EFFECT OF ORGANIC AND INORGANIC FERTILIZERS ON THE COWPEA APHID (*APHIS CRACCIVORA* KOCH.) INFESTING BROAD BEAN PLANTS AND THE ASSOCIATED PREDATORS AT ISMAILIA, EGYPT.

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Abstract

Different fertilizers were used over two successive seasons 2001/2002 and 2002/2003 in a newly reclaimed sandy area at Ismailia, Egypt. The effects of these fertilizers on the infestation of broad bean plants with the cowpea aphid *Aphis craccivora* Koch., the associated predators and seed yield were assessed. The fertility treatments included: recommended rate of farmyard manure (F), sewag sludge (S), F. + S. mixture, an equivalent rate of tafla, NPK and untreated control. Results showed that aphid population was significantly higher in plots treated with NPK (inorganic) followed descendingly by untreated control, farmyard manure, sewage sludge, F+S mixture and tafla. The associated predator numbers were positively correlated with aphid numbers. Treatments arranged due to their seed yield improvement percentages comparing with untreated control were F+S mixture (12.11 and 13.80), farmyard manure (11.33 and 13.06), sewage sludge (9.61 and 12.55), NPK (4.17 and 5.46) and tafla (1.92 and 2.77) for the two seasons, respectively.

Aphid reproductivity significantly affected by fertilizer treatments and could be arranged descendingly, NPK, untreated control, farmyard manure, sewage sludge, F+S mixture and telfa.

INTRODUCTION

Sustainable agriculture has become a catchword of the 1990s, as the economic and environmental impacts of conventional agriculture practices continue to be questioned. However, sustainable agriculture implies reductions in the use synthetic fertilizers and pesticides and greater reliance on biological control of crop pests (Edwards *et al.*, 1990). Nitrogenous fertilizer applied to agricultural system can affect aphids infestation. Generally, aphids population increased faster with increasing rates of nitrogen applied to host by increasing population growth rates (Archer *et al.*, 1982). Substitution of organic nitrogen sources for inorganic ones is important goal of sustainable agriculture (Hendrix *et al.*, 1992). It is not clear whether nutritional minerals from organic sources would produce vegetation more attractive to herbivores, in contrast with inorganic sources (Blumberg *et al.*, 1997).

This work amid to study nutritional minerals sources (organic or inorganic fertilizers) on broad bean infestation with the cowpea aphid *Aphis craccivora* Koch. and the associated predators regarding the effect on aphid fecundity and seed yield.

MATERIALS AND METHODS

The current study was carried out during the broad bean growing seasons of 2001/2002 and 2002/2003 in a newly reclaimed sandy area at Ismailia, Egypt. On November 15 and 12 broad bean (Giza 461) was planted in an area of about 1/4 feddan for the two seasons, respectively. The experimental area was divided into 24 plots each was 42 m^2 and separated by one meter width. In a completely randomized design 6 treatments (Table 1) were randomly applied just before planting, in 4 replicates. The normal agricultural practices without any chemical control treatments were carried out. The added levels of all fertilizers are shown in Table 1.

Table 1. Fertilizers added to the soil and its levels:

Fertilizers used	Application rate			
	Kg/Fed			Organic fertilizers and tafla
	N*	P**	K***	
Farmyard manure (F)	00	00	00	90 kg/plot
Sewage sludge (S)	00	00	00	90 kg/plot
F + S mixture	00	00	00	45 + 45 kg/plot
Tafla	00	00	00	90 Kg/plot
N P K	20	25	24	00
Untreated (control)	00	00	00	00

* Amnonium sulphate (20.5 % N) ** Calcium superphosphate (18 % P_2O_5). *** Potassium sulphate (48 % K_2O).

1- Effects on the population density of aphids and its predators

Weekly samples of five tillers were randomly collected after 3 weeks from sowing date till the end of each season. The number of aphids/tiller was counted. The total numbers of predators were counted on 30 randomly chosen tillers per each plot.

2- Effect on aphid fecundity

Under laboratory conditions (14-17 C^o, 65-72 % R.H.) number of offspring/one apterous viviparous adult was studied during the period extended from 30th and 27th of December to 6th and 3rd of January for the two seasons, respectively.

One newly apterous mother was carefully collected from each plot and transferred to a Petri dish with a terminal part of broad bean tiller (about 7 cm in length) free of infestation. Progeny in each Petri dish was counted and removed daily until mother death.

3-Effects on proteinous and elemental constituents of the host plant and soil analysis

Two months after sowing, samples of broad bean leaves were taken randomly from all plant levels for chemical analysis. Protein contents were determined as described by the Association of Official Agricultural Chemists, Washington, (A.O.A.C., 1965)

Iron (Fe), Zinc (Zn) and Manganese (Mn) contents were determined by the technique described by Chapman and Pratt (1961) using Atomic Absorption Spectrophotometer.

After soil fertilization and just before cultivation, soil samples (one sample from each plot) were taken and chemical analysis was done according to Lindsay and Norvell (1978).

4-Effect on yield

The average seed yield (g/m^2) was estimated on plants chosen which no sample was taken from all data were statistically analyzed according to Little and Hill (1978).

RESULTS AND DISCUSSION

The effect of adding organic and inorganic sources of nutritional minerals on the population density of *Aphis craccivora* Koch. infested broad bean plants and the associated predators in relation with the chemical composition of the host plant (micro-elements, protein and moisture content) and seed yield were studied during 2001/2002 and 2002/2003 seasons and the obtained results are shown in Table 2.

1- Effect on the population density of *A. craccivora* and its predators.

As shown in Table 2 adding organic fertilizers (farmyard manure (F), sewage sludge (S) and their mixture), tafla and inorganic N P K to the soil comparing with untreated control increased the soil content of Fe, Zn and Mn and consequently in broad bean leaves. Inorganic (N P K) treatment showed the same levels of the micro-elements in the soil and slight increase in the leaf content. Chemical analysis also showed high content of protein and relatively low content of moisture in organic fertilizer treatments, while relatively low protein and high moisture content in N P K treatment. Plants treated with tafla showed moderate increase in micro-elements and low content of protein and moisture. This conditions affected significantly the population density of *A. craccivora* infested broad bean plants. The highest density of tested insect showed on the N P K treatment recorded means of 14.80 and 12.53 insects/tiller, while the lowest were 11.03 and 8.05, 10.20 and 8.16 aphids/tiller recorded for F + S mixture and tafla treatments for the two seasons, respectively.

Table 2. Effect of nutritional minerals sources on *A. craccivora* Koch. infested broad bean plants, the associated predators in relation with chemical composition (micro-elements, protein and moisture content) and seed yield.

Fertilization treatments	Micro-elements content ppm						In leaves %		Weekly mean No. of			Seed yield	
	In soil			In leaves			Protein	Moisture	Aphids/ tiller***	Predators /30 tiller	Simple correlation	Average*** (g/m^2)	% Improvement
	Fe	Zn	Mn	Fe	Zn	Mn							
	2001 / 2002 season												
Farmyard manure (F)	11.80	0.26	0.42	16.32	1.43	1.31	29.14	84.70	12.70 c	2.33	0.8788*	335.57 a	11.33
Sewage sludge (S)	12.50	0.25	0.31	15.10	0.99	1.81	29.05	83.50	11.50 d	2.00	0.8806*	330.40 b	9.61
F + S mixture	12.40	0.24	0.34	15.39	1.23	1.73	29.79	84.00	11.03 d	1.67	0.9573**	337.92 a	12.11
Tafla	8.93	0.20	0.25	14.30	0.69	1.28	24.30	83.30	10.20 d	1.67	0.9149**	307.24 d	1.92
N P K	2.50	0.14	0.17	10.54	0.91	0.81	26.56	85.20	14.80 a	3.00	0.9431**	314.00 c	4.17
Untreated (control)	2.50	0.14	0.17	9.80	0.53	0.51	22.39	83.60	13.14 b	2.66	0.9479**	301.43 e	
	2002 / 2003 Season												
Farmyard manure (F)	10.20	0.24	0.41	15.92	1.62	1.37	28.94	84.90	10.41 b	1.99	0.9332**	342.80 a	13.06
Sewage sludge (S)	11.50	0.21	0.36	16.43	1.01	1.64	29.75	84.10	9.57 bc	1.66	0.9167**	341.25 a	12.55
F + S mixture	10.60	0.23	0.39	16.00	1.48	1.50	29.30	84.40	8.05 c	1.33	0.6839*	345.05 a	13.80
Tafla	8.82	0.19	0.25	14.64	0.66	1.35	27.64	83.90	8.16 c	1.33	0.7660*	311.61 c	2.77
N P K	3.74	0.12	0.19	12.57	0.62	0.50	26.79	85.10	12.53 a	2.66	0.7440*	319.76 b	5.46
Untreated (control)	3.74	0.12	0.19	11.80	0.60	0.49	21.52	84.00	11.95 a	2.33	0.8341*	303.21 d	

* significant at 0.05

** significant at 0.01

*** The mean values within column followed by the same letter are not significantly different at P. 0.05

Table 3. Productivity of one apterous newly mother of *A. craccivora* Koch. when fed on broad bean plants differed on fertilization treatments under laboratory conditions.

Fertilization treatments	Daily mean number of offspring/mother							General mean*
	1	2	3	4	5	6	7	
	2001 / 2002							
Farmyard manure (F)	5.00	4.33	3.67	2.67	1.33	0.67	0.00	2.5242 b
Sewage sludge (S)	4.67	4.33	3.33	2.33	1.33	0.67	0.33	2.4286 b
F + S mixture	4.67	4.00	3.00	2.00	1.00	0.33	0.00	2.1429 c
Tafla	5.00	3.67	3.00	2.00	1.00	0.00	0.00	2.0957 c
N P K	5.33	4.67	4.00	3.33	2.33	1.33	0.33	3.0471 a
Untreated control	5.00	4.33	3.67	2.33	1.33	0.67	0.00	2.4757 b
	2002 / 2003							
Farmyard manure (F)	5.33	4.33	3.67	2.00	1.33	0.67	0.00	2.4757 c
Sewage sludge (S)	5.00	4.67	3.33	2.00	1.00	0.67	0.00	2.3814 c
F + S mixture	4.67	4.00	3.00	1.67	1.00	0.67	0.00	2.1429 d
Tafla	5.00	4.33	3.00	1.33	1.00	0.33	0.00	2.1429 d
N P K	5.33	5.00	4.00	3.00	2.00	1.00	0.33	2.9514 a
Untreated control	5.00	4.33	3.67	3.00	1.67	0.33	0.00	2.5714 b

*The mean values within column followed by the same letter are not significantly different at P. 0.05

The dominant associated aphidophagous insect predators found on broad bean plants were *Coccinella undecimpunctata* L., *C. septempunctata*, *Scymnus* Spp., *Chrysoperla carnae* (Steph.), *Paederus alfierii* Koch.. As shown in Table 2, the highest mean number of insect predators/30 tillers were recorded on plants treated with recommended doses of NPK (inorganic fertilizers) 3.00 and 2.66 for the two investigated seasons, respectively. On the other hand, the lowest mean numbers were recorded on plants treated with F + S mixture (organic fertilizers) and tafla (which caused increased in micro- elements in soil and plant content) were 1.76 and 1.33 for the two seasons, respectively. Statistical analysis showed significant and highly significant correlation coefficients between the recorded mean numbers of aphids and the mean numbers of the associated insect predators, respectively. Generally, the numbers of predators were positively correlated with aphid numbers.

Concerning the seed yield, data presented in Table 2 revealed that the organic fertilizers recorded the highest means of 335.57 and 342.80 g/m^2 for farmyard manure, 330.40 and 341.25 g/m^2 for sewage sludge and 337.92 and 345.05 g/m^2 for their mixture for the two seasons, respectively. NPK and tafla showed moderate effect recording 314.00 and 319.76 g/m^2 and 307.24 and 311.61 g/m^2 for the two seasons, respectively. The lowest means of seed yield recorded in the untreated plots.

As for the improvement percentage, it was obvious that all treatments improved seed yield and could be arranged descendingly according to their improvement percentage as follows: farmyard manure and sewage sludge mixture (12.11 and 13.80), farmyard manure (11.33 and 13.06), sewage sludge (9.61 and 12.55), NPK (4.17 and 5.46) and tafla (1.92 and 2.77) for the two seasons, respectively.

From the obtained results, it could be noticed that addition of organic fertilizers before sowing which have affected aphid infestation may be attributed to increase in micro-elements (Fe, Zn and Mn), protein and reduction in moisture content. These results are in agreement with those of Edwards *et al.* (1996) in USA who found that aphid populations were higher in the inorganically fertilized plots than in organic fertilizered treatments. Also, Blumberg *et al.* (1997) in Athens stated that the source of N affected arthropod biomass in sorghum agri-ecosystems, where inorganic N had significant increases in arthropod biomass, while organic source of N had no increase in biomass of arthropods. These effects may be explained on the basis that the major factors controlling the population density of aphids are the

quantity and quality of the food offered by the potential host plant. Aphid species take up food from phloem, which contains high amount of nitrogen, therefore the development of aphids has often shown to be closely correlated with the nitrogen content. Archer *et al.* (1982) and Malik (1988) shown that the increase of free amino acids enhanced the nutritional quality of the plant to the aphids.

With regard to the effect of adding organic and inorganic sources of nutritional minerals to the soil before sowing on aphid fecundity, statistical analysis of the data tabulated in Table 3 revealed that the total numbers of progeny per aphid mother were significantly affected by fertilizer treatments. In both seasons, NPK treatment recorded the highest mean of total progeny per one aphid mother (3.0471 and 2.9514). Tafla (2.0957 and 2.1429) and the mixture (2.1429 and 2.1429) showed the lowest levels. Farmyard manure, sewage sludge and untreated control formed moderate levels ranged between 2.5242 -2.4286 and 2.5714 - 2.5714 offsprings/mother for 2001/2002 and 2002/2003 seasons, respectively.

Generally, treatments affected aphids reproduction showing nearly the same trend under field conditions, this may be due to the balanced manner of organic fertilizers and tafla which contain the micro and macro-elements, while NPK fertilizer adding to soils have poor content of micro-elements which play an important role in aphid nutritional quality by the influence the soluble nitrogen levels which affected reproduction and consequently the population growth rate. According to Van Emden and Wearing (1965) the reproductive rates of *Myzus persicae* (Sulzer) and *Brevicoryne brassicae* (L.) on brussels sprouts were depressed when plants received potassium, while soluble nitrogen level increased in the leaves by the increase in nitrogen fertilizer as well as by a decrease in potassium fertilizer. Abdel-Ghaffar (1986) reported that chemical composition of broad bean plants affected the number of progeny of *Aphis craccivora*. Moon *et al.* (1995) cleared that increasing aphid nymphal production was obtained by increasing the rate of nitrogen in host plant content.

The obtained results are in accordance with those of Megahad (1994), Edwards *et al.* (1996), Blumberg *et al.* (1997) and Abdallah *et al.* (2001) who found that plots receiving inorganic nitrogen has significant increase in aphid population, while plots with organic sources of nitrogen or sprayed with foliar micro-nutrient containing Zn, Mg, Mn or their mixture had decreased in aphid population and in biomass of arthropods.

It can be recommended that organic fertilizers must applied in the newly reclaimed lands and in poor soils where they play an important role in pest management.

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تأثير استخدام الاسمدة العضويه وغير العضويه علي اصابه نباتات الفول البلدي بمن اللوبيا وعلى المفترسات المصاحبه

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تم اختبار تأثير مصادر مختلفة من المخصبات علي اصابه نباتات الفول البلدى بمن اللوبيا والأعداء الحيوية المصاحبة ومحصول البذور خلال موسمي الدراسة ٢٠٠١/٢٠٠٢، ٢٠٠٢/٢٠٠٣ وذلك فى أرض رملية حديثة الاستصلاح بالاسماعيليه- مصر. تتضمن المعاملات السماديه المعدلات الموصي بها من الأسمده البلدية، حمأة، مخلوط من الأسمده البلدية والحمأة، كميه مساويه من الطفله ،سماد كيماوي نتروجيني وفوسفاتي وبوتاسي ومعامله بدون تسميد للمقارنه. اظهرت النتائج زياده التعداد الحشري للمن في القطع التجريبيه المعامله بالاسمده الكيماويه (الغيرعضويه) يليه تنازليا بقطع المقارنه التي لم تعامل ، الاسمده البلديه، الحمأه، مخلوط الاسمده البلديه والحمأه وكانت الطفله اقل المعاملات اصابه بالمن. أظهرت أعداد المفترسات المسجله ارتباطا موجبا مع تعداد المن. وكان ترتيب المعاملات حسب النسبه المئويه للزياده في محصول البذره مقارنه بالمعامله التي لم تسمد كالاتي: مخلوط الاسمده البلديـــه والحمأه (١٢,١١،١٣,٨٠)، السماد البلدي (١١,٣٣،١٣,٠٦)، الحمأه (٩,٦١،١٢,٥٥)،الاسمده الكيماويه (٤,١٧،٥,٤٦)، الطفله (١,٩٢،٢,٧٧) لكل من الموسمين علي التوالي.

اظهرت التجارب ان القدره التناسلية للمن تتأثر بالمعاملات السماديه ويكمن ترتيبها تنازليا حسب متوسط مقدارتعداد الذريه الناتجه كالاتي: الأسمده الكيماويه، المقارنه بدون معامله، الأسمده البلديه، الحمأه، مخلوط الاسمده البلديه والحمأه ثم الطفله.