarf of the leaves due to rise of the synthetic metabolism resulting from aphid feeding.

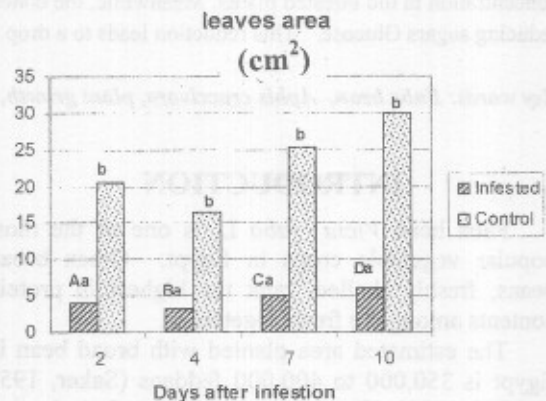


Fig. 1: Effect of *A. craccivora* on surface area of the leaves after 2, 4, 7 and 10 days.

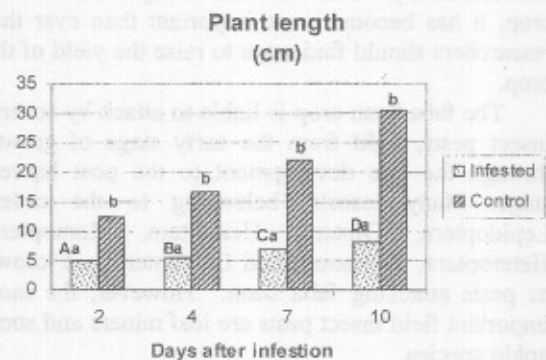


Fig. 2: Effect of *Aphis craccivora* on length of the plants after 2, 4, 7 and 10 days.

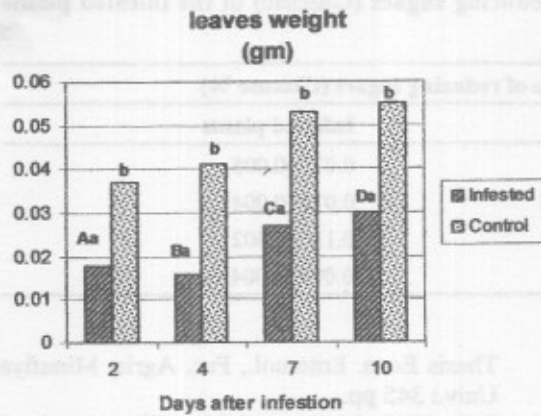


Fig. 3: Effect of *A. craccivora* on leaves weight after 2, 4, 7 and 10 days.

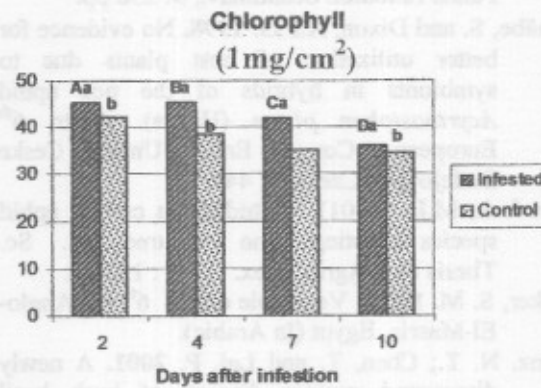


Fig 4: Effect of *Aphis craccivora* on the percentage of chlorophyll on the leaves after 2, 4, 7 and 10 days.

To evaluate the effect of *A. craccivora* infestation on amino acids in faba bean plants, Table (1) indicates that when amino acids were analyzed, 14 free amino acids FAAS were observed,

namely Aspartic acid, Glutamic acid, Proline, Glycine, Alanine, Valine, Methionine, Isoleucine, leucine, Tyrosine, Phenylalanine, Histidine, Lysine, and arginine. These acids decreased due to the feeding of *A. craccivora* compared with the untreated plants. Meanwhile the feeding of *A. craccivora* had no effect on Threonine and Serine during the experimental period. Auclair (1976) reviewed the nutritional investigation made over the past twenty years on the pea aphid including the development of a chemically defined diet with a suitable amino acid mixture. The concentrations of total soluble amino compounds, including those of 10 amino acids essential to pea aphid and of two amides (asparagine and glutamine) were generally twice as long as in water extracts of susceptible pea varieties than in those of resistant ones.

Decreasing of amino acids in faba bean plants ascribed to the use of large amount amino acids, which are essential for aphid growth and reproduction.

Table (2) shows that the reducing sugar glucose also decreased, the percentage of sugars averaged in the infested leaves 0.070 ± 0.005 , 0.076 ± 0.004 , 0.110 ± 0.002 and 0.099 ± 0.004 , respectively, versus 0.169 ± 0.007 , 0.099 ± 0.003 , 0.140 ± 0.005 and 0.169 ± 0.006 in uninfested ones, respectively after 2, 4, 7 and 10 days.

The obtained data denoted that *A. craccivora* reduced sugars in faba bean to secrete honey dew, which affects the content of total sugars in the plant.

The food of aphids is rich in carbohydrates and poor in mainly low-grade amino acids. They obtain sufficient amino acids by processing several times their body weight of phloem sap every day. In addition they have symbionts, which are able to upgrade the amino acid composition of their food (Heie, 1980 and Darwish, 1991).

Table 1: Effect of *A. craccivora* on amino acids of the infested plants after 2, 4, 7 and 10 days (mg/100gm dry matter).

Amino acids	2 days		4days		7days		10days	
	control	Infested plants	control	Infested plants	Control	Infested plants	control	Infested plants
Aspartic acid	724.26	582.35	552.01	331.01	528.52	334.22	493.28	324.26
Threonine	264.05	264.05	264.05	264.05	264.05	264.05	264.05	264.05
Serine	211.79	211.79	211.79	211.79	211.79	211.79	211.79	211.79
Glutamic acid	85.29	45.95	318.78	65.25	251.61	157.79	231.99	116.42
Proline	184.21	125.24	575.66	460.53	368.42	275.66	184.21	84.11
Glycine	150.14	90.83	96.32	24.51	101.74	64.53	128.72	75.52
Alanine	102.25	65.20	97.99	44.46	63.91	11.14	88.91	46.31
Valine	110.93	86.78	78.10	27.12	100.85	55.39	29.83	16.27
Methionine	94.78	26.99	574.99	157.96	454.94	221.15	213.25	63.19
Isoleucine	504.37	267.46	466.36	240.94	409.60	228.09	289.13	93.70
leucine	339.72	45.44	314.11	162.28	275.88	153.63	194.74	63.11
Tyrosine	167.29	22.94	183.48	71.23	151.10	38.85	164.32	19.43
Phenylalanine	637.55	289.07	690.68	169.77	591.91	417.31	409.10	137.65
Histidine	350.96	179.30	209.71	146.54	254.54	215.25	279.29	157.62
Lysine	333.32	157.19	183.85	139.17	241.74	200.10	257.77	149.70
Arginine	457.90	426.61	628.19	153.58	693.24	531.89	507.67	286.19

Table 2: Effect of *A. craccivora* on the percentage of reducing sugars (Glucose) of the infested plants after 2, 4, 7 and 10 days.

Samples	Percentage of reducing sugars (Glucose %)		
	Date	Control	Infested plants
2 days		0.169±0.007	0.070±0.005
4 days		0.99±0.003	0.076±0.004
7 days		0.140±0.005	0.110±0.002
10 days		0.169±0.006	0.099±0.004

REFERENCES

- Auclair, J.L. 1976. Feeding and nutrition of the pea aphid *Acyrtosiphon pisum* (Harris), with special reference to amino acids. Symp. Boil. Hung., 16: 29 – 34.
- Blackman, R.L. and Eastop V.F. 1984. Aphids on the world's crops; An identification and information guide. John Wiley & Sons, Chichester, New York Brisbane, Toronto, Singapore, 463 pp.
- Darwish, E.T.E. 1991. Chemical composition of host plant foliages and their role in the occurrence of two mealy aphid species. Minufiya J. Agric. Res., 16 (2): 1915 – 1925.
- Dixon, A.F.G. (1997). Aphid ecology: An optimization approach. Chapman and Hall, 259 pp.
- Eid, F. M. H. 1998. Studies on leafminers and their natural enemies in Egypt. Ph. D. Thesis, Fac. Agric., Cairo Univ., Egypt.
- El-Hawary, F. M. A. and Abd El-Salam, A. M. E. 2005. Insecticidal effects of Fenugreek oil and benzaldehyde (aromatic compounds) on cowpea aphid, *Aphis craccivora* Koch. J. Egypt. Ger. Soc. Zool, 46E, 1: 43 – 56.
- El-Komy, S.O.O. 1999. Interrelationships among some aphids and their host plants. Ph.D. Thesis Econ. Entomol., Fac. Agric. Minufiya Univ.: 345 pp.
- Heie, O.E. 1980. The Aphidoidea (Hemiptera) of Fennoscandia and Denmark. I, General part. The families Mindaridae, Hormaphididae, Thelaxidae, Anoeciidae and Pemphigidae. Fauna Entomol. Scandinav., 9: 236 pp.
- Knäbe, S. and Dixon, A.F.G. 1998. No evidence for better utilization of host plants due to symbionts in hybrids of the pea aphid *Acyrtosiphon pisum* (Harris). Abstr. 6th European Cong. Ent., Univ. Ceske Budejovice, Czech, 2: 442.
- Tawfeek, M.E. (2001). Studies on certain aphid species infesting some fruit trees. M. Sc. Thesis Fac. Agric. Alex. Univ. : 152 pp.
- Saker, S. M. 1952. Vegetable crops. 6th ed. Anglo-El-Masria, Egypt (In Arabic).
- Sanz, N. T.; Chen, T. and Lai, P. 2001. A newly discovered mosaic disease of bush basil *Ocimum basilicum* in Taiwan. Plant Pathology Bulletin, 10 (4): 155 – 164.
- Sexena, M. C. and Stewart, R. A. 1983. Faba bean in the Nile Valley. Report on the first Phase of ICARDA/IFAD Nile Valley Project, the Hague, Boston, London.

المخلص العربي

تأثير الإصابة بحشرة من البقوليات الأسود على بعض المقاييس البيولوجية لنبات الفول

سمية السيد على السيد ، محمد السيد توفيق

قسم علم الحشرات التطبيقي – كلية الزراعة – جامعة الإسكندرية

تم في هذا البحث دراسة تأثير الإصابة بحشرة من البقول الأسود على بعض المقاييس البيولوجية لنبات الفول. وقد وجد أن إصابة نبات الفول بحشرة من البقوليات الأسود أدت إلى انخفاض معنوي في متوسط مساحة سطح الورقة وطول النبات كما أنخفض وزن الأوراق بالإضافة إلى زيادة النسبة المئوية لقياس الكلوروفيل في الأوراق المصابة بالمن عن الأوراق السليمة وهذه النتيجة قد تكون نتيجة لانتفاخ الأوراق وكذلك لتعويض العناصر الغذائية المفقودة نتيجة لتخذية المن على العصارة النباتية بزيادة الكلوروفيل لزيادة معدل التمثيل الغذائي في النبات. أما بالنسبة لتقدير الأحماض الأمينية فقد وجد انخفاض في 14 حامض أميني وقد يعزى هذا الانخفاض إلى الاحتياج للمحتوى البروتيني للنمو والتكاثر. أما السكريات المختزلة في صورة جلوكوز فقد انخفضت نسبتها عن الأوراق السليمة نتيجة أفراز الندوة العملية، مما أدى إلى تقليل المحتوى السكري في أوراق النبات. هذا الانخفاض في الأحماض الأمينية و السكريات يؤدي إلى تقليل القيمة الغذائية لنبات الفول.