

NATURAL ENEMIES OF *BEMISIA TABACI* GENN. AND THEIR
ROLE IN SUPPRESSING THE POPULATION
DENSITY OF THE PEST

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Abstract

Natural enemies of *B. tabaci* immature stages were surveyed at Shebin-el-Kom district on 13 host plants throughout 1983/84 and 1984/85 growing seasons. Laboratory and field inspections indicated that parasites played no role against *B. tabaci* eggs. However, 5.2% (in 1983/84) and 7.94% (in 1984/85) of *B. tabaci* larvae and pupae found attacked by predators. The natural enemies of *B. tabaci* larvae and pupae included two parasitoids (*E. mundus* and *P. lutea*), 4 predators (*Amblyseius gossipi*, *Chrysopa carnea*, *Coccinella undecimpunctata*, and *Phenobremia aphidivora*), and an unidentified fungus. An effective role was played by parasitoids (average parasitism 20.72 and 33.75% on larvae and 44.23 and 60.06% on pupae in both years, respectively) followed by predators (7.26 and 13.1% on larvae and 15.65 and 12.06% on pupae in both seasons, respectively). However, the fungus had a minor role on both stages. It was generally concluded that the three beneficial groups together have a valuable role against both larvae and pupae of *B. tabaci*. This role has to be taken into consideration in any pest management programme for *B. tabaci* in Egypt.

INTRODUCTION

The whitefly, *Bemisia tabaci* is a well known pest of cotton in Egypt and in several parts of the world on various other crops. In Egypt, it has increased in large numbers infesting various crops, particularly vegetables (el-Sayed 1986). The behaviour of this insect makes chemical control difficult (Johnson *et al.* 1982). In addition, recent studies indicate that *B. tabaci* has developed resistance to several insecticides (Parbhaker *et al.* 1985). Biological control is one of the important methods that must be considered in any integrated control programme.

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The present work was carried out to survey the natural enemies of *B. tabaci* including predators, parasitoids, and diseases, and to evaluate their role against this pest.

MATERIALS AND METHODS

The natural enemies of *B. tabaci* immature stages were surveyed on different host plants (tomato, potato, eggplant, pepper, cabbage, cauliflower, okra, cotton, soybean, bean, cowpea, vegetable marrow, and cucumber) throughout 1983/84 and 1984/85 seasons, in the Experiment Farm of the Faculty of Agriculture at Shebin-el-Kom, Menoufia Governorate. Experimental design was randomized blocks with four replications of 10 x 7m² each. Cultural practices were standard and no insecticide were applied. Sampling started three weeks after planting until harvesting time, and from each replicate 10 plant leaves were randomly picked except in cases of cabbage and cauliflower where each sample consisted of 4 leaves only. Leaves of each sample were put in a cotton bag, carried to the laboratory, and 10 square inches of each sample were thoroughly examined by the aid of a binocular microscope. Infested leaves with *B. tabaci* were put on two wet filter papers placed in a petri dish (7.5 cm in diameter until emergence of adult parasitoids for the identification and counting). Parasitism was estimated throughout the period of *B. tabaci* presence on the host plant.

The predators and fungi were observed when collecting the samples in the field, then examined in the laboratory. Percentages of predation and fungus infection of *B. tabaci* immature stages were calculated. The same procedure was replicated two times in each plantation during the two successive seasons of the investigation.

RESULTS AND DISCUSSION

Survey of *B. tabaci* natural enemies

(A) Parasitoids :

Two aphelinids *Eretmocerus mundus* Mercet and *Prospaltella lutea* Masi (Hymenoptera) were the only parasitoids that have been found emerging from *B. tabaci* larvae and pupae throughout the whole period of study. Both are solitary internal parasitoids. It is worth mentioning that *Encarsia* spp. which are well known as the major parasitoids on *B. tabaci* in many parts of the world, e.g. Cowland (1934), Khalifa and el-Khidir (1964), and Gameel (1969) in Sudan, Priesner and Hosny (1925), Azab *et al.* (1969), el-Helaly *et al.* (1979), and el-Sayed (1981) in Egypt, Mismour (1946) in Morocco, and Gerling (1967) in USA, were not detected in any of the collected samples of this study.

(B) Predators :

The following predators were found attacking one or more of *B. tabaci* stages collected from different plants in the field. During inspection of the collected leaf samples, the total number of the predaceous stage or stages of each predator was counted monthly, and this number was considered an indicator for predator abundance and activity.

(1) *Amblyseius gossipi* El-Badry (Acarina - Phytoseiidae):

Adults and nymphs were found during the sampling period feeding on *B. tabaci* immature stages (eggs, larvae, and pupae) with pronounced activity on cotton, okra, bean, and soybean plants. The highest population of *A. gossipi* was detected during August in the first season and September in the second season (100 and 70 individuals, respectively) (Table 1).

(2) *Coccinella undecimpunctata* L. (Coleoptera - Coccinellidae):

Larvae of this predator were found during spring, early summer, and early autumn feeding on *B. tabaci* immature stages infesting cotton, okra, tomato, agplant, vegetable marrow, and cucumber with the highest activity of the predator during May and September. Higher numbers of *C. undecimpunctata* larvae were found during August (12 larvae) and May (11 larvae) in the first season, while these numbers reached 18 individuals in September and 10 larvae in May during the second season.

(3) *Chrysopa carnea* Stephens (Neuroptera - Chrysopidae):

Larvae of this predator were found feeding on the body fluids of different immature stages, preferably pupae of *B. tabaci* in different host plants throughout the whole period of the year. Highest activity of the predator was detected during August and November in the first season (90 and 53 larvae, respectively) and during October and November in the second season (79 and 24 larvae, respectively) (Table 1).

Larvae of *Chrysopa* spp. were previously reported as predators feeding on immature stages of *B. tabaci* by Husain and Trehan (1933) in India, Mimeur (1946) in Morocco, Nasir (1947) in India, Hafez *et al.* (1979) and el-Sayed (1981) in Egypt.

(4) *Phenobremia aphidivora* Rubsqaen (Diptera - Cecidomyiidae):

Larvae were observed feeding on *B. tabaci* pupae from July to October but only on certain host plants, i.e. vegetable marrow, cucumber, and rarely on bean or cowpea. The highest activity occurred during September (20 larvae) and October (28 larvae) for both seasons, respectively (Table 1).

(C) Diseases :

During summer and early autumn on the different host plants, an unidentified fungus was observed infecting the larvae and pupae of *B. tabaci* causing mortality. In similar

Table 1. Number of predators found feeding on *B. tabaci* immature stages on different host plants throughout three successive plantations in two seasons.

Months	Predators	No. of predators	
		1983/84	1984/85
June	<i>A. gossipi</i> <i>C. carnea</i> <i>C. undecimpunctata</i>	17 18 3	55 13 0
July	<i>A. gossipi</i> <i>C. carnea</i> <i>C. ur decimpunctata</i> <i>P. aphidivora</i>	35 14 2 2	35 11 3 0
August	<i>A. gossipi</i> <i>C. carnea</i> <i>C. undecimpunctata</i> <i>P. aphidivora</i>	100 90 12 13	67 9 8 1
September	<i>A. gossipi</i> <i>C. carnea</i> <i>C. undecimpunctata</i> <i>P. aphidivora</i>	4 11 3 20	70 12 18 0
October	<i>A. gossipi</i> <i>C. carnea</i> <i>P. aphidivora</i>	7 14 0	20 79 28
November	<i>A. gossipi</i> <i>C. carnea</i>	9 53	11 24
December	<i>A. gossipi</i> <i>C. carnea</i>	3 4	7 9
January	<i>A. gossipi</i>	4	2
February	<i>A. gossipi</i> <i>C. carnea</i>	7 3	6 2
March	<i>A. gossipi</i> <i>C. carnea</i>	3 4	3 9
April	<i>A. gossipi</i> <i>C. carnea</i>	7 54	10 5
May	<i>A. gossipi</i> <i>C. carnea</i> <i>C. undecimpunctata</i> <i>P. aphidivora</i>	94 24 11 0	7 8 10 14

observations, Pruthi and Samwel (1942) in India found that the fungus *Alternaria* sp. caused mortality of *B. tabaci* pupae, while Dysart (1966) in USA found three genera of fungi associated with *Trialeurodes abutilona* Hald., i.e. *Cladosporium* sp. on honey dew, *Alternaria* sp. and *Cladosporium* sp. on pupae, and *Alternaria* sp., and *Cladosporium* sp. on the adults. In the United Kingdom, Hussay (1958) reported that *Penicillium* sp. and *Cladosporium sphaerosporium* Penzig. infected larvae of *Trialeurodes vaporariorum* West., while the third species *Cephalosporium aphidicola* Petch. covered the scales pupae and adults of the host.

Efficiency of the natural enemies of *B. tabaci* eggs :

Throughout the two successive years of study, inspections in the laboratory and also in the field indicated that no parasites played a role against *B. tabaci* eggs. On the other hand, eggs that showed symptoms of predators having piercing and sucking mouth-parts were counted in monthly records to estimate their role against this stage. According to Table 1, the main predators feeding on the whitefly eggs are *A. gossipi* nymphs and adults, *C. undecimpunctate* larvae, *C. carnea* larvae, *P. aphidivora* larvae.

Irrespective of the kind of host, and according to the data in Table 2, the percentage of predation amongst the collected *B. tabaci* eggs ranged from 0.74 in March to 13.89% in November of the first season and nil in January and February to 22.01% in September of the second season. The percentages of predation on *B. tabaci* eggs averaged 5.2% in 1983/84 and 7.94% in 1984/85.

Role of natural enemies on *B. tabaci* larvae and pupae:

As shown in Tables 3 and 4 the role of parasitoids, predators, and the fungus in suppressing the population of *B. tabaci* larvae and pupae was evident throughout all months of the year, but their values differed from one month to another. Parasitoids showed a pronounced role than predators, while the fungus was of less importance.

Concerning *B. tabaci* larvae, percentages of parasitism ranged from 1.29% in June to 32.71% in August during the first season and from 2.74% in April to 56.63% in September during the second (Table 3). Consequently, August, September, and October were the most favourable for high abundance of parasitoids during both seasons. As for predators on the larvae the highest abundance (10.56 and 25.58%) was recorded in September and October of both years, respectively. The lowest percentages were observed in March of both seasons. On the other hand, few numbers of larvae were found infected by the parasitic unidentified fungus as expressed by nil to 0.48% and nil to 6.94% during the first and second seasons, respectively (Table 3).

Data presented in Table 4 indicate that the three groups of natural enemies played a more effective role on *B. tabaci* pupa than on the larvae. The percentages of parasitism

Table 2. Predation percentages amongst *B. tabaci* eggs collected during 1983/84 and 1984/85 seasons.

Months	1983/84		1984/85	
	No. of collected eggs	Predation %	No. of collected eggs	Predation %
June	280	4	791	11
July	1688	89	491	7
August	19122	999	848	59
September	7070	170	2789	614
October	4715	90	3016	131
November	3599	500	860	17
December	992	120	1198	5
January	540	6	138	0
February	175	6	86	0
March	270	2	104	5
April	511	7	275	6
May	526	60	254	3
Overall	39488	2053	10850	861

ranged from 7.86% in April to 52.86% in September in 1983/84 season and from nil in March to 73.79% in September in 1984/85 season. Predators were generally detected throughout all months of both seasons and their percentages ranged between 2.06 to 31.47% and from nil to 20.86% during first and second seasons, respectively. The fungus infection to *B. tabaci* pupae was noticed from August to December in the first season and from June to October in the second season. The highest percentages of fungal infection to host pupae was 5.25% in November 1983 and 6.62% in July 1984.

Regarding the monthly total percentages of natural enemies of *B. tabaci* larvae (Table 3), the percentages ranged from 7.65 to 40.63% during 1983/84 season and from 6.85 to 74.28% in 1984/85 season. The active role of the three beneficial groups was more pronounced in the second year than in the first one. Also, the role of the three groups together of natural enemies, was more evident during the period that extended from July to December in both years.

On *B. tabaci* pupae, the total percentages of attacked individuals ranged from 10.11

Table 3. Percentages of parasitism, predation, and fungus infection on *B. tabaci* larvae throughout two successive seasons.

Months	1983/84					1984/85				
	No. of larvae	Parasitism %	Predation %	Fungus infection %	Total natural enemies %	No. of larvae	Parasitism %	Predation %	Fungus infection %	Total natural enemies %
June	232	1.29	7.33	0.0	8.62	1360	3.08	10.44	0.0	13.52
July	1600	10.00	10.31	0.0	20.31	1254	10.69	17.62	4.23	32.54
August	7694	32.71	5.94	0.24	38.89	5203	36.51	6.69	2.27	45.47
September	6601	29.67	10.56	0.40	40.63	4787	56.63	16.27	1.38	74.28
October	5379	22.68	10.22	0.48	33.38	1930	27.10	25.85	6.94	59.89
November	4536	6.46	3.42	0.15	10.03	665	17.29	8.87	3.01	29.17
December	1292	14.86	7.43	0.15	22.44	888	11.48	10.59	0.45	22.51
January	2051	5.80	5.36	0.0	11.16	198	22.22	5.55	0.0	27.77
February	780	8.33	3.08	0.0	11.41	43	16.28	2.33	0.0	18.61
March	282	10.28	2.48	0.0	12.76	26	11.54	0.00	0.0	11.54
April	476	4.83	2.73	0.0	7.56	73	2.74	4.11	0.0	6.85
May	1197	6.27	3.43	0.0	9.70	210	15.23	10.48	0.0	25.71
Overall	32120	20.72	7.26	0.25	28.23	16637	33.75	13.10	2.37	49.22

Table 4. Percentages of parasitism, predation, and fungus infection on *B. tabaci* pupae throughout two successive seasons.

Months	1983/84					1984/85				
	No. of larvae	Parasitism %	Predation %	Fungus infection %	Total natural enemies %	No. of larvae	Parasitism %	Predation %	Fungus infection %	Total natural enemies %
June	182	19.78	5.49	0.0	25.27	252	9.92	8.33	1.59	19.84
July	1309	27.20	2.06	0.0	29.26	588	11.22	10.37	6.62	28.23
August	4916	46.28	7.34	0.39	54.01	4158	59.88	10.22	2.43	72.53
September	3411	52.86	26.56	0.79	80.21	5459	73.78	13.06	0.53	87.37
October	2931	50.32	23.13	0.51	73.96	888	58.22	18.81	1.57	78.60
November	305	22.30	31.47	5.25	59.02	361	35.73	8.31	0.0	44.04
December	263	12.93	19.01	0.76	32.60	144	9.03	11.11	0.0	20.14
January	175	23.43	8.57	0.0	32.00	163	32.51	20.86	0.0	53.37
February	95	14.74	13.68	0.0	28.42	20	5.00	5.00	0.0	10.00
March	45	8.88	15.56	0.0	24.44	17	0.0	0.0	0.0	0.0
April	89	7.86	2.25	0.0	10.11	34	2.94	0.0	0.0	2.94
May	148	14.19	4.05	0.0	18.24	143	14.68	4.90	0.0	19.58
Overall	13869	44.23	15.65	0.57	60.45	12227	60.06	12.06	1.53	73.65

to 80.12% and from nil to 87.37% during both seasons, respectively. Moreover, from the data in Table 4 the period that extended from June to January can be considered the period of higher activity of natural enemies.

In conclusion, the role played by natural enemies *E. mundus*, *P. lutea*, *A. gossipi*, *C. carnea*, *C. undecimpunctata*, *P. aphidivora*, and the fungus disease accounts for the destruction of 80% of *B. tabaci* population, a situation that must be considered in the development of *B. tabaci* control programmes in Egypt.

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