# RESULTS AND DISCUSSION

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## I. Rate of infestation by the pink stalk borer *Sesamia cretica* Led. in maize plants after application of onion bulb extracts, juice and natural granules.

### I. 1- Infestation by *S. cretica* egg-masses:

The obtained data, clearly, indicate that the untreated maize plants received, significantly, the highest infestation rates with *S. cretica* egg-masses (30.6; 23.7 - 37.2 egg-masses in 1996, (Table 1) and 24.65 egg-masses/100 plants in 1997, (Table 2)) compared to all records from plants that received different treatments. On the contrary, the lowest average number of *S. cretica* egg-masses was recorded from plants treated by onion natural granules in 1996 (9.65; 6.1-12 egg-masses; Table, 1) and from those treated by the juice of onion bulbs in 1997 (4.52; 2.8-6.6 egg-masses/100 plants; Table, 2). Treatments by onion juice, extracts and natural granules may be arranged in a descending order (according to the rate of *S. cretica* egg-masses infestation) in 1996 corn season as petroleum ether extract (25.4 egg-masses), acetone extract (18.3), onion juice (16.25), water extract (16.05), methanol extract (15.7) and natural granules (9.65 egg-masses/100 plants) (Table, 1). While, the effectiveness of these materials in 1997 season could be arranged as; Petroleum ether extract (10.8 egg-masses), followed descendingly by acetone extract (10.1), methanol extract (9.7), natural granules (9.65), water extract (7.25) and finally the juice of onion bulb (4.52 egg-mass/100 plants) (Table 2). As for the two maize season means

Table (1): Averages in number of *S. cretica* egg-masses on treated maize plants during 1996 early summer plantation.

| Treatment | No. of egg-masses/100 plants | | | | | % reduction than control |
|---|---|---|---|---|---|---|
| | $R_1$ | $R_2$ | $R_3$ | $R_4$ | Mean | |
| Water extract | 13.6 | 14.2 | 25 | 11.4 | $16.05\pm3.04^{ab}$ | 47.6 |
| Methanol extract | 11.4 | 23.2 | 11.7 | 16.6 | $15.7\pm2.76^{ab}$ | 48.7 |
| Actone extract | 20 | 13.3 | 20 | 20 | $18.3\pm1.17^{bc}$ | 40.2 |
| Pet . ether extract | 27.02 | 32.2 | 19.2 | 23.3 | $25.4\pm2.76^{cd}$ | 17.09 |
| Juice of onion bulb | 11.7 | 16.6 | 25.9 | 10.8 | $16.25\pm1.29^{ab}$ | 47.02 |
| Natural granules | 11.5 | 12 | 9 | 6.1 | $9.65\pm1.35^{a}$ | 68.54 |
| Control | 31.8 | 30 | 37.2 | 23.7 | $30.6\pm2.79^{d}$ | |

F value = 6.96*
L.S.D. = 7.77
Values followed by the same letter (s) are not significantly different.

Table (2): Averages in number of *S. cretica* egg-masses on treated maize plants during 1997 early summer plantation.

| Treatment | No. of egg-masses/100 plants | | | | | % reduction than control |
|---|---|---|---|---|---|---|
| | $R_1$ | $R_2$ | $R_3$ | $R_4$ | Mean | |
| Water extract | 12 | 8 | 4 | 5 | 7.25±1.79[a] | 70.5 |
| Methanol extract | 7.1 | 5.7 | 16 | 10 | 9.7±2.28[a] | 60.6 |
| Actone extract | 23.8 | 6.25 | 2.5 | 8 | 10.1±7.70[a] | 58.8 |
| Pet. ether extract | 16.6 | 6.6 | 10 | 10 | 10.8±2.09[a] | 56.1 |
| Juice of onion bulb | 4 | 6.6 | 4.7 | 2.8 | 4.52±0.51[a] | 81.6 |
| Natural granules | 12 | 16.6 | 2 | 8 | 9.65±3.10[a] | 60.8 |
| Control | 20 | 28 | 26.6 | 24 | 24.65±1.71[b] | |

F value = 5.82*
L.S.D. = 7.81

of *S. cretica* egg-mass counts after different onion treatments, it is clear from Table (3) that maize plants treated by the onion natural granules harboured the lowest mean number of egg-masses (9.65; 2-16.6 egg-masses/100 plants) being the best treatment, followed by the onion juice treatment (10.39; 2.8-25.9 egg-masses), water extract (11.65; 4-25 egg-masses), methanol extract (12.7; 5.7-23.2 egg-masses) and acetone extract (14.2; 2.5-23.8 egg-masses/100 plants). While, the highest infestation occurred in both years by applying the petroleum ether extract as 18.1 (6.6-32.2) egg-masses were counted /100 maize plants opposed to 27.63 egg-masses counted on 100 plants of the control treatment. Regarding the mean counts of *S. cretica* eggs on treated and untreated maize plants throughout 1996 and 1997 corn seasons, it is clear from Table (3) that treatments by natural onion granules and onion juice were the least infested (9.25; 2-16.6 and 10.39; 2.8-25.9 egg-masses/100 plants, respectively). That was followed by water and methanol extracts which were associated with 11.65, 4-25 and 12.7; 5.7-23.2 egg-masses, respectively. While, on the contrary, maize plants treated by acetone and petroleum ether extracts harboured the highest infestation rates of *S. cretica* egg-masses (14.2; 2.5-23.8 and 18.1; 6.6-32.2 egg-masses/100 plants, respectively opposed to a mean count of 27.63; 20-37.2 egg-masses in case of the control check (Table 3). All data in Tables (1, 2 and 3) indicate that either of the 6 onion treatments caused significant reductions in the rate of *S. cretica* egg-masses infestation than control, although there were variations between the effectiveness of the applied treatments. From the means of the two seasons' data (Table 3), the used materials may be arranged descendingly concerning the reduction

Table (3): Two maize season means (1996 & 1997) of *S. cretica* egg-mass counts after different treatments to maize plants.

| Treatment | Mean (range) of *S. cretica* egg-mass counts | % reduction than control |
|---|---|---|
| Water extract | 11.65±2.32[a] (4-25) | 57.84 |
| Methanol extract | 12.70±2.00[a] (5.7-23.2) | 54.04 |
| Actone extract | 14.20±2.77[ab] (2.5-23.8) | 48.61 |
| Pet.ether extract | 18.10±3.19[b] (6.6-32.2) | 34.49 |
| Onion bulb juice | 10.39±2.75[a] (2.8-25.9) | 62.40 |
| Natural granules | 9.65±1.56[a] (2.0-16.6) | 65.07 |
| Control | 27.63±1.89[c] (20-37.2) | |

**F value = 5.90***
**L.S.D. = 5.35**

percentage in the mean count of egg-masses than control as natural onion granules which caused 65.07 % reduction in the number of egg-masses infesting maize plants than control. Onion bulb juice came the next, showing nearly a similar effect as of the natural granules (62.4 % reduction than control)) and accordingly these two materials could be considered as highly effective in reducing the rate of infestation by *S. cretica* egg-masses. In this respect, natural onion granules proved as the most effective in 1996 season as it caused 68.54 % reduction in *S. cretica* egg-masses infestation than control (Table 1), while onion bulb juice was the most effective than the remaining treatments in the subsequent season (1997) as it caused 81.6 % reduction in egg-mass counts than control (Table 2). Water and methanol extracts of onion could be fairly considered as intermediately effective as treatments by these two materials to maize plants caused reductions in the egg-masses counts by 57.84 and 54.04 % than control (Table 3). While, the least effective materials, in this respect, were acetone and petroleum ether extracts which caused 48.61 an 34.49 % reductions, respectively than control (Table 3).

**I. 2- *S. cretica* larval infestation:**

As shown in Tables (4 & 5) in both seasons of study, the untreated maize plants received, significantly, the highest infestation rates with *S. cretica* larvae (129.75; 95-164 and 129; 76-160 larvae/100 plants in 1996 and 1997 seasons, respectively) than all the onion treatments. Among the different onion treatments, similar trend of efficacy was

Table (4): Averages in numbers of *S. cretica* larval counts on treated maize plants during 1996 early summer plantation.

| Treatment | No. of larvae/100 plants | | | | | % reduction than control |
|---|---|---|---|---|---|---|
| | $R_1$ | $R_2$ | $R_3$ | $R_4$ | Mean | |
| Water extract | 36.3 | 22.8 | 30 | 20 | $27.27 \pm 3.67^a$ | 78.9 |
| Methanol extract | 13 | 31. | 21 | 11 | $19 \pm 7.55^a$ | 85.35 |
| Actone extract | 25 | 20.5 | 20.94 | 30 | $24.11 \pm 2.21^a$ | 81.41 |
| Pet. ether extract | 35 | 40 | 30 | 35 | $35 \pm 2.04^{ab}$ | 73.03 |
| Juice of onion bulb | 21 | 30 | 25 | 24 | $25 \pm 3.11^a$ | 80.73 |
| Natural granules | 50 | 40 | 70 | 50 | $52.5 \pm 6.29^b$ | 59.53 |
| Control | 160 | 100 | 95 | 164 | $129.75 \pm 18.68^c$ | |

F value = 24.59*
L.S.D. = 23.17
Values followed by the same letter (s) are not significantly different.

Table (5): Averages in numbers of *S. cretica* larval counts on treated maize plants during 1997 early summer plantation.

| Treatment | No. of larvae/100 plants | | | | | % reduction than control |
|---|---|---|---|---|---|---|
| | $R_1$ | $R_2$ | $R_3$ | $R_4$ | Mean | |
| Water extract | 48 | 16 | 35 | 14 | 29±8.12[a] | 77.5 |
| Methanol extract | 17.8 | 34.2 | 24 | 10 | 21.5±5.11[a] | 83.3 |
| Actone extract | 14.2 | 10 | 25 | 56.3 | 26.4±10.47[a] | 79.5 |
| Pet. ether extract | 26.6 | 46.6 | 30 | 40 | 35.8±4.59[a] | 72.2 |
| Juice of onion bulb | 11.4 | 33.3 | 33.3 | 36 | 28.5±5.59[a] | 77.9 |
| Natural granules | 60 | 50 | 85 | 65 | 65±7.36[b] | 49.6 |
| Control | 150 | 160 | 76 | 130 | 129±18.75[c] | |

F value = 12.8
L.S.D. = 27.4

detected in the two seasons of study, as methanol extract of onion bulb was the most effective; maize plants treated with this extract harboured 19; 11-31 and 21.5; 10-34.2 larvae 100 plants, respectively (Tables 4 & 5). These larval counts were significantly lower than those recorded from maize plants treated by acetone extract (24.11; 20.5-30 and 26.4; 10-56.3 larvae), onion bulb juice (25; 21-30 and 28.5; 11.4-36 larvae), water extract (27.27; 20-36.3 and 29; 14-48 larvae) and Petroleum ether extract (35; 30-40 and 35.8; 26.6-46.6 larvae/100 plants in 1996 and 1997 seasons, respectively). While, on the contrary, maize plants treated by natural granules of onion were found infested by, significantly, higher numbers of ***S. cretica*** larvae (52.5; 40-70 and 65; 50-85 larvae/100 plants in 1996 and 1997, respectively) than those recorded from the remaining onion treatments (Tables 4 & 5) .

Regarding the reduction percentages in ***S. cretica*** larval counts due to different onion treatments than control, it is clear from Tables (4 & 5) that, in both years, all the onion treatments caused reductions in the rates of infestation by ***S. cretica*** larvae than control. The reduction percentages ranged from 59.53 % by using natural onion granules to 85.35 % in case of methanol onion extract treatment in 1996 (Table 4) and from 49.6 % (natural onion granules treatment) to 83.3 % (methanol extract of onion) in 1997 (Table 5). Treatments by petroleum ether extract, water extract, onion bulb juice and acetone onion extract caused reductions in ***S. cretica*** larval infestations than control by 73.3, 78.9, 80.73 and 81.41 %, respectively in 1996 (Table 4) and by 72.2, 77.5, 77.9 and 79.5 %, respectively in 1997 (Table 5).

As a general conclusion, it could be stated that all onion treatments to maize plants caused significant reductions in the rates of infestation by ***S. cretica*** eggs and larvae (Tables 1-5). But, the order of efficacy of onion preparations on the pest eggs varied than that on larvae. Natural onion granules which appeared as the most effective in reducing the percentage in ***S. cretica*** egg-masses infestation than control, caused the lowest reduction % in larval counts in 1996 and 1997 seasons. On the other hand, petroleum ether extract of onion bulbs which proved as the least effective preparation in reducing egg-mass counts, gave more than 72 % reductions in the infestation rates by ***S. cretica*** larvae in both seasons of study. Also, acetone extract was categorized as of low efficacy in reducing egg-mass counts than control, proved of high efficacy in reducing the larval counts of this pest giving about 80 % reduction than control. While onion bulb juice gave good percentages of reduction in the egg-masses and larval counts.

**I.3. Numbers of perforated leaves.**

Data presented in Tables (6 & 7) clearly indicated that, in both seasons of study, the untreated maize plants had significantly the highest numbers of perforated leaves by ***S. cretica*** larvae (26.5; 20-33.3 and 31.7; 16.6-47.1 perforated leaves/100 plants in 1996 and 1997 seasons, respectively). These averages were found, statistically, significantly higher than the mean numbers of perforated leaves of either of the onion treatments. Comparing the perforated leaf counts in maize plants that received different treatments of onion preparations, it could be deduced

Table (6): Averages in numbers of perforated leaves/100 maize plants due to *S. cretica* infestation during 1996 early summer plantation.

| Treatment | No. of perforated leaves/100 plants | | | | | % reduction than control |
|---|---|---|---|---|---|---|
| | $R_1$ | $R_2$ | $R_3$ | $R_4$ | Mean | |
| Water extract | 11.9 | 13.1 | 15.1 | 7.5 | $11.9 \pm 1.61^{ab}$ | 55.13 |
| Methanol extract | 10.1 | 11.3 | 13.1 | 12.5 | $11.7 \pm 0.66^{ab}$ | 55.70 |
| Actone extract | 22.2 | 14.6 | 10 | 18.7 | $16.3 \pm 2.63^{b}$ | 38.26 |
| Pet. ether extract | 12.5 | 14.03 | 14.5 | 8.3 | $12.3 \pm 1.41^{ab}$ | 53.5 |
| Juice of onion bulb | 12.5 | 9.5 | 7.2 | 6.6 | $8.9 \pm 1.34^{a}$ | 66.2 |
| Natural granules | 12 | 14 | 13.1 | 8.9 | $12 \pm 1.11^{ab}$ | 54.7 |
| Control | 20 | 22.5 | 33.3 | 30.3 | $26.5 \pm 3.15^{c}$ | |

F value = 9.53*
L.S.D. = 5.55

Table (7): Averages in numbers of perforated leaves/100 maize plants due to *S. cretica* infestation during 1997 early summer plantation.

| Treatment | No. of perforated leaves/100 plants | | | | | % reduction than control |
|---|---|---|---|---|---|---|
| | $R_1$ | $R_2$ | $R_3$ | $R_4$ | Mean | |
| Water extract | 18.5 | 10.8 | 19.7 | 18.75 | $16.9 \pm 2.06^{ab}$ | 46.5 |
| Methanol extract | 19.3 | 17.8 | 22.5 | 12.7 | $18.07 \pm 2.04^{ab}$ | 42.9 |
| Actone extract | 34.7 | 9.6 | 19.1 | 36.9 | $25.07 \pm 6.51^{bc}$ | 20.8 |
| Pet. ether extract | 20.8 | 17.5 | 40.2 | 32.7 | $27.8 \pm 5.27^{bc}$ | 12.3 |
| Juice of onion bulb | 9.4 | 11.6 | 16 | 7.6 | $11.15 \pm 1.81^{a}$ | 64.8 |
| Natural granules | 17.3 | 18.2 | 15.1 | 26.7 | $19.32 \pm 2.54^{ab}$ | 39.03 |
| Control | 47.1 | 16.6 | 32.7 | 30.4 | $31.7 \pm 6.25^{c}$ | |

F value = 2.84*
L.S.D. = 12.34

from Tables (6 & 7) that plants which were sprayed by onion juice had the lowest perforated leaf numbers than those recorded from the 5 remaining treatments (8.9; 6.6-12.5 and 11.15; 7.6-16 perforated leaves/100 plants in 1996 and 1997 seasons, respectively). These averages were, insignificantly, lower than those recorded from maize plants treated by methanol extract. water extract, onion granules and petroleum ether extract of onion in 1996 season (means of 11.7, 11.9, 12 and 12.3 perforated leaves/ 100 plants, respectively; Table 6), and than treatments by water extract (16.9 perforated leaves), methanol onion extract (18.07) and onion granules (19.32 perforated leaves/100 plants) in 1997 early summer season (Table 7). On the contrary, the highest mean count of perforated leaves due to ***S. cretica*** larval feeding was associated with plants treated by the acetone onion extract followed by those treated by the petroleum ether extract of onion in 1996 season (16.3; 10-22.2 and 12.3; 8.3-14.5 perforated leaves/100 plants, respectively, Table 6). While in 1997 early summer corn season, plants that showed highest mean count of perforated leaves were these received spraying by petroleum ether extract (27.8; 17.5-40.2 leaves) followed by those sprayed by acetone extract of onion (25.07; 9.6-36.9 perforated leaves/100 plants; Table 7).

Regarding the percentages of reduction in perforated leaf numbers due to onion treatments than control, onion juice was the most effective in the two seasons of study as it caused 66.2 % (Table 6) and 64.8 % (Table 7) reductions than control in 1996 and 1997 early summer seasons, respectively. The remaining onion preparations may be arranged, descendingly, according to their efficacy in reducing the rate of perforated leaves in 1996 season as methanol extract, water extract, onion granules, petroleum ether extract and finally acetone extract (55.7, 55.13, 54.7, 53.5 and 38.26 % reduction in perforated leaf numbers than control, respectively; Table 6). In the subequent year (1997 season) those followed onion juice could be arranged decendingly as water extract (46.5 % reduction), methanol extract (42.9 %), natural granules (39.03 %), acetone extract (20.8 %) and finally petroleum ether extract which caused only 12.3 % reduction in perforated leaf numbers than control (Table 7).

From the two years' data, as shown in Table (8), the assayed preparations of onion may be categorized as:

1- Highly efficient; including only the onion juice which caused 65.5 % reduction in the mean number of perforated leaves due to ***S. cretica*** larval feeding (10.03 perforated leaves/100 maize plants opposed to 29.1 leaves in the control plants)

2- Intermediately efficient, including the water & methanol onion extracts and onion granules, as these materials caused 50.52, 48.83 and 46.15 % reductions in perforated leaf numbers than control plants, respectively.

3- Least efficient; represented by the petroleum ether and acetone onion extracts which caused 31.1 and 28.9 % reductions, respectively in the

**Table (8): Two year means of the reduction percentages in perforated leaf numbers by *S. cretica* larvae due to application of onion preparations to maize plants**

| Treatment | Mean counts of perforated leaves/100 plants | % reduction than contrtol |
|---|---|---|
| Water extract | $14.4 \pm 1.53^{a}$ (7.5-19.7) | 50.52 |
| Methanol extract | $14.89 \pm 1.55^{a}$ (10.1-22.5) | 48.83 |
| Actone extract | $20.69 \pm 3.63^{b}$ (9.6-36.9) | 28.9 |
| Pet. ether extract | $20.05 \pm 3.85^{b}$ (8.3-40.2) | 31.1 |
| Juice of onion bulb | $10.03 \pm 1.12^{a}$ (6.6-16.0) | 65.5 |
| Natural granules | $15.67 \pm 1.88^{ab}$ (8.9-26.7) | 46.15 |
| Control | $29.1 \pm 3.37^{c}$ (16.6-47.1) | |

**F value = 4.71***
**L.S.D. = 6.62**

number of leaves perforated by ***S. cretica*** larvae than control.

**I.4- Number of dead heart cases:**

As occurred concerning the effect of onion preparation treatments on ***S. cretica*** infestation rates to maize plants and on the number of perforated leaves by ***S. cretica*** larvae, these treatments caused significant reductions in the numbers of maize plants that showed dead heart symptoms than control. Inspections of the control plants showed a very high number of dead heart symptoms, being 58; 45.1-72.7 (Table 9) and 45.17; 29.1-65.2 cases/100 maize plants (Table 10) in 1996 and 1997 early summer seasons, respectively. The order of effectiveness of the used preparations was the same in both 1996 and 1997 seasons. The least number of maize plants that showed dead heart symptoms occurred, in both seasons, by using onion juice (16.07; 11.1-25.4 in the former season; Table 9 and 19.14; 8.9-25.3 dead heart cases/100 plants; Table 10, respectively). Thus led to the highest reductions in dead heart cases than control (72.2 and 57.62 %, respectively due to using this preparation). Methanol onion extract came the next, as spraying by this material resulted in 16.5; 13.1-24.5 and 20.77; 17.44-23.75 dead heart cases/100 plants showing reductions in dead heart by 71.5 and 54.01 %, respectively in 1996 and 1997 seasons, respectively. Accordingly the onion juice and methanol extract were the only that could be categorized as highly effective preparations. The water onion extract and onion granules followed, respectively, the aforementioned preparation, as treatments by these two preparations resulted in 23.5; 13.2-39.3 and

Table (10): Averages in numbers of dead heart/100 plants due to *S. cretica* infestation during 1997 early summer plantation.

| Treatment | No. of dead heart/100 plants | | | | | % reduction than control |
|---|---|---|---|---|---|---|
| | $R_1$ | $R_2$ | $R_3$ | $R_4$ | Mean | |
| Water extract | 30.8 | 10.8 | 27.6 | 18.75 | $21.98 \pm 4.52^{ab}$ | 51.3 |
| Methanol extract | 19.3 | 22.6 | 23.75 | 17.44 | $20.77 \pm 1.45^{a}$ | 54.01 |
| Actone extract | 54.1 | 12.9 | 28.8 | 35.8 | $32.9 \pm .54^{abc}$ | 27.1 |
| Pet. ether extract | 30.5 | 24.3 | 56.9 | 34.5 | $36.55 \pm 7.10^{bc}$ | 19.09 |
| Juice of onion bulb | 22.9 | 19.48 | 25.3 | 8.9 | $19.14 \pm 3.62^{a}$ | 57.62 |
| Natural granules | 26.6 | 31.7 | 37.8 | 20.9 | $29.25 \pm 3.60^{ab}$ | 35.25 |
| Control | 53.7 | 29.1 | 32.7 | 65.2 | $45.17 \pm 8.61^{c}$ | |

F value = 2.59*
L.S.D. = 17.4

23.85; 16.9-30.6 dead heart cases, respectively in 1996 (Table 9) and 21.98; 10.8-30.8 and 29.25; 20.9-37.8 cases, respectively/100 maize plants in 1997 early summer season (Table 10), thus led to 59.4 and 58.8 % reductions in 1996 and to 51.3 and 35.25 % reductions in the dead heart cases than control in 1997. Consequently these two preparations may be considered as moderately effective in reducing the dead heart cases due to *S. cretica* infestation. The remaining two preparations; i.e. Acetone and petroleum ether extracts of onion proved as the least effective in reducing the dead heart symptoms than control. By spraying acetone onion extract in the whorl of maize plants, these plants showed the numbers of 26.3; 14-37.5 and 32.9; 12.9-54.1 dead heart cases/100 plants in 1996 (Table 9) and 1997 (Table, 10) seasons, respectively indicating 54.9 and 27.1 % reductions than control. While, treatments by petroleum ether extract of onion resulted in 24.4; 16.6-33.3 dead heart cases (57.9 % reduction) in 1996 and 36.55; 24.3-56.9 dead heart cases/100 plants showing only 19.09 % reduction in these cases than control (45.17 cases/100 plants) in 1997 early summer season.

**I. 5- Maize yield in relation to onion preparation treatments:**

At the end of 1997 early summer season, maize yield from each of the experimental plots was weighed in order to find out the effect of reducing *S. cretica* infestations by applying different onion preparations on the obtained grain yield. The mean yield obtained/plot was transferred to represent that of a feddan.

As shown in Table (11), the untreated maize plots yielded a mean of 7.53 Ardab/feddan. Treatments of maize plants by petroleum ether & acetone extracts of onion resulted in insignificant increases in the obtained yield which reached 9.12 and 9.78 Ardab/feddan, respectively indicating 21.04 and 29.73 % in the obtained yield than control. On the other hand, significant increases in grain yield were obtained when maize plants were treated by onion bulb granules, water & methanol extracts of onion and by onion bulb juice as the obtained grain yield reached 12.3, 17.19, 19.31 and 21.16 Ardab/feddan, respectively showing 63.11, 127.9, 156.0 and 180.5 % increase in the obtained yield, respectively than control. These data proved that onion juice may be considered as the best onion treatment as it led finally to the highest yield, followed by methanol and water onion extracts.

According to the obtained yield from different treatment and to the percentage of increase in this yield than control, the assayed preparations of onion may be, fairly, divided into the following three categories:

1- Highly efficient: including onion bulb juice which proved as the most efficient, followed by methanol extract and water extract of onion, respectively.
2- Moderately effective: represented by the onion granules which led to 63.11 % increase in grain yield than control.
3- Least effective preparations: those included petroleum ether and acetone extracts of onion which led to only 21.04 and 29.73 %

Table (11): Averages of yield weights/feddan in different treatments throughout 1997 maize early summer plantation.

| Treatment | Dry ears yield (kg) | | | | | Weight (Ardab/ feddan) | % increase than control |
|---|---|---|---|---|---|---|---|
| | $R_1$ | $R_2$ | $R_3$ | $R_4$ | Mean | | |
| Water extract | 16.5 | 14 | 18 | 16.5 | 16.25±0.82[b] | 17.19 | 127.91 |
| Methanol extract | 19.5 | 17.5 | 18 | 18 | 18.25±0.43[ab] | 19.31 | 156.0 |
| Actone extract | 10 | 13 | 10 | 14 | 9.25±1.77[cd] | 9.78 | 29.73 |
| Pet. ether extract | 11 | 8 | 7.5 | 8 | 8.63±0.80[d] | 9.12 | 21.04 |
| Juice of onion bulb | 20 | 21 | 19 | 20 | 20.0±0.5[a] | 21.16 | 180.5 |
| Natural granules | 9.5 | 13 | 10 | 14 | 11.63±1.11[c] | 12.30 | 63.11 |
| Control | 7 | 8 | 6.5 | 7 | 7.13±0.31[d] | 7.53 | |

F value = 34.72*
L.S.D. = 2.44
Ardab = 140 kg
dry weight of ardab = 225 kg
(4) Plots = (replicates) = 58.8 $m^2$

increases in the obtained grain yield than control.

### I. 6- Prolonged effect on onion preparations on *S. cretica*:

Pupae collected from different field treatments in 1997 early summer season were weighed and the observed malformations were recorded. Normal pupae were kept in plastic jars until adults' emergence. Malformations amongst the resultant moths were also recorded, while the normal adults were paired in glass chimney cages and allowed to lay their eggs which were counted for each of the onion treatments and control.

### 6.1- Effect on pupal weight:

From data presented in Table (12), it could be noticed that onion preparation treatments to maize plants caused significant reductions in weights of the obtained pupae that those collected from the untreated plots (0.207 gm for pupa from the control opposed to 0.123-0.168 gm for pupa from treated plants. The severest effect on pupal weight occurred to pupae collected from replicates treated by methanol onion extract showing a weight of 0.123 gm/pupa. This mean weight of pupa was, insignificantly, lower than that of pupa collected from acetone onion extract, onion bulb juice, water extract and petroleum ether extract (0.124, 0.127, 0.137 and 0.140 gm/pupa, respectively). While, the pupae collected from replicates in which maize was treated by natural onion granules showed a mean weight of 0.168 gm/pupa which proved heavier, significantly,than pupa from either of the remaining treatments although

Table (12): Averages in *S. cretica* pupal weight (gm./pupa) after field treatments of maize plants by different onion preparation (Data from 19 pupae/treatment)

| Treatments | Water extract | Methanol extract | Acetone extract | Petroleum ether extract | Juice of onion bulb | Natural granules | Control |
|---|---|---|---|---|---|---|---|
| Mean Weight (mg/pupa) | $0.137\pm0.01^{a}$ (0.09-0.2) | $0.123\pm0.006^{a}$ (0.1-0.17) | $0.124\pm0.01^{a}$ (0.07-0.21) | $0.14\pm0.006^{a}$ (0.11-0.21) | $0.127\pm0.008^{a}$ (0.09-0.22) | $0.168\pm0.02^{b}$ (0.12-0.31) | $0.207\pm0.011^{c}$ (0.12-0.22) |
| L.S.D. | 0.028 | | | | | | |
| % reduction than control | 33.98 | 40.44 | 40.37 | 32.41 | 38.76 | 22.81 | -- |

remained of significantly, lighter weight than control (Table 12).

As for the reduction percentages in pupal weight due to onion preparation treatments, methanol and acetone onion extracts caused the highest reduction percentages in pupal weight than control (40.44 and 40.37 %, respectively, Table (12). That was followed by onion bulb juice (38.76 %), water extract of onion (33.98 %) and petroleum ether extract (32.41 %). While, the least reduction in pupal weight than control (22.81 % occurred when maize plants were treated by natural granules of onion (Table 12).

### 6.2- Malformations in *S. cretica* pupae due to field treatment by onion preparations:

Among the collected pupae from different treatments, certain numbers of these pupae showed different degrees of malformation. Generally, the malformed pupae were stunted, compared to the normal ones, and showed indentation at the ventral side between the antennal and wing regions, and also between the third and fourth abdominal sigments.

The numbers and percentages of malformed pupae due to different onion preparation field treatments are tabulated in Table (13). These data, clearly, indicate that the lowest malformation cases than all onion preparation treatments (7.23 %) occurred among pupae collected from the untreated plots. This percentage was, insignificantly, Table (13): Percentages of malformated *S. cretica* pupae which were collected in different treatment throughout 1997 maize summer plantation season

| Treatments | Collected pupae | | | | | | | | Mean % malformed Pupae | % increase than control |
|---|---|---|---|---|---|---|---|---|---|---|
| | $R_1$ | | $R_2$ | | $R_3$ | | $R_4$ | | | |
| | No | %M | No | %M | No | %M | No | %M | | |
| Water extract | 16 | 14.2 | 9 | 12.5 | 19 | 18.75 | 9 | 12.5 | $14.48^{abc}$ | 100.38 |
| Methanol extract | 5 | 25 | 7 | 16.6 | 10 | 11.1 | 12 | 9.09 | $15.44^{bc}$ | 113.65 |
| Actone extract | 10 | 11.1 | 12 | 0.09 | 11 | 10 | 16 | 14.2 | $11.08^{ab}$ | 53.31 |
| Pet. ether extract | 14 | 7.6 | 14 | 7.6 | 12 | 9.09 | 13 | 8.33 | $8.15^{ab}$ | 12.79 |
| Juice of onion bulb | 7 | 16.6 | 22 | 22.22 | 20 | 17.6 | 22 | 22.22 | $19.74^{c}$ | 173.13 |
| Natural granules | 10 | 11.1 | 7 | 16.6 | 8 | 14.2 | 7 | 16.6 | $14.62^{abc}$ | 102.28 |
| Control | 20 | 5.26 | 34 | 9.6 | 16 | 6.66 | 29 | 7.40 | $7.23^{a}$ | |

F value = 8.77*
L.S. D. = 8.13

lower than the ***S. cretica*** pupal malformation percentages obtained after treatment by petroleum ether extract of onion (8.15 %), acetone extract (11.08 %), water extract (14.48 %) and onion granules (14.62 %). While, the obtained percentage from the control treatment was, significantly, lower the those obtained from methanol extract (15.44 %) and onion bulb juice (19.74) treatments.

It could be generally stated that treatment of maize plants by the juice of onion lead to ***S. cretica*** pupae having the highest malformation cases, followed by methanol extract, onion granules and water extract with insignificant differences between the 4 treatments. While, the malformation percentage which was obtained from treatment by onion juice appeared, significantly, higher than those recorded from the remaining 3 treatments.

**6.3- Effect on the percentages of malformed adults:**

Normal pupae collected from each field treatment were placed in plastic jars until emergence of ***S. cretica*** adults. The obtained adults were inspected for any malformations. The malformed moths were those having zigzagged, being completely unable to fly. The pedical region of antennae appeared incompletely broken and the abdomen appeared also of malformed shape. Malformed adults were counted and subsequently the malformation percentages amongst the obtained moths could be calculated. The obtained data are presented in Table (14).

A percentage of 7.08 % malformed ***S. cretica*** moths emerged

Table (14): Percentages of malformated *S. cretica* adult for normal pupae which collected in different treatment throughout 1997 maize summer plantation season

| Treatment | Collected adults | | | | | | | | Mean % malformed adult | % increase than control |
|---|---|---|---|---|---|---|---|---|---|---|
| | $R_1$ | | $R_2$ | | $R_3$ | | $R_4$ | | | |
| | No | % M | No | % M | No | % M | No | % M | | |
| Water extract | 9 | 12.5 | 9 | 12.5 | 9 | 12.5 | 9 | 12.5 | 12.5[ab] | 76.55 |
| Methanol extract | 5 | 25 | 5 | 25 | 9 | 12.5 | 9 | 12.5 | 18.75[ab] | 164.83 |
| Actone extract | 9 | 12.5 | 11 | 10 | 11 | 10 | 11 | 10 | 10.62[ab] | 50.07 |
| Pet. ether extract | 12 | 9.09 | 12 | 9.09 | 11 | 10 | 11 | 10 | 9.54[a] | 34.81 |
| Juice of onion bulb | 5 | 25 | 3 | 50 | 5 | 25 | 5 | 25 | 31.25[c] | 341.38 |
| Natural granules | 9 | 12.5 | 10 | 11.11 | 10 | 11.11 | 11 | 10 | 11.18[ab] | 57.91 |
| Control | 16 | 6.66 | 16 | 6.66 | 11 | 10 | 21 | 5 | 7.08[a] | |

F value = 8.83*
L.S. D. = 8.16

from pupae collected from the untreated plots. By application of different onion preparations to maize plants, higher percentages of malformed adults were detected than control. The increases in malformation percentages than control were insignificant when the used onion preparations were petroleum ether extract (9.54 %), acetone extract (10.62 %), natural granules (11.18 %)or water extract (12.5 %). While significant increases occurred by applications of methanol onion extracts and onion bulb juice (18.75 and 31.25 %, respectively; Table, 14). On the other hand, it is quite evident from the obtained results that treatment of maize plants with onion juice led to the highest percentage of malformations among the resultant moths with significant differences than all the remaining treatments, followed by methanol extract treatment (Table 14).

### 6.4- Effect on eggs reproductivity by emerged *S. cretica* females:

Healthy ***S. cretica*** moths that emerged from pupae collected from each treatment were paired, confined in glass chimny cages, supplied with 30 % sucrose solution and allowed to oviposit on rolled pieces of wax paper.

As shown in Table (15), females that emerged from pupae collected from the untreated plots showed highest reproductivity of eggs (average 92.17 eggs/female); being significantly higher than those counted from female moths resulted from pupae collected from maize plots treated by either of the 6 treatments of onion preparations. On the

Table (15): Averages of eggs production rate/*S. cretica* female resulted from pupae collected in different onion preparation treatments, in maize field (1997 early summer plantations)

| Treatment | Total deposited egg/*S. cretica* | | | | | % reduction than control |
|---|---|---|---|---|---|---|
| | $R_1$ | $R_2$ | $R_3$ | $R_4$ | Mean | |
| Water extract | 46.6 | 60 | 71.4 | 55.5 | 58.37±5.16$^b$ | 36.66 |
| Methanol extract | 53.5 | 50 | 60 | 57.6 | 55.28±2.21$^b$ | 40.03 |
| Actone extract | 80 | 75 | 76.9 | 66.6 | 74.63±2.87$^c$ | 19.03 |
| Pet. ether extract | 84 | 90 | 80.9 | 71.4 | 81.58±3.89$^c$ | 11.49 |
| Juice of onion bulb | 46.2 | 38 | 43.4 | 37.2 | 41.2±2.16$^a$ | 55.30 |
| Natural granules | 69.5 | 50 | 60.7 | 54.5 | 58.68±4.23$^b$ | 36.34 |
| Control | 92.9 | 88.1 | 97.6 | 90.09 | 92.17±2.06$^d$ | |

F value = 26.38*
L.S.D. = 10.03

contrary, moths from maize plots treated with onion juice deposited the lowest mean count of eggs (41.2 eggs/female), showing statistically significant differences that those counted from females resulted from the methanol onion extract treatment (55.28 eggs/female) and water onion extract (58.37 eggs/female) and significant differences than either of those recorded from the remaining four treatments (Table 15).

Concerning the eggs' reproductivity by *S. cretica* females obtained after treatments by water extract of onion and onion granules (58.37 and 58.68 eggs/female), those indicated that these two onion preparations had prolonged effect on the emerging females, although the counted total eggs deposited/female were, significantly, higher than those in case of onion juice treatment (41.2 eggs/female). While, acetone and petroleum ether extracts of onion were less effective on the resultant moth females which recorded the totals of 74.63 and 81.58 eggs/female (Table 15).

Regarding the reduction percentages in eggs reproductivity by *S. cretica* due to onion preparation treatments compared to that obtained from the control, data in Table (15) show that treatment of maize plants by onion juice caused the highest reduction (55.30 %), followed by methanol onion extract (40.03 %), water extract (36.66 %) and natural granules of onion bulb (36.34 %). While on the contrary, the lowest effect resulted from petroleum ether extract of onion which resulted in only 11.49 % reduction in the number of deposited eggs than control, followed by acetone extract which caused 19.03 % reduction in eggs reproductivity/ ***S. cretica*** female (Table 15).

The high efficacy of onion preparations, reported in this study, in reducing ***S. cretica*** egg-masses and larval infestations, and increasing the obtained yield confirms the findings of **Awadallah (1984)** who indicated that onion juice was the sole (among 13 aromatic plants) which acted as repellent of ***S. cretica*** moths that resulted in reducing the number of egg-masses to be as low as 3.8 egg-masses/100 plants opposed to 14.2 egg-mass/100 plants in the untreated check. Also, **Tantawy (1992)** found that intercropping of onion in sugarcane fields reduced the percentage of dead-hearts to 5.8 % opposed to 16.6 % due to ***S. cretica*** infestation among the onion free plants. **Awadallah *et al.* (1993)**, also, reported that planting corn into onion fields before onion last irrigation was useful since ***S. cretica*** infestation to maize plants was greatly reduced to non-harmful level, and the onion yield was not affected as well. The onion yield/unit area increased significantly even over corn when was planted alone and treated with the proper insecticide. Also, **Shalaby (1996)** found that planting onion in maize fields reduced the numbers of ***S. cretica*** egg-masses than control (8.8 egg-masses/100 plants). The means of egg-mass counts was reduced to 6.2, 4 and 3.2 egg-masses/100 plants due to interplanting onion bulbs in maize fields at distances 100, 50 and 25 cm., respectively. The same author recorded, also, the highest percentages of leaf feeding and dead-hearts in maize fields free from onion plants.

## II- Maize treatments by the entomopathogenic nematode, *Steinernema carpocapsae* for controlling *S. cretica*:

The water suspension of *Steinernema carpocapsae* was applied to maize plants at two concentration; 3000 and 1500 juveniles/ml, at a rate of about 2 ml in the whorl of each plant using a 1 L. sprayer. Spraying took place on April 1997, and the effect on the numbers of *S. cretica* larvae, perforated leaves, dead heart cases and the obtained yield were estimated and recorded.

### II. 1- Effect on the number of *Sesamia cretica* Led. larvae:

Data presented in Table (16) indicate, clearly, that *S. carpocapsae* may be, fairly, considered as an effective nematode species against *S. cretica* field infestations to maize plants. Treatment at either of the two applied concentrations (1500 and 3000 juveniles/ml) caused, significant, reduction in the number of counted *S. cretica* larvae/100 maize plants. The counted larval numbers of the pest under investigation reached means of 35.35 and 35.72 larvae by applying the mentioned concentrations, respectively opposed to a mean count of 129 larvae/100 maize plants from the control check (Table 16). Thus indicating reductions in the numbers of *S. cretica* infesting maize plants by 72.6 and 72.3 %, respectively than control. It is clear that both concentrations were, nearly, equal in their efficacy as the treated maize plants harboured nearly the same number of larvae and subsequently both caused nearly the same reduction percentage in the infesting larvae than control.

Table (16): Averages in *S. cretica* larval counts/100 maize plants after entomopathogenic nematode, *Steinernema carpocapsae* treatments on 1997 early summer plantation.

| Concentration Juveniles/ml. | No. of larvae/100 plants | | | | | % reduction than control |
|---|---|---|---|---|---|---|
| | $R_1$ | $R_2$ | $R_3$ | $R_4$ | Mean | |
| 1500 | 40 | 30 | 31.4 | 40 | 35.35±2.70$^a$ | 72.6 |
| 3000 | 35.08 | 35.8 | 38 | 34 | 35.72±0.85$^a$ | 72.3 |
| Control | 150 | 160 | 76 | 130 | 129±18.75$^b$ | |

F value = 24.3*
L.S.D. = 34.8

**II. 2- Effect on the number of perforated leaves:**

As shown in Table (17), a mean of 31.7 perforated maize leaves due to *S. cretica* infestations were counted/100 plants from the control plots. While, by application of *S. carpocapsae* water suspension in the whorl of plants, the numbers of perforated leaves were found to be reduced, significantly, to 19.27 and 16.59/100 maize plants for the concentrations 1500 and 3000 juveniles/ml., respectively. Thus indicating that the two nematode treatments caused 39.1 and 47.6 % reductions in the mean number of perforated leaves, respectively than control (Table 17). It could be also noticed from the same table that the difference between numbers of perforated leaves in the two treated maize areas was insignificant.

**II. 3- Effect on the number of dead heart cases:**

As occurred in cases of counting *S. cretica* larvae and perforated maize leaves; maize plants treated by the juveniles of *S. carpocapsae* showed, significantly, lower counts of dead heart cases than control (17.41 and 19.62 dead heart cases/100 plants treated by rates of 1500 and 3000 Juveniles/ml., respectively opposed to 45.17 dead hearts in plants of the control; Table 18). It is worthmentioning to indicate that the difference between means of dead heart cases in the two testaments was, statistically, insignificant. Table (18) shows also that nematode treatments at concentrations 1500 and 3000 juveniles led to 61.4 and 56.5 % reductions in the dead heart cases than control.

Table (17): Perforated leaf counts /100 maize plants due to *S. cretica* infestation after treatments of the 1997 early summer plantations by *S. carpocapsae* at two concentrations.

| Concentration Juvenoiles/ml. | No. of perforated leaves/100 plants | | | | | % reduction than control |
|---|---|---|---|---|---|---|
| | $R_1$ | $R_2$ | $R_3$ | $R_4$ | Mean | |
| 1500 | 14.2 | 26.6 | 18.8 | 17.6 | 19.27±2.62[a] | 39.1 |
| 3000 | 18.07 | 17.5 | 16.4 | 14.4 | 16.59±0.81[a] | 47.6 |
| Control | 47.1 | 16.6 | 32.7 | 30.4 | 31.7±6.25[b] | |

F value = 4.16*
L.S.D. = 12.63

Table (18): Dead heart counts/100maize plants due to *S. cretica* infestation after treatments of the 1997 early summer plantations by two concentrations of *S. carpocapsae*

| Concentration Juveniles/ml. | No. of dead heart cases/100 plants | | | | | % reduction than control |
|---|---|---|---|---|---|---|
| | $R_1$ | $R_2$ | $R_3$ | $R_4$ | Mean | |
| 1500 | 13.09 | 12 | 17.5 | 27.05 | $17.41 \pm 3.43^a$ | 61.4 |
| 3000 | 14.4 | 20 | 20 | 24.09 | $19.62 \pm 1.99^a$ | 56.5 |
| Control | 53.7 | 29.1 | 32.7 | 65.2 | $45.17 \pm 8.61^b$ | |

F value = 7.96*
L.S.D. = 17.4

**II. 4- Effect on the obtained final yield:**

The high efficacy of ***S. carpocapsae*** applications to maize plants on ***S. cretica*** which could be detected as significant reductions in counts of the pest larvae, perforated leaves and dead hearts, normally, reflected finally on the obtained yield which increased, significantly, due to nematode treatments than control. The mean grain yield obtained from the control weighed 7.62 kg/replicate. This yield increased in the treated plots to 15 and 11.75 kg/replicate by applying the nematode suspension at concentrations 1500 and 3000 juveniles/ml. (Table 19). By converting the obtained yield from the experimental plots to that per feddan, the resultant yield was 8.06 ardab/feddan for the control opposed to 15.87 and 12.43 ardab/feddan for the two nematode concentration treatments, respectively indicating increases in the final yield, by using ***S. carpocapsae*** for controlling ***S. cretica*** , reached 96.72 and 54.09 % due to the two treatments, respectively than control (Table, 19). It is clear from these results that ***S. carpocapsae*** may be considered as a very good biocontrolling agent against ***S. cretica*** infestations to maize plants and the lower concentration used; i.e., 1500 juveniles/ml is enough to obtain good results and there is no need to increase the nematode concentration in the applied suspension as this increase (up to 3000 juveniles/ml) did not cause any increasing effect than the lower concentration.

Table (19): Averages of yield weights/feddan after entomopathogenic nematode *S. carpocapsae* treatments throughout 1997 early summer plantations season.

| Concentration Juveniles/ml. | Dry ears yield (kg) | | | | | Weight (Ardab/feddan) | % increase than control |
|---|---|---|---|---|---|---|---|
| | $R_1$ | $R_2$ | $R_3$ | $R_4$ | Mean | | |
| 1500 | 16 | 15 | 13 | 16 | $15 \pm 0.70^c$ | 15.87 | 96.72 |
| 3000 | 13 | 10 | 13 | 11 | $11.75 \pm 0.75^b$ | 12.43 | 54.09 |
| Control | 7 | 9 | 6 | 8.5 | $7.62 \pm 0.68^a$ | 8.06 | |

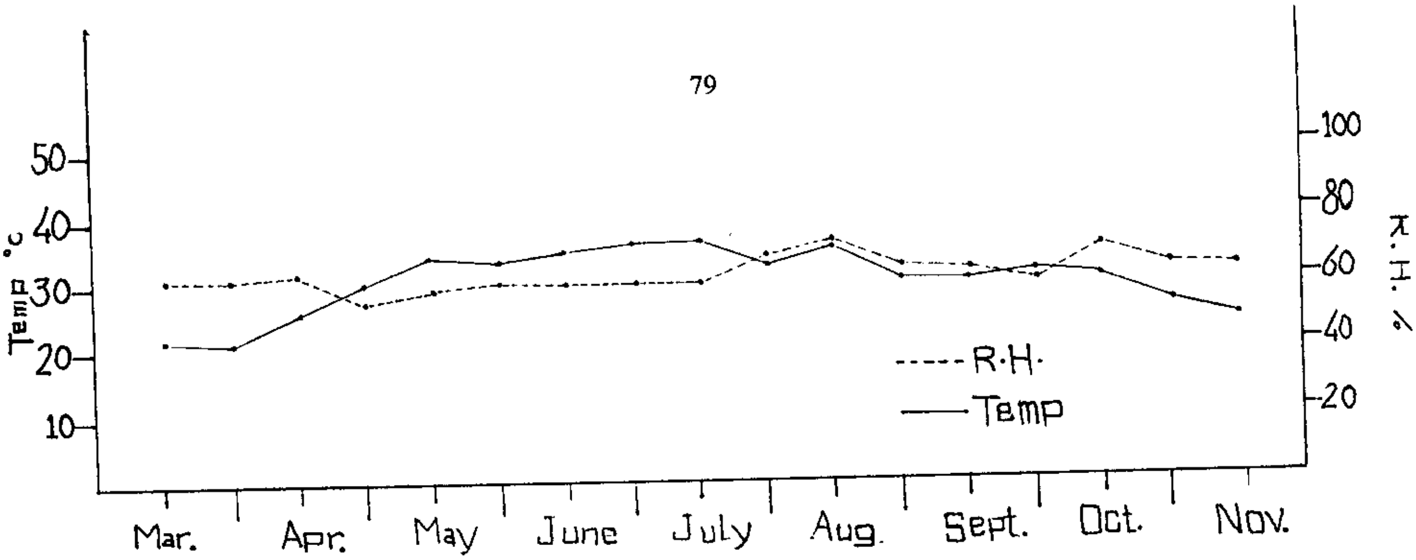
F value = 26.65*
L.S.D. = 2.29
Ardab = 140 kg (15.5 % R.H.)
dry weight of ardab = 225 kg
(4) Plots = (replicates) = 58.8 $m^2$

## III. Seasonal abundance of *S. cretica* moths:

A robinson type light trap was placed on a roof at the southern direction of the Experimental Farm of the Faculty of Agriculture at Moshtohor throughout the period extended from March, 1*st* until the end of November of each of 1996 and 1997. ***S. cretica*** moths were weekly counted. The obtained data are illustrated in Figs. (1 & 2) as means of biweekly counts during the mentioned period.

Data demonstrated in the mentioned figures show that ***S. cretica*** moths abundance in Qalubiyah Governorate took nearly the same trend of population abundance throughout the two years of study. No adult was trapped during the period extended from the beginning of December 1996 up to the beginning of March, 1*st* indicating that ***S. cretica*** moths were, nearly, absent from the field during this period. These data indicated that during these three months, almost,all the full grown larvae of ***S. cretica*** are in hibernation.

In both years of study, ***S. cretica*** moths started to appear in March, 15*th* by few number of moths in the light trap (17 moths/2 weeks in 1996 at 24.4 °C and 63 % R.H. in 1996; Fig. 1 and 11 moths/2 weeks in 1997 at 21.5 °C and 61.5 % R.H. in 1997; Fig. 2). From the mentioned figures, 4 peaks of abundance could be detected in each year. The first peak occurred in April, 15*th* (at 25.7 °C &60 % R. H. in 1996 and 25.4 °C&61.8 % R.H. in 1997)and was the highest(110 and 97 adults/2 weeks



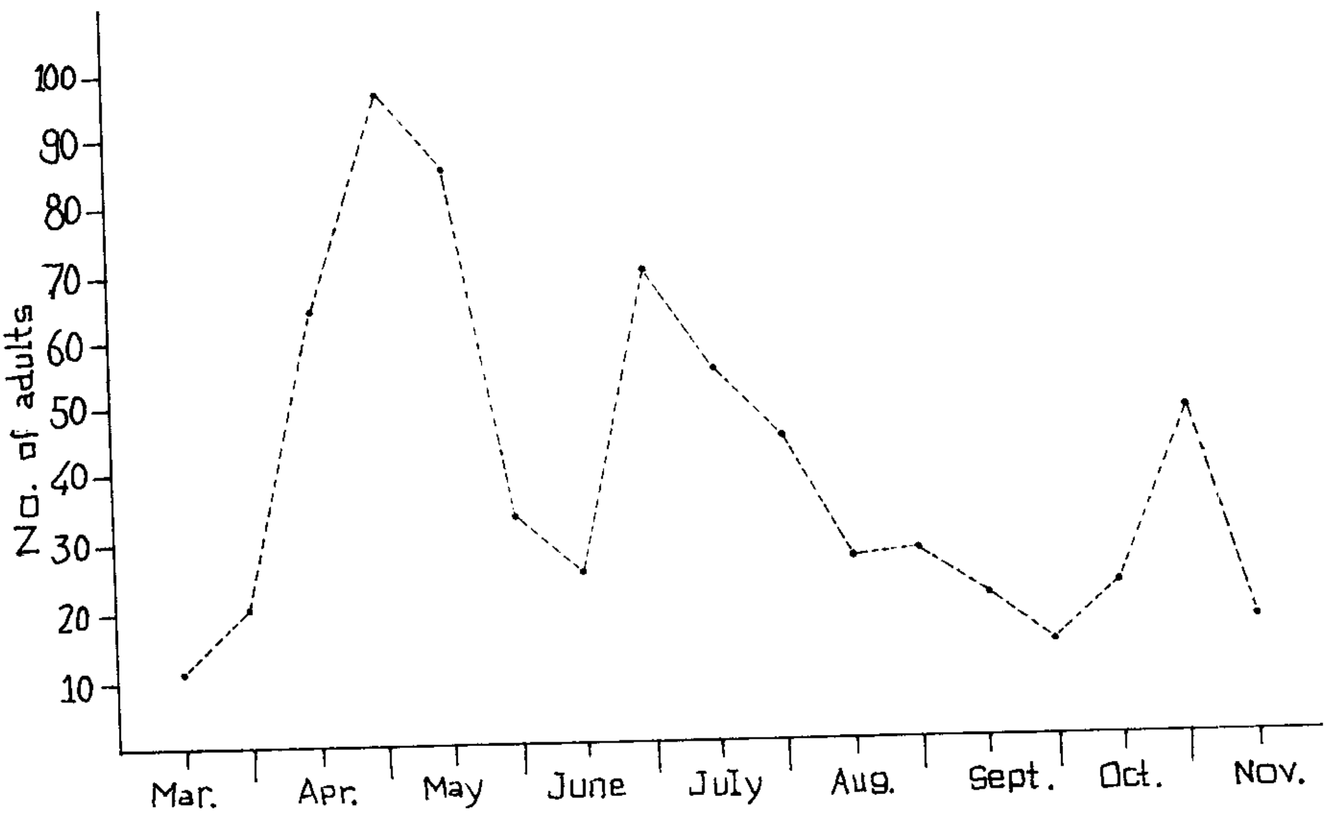




Fig. (2): Flactuations of *Sesamia cretica* Led.adults' population as indicated by a light trap during 1997 at Moshtohor region.

in 1996 and 1997, respectively). The second one which was much lower than the first, occurred on July, 1*st* and consisted of 58 moths at 34.9 °C & 66 % R.H. in 1996 and of 70 moths/week at 35.4 °C & 70 % R.H. in 1997. The third peak of abundance was the lowest and occurred on August, 15*th* 1996 at 35 °C and 65 % R.H. (45 adults) and on September, 1*st* 1997 at 30 °C and 62.8 % R.H.(28 moths). While, the fourth peak occurred, in both years, on November, 1*st* and was represented by 55 adults at 25.2 °C and 75 % R.H. in 1996 (Fig. 1) and by 49 moths at 26.5 °C and 63.5 % R.H. in 1997 (Fig. 2).

Regarding the 4 peaks of ***S. cretica*** population abundance of adults and from data illustrated in Figs. (1 & 2), it could be deduced that *S. cretica* moths were present in the field throughout the period extended from March, 15*th* up to half November and that the insect has, mostly, four generations at the region of study, those could be arranged as follows:

**First generation**: This generation was the highest abundant and extended for about 13 weeks (from mid-March;17 adults/2 weeks at 24.4 °C and 63 % R.H. in 1996 and 11 adults at 21.5 °C and 61.5 % R.H. in 1997 to mid-June when 33 adults were counted at 34 °C and 60 % R.H. in 1996 and 25 adults were counted at 34.5 °C and 59.5 % R.H. in 1997).

**Second generation**: This generation may be considered, fairly, the second in size as it followed the previously mentioned generation in the degree of moths abundance. It started, in both years of study, on June, 15*th* (33 & 25 adults, respectively) and extended up to the end of July, 1996 at 33.6 °C and 71 % R.H. when 45 moths were counted/biweekly (Fig. 1) and to August, 15*th* 1997 at 34.3 °C & 69.2 % R.H. by 27 moths/biweekly (Fig. 2).

**Third generation**: This generation was the least abundant. It started at the beginning of August, 1996 and on mid-August 1997 (34 & 34.3 adults, respectively) and extended for about 6-8 weeks up to the end of September of both years when a number of 30 moths were counted at 33.7 °C &66 % R.H. in the former year, and 21 moths were counted at 30.2 °C & 62 % R.H. in the latter one.

**Fourth generation**: This generation was the third in its size, as it followed the second one in the degree of abundance. It extended for a period of about 6 weeks from the beginning of October of both years (25 & 14 moths, respectively) up to mid-November by 25 adults/biweekly at 25 °C & 78 % R.H. in 1996 (Fig. 1) and by 18 adults/biweekly at 24.8 °C and 63.1 % R.H. in 1997 (Fig. 2).

In agreement with the present results concerning the number of ***S. cretica*** generations, **Hassanein and Badawy (1959)** determined four annual generations at Shebin El Kom, the 1*st* extended from May to June, 2*nd* extended from June to July, 3*rd* extended from July to August and 4*th* extended from August to October. While, **Isa, (1959) and El**

**Sherif (1965)** revealed that the *1st* generation extended from the first week of February to the first week of March, *2nd* from the second week of March to the second week of July, *3rd* extended from August to the second week of October and *4th* on November. **Awadallah (1974)** determined also four annual generations at Bahtim region; the first generation at the first week of May and the last one at the fourth week of August in 1969, while in 1970 the first occurred at the second week of May and the last at the third week of September. In Kafr El Sheikh, **Shalaby (1996)** agreed with the former results and revealed that the first generation was almost the strongest one and lasted 11-13 weeks and reached its peak at April and May in both years of study, the second generation occurred at late June and July, the third generation was the shortest and lasted 4-5 weeks during August and the fourth generation continued for a markedly long period beginning from August or September to October or November.

On the other hand, the presented results disagree with the results of some other authors such as **Ahmed & Kira (1960) and Abdalla & Bleih (1994)** that reported two annual generations of ***S. cretica***, while **Ismail (1968)** stated that the insect had three annual generations/year, but **El Saadany (1965), El Naggar (1967) and Mostafa (1981)** deduced from their results that it had five generations annually. These disagreements with the present results may be due to the differences in environmental conditions, on one hand, and the differences it the technique followed in counting the annual generations, on the other hand.

**IV. Laboratory bioassay tests on onion preparations against *S. cretica*:**

Freshly hatched ***S. cretica*** larvae were allowed to feed on fresh tender pieces of the upper growing parts of maize stems treated with either of the six onion preparations or water. Two days later, larval mortalities were recorded and the supplied food was renewed with another fresh untreated food. Mortality records and renewing of food took place every couple of days until pupation.

Two days after treatment a percentage of 6.25 % mortality was recorded amongst the control larvae (those fed on maize stem pieces treated with water only), while amongst the larvae fed on food treated with different onion preparations, the mortality percentages ranged from 20 % (petroleum ether and acetone extract treatments) to 33.3 % by feeding on food treated by water onion extract (Table 20).

Table (20) shows the cumulative mortality percentages among ***S. cretica*** treated larvae throughout 30 days after treatment when the remaining alive larvae transferred to the pupal stage, The recorded cumulative mortalities showed successive increases in percentages indicating that the tested onion preparations continued their effect up to the 26*th* or 30*th* days after treatment. From the tabulated mortality percentages, it could be concluded that water extract of onion and onion juice had the severest direct toxicity on ***S. cretica*** 1*st* instar larvae as 33.3 and 32 % of the treated larvae died, respectively at 48 hours post-

Table (20): Corrected mortality percentages of *S. cretica* 1*st* instar larvae fed on pieces of maize stem treated with different onion preparations (at 31± 2 °C and 60 ± 5 % R.H.)

| Treatments | Cumulative mortality percentages after periods (days) of treatments | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2 | 6 | 10 | 14 | 18 | 22 | 26 | 30 | |
| Water extract | 33.33 | 37.68 | 53.73 | 58.75 | 72.30 | 79.68 | 85.93 | 90.62 | The surviving larvae reached the pupal stage |
| Methanol extract | 30.66 | 36.23 | 55.22 | 56 | 58.46 | 65.62 | 73.37 | 78.12 | |
| Acetone extract | 20 | 21.73 | 25 | 30.43 | 34.37 | 42.18 | 50 | 60.93 | |
| Pet. ether extract | 20 | 20.28 | 20.89 | 21.21 | 23.07 | 25 | 28.12 | 35.87 | |
| Onion bulb Juice | 32 | 53.62 | 64.17 | 69.69 | 76.92 | 82.81 | 84.68 | 90.62 | |
| Natural granules | 24 | 30.43 | 38.80 | 43.93 | 49.23 | 53.12 | 60.93 | 60.93 | |
| Control | 6.25 | 13.75 | 16.25 | 17.5 | 17.5 | 20 | 20 | 20 | |

treatment. After 6 days of treatment, onion juice caused the highest mortality rate (53.62 %), while mortality due to water treatment increased to 37.68 %. During the subsequent period, the mortality percentages increased successively in both treatments until reached the highest percentage (90.62 %) after 30 days of treatment by either of the two preparations. Methanol extract of onion was the third in its effectiveness, it could be categorized as highly effective (33.66 to 78.12 % mortality after 2 and 30 days of treatment, respectively). Onion bulb granules and acetone extract of onion could be considered as moderately effective as those caused 24-60.93 and 20-60.93 % mortalities, respectively, (Table, 20). The remaining preparation; i.e., petroleum ether extract of onion could be, fairly, categoriezed as the least toxic onion preparation on ***S. cretica*** larvae (20-35.87 % mortality after 2 and 30 days of treatment; Table 20).

The $LT_{50}$ values due to feeding the ***S. cretica*** first instar larvae on pieces of young maize stems treated by different onion preparations are tabulated in Table (21) and illustrated in Fig. (3). The presented data show that the shortest $LT_{50}$ value (5.2 days after treatment) was obtained from treatment the maize pieces by onion bulb juice. Water onion extract came the next as it caused 50 % mortality of the treated larvae after 8.4 days of treatment, then methanol extract which resulted an $LT_{50}$ of 10 days while, onion granules and acetone extract of onion caused mortality of 50 % of the treated larvae after much longer periods (17.5 and 26 days of starting treatment; Table 21 and Fig. 3) indicating much lower efficacy on ***S. cretica*** 1*st* instar larvae than the former 3 onion preparations.

Table (21): Comparative mortality-time values of *S. cretica* 1*st* instar arvae fed on maize stem pieces dipped in different onion preparation treatments

| Treatment | $LT_{50}$ | Slope | Confidence limits at $P_{0.05}$ of | |
|---|---|---|---|---|
| | | | $LT_{50}$ | Slope |
| Water extract | 8..4 | 3.16 | 7.26 - 9.71 | 2.21 - 4.52 |
| Methanol extract | 10 | 4.52 | 8.38-11.93 | 2.37 - 8.58 |
| Actone extract | 26 | 4.01 | 22.10 - 30.57 | 2.00 - 8.02 |
| Onion bulb juice | 5.2 | 4.76 | 4.27 - 6.32 | 3.28 - 6.90 |
| Natural granules | 17.5 | 6.74 | 13.76 - 22.24 | 2.10 - 21.56 |

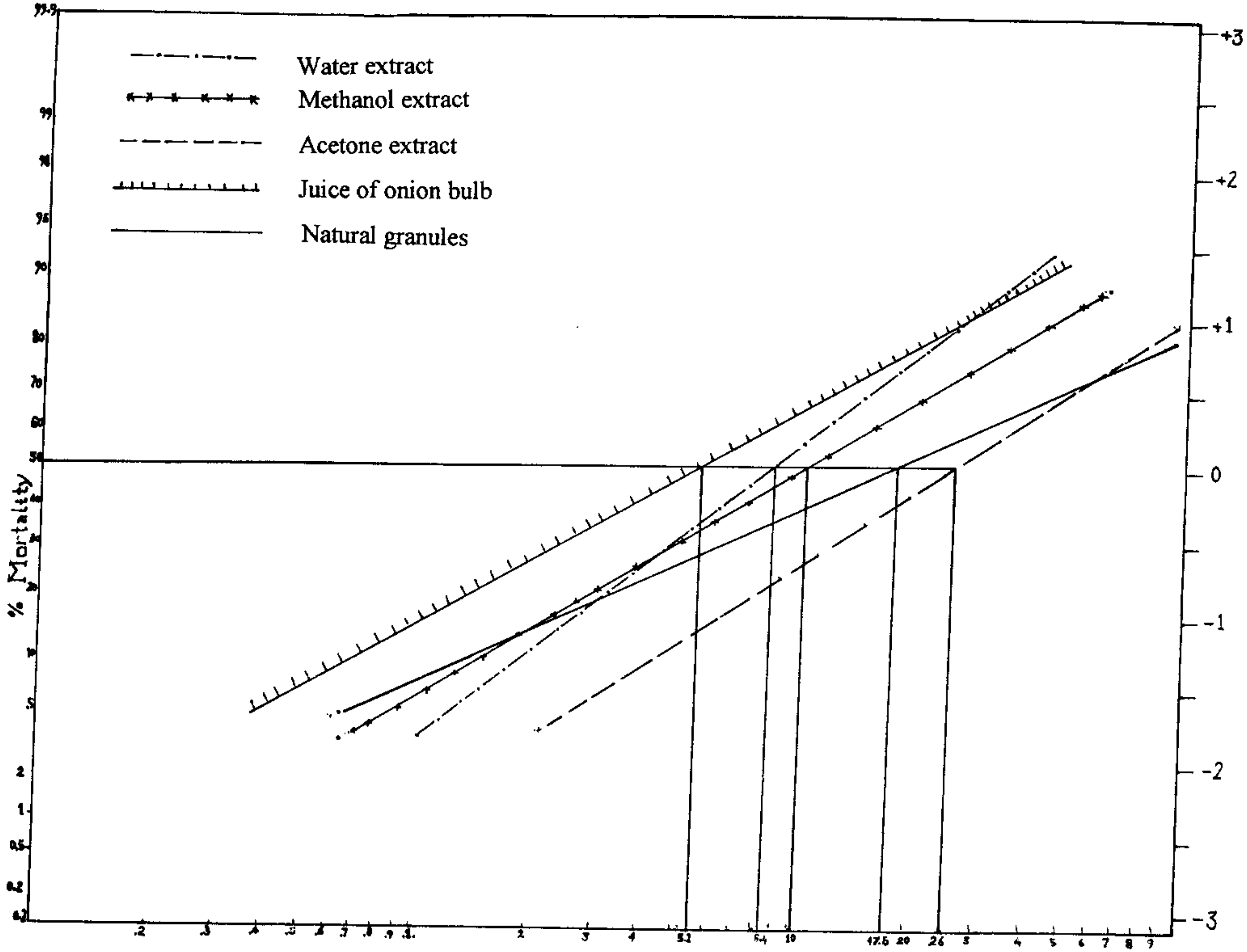



Fig. (3): Probit-regression-time lines showing response of 1*st* instar *S. cretica* larvae fed on tender pieces of maize stem treated with different onion preparations..

V- *Pteromalus* sp., a pupal parasitoid on *S. cretica*:

Throughout the field study of this investigation, ***S. cretica*** pupae were collected from maize replicates and kept in plastic containers until moths emergence, From some of these pupae adults of a gregarious hymenopterous endoparasitoid were observed to emerge from the collected pupae. This parasitoid was identified as *Pteromalus* sp. (Hymenotera : Pteromalidae). The adult male and female are photographically presented in fig. (4).

According to the available literature most of the parasitoid species that were recorded on ***S. cretica*** belong to Hymenoptera and those included the scelionid egg parasite, ***Platytelenomus hylas*** **(Ahmed and Kira, 1960; El-Naggar, 1967; Fayad, 1975 and Hafez *et al.* 1977 a),** the braconid larval ectoparasite ***Bracon brevicornis*** **(Temerak, 1976; Saleh 1986; Lutfallah and Kares, 1989; El-Heneidy and Hassanein, 1989 and El-Said, 1992)**, the endolarval solitary braconid, ***Meteorus gyrator*** **(El-Heneiday and Hassanien, 1992)**, the endolarval gregarious parasitoid, ***M. rubers*** **(El-Heneidy** and **Hassanein, 1989)** and **Gesraha, (1993)** and the gregarious endopupal eulophid parasitoid, ***Pediobus farvus*** **(El-Wakeel, 1997).**

As far as the writer knows, the ***S. cretica*** pupal parasitoid found in this investigation; i.e.; ***Pteromalus*** **sp**. has never been recorded on ***S. cretica*** in any of the available literature. Accordingly, it could be fairly considered the first record of ***Pteromalus*** **sp**. on ***S. cretica***.

(A)

(B)

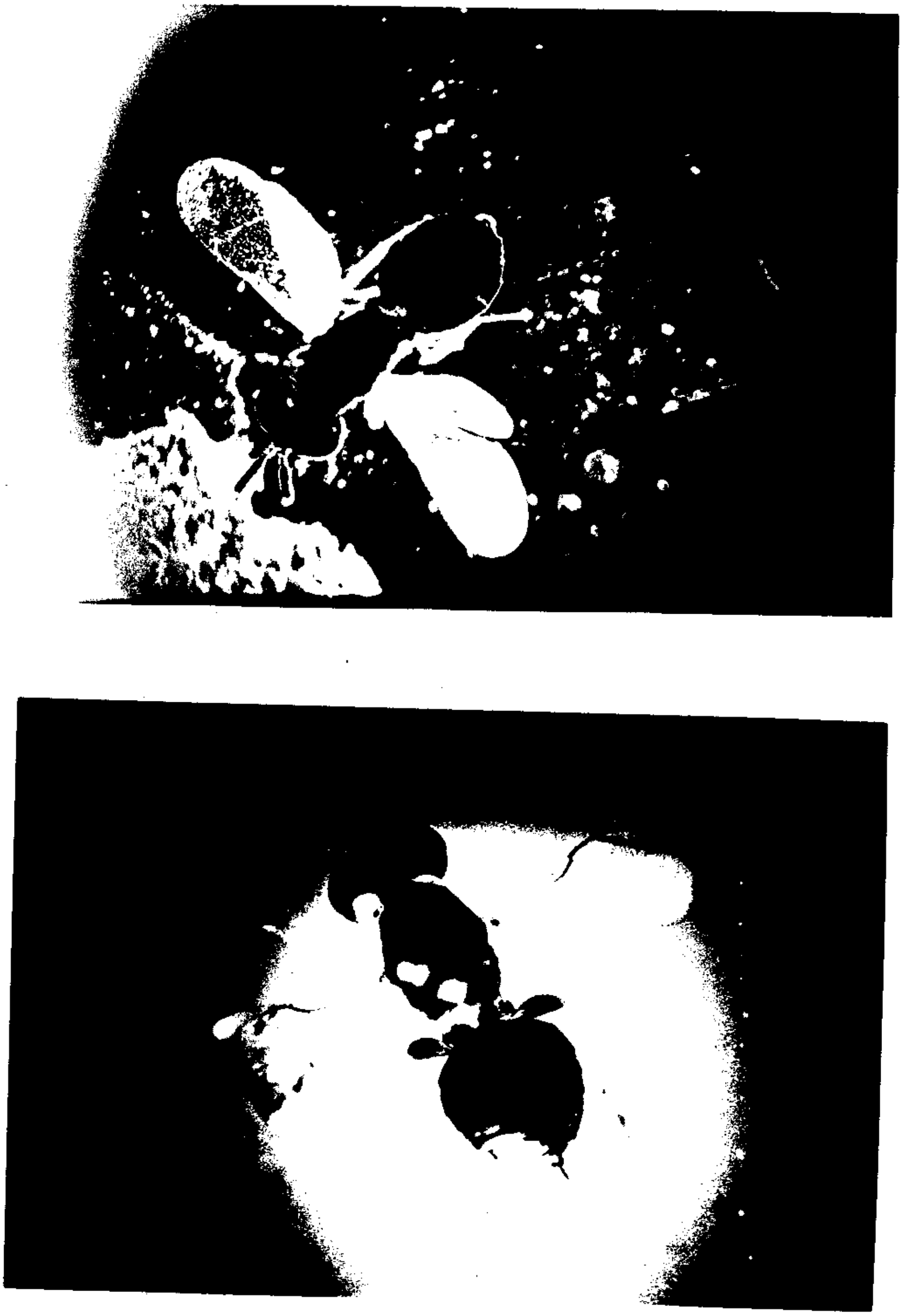


Fig. (4): Male (A) and Female (B) adults of *Pteromalus* sp. (20x)

As for parasitism by ***Pteromalus; P. puparum*** was reported as a gregarious pupal parasitoid on ***Pieris rapae*** in Egypt by **El Ghadri (1937) and Abbas & Dakroury (1985)** and in USA by **McDonald and Kok, (1990)** on pupae of ***P. brassica*** in France by **Bouletreau and David (1967)** and in Pakistan by **Mushtaque *et al.* (1993)**; on pupae of ***Artogeia rapae*** L. infesting cabbage in USA by **Lasota and Kok (1986a & b)** and in Georgia, Athens (**Chamberlin and Kok, 1986**); on ***Papilio xuthus*** L. infesting citrus in Japan by **Takagi (1976 & 1987),** and on ***Papilio demoleus*** in Pakistan by **Rafi *et al.* (1991).** Other species belonging to the same genus included ***Pteromalus potaniae*** which was reported by **Askew (1985)** in UK as a parasitoid in galls of alpine potania species on ***Salix. Pteromalus apum*** **(Relizius)** was recorded to parasitise the alfalfa leafcutting bee, ***Megachile rotundata*** **(Fabr.)** in Europe (**Holm and Farkes, 1986**), while **Tepedino (1988a & b)** revealed that ***Pteromalus venustus*** emerged from the immature stages of the same host species, ***M. rotundata*** in USA.

**Roininen *et al.* (1996)** found that ***P. caprea*** was the most common parasitoid attacking the gall sawfly, ***Salix pentandra*** in Finland. **Romstoeok-Voelkl (1990)** found that the larvae of the dipterous, ***Tephritis conura*** **Loew** which live gregariously in flower heads of ***Crisium helerophyllum*** **(L.)** were parasitised by ***Pteromalus cavdiger*** **(Graham).** Also, **Biran Wen et al. (1995)** studied ***Pteromalus cerealella*** **(Ashmead),** a successful parasitoid on larvae, prepupae and pupae of the Angoumois grain moth, ***Sitotroga cerealella.*** **Smith *et al.***

(1995) revealed that parasitism by ***P. cerealella*** was greater on ***S. cerealella*** than on the maize weevil, ***Sitophilus zeamais*** Moschulsky.

## V.1- Numbers of *Pteromalus* sp. adults emerging from an *S. cretica* pupa:

As a matter of fact, ***Pteromalus*** sp. was found as a gregarious endopupal parasitoid on ***S. cretica***. The number of adults which emerged from a single pupa was counted when pupae were exposed, individually, each to a mated parasitoid female in a glass vial for 24 and 48 hours. Data tabulated in Tables (22 & 23) indicate that the number of ***Pteromalus*** sp. individuals that could complete their life-cycle inside a single pupa increased as the period of exposure to the female prasitoid increased. By exposure for 24 hours the mean number of adults emerged were 5.8±0.29 (5-7) adults/pupa (Table, 22). As the exposure period was prolonged to 48 hours, the emerged mean number of parasitoid adults increased to about 7 times that obtained in the former exposure period (35 7±2.08; 28-46 adults/pupa; Table 23). On ***Pteromalus puparum*** **Abbas and Dakroury (1985)** found that in samples collected from the field; 1-105 adults emerged from a single ***Pieris rapae*** pupa, and reached a maximum of 149 adults when the parasitoid was reared in the laboratory.

## V.2- Sex-ratio of *Pteromalus* sp. reared on *S. cretica* pupae:

Females of ***Pteromalus*** sp. could be easily differentiated, in the laboratory, from males by the distinct ovipositor which could be easily recognized on the ventral side of the terminal end of female abdomen (Fig. 3). Amongst the adults obtained in the laboratory, the number of females dominated those of males, irrespective of the period during which pupae were exposed to the parasitoid. But, it could be also noticed from Tables (22 & 23) that the sex-ratio varied according to the expeosure period. By exposure of the host pupae to the parasitoid mated females for 24 hours, a total of 58 adults were obtained in the laboratory, from which 42 were females and 16 were males indicating a sex-ratio of 2.5 ♀♀ : 1 ♂(Table, 22). By increasing the exposure period to 48 hours, a total of 357 adults were obtained. This number was differentiated to 227 females and 130 males. Thus indicating a sex-ratio of 1.75 ♀♀ : 1 ♂) in the latter case (Table 23). These data indicated that the percentage of females in the resultant progeny decreased when more parasites developed in each *S. cretica* pupa. In this respect, **Abbas and Dakroury (1985)** reported a sex-ratio of 6 females : 1 male among ***P. puparum*** adults emerged from pupae of ***Pieris rapae***. **Takagi (1986)** indicated that when more than one ***P. puparum*** females attacked a single host pupa, the number and sex-ratio of progeny per host increase.

## V.3- Longevity of *Pteromalus sp.* adults emerged from pupae of *S. cretica*:

Adult males and females were kept, individually, and supplied with either of bee-honey, 50 % sucrose solution or water droplets, or kept starved with nutrition at 27±2 °C and 65±5 % R.H.

Table (22): Sex-ratio of *Pteromalus* sp. in the laboratory after 24 hours exposure to *S. cretica* pupae.

| Pupae No. | No. of emerged adults/pupa | Obtained | | Sex-ratio | | |
|---|---|---|---|---|---|---|
| | | Female | Male | Females | : | Male |
| 1 | 5 | 4 | 1 | 4 | : | 1 |
| 2 | 5 | 5 | - | 0 | : | 0 |
| 3 | 6 | 4 | 2 | 2 | : | 1 |
| 4 | 7 | 5 | 2 | 2.5 | : | 1 |
| 5 | 7 | 5 | 2 | 2.5 | : | 1 |
| 6 | 5 | 3 | 2 | 1.5 | : | 1 |
| 7 | 5 | 3 | 2 | 1.5 | : | 1 |
| 8 | 7 | 5 | 2 | 2.5 | : | 1 |
| 9 | 5 | 4 | 1 | 4 | : | 1 |
| 10 | 6 | 4 | 2 | 2 | : | 1 |
| Overall | 5.8 ± 0.29 | 42 | 16 | 2.5 | : | 1 |

Table (23): Sex-ratio of *Pteromalus sp.* in the laboratory after 48 hours exposure to *S. cretica* pupae.

| Pupae No. | No. of emerged adults/pupa | Obtained | | Sex-ratio | |
|---|---|---|---|---|---|
| | | Females | Males | Female | Male |
| 1 | 36 | 23 | 13 | 1.8 : | 1 |
| 2 | 29 | 19 | 10 | 1.9 : | 1 |
| 3 | 30 | 20 | 10 | 2.0 : | 1 |
| 4 | 41 | 26 | 15 | 1.3 : | 1 |
| 5 | 30 | 20 | 10 | 2.0 : | 1 |
| 6 | 36 | 24 | 12 | 2.0 : | 1 |
| 7 | 45 | 28 | 17 | 1.7 : | 1 |
| 8 | 46 | 26 | 20 | 1.3 : | 1 |
| 9 | 36 | 23 | 13 | 1.8 : | 1 |
| 10 | 28 | 16 | 10 | 1.8 : | 1 |
| Overall | 35.7±2.08 | 227 | 130 | 1.75 : | 1 |

From data tabulated in Table (24), it could be noticed that, irrespective of the applied regime of nutrition, females had a longer life-span than males. It is also clear from the same table that adults of the parasitoid supplied by bee-honey manifested, significantly, the longest life-span of both sexes (17.3±2.2; 9-31 and 25.9±1.63; 19-31 days for males and females, respectively). The 50 % sucrose solution came the next (5.7±1.56; 1-16 and 11.4±1.74, 1-20 days, respectively).While, adults which were supplied with water or kept starved lived for very short periods of 1.5 days in case of males and 3. or 3.4 days in case of females (Table, 24).

Table (24): Effect of food type on the longevity of *Pteromalus* sp. adults (at 27±2 °C and 60±5% R.H.)

| Treatment | Longevity of adults (days) | |
|---|---|---|
| | Male | Female |
| Starvation | 1.5 ± 0.16[c] (1-2) | 3.44 ± 0.22[c] (2-4) |
| Water | 1.5 ± 0.16[c] (1-2) | 3.0 ± 0.53[c] (1-6) |
| Bee honey | 17.3 ± 2.20[a] (9-31) | 25.9 ± 1.63[a] (19-31) |
| 50 % sucrose sol. | 5.7 ± 1.56[b] (1-16) | 11.4 ± 1.74[b] (1-20) |
| F. Value | 30.37 | 85.67 |
| L.S.D. | 3.88 | 3.32 |

# CONCLUSION

# CONCLUSION

In this study six onion preparations; i.e., onion extracts by water, methanol, acetone and petroleum ether, onion juice and onion bulb granules, and also two concentrations of the entomopathogenic nematode suspension in water were applied in the field in the whorl of maize plants sown at early summer plantation to field out their efficacies against *Sesamia cretica* Led. and their effects on the resultant yields. The parameters used for evaluation included the numbers of *S. cretica* egg-masses, *S. cretica* larvae, perforated leaves and dead-heart cases, in addition to the prolonged effect on pupae and adults. The dry ears yield resulted from treated and control plots was weighed and transferred as Ardab/feddan.

From the obtained results, it could be concluded that all of the applied preparations, which are completely safe to the environment, gave different rates of *S. cretica* control. As for the six onion preparations; onion juice followed by onion extract by methanol may be, fairly, considered the best treatments. Those led to more than 50 % reduction in the egg-mass counts, mostly more than 80 % reduction in *S. cretica* larval counts, 66 and 49 % reductions in the numbers of perforated leaves, more than 60 % reductions in the dead-heart cases, in addition to 181 and 156 % increase in the resultant yield than control. These increases in yield may be attributed mainly to the efficacy of these two preparations against *S. cretica* which mostly causes complete damage of maize plants especially those dead-hearted due to larval infestations to maize seedlings. In addition to the mentioned effects, these preparations manifested prolonged effects on pupae which showed higher rates of malformed individuals (19.74 and 15.44 %, respectively opposed to 7.23% among control pupae), and adults which showed also malformations (31.25 and 18.75 % respectively opposed to 7.1 % among adults from control), and showed also reductions in eggs-reproductivity (55.3 and 40 % reductions, respectively, than those deposited by a control female, *i.e.*, 92.2 eggs/female). The water extract of onion followed by onion bulb granules gave also good results although proved of lower efficacy than the two former preparations. While, on the contrary, acetone and petroleum ether extracts of onion proved, mostly, as the least effective although those caused significant reductions in egg-masses and larval counts, perforated leaves and dead-heart, while the increases in the yield weights were insignificant than that from control plots.

Laboratory assays were also conducted to study the toxicity of each of the six onion preparations of *S. cretica* larvae when the contaminated tender maize stems were offered to the 1*st* instar larvae. Data showed, to great extent, confirmation to the field results where the shortest $LT_{50}$ (5.2 days) occurred when larvae were allowed to feed on maize stems contaminated with onion juice, followed by water and methanol extracts. As occurred in field studies, acetone and petroleum ether extracts of onion were the least effective.

Generally, it is thought that these preparations proved as very good controlling materials and may be used in the near future as alternatives of the classical control methods for the maintenance of clean, unpolluted environment. But, further intensive studies have to be carried out to find out the active ingredient responsible for control to be synthesized and used in manufacture of new clean insecticides for controlling *S. cretica* in the field.

Field studies by application of *Steinernema carpocapsae* suspension in water at two concentrations (1500 & 3000 juveniles/ml.) confirmed that this species which is well known by wide range of insect hosts, was also effective against the sugarcane borer, *S. cretica.* Treatments caused significant reductions in the number of larvae infesting maize stems, perforated leaves and dead-hearted plants, and significant increases in the resultant yield than control. Generally, the lower concentration gave better results than higher one. This entomopathogenic species of nematode proved efficient against the pest under study, and it is thought that more efforts and studies have to be paid on wide areas cultivated with maize and by using more concentrations than those used in this experiment, in addition to laboratory studies to confirm the field studies to reach an exact evaluation of this nematode species which may prove in the near future as a very good and safer alternative to chemical insecticides used for *S. cretica* control.

Studies concerning the seasonal abundance of *S. cretica* moths by light traps indicated four peaks of moths abundance and according to the curve of moths' abundance it could be concluded that *S. cretica* may have 4 generations in Qalyubiyah Governorate. The obtained data are, undoubtedly, useful for prediction and precising the best time for *S. cretica* control. This time is preferably at the beginning of each generation (mid-March, mid-June, beginning or mid-August and beginning of November). But, it is usually of great importance that actual evaluation of the rate of infestation in the field at each date has to be carried out.

Finally, the hymenopterous endopupal gregarious parasitoid, *Pteromalus* sp. that emerged from *S. cretica* pupae was the first record on this pest in Egypt and the world. Due to the high activity of this parasitoid, its gregarious habit in which a range of 5-46 adults were counted to emerge from one pupa, its relatively long life-span of adults fed on pure bee-honey droplets, and also due to the dominance of female numbers than males (1.75-2.5 females : one male), it is thought that mass production and release of this parasitoid in maize fields may prove as very effective biocontrol method against *S. cretica*. It seems necessary to consider this parasitoid in addition to the true egg-parasitoid, *Platytelenomus hylas* in any IPM program against the pest under study.