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ECOLOGICAL AND BIOLOGICAL STUDIES OF THE SOYBEAN STEM FLY, *Melanagromyza cunctans* MEIGEN (Diptera: Agromyzidae) AND THE ROLE OF ITS PARASITOIDS AS PROMISING BIOLOGICAL CONTROL AGENTS.

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ABSTRACT

The field trials were conducted at the experimental farm of the Faculty of Agriculture, Mansoura University, Egypt during the two successive seasons, 2001 and 2002 to investigate the relative susceptibility of three soybean varieties to infestation with the soybean stem fly, *Melanagromyza cunctans* Meigen and to study the population density of this insect pest together with the role of its associated parasitoids. The effect of certain weather conditions on its abundance was also determined. Certain biological and life table characteristics of *M. cunctans* under laboratory conditions were investigated.

Giza 35 and Giza 21 varieties were less susceptible to infestation with *M. cunctans* than Giza 82. *Melanagromyza cunctans* larvae and pupae had three peaks by dissecting the soybean stems of all varieties. The abundance of the adults by a sweeping-net indicated that the insect showed two peaks on Giza 82. Moreover, three peaks on Giza 35 and Giza 21 were recorded during 2001 season, whereas, in the second season of 2002, four peaks occurred on Giza 82 and Giza 35. Meanwhile, on Giza 21, the adult stage had three peaks.

Three endoparasitoid species were associated with *M. cunctans* pupae. They were *Eurytoma* sp., *Cryptoprymna* sp., and *Halticoptera* sp. During 2001 season, *Eurytoma* sp. occurred in a relatively short period from July 19 to September 15 and the highest percentage of 75.0% parasitism was recorded during the fourth week of August on Giza 35. Meanwhile, in the second season (2002), the highest percentage of parasitism was 50.0% in the first week of August on Giza 82.

In both seasons of 2001 and 2002, *Cryptoprymna* sp. prevailed in the period from the third week of June to the end of experiment in the second week of September. The percentage of parasitism varied from 14.0 to 60.0%, 25.0 to 66.0%, and 20.0 to 75.0% on Giza 82, Giza 35 and Giza 21, respectively in the first season. The parasitoid had four peaks on Giza 82 variety, and five peaks on Giza 21 and Giza 35. In the second season, the percentage of parasitism ranged from 14.0 to 75.0%, 25.0 to 60.0%, and 9.0 to 80.0% on Giza 82, Giza 35 and Giza 21, successively.

The percentage of parasitism by *Halticoptera* sp. in the first season varied from 14.0 to 50.0% on Giza 82, 16.0 to 40.0% on Giza 35, and 17.0 to 40.0% on Giza 21. The parasitoid showed two peaks on the three tested varieties. In the second season, the percentage of parasitism ranged from 14.0 to 60.0%, 14.0 to 33.0%, and 9.0 to 40.0% on Giza 82 and Giza 35 and Giza 21, respectively. The parasitoid had two peaks on Giza 82 and Giza 21. While, it had three peaks on Giza 35.

The average duration from egg to adult was 18.5 days. The total mortality percentage of immature stages reached 44.1%. The longevity of female and male

were 15.75 and 9.7 days. The average number of eggs laid per female was 121.0. In addition, certain life table parameters were determined.
Keywords: *Melanagromyza cunctans*, soybean varieties, weather factors, parasitoids, biology, life table parameters.

INTRODUCTION

Melanagromyza cunctans Meigen is a serious pest of soybean plantations. This insect lays its eggs into the underside of young unifoliate leaves of seedlings or into the newly opened trifoliate leaves of older plants. The larva feeds on parenchyma cells within the pith cavity of the stem and in doing so it creates a feeding tunnel. Before pupation, which takes place inside the stem, the larva gnaws an exit hole through the xylem and phloem tissues for emergence of the adult and secures the hole with debris (Berg *et al.*, 1998). One of the most important external symptoms is the existence of visible brown holes among the stem and branches where the pupae settle down inside (Talekar, 1989, and Mesbah and El-Galaly, 1999). It has been reported that 22 plant species from 6 families are attacked by *M. cunctans* in northern Sinai (El-Basiony *et al.*, 1996). The soybean stem fly, *M. cunctans* causes significant losses in soybean yield, quality and germination potential.

Plant resistance is one of the most important and widely used components in an integrated pest management. Resistant varieties, when available, provide a sustainable solution at relatively low cost to a wide variety of farmers. Differences in the damage, which are caused by soybean stem fly, reflect their relative susceptibility or resistance. The degree of damage would vary according to the population density and dynamics of the soybean stem fly on the different cultivars. Improvement of plant germplasm for resistance to pests is one of the many avenues of research being explored to reduce the pests associated losses (Dubey *et al.*, 1998; Mesbah and El-Galaly, 1999; Sharma *et al.* 1994 a & b; Kundu *et al.* 1995, and Sekhar *et al.* 2000 a & b).

Recently, biological control is an increasingly important component of integrated pest management (IPM) programs for agriculture as well as for urban environment. Thus, techniques for mass production of some parasitoids may relatively help in solving the problem of *M. cunctans* on soybean and reduce the hazard of pesticides to human and environment. Therefore, the objectives of the current study were to: 1) determine the seasonal abundance of soybean stem fly stages on the three soybean varieties, 2) know the effect of soybean varieties on the abundance of this insect, 3) study the effect of certain weather factors on the seasonal abundance of this insect, 4) evaluate the percentage of parasitism on soybean stem fly pupae by associated parasitoids, and 5) study certain biological and life table parameters of *M. cunctans*.

MATERIAL AND METHODS

I. Determination of the seasonal abundance of soybean stem fly and its associated parasitoids on three soybean varieties

The field experiments were conducted at the experimental farm of the Faculty of Agriculture, Mansoura University, Egypt during the two summer

seasons, 2001 and 2002. The soybean varieties, Giza 21, Giza 35, and Giza 82 were cultivated on May 24, 2001 and June 8, 2002. An area of about half feddan was divided into three plots. The plants received the normal agricultural practices with no insecticidal treatments. Throughout the two successive seasons, sampling was carried out weekly, when the plants were fourteen days old and continued until the end of the growing seasons. The following sampling techniques were used to survey the different stages of *M. cunctans* infesting soybean varieties.

II. Sampling technique:

1. Dissection of soybean stems

Fifteen plants were chosen randomly from each variety. The collected plants were placed in polyethylene bags and transferred to the laboratory for dissection and examination. The larvae or pupae which harbored the stems of plants were counted. Each larva was put into a petri dish (12 cm. in diameter) with a piece of fresh soybean stem. After pupation, the stems were dissected to obtain pupae. All pupae were kept in petri dishes until emergence of soybean stem fly or its parasitoids. The same procedure was followed for the pupae which were collected directly from soybean stems. The percentage of parasitism for each parasitoid was calculated.

The parasitoids were identified by the Department of Insect Identification and Systematic, Plant Protection Research Institute, Agricultural Research Center, Ministry of Agriculture.

2. Sweep-net

Twenty five double strokes were carried out weekly for each variety. Each collected sample was put into plastic bags and transferred to the laboratory. The specimens were anaesthetized by diethyl ether and examined. The numbers of soybean stem fly adults and its associated parasitoids were recorded and the unidentified specimens were kept in vials containing 70% ethyl alcohol for later identification.

III. Effect of temperature and relative humidity on the seasonal abundance of soybean stem fly

The daily temperature and relative humidity recorded were obtained from the Agricultural Research Station in Dakahlia Governorate. The weekly average degree of these weather factors was calculated in each season to study these effects on the seasonal abundance of the insect.

IV. Certain biological characters of the stem fly, *M. cunctans*

To obtain the pupae of soybean stem fly, stems of soybean were dissected. The pupae were kept in Petri dishes until the emergence of the adults. After eclosion, four males and four females of *M. cunctans* were fed on soybean plants until development was completed. The duration of the pre-oviposition, oviposition, post-oviposition periods, the fecundity of female and the longevity of male were recorded. The eggs laid by each female were counted daily, and monitored until hatching. The durations of eggs, larval, and pupal stages were also determined.

The effects of soybean plants on the life table parameters were calculated using a BASIC computer program (Abou-Setta *et al.* 1986) for

females reared on soybean plants. This computer program is based on Birch's method (1948) for the calculation of an animal's life table. The effect of soybean plants on population growth of the soybean stem fly was assessed by constructing a life table, using rates of age-specific (Lx), and fecundity (Mx) for each age interval (x). The mean generation time (T), the net reproductive increase (R_o), the intrinsic rate of increase (r_m), and the finite rate of increase (λ) were determined. The doubling time (DT) was calculated according to Mackauer's method (Mackauer 1983). The life tables were constructed from the data recorded daily on developmental time (egg to first egg laid), sex ratio, the number of deposited eggs, the fraction of eggs reaching maturity, and the survival of females. An interval of one day was chosen as the age class for constructing the life table.

The experiment was run for fluctuated temperatures, relative humidities and a light regime of 16 h. L: 8 h. D.

V. Statistical analysis

To reveal the apparent direct relationship between *M. cunctans* and certain weather factors and between the insect pest and its parasitoids for each variety, statistical analysis was fulfilled. The correlation coefficient was obtained to describe the type of relationship among the studied variables. The susceptibility of three soybean varieties to insect pest was also subjected to two way analysis of variance (ANOVA) (Costat, 1990).

RESULTS

Effect of soybean varieties and seasons on the seasonal abundance of *M. cunctans* larvae and pupae

As shown in Table (1), the effects of soybean varieties and seasons on the relative abundance of the soybean stem fly, *M. cunctans* were highly significant. The statistical analysis showed that Giza 35 and Giza 21 were less susceptible to infestation with *M. cunctans* than Giza 82. Figure (1) revealed that *M. cunctans* had three peaks on Giza 82 in the fourth week of June, third week of July, and fourth week of August, Moreover, on Giza 35 and Giza 21, it had three peaks during 2001 season. During the second season, four peaks were recorded on Giza 82 in the first and fourth weeks of July, third and fourth weeks of August. On Giza 35 and Giza 21, it had three peaks.

Table 1. Two way analysis of variance (ANOVA) for the effects of varieties and seasons on the numbers of *M. cunctans* larvae and pupae sampled by dissecting the soybean stems during seasons 2001 and 2002 in Mansoura region.

Factor	Sum of squares	Degrees of freedom	Mean square	F. Test	P
Varieties	626.6	2	313.3	5.08	0.008 **
Seasons	915.2	1	915.2	14.85	0.0002 ***
Varieties X Seasons	71.48	2	35.74	0.58	0.562 ns
Error	5174.8	84	61.60		

The relationship between *M. cunctans* larvae and pupae and certain weather components

In the first season, there was a significant positive correlation between the population of *M. cunctans* and maximum temperature, average temperature and average R. H. In the second season, the data indicated that there was no significant correlation between certain weather factors and the number of *M. cunctans* (Table 2).

Table 2. Correlation coefficient between *M. cunctans* larvae and pupae and certain weather components in both seasons 2001 and 2002 in Mansoura region.

Weather components	2001				2002			
	r± S. E.	Slope (b) ± S.E	Y Int. (a) ± S.E	P	r± S.E.	Slope (b) ± S.E	Y Int. (a) ± S.E	P
Max. temp.	0.524± 0.236	2.331± 1.048	-76.1077	0.0445 *	0.155± 0.258	3.440± 1.726	-108.922	0.0717 ns
Min. temp.	0.195± 0.272	0.664± 0.927	-10.141	0.4866 ns	0.304± 0.287	2.552± 2409	-47.495	0.3124 ns
Ave. temp.	0.543± 0.232	3.489± 1.494	-86.075	0.0362 *	0.472± 0.265	3.431± 1.930	-88.347	0.1031 ns
Max. R.H.	-0.118 ±0.275	-0.928± 2.159	93.1968	0.6744 ns	-0.307± 0.186	-15.14± 14.13	1471.19	0.306 ns
Min. R. H.	0.163± 0.273	0.137± 0.228	-1.5402	0.5597 ns	0.254± 0.256	1.702± 0.837	-60.56	0.0662 ns
Ave. R.H.	0.599± 0.271	1.227± 0.408	-72.632	0.029 *	0.259± 0.255	3.654± 1.763	-242.83	0.062 ns

Effect of varieties and seasons on the seasonal abundance of *M. cunctans* adults

Table (3) shows the two way analysis of variance (ANOVA) for the effects of varieties and seasons on the abundance of *M. cunctans* adults by sweep-net. The interaction between varieties and seasons showed highly significant effect on the abundance of *M. cunctans* adults.

Table 3. Two way analysis of variance (ANOVA) for the effects of varieties and seasons on the number of *M. cunctans* adults by sweeping-net during the seasons 2001 and 2002 in Mansoura region.

Factor	Sum of squares	Degrees of freedom	Mean square	F. Test	P
Varieties	0	2	0	0	1.0 ns
Seasons	5.87	1	5.87	3.262	0.075 ns
Varieties X Seasons	28.88	2	14.44	8.017	0.000 ***
Error	151.33	84	1.80		

The abundance of *M. cunctans* indicated that this insect had two peaks in the fourth week of July and third week of August on Giza 82. Moreover, three peaks during the first and third weeks of July and the fourth week of August on Giza 35 were recorded. Meanwhile, it had three peaks in the first and fourth weeks of July, and fourth week of August on Giza 21 during 2001 season (Fig. 2). During the 2002 season, the insect had four

peaks in the first and third weeks of July, first week of August, and first week of September on Giza 82. Moreover, it had four peaks on Giza 35 in the fourth week of June, fourth week of July, third week of August and second week of September. Meanwhile, on Giza 21, the insect had three peaks in the fourth week of July, third week of August, and second week of September.

Relationship between *M. cunctans* adults and certain weather components.

The data presented in Table (4) indicate that the minimum temperature, average temperature and minimum R. H. exerted highly significant positive effect on the population of *M. cunctans* adults. Moreover, the average R.H. exhibited positive correlation with the insect during season 2001. In the second season, the stem fly and minimum R. H. and average R. H. showed positive significant relationship.

Table 4. Correlation coefficient between *M. cunctans* adults and certain weather components during 2001 and 2002 seasons in Mansoura region.

Weather components	2001				2002			
	R ± S. E.	Slope (b) ± S.E	Y Int. (a)	P	r± S.E.	Slope(b) ± S.E	Y Int. (a)	P
Max. temp.	0.429± 0.250	0.518± 0.302	-16.226	0.110 ns	0.495± 0.261	0.593± 0.313	-19.7041	0.085 ns
Min. temp.	0.763± 0.179	0.617± 0.144	-11.804	0.000 ***	0.342± 0.282	0.458± 0.375	-9.615	0.247 ns
Ave. temp.	0.674± 0.204	0.673± 0.204	17.296	0.005 **	0.461± 0.267	0.550± 0.320	-14.969	0.113 ns
Max. R.H.	0.060± 0.276	0.1088± 0.51	-8.985	0.831 ns	-0.2731± 0.29	-0.002± 0.001	1.5739	0.366 ns
Min. R.H.	0.668± 0.006	0.129± 0.039	-3.8238	0.006 **	0.597± 0.241	0.287± 0.116	-10.781	0.031 *
Ave. R.H.	0.548± 0.241	0.191± 0.084	-11.498	0.042 *	0.592± 0.243	0.614± 0.252	-41.426	0.033 *

Relationship between *M. cunctans* and its associated parasitoids.

The data in Table (5) present the simple correlation coefficient values between *M. cunctans* and its parasitoids during the two seasons of study. In 2001 season, there were no significant differences between *M. cunctans* and its parasitoids. Meanwhile, the parasitoid of the pupae of the stem fly *Cryptoprymna* sp. exerted highly significant negative effect on the population of *M. cunctans* in 2002 season.

Estimation of the parasitism rate of *M. cunctans* pupae

Three endoparasitoid species namely *Eurytoma* sp., *Cryptoprymna* sp., and *Halticoptera* sp. were associated with *M. cunctans* pupae in the first and second seasons of study. The rates of parasitism are illustrated in Figures (3, 4, and 5).

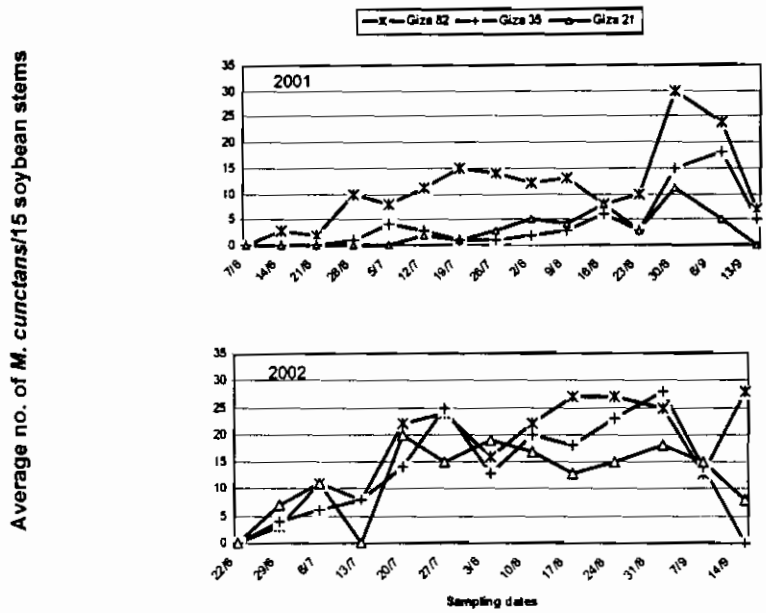

Fig. 1. Average number of *M. cunctans* larvae and pupae per 15 plants on the three soybean varieties during 2001 and 2002 seasons.

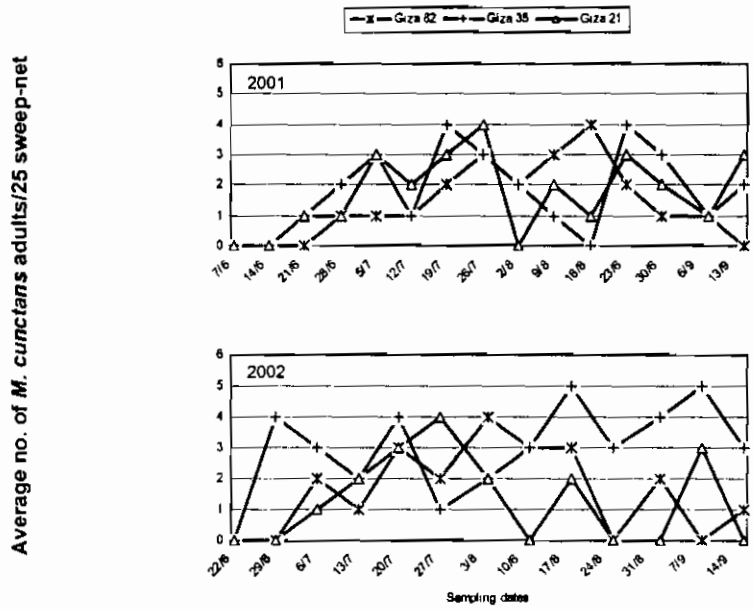

Fig. 2. Average number of *M. cunctans* adults per 25 double strokes of sweep-net on the three soybean varieties during 2001 and 2002 seasons.

Table 5. Correlation coefficient between *M. cunctans* adults and their parasitoids on the three soybean varieties in 2001 and 2002 seasons.

Parasitoids	Giza 82				Giza 35				Giza 21			
	r± S.E.	Slope b ± S.E	Y Int. (a)	P	r± S.E.	Slope b ± S.E	Y Int. (a)	P	r± S.E.	Slope b ± S.E	Y Int. (a)	P
2001												
Cryptoprymna sp.	0.0917± 0.276	0.2638 ±0 794	3.0797	0.745 ns	-0.2701 ±0.267	0.7196 ±0.711	1.3712	0.330 ns	-0.026± 0.277	-0.0983 ±1.032	5.5168	0.925 ns
Halticoptera sp.	0.3405± 0.260	0.1687 ±0.19	0.0858	0.214 ns	0.1736 ± 0.273	0.1818 ± 0.285	0.9393	0.535 ns	0.3120 ± 0.263	0.2303 ± 0.194	0.3033	0.257 ns
Eurytoma sp.	-0.0897 ±0 26	-0.1319 ±0.405	1.4601	0.750 ns	0.2417 ±0.269	0.1818 ± 0.202	0.6060	0.385 ns	0.4169 ± 0.252	0.7106 ± 0.429	0.6067	0.122 ns
2002												
Cryptoprymna sp.	-0.4698 ± 0.266	-0.6554 ± 0.371	2.8783	0.105 ns	-0.7142 ± 0.21	-1.1554± 0.341	5.797	0.006 **	-0.2411± 0.292	-0.6521± 0.791	3.391	0.427 ns
Halticoptera sp.	0.0991 ± 0.300	0.0270 ± 0.081	0.1081	0.747 ns	0.314 ± 0.286	0.2927 ± 0.266	0.2305	0.294 ns	-0.2829± 0.289	-0.1180± 0.020	0.3850	0348 ns
Eurytoma sp.	0.1912 ± 0.295	0.1587 ±0.245	0.8851	0.531 ns	0.497 ± 0.261	0.3056 ± 0.160	-0.5025	0.083 ns	0.2223 ± 0.293	0.1770 ± 0.233	0.9223	0.465 ns

Eurytoma sp.

In 2001 season, *Eurytoma* sp. occurred for a short period from July 19 to September 15. The percentage of parasitism ranged from 17.0 to 60.0%, 13.0 to 66.0%, and 16.0 to 75.0% on Giza 82, Giza 21 and Giza 35 varieties, respectively. The highest percentage of 75.0% was recorded in the fourth week of August on Giza 35. In the second season, the percentage of parasitism varied from 14.0 to 33.0%, 20.0 to 40.0%, and 2.0 to 50.0% on Giza 35, Giza 21 and Giza 82, successively. The highest percentage was 50.0% in the first week of August on Giza 82 (Fig. 3).

Cryptoprymna sp.

In both seasons of 2001 and 2002, *Cryptoprymna* sp. prevailed during the period from the third week of June to the end of the experiment in the second week of September. The percentage of parasitism ranged from 14.0 to 60.0%, 25.0 to 66.0%, and 20.0 to 75.0% on Giza 82, Giza 35 and Giza 21, respectively. The parasitoid had four peaks in the third week of June, second, and fourth weeks of July, and first week of September on Giza 82 variety. It had five peaks on Giza 21 and Giza 35. Meanwhile in the second season, it was recorded in the first week of July and continued till the end of the experiment. The percentage of parasitism varied from 14.0 to 75.0%, 25.0 to 60.0%, and 9.0 to 80.0% on Giza 82, Giza 35 and Giza 21, respectively (Fig. 4). The parasitoid had two peaks in the first week of July and second week of August on Giza 82 and in the second week of July and first week of August on Giza 35 and Giza 21.

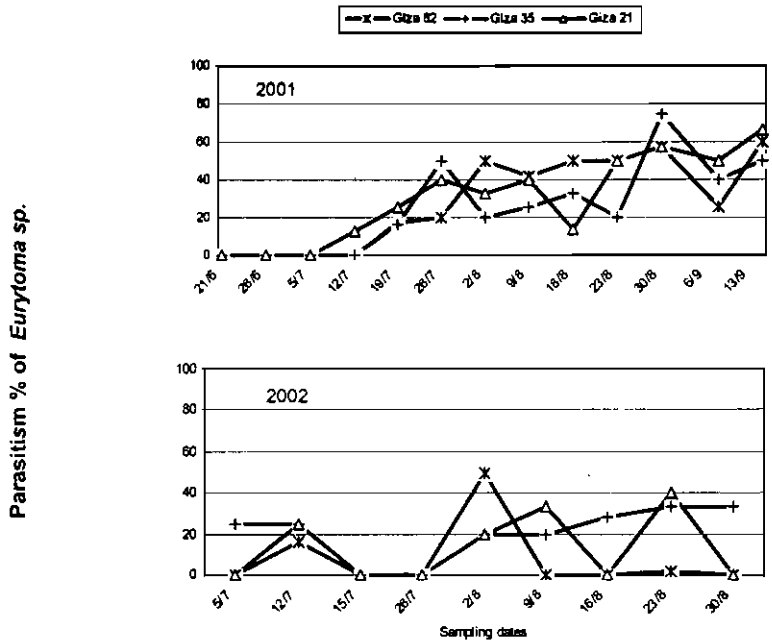

Fig. 3. Parasitism percentage of *Eurytoma sp.* on *M. cunctans* pupae on the three soybean varieties during 2001 and 2002 seasons.

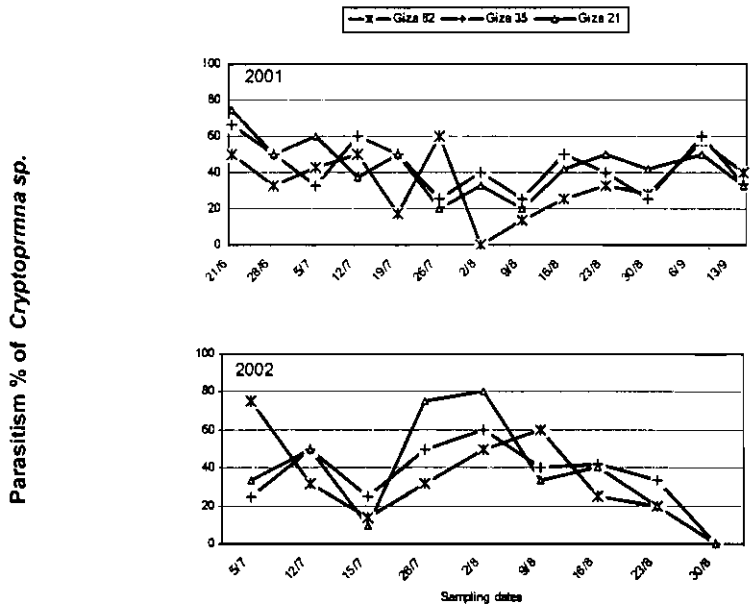

Fig. 4. Parasitism percentage of *Cryptoprymna sp.* on *M. cunctans* pupae on the three soybean varieties during 2001 and 2002 seasons.

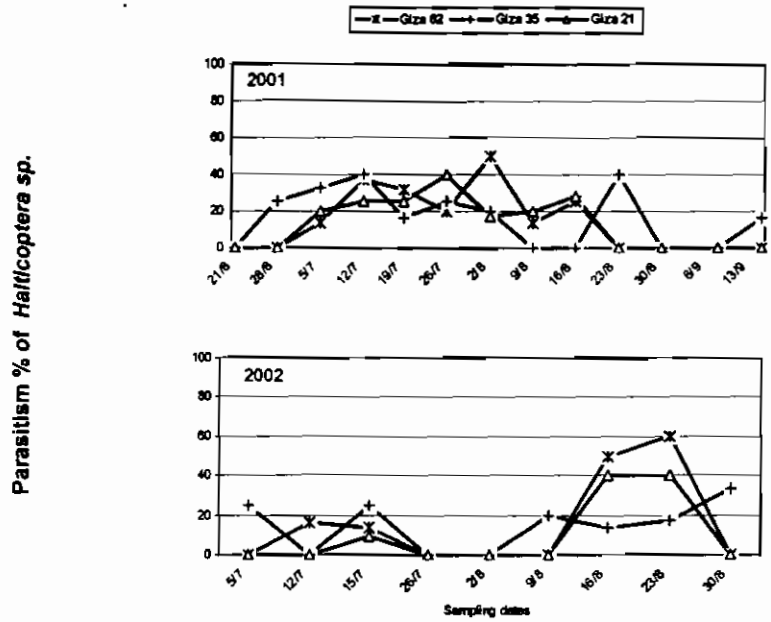

Fig. 5. Parasitism percentage of *Halticoptera sp.* on *M. cunctans* pupae on the three soybean varieties during 2001 and 2002 seasons.

***Halticoptera* sp.**

The data in Fig. (5) indicate that the percentage of parasitism in the first season ranged from 14.0 to 50.0% on Giza 82, 16.0 to 40.0% on Giza 35, and 17.0 to 40.0% on Giza 21, respectively. The parasitoid had two peaks in the second week of July and first week of August on Giza 82, July 12 and 26 on Giza 21, and July 12 and August 23 on Giza 35. In the second season, parasitism percentage ranged from 14.0 to 60.0%, 14.0 to 33.0%, and 9.0 to 40.0% on Giza 82 and Giza 35 and Giza 21, respectively. The parasitoid had two peaks on July 12 and August 23 on Giza 82, July 19 and August 16 on Giza 21. It had three peaks on Giza 35 on July 5 , July 17 and August 30.

Certain biological characters of the stem fly, *Melanagromyza cunctans*

Developmental duration of immature stages:

Fig. (6) shows the duration of the developmental stages of *M. cunctans* reared on soybean plants under laboratory conditions. It may be noticed that the average incubation period lasted two days. From the time of hatching, the tiny maggot immediately started to feed on the tissue between the two epidermal layers of the soybean leaf, until it reached the end of the stem, where it started its pupation period. The average larval period was 8.5 days. The pupation period took an average of 8.0 days. The average duration from egg to adult was 18.5 days.

Mortality percentage of immature stages:

The average mortality percentage of *M. cunctans* immature stages reared on soybean plants under laboratory conditions is presented in Fig (7).

It may be noticed in this figure that the average mortality percentage of eggs, larvae, and pupae were 18.0, 16.3, and 9.8% respectively. The total mortality percentage of immature stages was 44.1%.

Longevity and fecundity of adult stage:

The average longevity of *M. cunctans* adult female fed on soybean plants is illustrated in Fig. (8). The pre-oviposition period, oviposition period, post-oviposition period were 2.5, 11.75, and 1.5 days, respectively. The longevity of adult female averaged 15.75 days. The longevity of adult male was 9.7 days. The fecundity of *M. cunctans* female reared on soybean plants under laboratory conditions was 121.0 eggs per female.

Life table parameters:

The mean generation time was 23.7 days (Table 6). The doubling time (DT) was 4.7 days. The value of net reproductive rate (R_o) was 33.7. The values of the intrinsic rate of increase (r_m) and the finite rate of increase (λ) were 0.148 and 1.16. The data illustrated in Fig. (9) indicated that the survivorship (Lx) for female age intervals was medium (0.56), which means that more than 50.0% of eggs had developed to maturity, and death happened gradually after an extended ovipositional period.

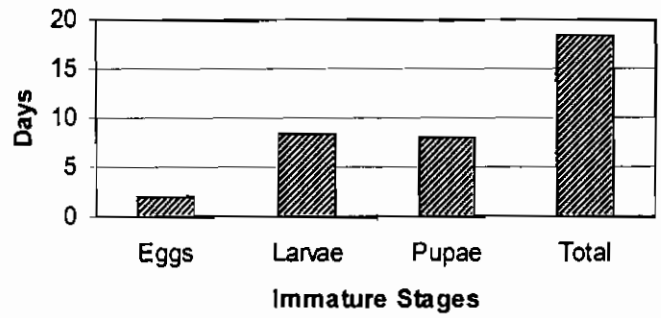

Fig. 6. Duration of the developmental stages of *M. cunctans* reared on soybean plants under laboratory conditions.

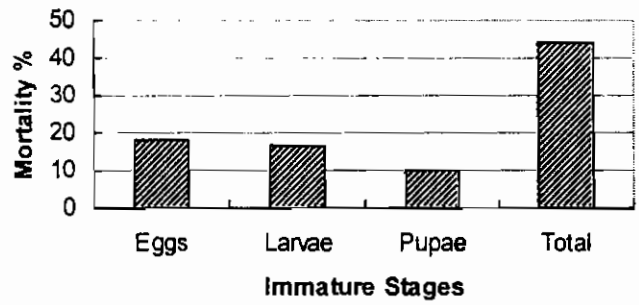

Fig. 7. Mortality percentage of immature stages of *M. cunctans* reared on soybean plants under laboratory conditions.

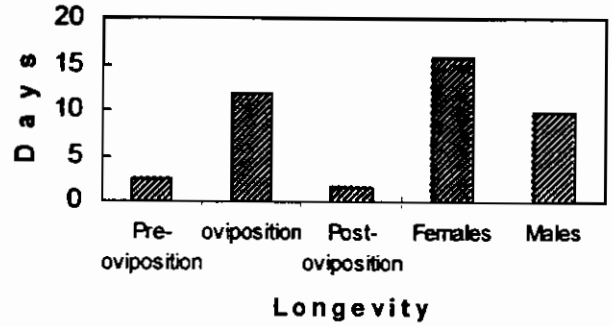

Fig. 8. Longevity of *M. cunctans* reared on soybean plants under laboratory conditions.

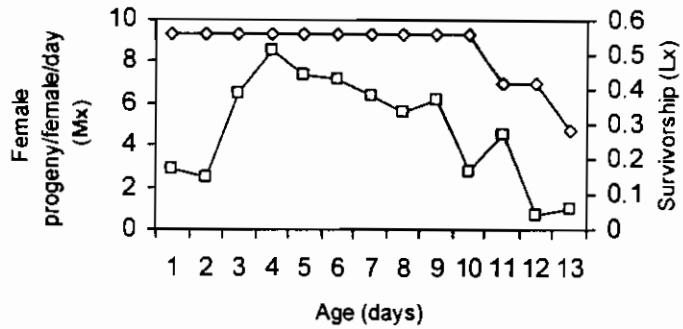

Fig. 9. Age specific fecundity (Mx) and survivorship (Lx) of *M. cunctans* reared on soybean plants under laboratory conditions.

Table 6. Life table parameters of *M. cunctans* reared on soybean plants under laboratory condations.

Life table parameters	
Mean generation time (T) (in days)	23.7
Doubling time (DT) (in days)	4.70
Net reproductive rate (R_o)	33.70
Intrinsic rate of increase (r_m)	0.148
Finite rate of increase (λ)	1.16

DISCUSSION

The soybean stem fly, *M. cunctans* has been recently realized as an important insect pest of soybean in Egypt (El-Basiony *et al.*, 1996). In Turkey, Civelek (2003) also reported *M. cunctans* as a new record among the Turkish leaf miner fauna. A scanty information is now available about the effect of soybean varieties on the abundance of this insect, effect of certain weather

factors and the natural role of its parasitoids as biological control agents, but no previous studies have been conducted on its biology and life table parameters.

However, the results of the present investigation indicated that *M. cunctans* was highly affected by the soybean varieties and seasons. These findings disagree with those reported by Singh *et al.* (1998) who found that various cultivars did not differ significantly with regard to infestation with another species of the genus *Melanagromyza* (*M. sojae*). Meanwhile, Sharma *et al.* (1994 a) evaluated forty five varieties of soybean for damage caused by *M. sojae*. The grain yield was negatively correlated with infestation and stem tunneling. The varieties PK262, PK 416, PK 564 and Shivalik gave good yields despite tunneling in their stems and it is suggested that they may be tolerant to this pest. In addition, Sharma *et al.* (1994 b) found that none of the soybean varieties was free from attack by the agromyzid, but JS-87-36 was the least susceptible and had the greatest grain yield, followed by JS-87-39, JS-87-27 and JS-87-1. Kundu *et al.* (1996) also evaluated the yield losses in seven varieties of soybeans caused by *M. sojae*. The losses fluctuated between 18.6 (var. PK-960) and 40.1 (var. Pusa-20). Sekhar *et al.* (2000 a & b) reported that thirty nine genotypes were moderately resistant with a percentage of stem tunneling ranging from 28.9 to 41.7%.

The present data indicated that *M. cunctans* larvae, pupae, and adults had two to four peaks from June to September on the three tested varieties during the two successive seasons. Ipe and Bhati (1977) noted that *M. sojae* had three generations yearly, the two latter being more destructive than the first to the crops. Soybean flowers were observed as a result of infestation by the third generation. The larvae of all generations tunneled in the stem at levels progressively higher with each generation. Kwon *et al.* (1981) observed that the larvae were found in soybean samples from June 20 onwards, and larval peaks occurred on July 10, August 10, and August 30. Two pupal peaks were also observed. The highest population peaks of larvae and pupae occurred on August 10 and 30. Wang (1987) recorded four generations yearly for *M. sojae* in late May, June, July and August. The larvae of the first and second generations fed on the base of the soybean stems, while those of the third generation fed on the middle and upper parts of the stems. According to Berg *et al.* (1995), *M. sojae* generally infested soybean throughout the season; infestation was initially low, reached its peak in the 5^{th}-8^{th} weeks after planting and declined towards the end of the season. The current study reveled that the infestation with this insect started within four weeks after germination. Feng (1996) observed that *M. sojae* completed five generations per year, with the third and fourth generations causing the heaviest yield loss. Meanwhile, Mesbah and El-Galaly (1999) and Mesbah *et al.* (2001) mentioned that *M. sojae* pupae had three overlapping broods from mid June to late September.

There was a significant positive correlation between the population of *M. cunctans* larvae and pupae and maximum temperature, average temperature and average R. H. in the first season. In the second season, there was no significant correlation between certain weather factors and the numbers of *M. cunctans*. The results also indicated that minimum

temperature, average temperature and minimum R. H. exerted highly significant positive effect on the population of *M. cunctans* adults. Moreover, the average R. H. exerted positive correlation with the insect population in 2001 season. In the second season, the stem fly and minimum R. H. and average R. H. showed positive significant relationships. Any insect infestation or its absence, is therefore a function of a biotic factor or a weather parameter. Dahiya *et al.* (1999) reported that the correlation between the numbers of *Melanagromyza obtusa* and mean temperature and relative humidity were inconsistent. Meanwhile, Nayak *et al.* (2004) noted that the minimum temperature and relative humidity were negatively correlated with the population build up of the stem fly, *Melanagromyza* sp. and its parasitoids.

Three endoparasitoid species namely, *Eurytoma* sp., *Cryptoprymna* sp., and *Halticoptira* sp. were associated with *M. cunctans* pupae. During the first season of study, there was no significant correlation between *M. cunctans* and its parasitoids. Meanwhile, the parasitoid of the stem fly pupae, *Cryptoprymna* sp. exerted highly negative significant effect on the population of *M. cunctans* during 2002 season. *Eurytoma* sp. occurred in a short period from July 19 to September 15. The highest percentage of parasitism was 75.0% in the fourth week of August on Giza 35, while in the second season, the highest percentage was 50.0% which was recorded in the first week of August on Giza 82. *Cryptoprymna* sp. seemed to be the most common and efficient parasitoid of the insect pupae since it occurred throughout the longest period. This parasitoid covered the period from the third week of June to the end of the experiment and had four peaks. Meanwhile, *Halticoptera* sp. had two peaks. In Egypt, Abul-Nasr and Assem (1968) recorded the same parasitoids, *Eurytoma* sp., *Cryptoprymna* sp. and *Halticoptera* sp on the pupae of *Melanagromyza phaseoli* (Tryon). Ipe and Bhati (1977) noted that parasitism of *M. sojae* larvae by unidentified braconids, eurytomids and pteromalids was about 22.9% on soybean. Krishnakumar and Srinivasan (1988) studied the seasonal abundance of *Eurytoma* sp., a parasitoid of the agromyzid, *Melanagromyza hibisci*. The percentage of parasitism varied from 10.0 to 68.0%. *M. hibisci* did not occur in June and February, and the number of infested petioles increased in October-December. The parasitism occurred in July, September, December and January. The number of host pupae and the number of parasitoids were positively correlated. Berg *et al.* (1995) also reported that a hymenopterous parasitoid, *Eurytoma* sp. had a high impact on the same pest. Parasitism levels rose with increasing host density and remained high until just before harvest. According to Berg *et al.* (1998), the average parasitism level was 60.0% towards the end of soybean season. Mesbah *et al.* (2001) observed that three hymenopterous parasitoids, *Sphegigaster* sp., *Eurytoma* sp. and *Halticoptera* sp. were obtained from *M. sojae* pupae. *Eurytoma* sp. was detected from June to July. Meanwhile *Halticoptera* sp. was observed from August to September. Jayappa et al. (2002) recorded that parasitism percentage of *Eurytoma melanagromyzae* was 20.0% on *M. sojae* pupae.

The average duration from egg to adult was 18.5 days. The total mortality percentage among the immature stages was 44.1%. The longevity

of adult female was 15.75 days, while it was 9.7 days for the adult male. The fecundity of *M. cunctans* female was 121.0 eggs per female. These results are in agreement with those of Aboul-Nasr and Assem (1968) who noted that the incubation period of *M. phaseoli* was two days, the developmental time of the larval period ranged from 7.0 to 8.0 days, and the pupation period varied between 8.0 and 9.0 days. Wang (1979) mentioned that in the laboratory at 24.5°C and 75-90% R.H., the egg stage of *M. sojae* lasted 2.0 to 7.0 days, the three larval instars 2.3, 2.5 and 2.9 days, respectively, and the pupal stage 6.0 to 12.0 days. The larval mortality in the three instars was 62.1, 24.1 and 20.0%. At 25.6°C and 70-90% R. H., the adult life-span was 19.0 days and the females laid an average of 171.0 eggs.

In conclusion, the present investigation provided useful information of some ecological and biological aspects of the important soybean stem fly, *M. cunctans*. The obtained results will secure valuable help to study other important problems such as the nutritional requirements of the insect, the qualitative specificity of other soybean host varieties, evaluation of the damage to its hosts, and the role of other biotic factors with regard to the integrated pest management.

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دراسات إيكولوجية وبيولوجية لحشرة ذبابة ساق فول الصويا ودور الطفيليات كعناصر مكافحة إحيائية واعدة

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تم إجراء دراسة بمزرعة كلية الزراعة – جامعة المنصورة لمدة موسمين متتاليين (٢٠٠١ ، ٢٠٠٢) لتحديد الحساسية النسبية لثلاثة أصناف من محصول فول الصويا للإصابة بحشرة ذبابة ساق فول الصويا وكذلك تحديد الكثافة العددية لتلك الحشرة ونسبة التطفل بالطفيليات المصاحبة لها ، كما تم دراسة تأثير بعض العوامل الجوية على تواجد تلك الآفة الحشرية. بالإضافة إلى دراسة بعض المقاييس البيولوجية وجداول الحياة لها تحت الظروف المعملية.

وقد أوضحت النتائج أن صنفى جيزة ٣٥ ، جيزة ٢١ أقل حساسية للإصابة بذبابة ساق فول الصويا عن الصنف جيزة ٨٢. كما إتضح أن ليرقات وعذارى الحشرة ثلاثة ذروات للنشاط وذلك عن طريق تشريح سيقان أصناف فول الصويا للإستدلال على تواجد تلك الأطوار. كما إتضح من النتائج بواسطة شبكة الجمع أن الحشرة الكاملة لها ذروتان نشاط على الصنف جيزة ٨٢ ، وثلاث ذروات على كل من جيزة ٣٥ ، جيزة ٢١ وذلك خلال العام الأول للدراسة أما فى العام الثانى فظهر للحشرة أربع ذروات نشاط على كل من جيزة ٨٢ ، جيزة ٣٥ ، وثلاث ذروات نشاط على الصنف جيزة ٢١ .

وكذلك بينت النتائج أن هناك ثلاثة طفيليات مصاحبة لعذارى هذه الحشرة وهى : *Eurytoma* sp., *Cryptoprymna* sp., *Halticoptera* sp. . ومن خلال نتائج دراسة العام الأول أن الطفيل *Eurytoma* sp. تواجد خلال فترة قصيرة من الأسبوع الثالث من يوليو وحتى الأسبوع الثالث من شهر سبتمبر.وكان أعلى نسبة تطفل هى ٧٥% وذلك خلال الأسبوع الرابع من شهر أغسطس على الصنف جيزة ٣٥ ، أما فى العام الثانى فكانت أعلى نسبة تطفل هى٥٠% خلال الأسبوع الأول من شهر أغسطس على الصنف جيزة ٨٢.

وقد أشارت النتائج أيضا خلال عامى الدراسة أن الطفيل *Cryptoprymna* sp. قد تواجد خلال الفترة من الأسبوع الثالث من شهر يوليو وحتى نهاية الدراسة. وكانت نسبة التطفل بهذا الطفيل خلال العام الأول من الدراسة تتراوح من ١٤ إلى ٦٠% ، ٢٥ إلى ٦٦% ، ٢٠ إلى ٧٥% على أصناف جيزة ٨٢ ، جيزة ٣٥ ، جيزة ٢١ على التوالى. وتم تسجيل أربعة ذروات نشاط على الصنف جيزة ٨٢ . بينما تم تسجيل خمسة ذروات نشاط للطفيل على أصناف جيزة ٣٥ و ٢١ . أما فى العام الثانى من الدراسة فكانت نسبة التطفل تتراوح من ١٤ إلى ٧٥% ، ٢٥ إلى ٦٠% ، ٩ إلى ٨٠% على أصناف جيزة ٨٢ ، جيزة ٣٥ ، جيزة ٢١ على التوالى.

كما أظهرت النتائج خلال العام الأول من الدراسة أن نسبة التطفل بالطفيل *Halticoptera* sp تراوحت بين ١٤ و٥٠% على الصنف جيزة ٨٢ ، ١٦ إلى ٤٠% على الصنف جيزة ٣٥ ، ١٧ إلى ٤٠% على الصنف جيزة ٢١ . وكان لهذا الطفيل ذروتان للنشاط على الأصناف الثلاثة المختبرة. أما خلال العام الثانى فكانت نسبة التطفل تتراوح من ١٤ إلى ٦٠% ، ١٤ إلى ٣٣% ، ٩ إلى ٤٠% على أصناف جيزة ٨٢ ، جيزة ٣٥ ، جيزة ٢١ على التوالى. وتم تسجيل ذروتين لنشاط الطفيل على صنفى جيزة ٨٢ ،٢١ وثلاث ذروات على الصنف جيزة ٣٥ .

كذلك أوضحت نتائج الدراسة البيولوجية للحشرة أن فترات الأطوار غير الكاملة من طور البيضة وحتى الوصول لطور الحشرة الكامل إستغرقت ١٨,٥ يوم وكانت نسبة الموت للأطوار غير الكاملة ٤٤,١%. وفترة حياة الإناث والذكور ١٥,٧٥ ، ٩,٧ يوم على التوالى ، وعدد البيض الكلى للأنثى الواحدة هو ١٢١ بيضة. إلى جانب ذلك تم تحديد بعض مقاييس جداول الحياة لتلك الحشرة والتى درست لأول مرة.