RESULTS AND DISCUSSION

IV. RESULTS AND DISCUSTION

I. Laboratory studies:

1. Effect of temperature on some biological aspects of *P. gossypiella* (Saund.):

Temperature is the main abiotic factor which influence the biology and population dynamics of pests. Development and formation of pink bollworm eggs, growth of larvae, pupae and adults are temperature related (**Butler and Hamilton (1976)**). The aim of this study was to establish the effect of constant temperatures on some biological aspects of pink bollworm. This study covered the relationship between the different constant temperatures and the developmental rates for the different stages, generation and the requirement of thermal heat units expressed as degree-days needed for completing each stage.

1.1. Egg Stage:

In this stage, the study included the incubation period, thermal heat units required to complete embryological development and the hatchability percentage.

1.1.1. Incubation period of eggs and thermal heat units required:

Date given in Table (1) show that the mean of incubation periods of pink bollworm eggs lasted 12.40, 7.54, 5.65, 4.35 and 3.45 days under constant temperatures 19, 22, 25, 28 and 31 °C, respectively.

Table (1): Effect of different constant temperatures on durations (in days) of immature stages, adult emergence percent and longevity (days) of *Pectinophora gossypiella* (field strain).

<table>
<tr><th colspan="2" rowspan="2">Stage</th><th colspan="5">Temperature °C</th></tr>
<tr><th>19</th><th>22</th><th>25</th><th>28</th><th>31</th></tr>
<tr><td rowspan="2">Egg</td><td>Incubation period</td><td>12.40</td><td>7.54</td><td>5.65</td><td>4.35</td><td>3.45</td></tr>
<tr><td>Hatchability percentage</td><td>57.9</td><td>66.58</td><td>78.70</td><td>83.23</td><td>63.43</td></tr>
<tr><td rowspan="2">larva</td><td>larval period</td><td>0</td><td>25.32</td><td>19.22</td><td>15.31</td><td>13.27</td></tr>
<tr><td>% of Mortality in larval stage</td><td>49.35</td><td>35.60</td><td>19.35</td><td>26.12</td><td>37.20</td></tr>
<tr><td colspan="2">Pre pupal period</td><td rowspan="12">All larvae entered diapause</td><td>5.24</td><td>4.02</td><td>3.44</td><td>2.35</td></tr>
<tr><td colspan="2">Pupal period</td><td>13.00</td><td>9.34</td><td>8.24</td><td>7.86</td></tr>
<tr><td colspan="2">Adult emergence %</td><td>70.50</td><td>76.32</td><td>80.90</td><td>73.22</td></tr>
<tr><td rowspan="4">Adult females</td><td>Pre-oviposition period</td><td>4.59</td><td>3.38</td><td>2.95</td><td>2.35</td></tr>
<tr><td>Oviposition period</td><td>9.32</td><td>8.71</td><td>6.15</td><td>4.88</td></tr>
<tr><td>Post-ovipostion period</td><td>7.61</td><td>4.38</td><td>2.14</td><td>1.75</td></tr>
<tr><td>Total longevity</td><td>21.52</td><td>16.47</td><td>11.24</td><td>8.98</td></tr>
<tr><td colspan="2">Male longevity</td><td>19.23</td><td>15.6</td><td>12.35</td><td>6.89</td></tr>
<tr><td colspan="2">Mean No. of eggs/♀</td><td>39.40</td><td>117.67</td><td>48.04</td><td>17.80</td></tr>
<tr><td colspan="2">Hatchability percentage</td><td>49.50</td><td>86.33</td><td>84.25</td><td>20.24</td></tr>
<tr><td colspan="2">Life-cycle</td><td>55.69</td><td>41.61</td><td>34.19</td><td>29.00</td></tr>
</table>

The thermal heat units in degree-days (DD) needed for completing egg development were 78.62, 70.42, 69.72, 66.73 and 63.27 DD for 19, 22, 25, 28 and 31 °C. The rates of development in days for the above different temperatures were 8.06, 13.26, 17.70, 22.99 and 28.99, respectively (Table, 2). Data indicated that the rate of eggs development was the slowest at 19 °C. Also, the required duration in days to complete the embryogenesis decreased as temperature increased.

Lower and upper temperature thresholds for the incubation period of eggs were calculated by the linear regression between the rate of development (1/duration x100) or development period and the corresponding temperature. From the relationship between the rate of development and temperature, resulted the lower development temperature threshold of pink bollworm eggs was 13.88 °C, while the upper temperature threshold was 34.76 °C (Table, 3 and Fig., 1).

Generally, it can be concluded that the incubation period was decreased as temperature increased; it ranged between 12.4 - 3.45 days when temperature ranged between 19-31 °C. The thermal heat units required for complete development were 78.6, 70.4, 69.7, 66.7 and 63.9 DD for 19, 22, 25, 28 and 31 °C (Table, 2).

El-Sayed and Abd El-Rahman (1960) recorded the average incubation periods of pink bollworm eggs as 15.62, 10.37, 7.37, 5.06 and 4.31 days at temperatures 18, 22, 25, 30.5 and 35 °C, respectively. **Dahi (1997)** found that the required time for completion of embryogenesis decreased as temperature increased for pink bollworm eggs. The thermal units degree days

Table (2): Effect of different constant temperatures on developmental rate and thermal heat units (DD) for different developmental stages of pink bollworm (field strain).

Stage	Rate of development					Thermal heat units (DD)				
	19°C	22°C	25°C	28°C	31°C	19°C	22°C	25°C	28°C	31°C
Egg	8.06	13.26	17.70	22.99	28.99	78.62	70.42	69.72	66.73	63.27
larva	All larvae entered diapause	3.95	5.20	6.53	7.54	All larvae entered diapause	236.49	237.17	234.86	243.37
pre-pupa		19.08	24.88	29.94	44.44		48.94	49.61	51.24	41.27
pupa		7.69	10.71	12.14	13.02		121.42	115.26	126.40	140.85
pre-ovipostion		21.79	29.59	33.90	42.55		42.87	41.71	45.25	43.10
Oviposition		10.73	11.48	16.26	20.49		87.05	107.48	94.34	89.50
Post-ovipostion		13.15	22.83	46.73	57.14		71.03	54.05	32.83	32.10
Male longevity		5.20	6.41	8.10	14.51		179.61	192.50	189.45	126.36
Life-cycle							520.14	513.47	524.47	531.86

Table (3): Upper and lower developmental temperatures of different stages and life-cycle of pink bollworm field strain reared under constant temperatures.

Stage	Temperature °C	
	Upper	Lower
Egg	34.76	13.88
larva	39.76	12.74
Pre-pupa	38.70	14.93
Pupa	40.64	11.54
Pre-ovipostion	40.42	12.11
Oviposition	40.23	13.52
Post-ovipostion	32.51	19.77
Female	38.22	14.38
Male	36.57	17.84
Life-cycle	40.26	12.01

required for completing eggs development were 70.12, 68.41, 68.17 and 69.57 DD at 20, 25, 30 and 35 °C. **Gergis *et al.* (1990)** stated that the mean degree days required for completing eggs, development was 71.94 DD and the lower threshold was 13.22 °C and the upper 35.46 °C for pink bollworm eggs.

1.1.2. Hatchability percentages:

Data in Table (1) indicate that the highest percentage of hatchability was 83.23 at 28 °C. while the lowest one was 57.9 % at 19 °C. The hatchability percentages at all tested temperatures (19,22,25,28 and 31°C) indicated that 25 and 28°C were the favorable constant temperatures for the eggs hatching. In this respect **El-Banby *et al.* (1989)** mentioned that

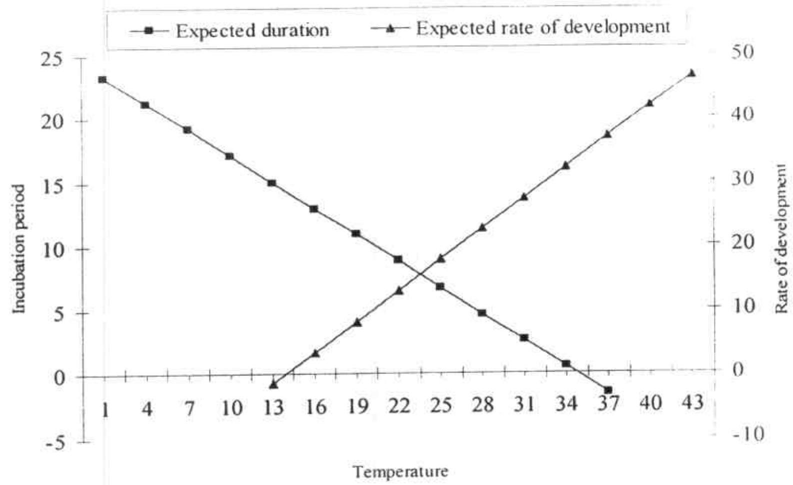


Fig (1): Incubation period and rate of development of the pink bollworm eggs under constant temperatures.

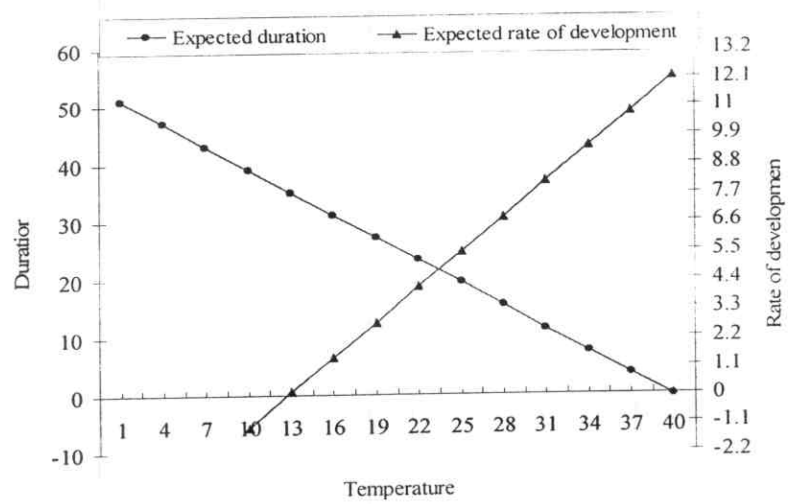


Fig (2): Larval period and rate of development of the pink bollworm larvae under constant temperatures.

hatchability was reduced at higher temperature than 30°C and no hatching was induced at 35 °C.

1.2. Larval stage:

In this stage, the study included the duration of larvae in days, thermal heat units required and % of larval mortality.

1.2.1. Durations and thermal heat units required:

The durations of pink bollworm larval stage were tabulated in Table (1). These periods were 25.32, 19.22, 15.31 and 13.27 days under the constant temperatures 22, 25, 28 and 31 °C. However, at 19 °C, all larvae entered diapause. On the other hand, the developmental rates of pink bollworm larvae increased with the increasing of temperature, while duration in days decreased. The lowest development rate was 3.95 at 22°C and the highest was 7.54 at 31 °C (Table, 2).

The means of thermal heat units required for larval development of the pink bollworm from hatching to pupation were 236.49, 237.17, 234.86 and 243.37 DD at 22, 25, 28 and 31 °C, respectively (Table, 2).

The lower and upper developmental temperatures were 12.74 and 39.76 °C for the pink bollworm larvae, (Table, 3 and Fig., 2).

1.2.2. Mortality:

When the larvae were incubated at 22, 25, 28 and 31°C, mortality percentages were 49.35, 35.6, 19.35 26.12 and 37.2%, respectively. The constant temperatures 25 and 28 °C were the favorable for pink bollworm larval development (Table, 1).

El-Banby *et al.* (1989) found that the shortest larval period occurred at 35°C, while the longest one was at 20 °C. The highest percentage of survival of larvae was at 30°C and the lowest was at 35 °C. **Gergis *et al.* (1990)** found that the mean degree day's accumulation required for completion of larval stage was 144.92 DD.

1.3. Pre-pupa:

When reaching maturity, the larva stops the feeding and constructs an oval silken cocoon within which it enters the pupal stage the larva lies. The duration of the pre-pupa as affected by different temperatures is shown in Table (1). It appeared that the duration periods of the pre-pupal stage decreased with the increase of temperature. The averages of duration of pre-pupa were 5.24, 4.02, 3.34 and 2.35 days at 22, 25, 28 and 31°C, respectively.

The thermal units required for pre pupa were 48.94, 49.61, 51.24 and 41.27 DD at 22, 25, 28 and 31 °C, respectively. The rate of development increased with the increase of temperature, (Table, 2). The lower development threshold for pink bollworm was 14.93 °C, while the upper was 38.70 °C, (Table, 3 and Fig., 3).

1.4. Pupal stage:

The effects of the four tested constant temperatures on the pupal duration of ***P. gossypiella*** are shown in Table (1). The average durations were 13.00, 9.34, 8.24 and 7.86 days at 22, 25, 28 and 31 °C, respectively. Concerning, the thermal heat units

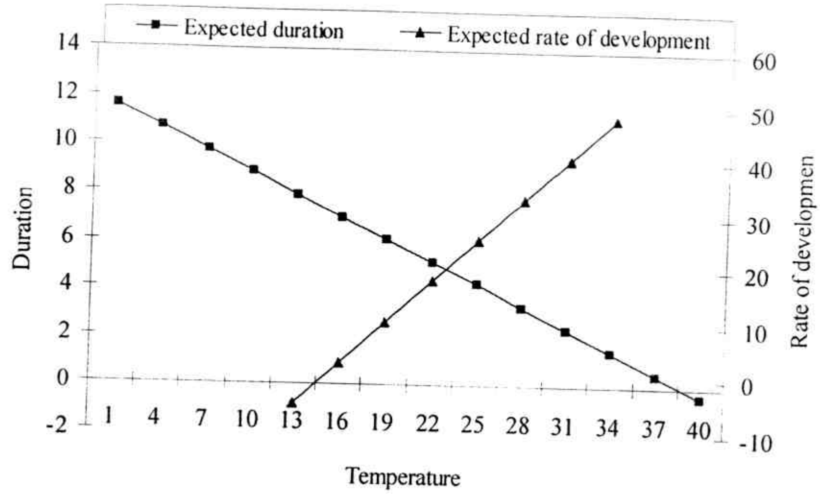


Fig (3): Duration and rate of development of the pre-pupal stage of the pink bollworm under constant temperatures.

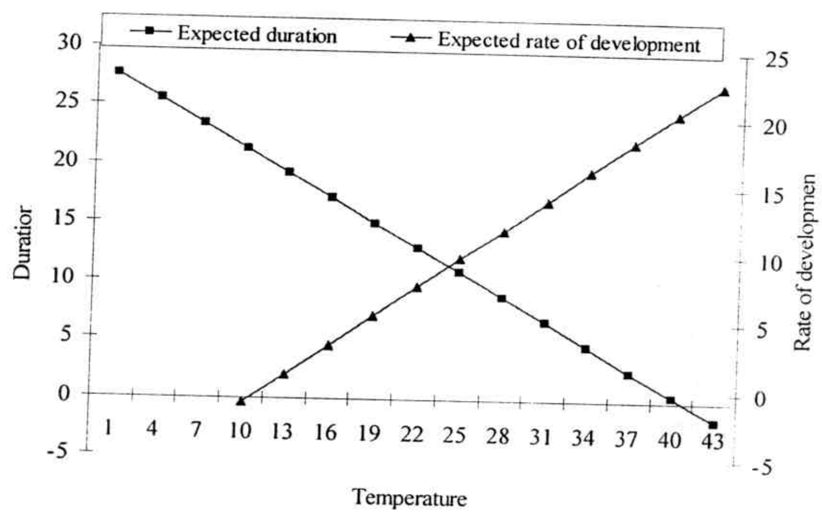


Fig (4): Duration and rate of development of the pupal stage of the pink bollworm under constant temperatures.

required for pupal duration completion till adult emergence were 121.42, 115.26, 126.40 and 140.85 DD at 22, 25, 28 and 31 °C, respectively. The rate of pupal development increased with temperature increase. The rates of pupal development were 7.69, 10.71, 12.14 and 13.02 at 22, 25, 28 and 31 °C, respectively (Table, 2). The lower development threshold for the pupae of pink bollworm was 11.54 °C, while, the upper one was 40.64 °C, (Table, 3 and Fig., 4). **El-Banby *et al.* (1989)** and **Metwally *et al.* (1991)** stated that the longest pupal period of ***P. gossypiella*** was recorded at 20 °C, while the shortest was recorded at 35 °C. **Gergis *et al.* (1990)** found that the mean degree-day required for completion of pupal stage was 232.65 DD. **Dahi (1997)** found that the pupal period of pink bollworm decreased as temperature increased from 20 to 35 °C. The thermal heat units required for pupal duration till adult emergence were 234.8, 235.03, 232.65 and 234.71 DD at 20, 25, 30 and 35 °C, respectively.

1.5. Adult stage:

Results presented in Table (1) showed that the highest percentage of adult emergence was 80.9 at 28 °C, while the lowest was 70.5 at 22 °C. These results indicated that 28 °C is the optimum effective temperature for pupal development and adult emergence.

1.5.1. Female's duration:

The pre-oviposition, oviposition and post-oviposition periods in days and thermal heat units were as follows:-

1.5.1.1. Pre-oviposition period:

Data in Table (1) show the pre- oviposition period for the female of pink bollworm at different constant temperatures. It was appreciably clear that the mean time required for maturation of the ovaries and starting egg laying, decreased as the temperature increased. The pre- oviposition periods were 4.59. 3.38, 2.95 and 2.35 days at 22, 25, 28 and 31 °C, respectively. But, the rate of development increased as temperature increased (Table, 2). The lower development temperature for the pre-oviposition period was 12.11 °C while, the upper threshold temperature was 40.4°C (Table, 3 and Fig., 5).

Regarding the average thermal units required for development of ovaries at the range of temperature 22-31 °C, it were 42.87, 41.71, 45.25 and 43.10 DD at 22, 25, 28 and 31 °C, respectively (Table, 2).

1.5.1.2. Oviposition period:

Data in Table (1) cleared that oviposition periods averaged 9.32, 8.71, 6.15 and 4.88 days at 22, 25, 28 and 31 °C, respectively. The oviposition period decreased as temperature increased. The thermal units required for ovipostion period were 87.05, 107.48, 94.34 and 89.50 DD at 22, 25, 28 and 31 °C, respectively. The lower and upper temperatures for ovipostion periods were 40.23 and 13.52 °C, respectively (Table, 3 and Fig. 6).

1.5.1.3. Post oviposition period:

The post oviposition period (in days) of the pink bollworm female at different constant temperatures are shown in

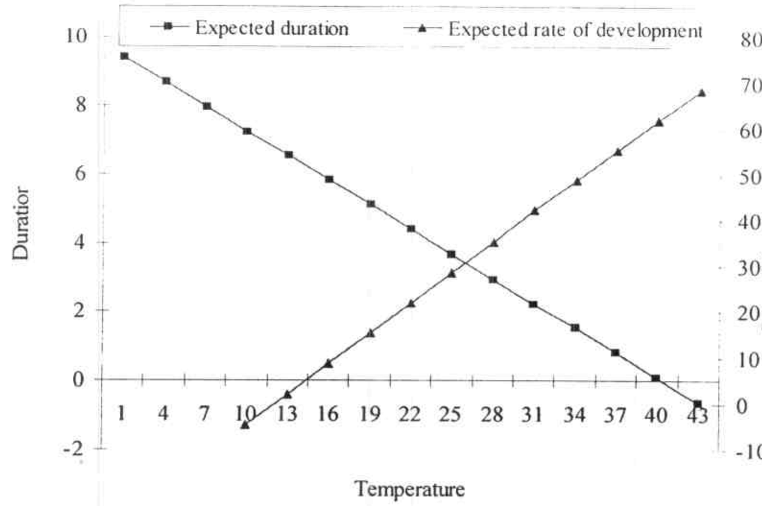


Fig (5): Pre-ovipostion and rate of development for the female of pink bollworm under constant temperatures.

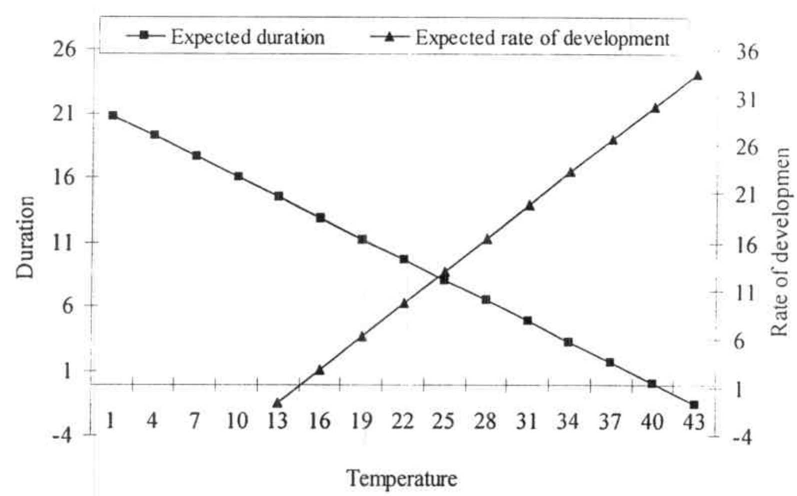


Fig (6): Ovipostion and rate of development for the pink bollworm female under constant temperatures.

Table (1). It is clear that these periods were 7.605, 4.38, 2.14 and 1.75 days at 22, 25, 28 and 31 °C, respectively. As in case of oviposition period, the post-oviposition period decreased with temperature increase. The thermal units required for post oviposition till moth mortality were 71.03, 54.05, 32.83 and 32.10 DD at 22, 25, 28 and 31 °C, respectively. The rates of development were increased as temperature increased (Table, 2). The lower development temperature was 19.77 °C and the upper one was 32.51°C (Table, 3 and Fig., 7).

1.5.1.4. Egg laying:

The effects of different constant temperatures from 22 to 31 °C on the number of the laid eggs per female of pink bollworm are shown in Table (1). It is clear that the average numbers of laid eggs per female were 39.4, 117.67, 48.04 and 17.8 eggs/female at 22, 25, 28 and 31 °C, respectively. The lower temperature 22 °C and higher temperature 31 °C caused reduction in the number of deposited eggs / female. Hatchability percentages were 49.5, 86.33, 84.25 and 20.24%.

In this respect **El-Sayed and Abd El-Rahman (1960)** found that the averages of adult longevity of pink bollworm moths were 18.6, 11.25. 9.23, 7.32 and 3.45 days at 18, 22, 25, 30.5 and 35.5 °C, respectively. **Henneberry *et al.* (1977)** and **El-Banby *et al.* (1989) Abdel Hafez (1993)** concluded that the constant temperatures of 23-35 or higher, generally, resulted in reproductive failure of ***P. gossypiella*** if the exposure occurred during larval and pupal or adult stage. **Gergis *et al.* (1990)** found that the mean degree day for pre oviposition period of pink bollworm moths was 41.84, while **Dahi (1997)** showed that the

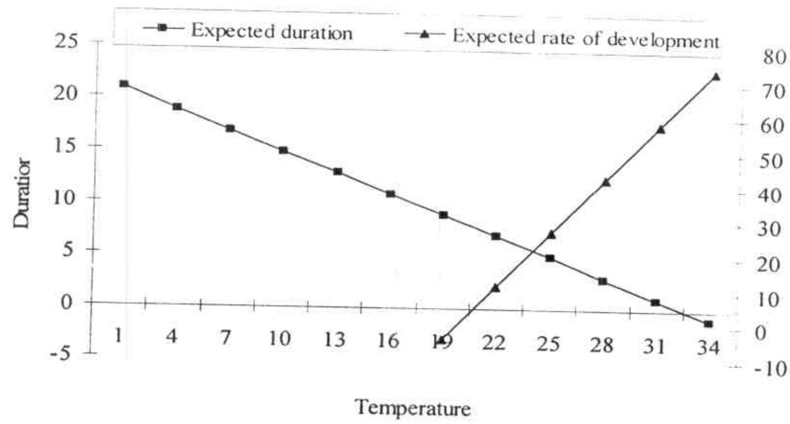


Fig (7): Post ovipostion and rate of development for the female of pink bollworm under constant temperatures.

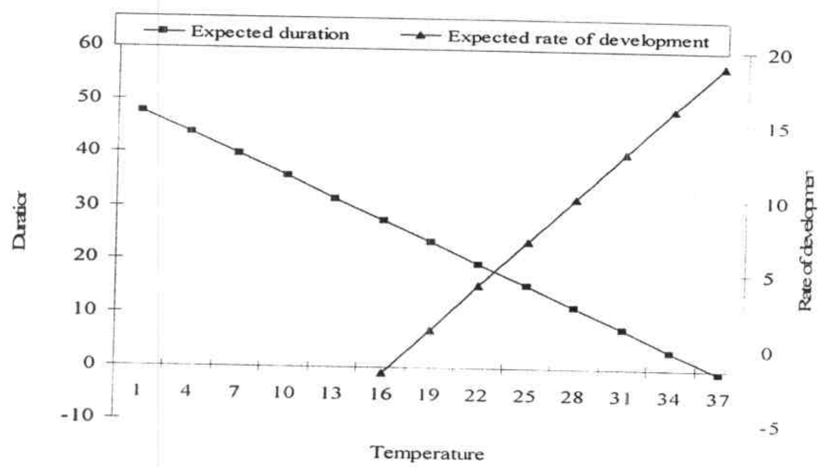


Fig (8): Longevity and rate of development of the pink bollworm males under constant temperatures.

degree days required for pre oviposition period for pink bollworm was 25.79. The lower threshold at which the female started to develop and complete pre-oviposition period was 13.17 °C. Also, he stated that the moths' longevity lengthens as temperature decrease.

1.5.2. Adult male longevity:

Data (Table 1) indicated that the pink bollworm male longevity decreased when temperature increased from 22 to 31 °C, where the averages of male longevity were 19.23, 15.60, 12.35 and 6.90 days at 22, 25, 28 and 31 °C, respectively. The respective rates of development for males were 5.20, 6.41, 8.10 and 14.51. The thermal units required for pink bollworm male moths were 179.61, 192.50, 189.45 and 126.36 DD at 22, 25, 28 and 31 °C, respectively (Table, 2). The lower and the upper thresholds of development for pink bollworm male were 17.84 and 36.57 DD, respectively (Table, 3 and Fig., 8).

1.6. Life-cycle:

The average duration in days of the life-cycle at different constant temperatures was calculated by using the mean duration of different developmental stages, which were incubation period, larval period, pre pupal period, pupal period and pre-oviposition period.

Data in Table (1) clear that means of the life-cycle were 55.69, 41.61, 34.19 and 29 days at 22, 25, 28 and 31 °C, respectively. The thermal heat units required to complete life-cycle using the equation DD = D(T - 12.66) **(Gergis *et al.*, 1990)** at different constant temperatures were 520.14, 513.47, 524.47

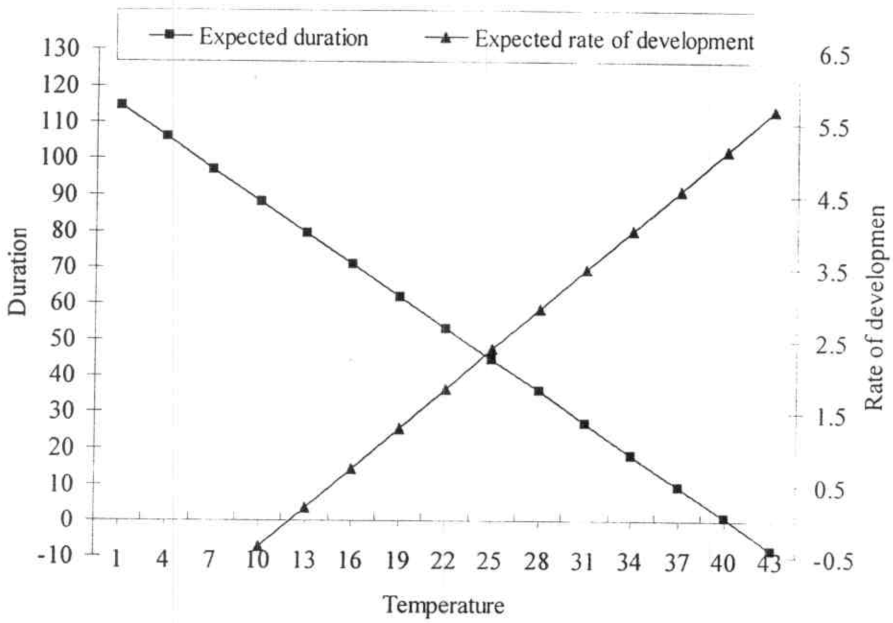


Fig (9): Life-cycle and rate of development for the pink bollworm under constant temperatures.

and 531.86 DD at 22, 25, 28 and 31 °C, respectively. The lower threshold for life-cycle was 12.01°C but the upper threshold was 40.26 °C (Table,3 and Fig., 9). **Gergis *et al.* (1990)** revealed that the lower and upper development thresholds for generation of pink bollworm were 12.68 and 35.39 °C, respectively. **Beasly and Adams (1996)** mentioned that the degree days for one generation adult was determined to be 492 DD, also **Dahi (1997)** found it 462.3 DD for complete generation from eggs to pre oviposition period.

2. Effect of temperature on some biological aspects of the parasitoid *D. cavus*:

The effects of temperature on the biology of the hymenopterous parasitoid, ***Dibrachys cavus*** (Family: Pteromalidae) on the full grown larvae of pink bollworm were studied under controlled conditions of 19, 22, 25 ,28 and 31°C and (65-75%) R.H. The relationship between different constant temperatures, developmental rates for the different stages of the parasitoid and the requirement of thermal heat units in degree-days for complete development of each stage were also studied.

2.1. Egg stage:

In this stage, the study included the incubation period (in days), thermal heat units required for completeness of development and hatchability percentage.

2.1.1. Incubation period and thermal heat units required:

Directly, after the female parasitoid deposited eggs on ***P. gossypiella*** full grown larvae, host larvae were incubated under

Table (4): Effect of different constant temperatures on some biological aspects of the parasitoid *Dibrachys cavus*.

Stage		Temperature °C				
		19	22	25	28	31
Egg	Incubation period	2.89	2.32	1.82	1.52	1.15
	Hatchability %	96.00	95.00	93.00	91.00	86.00
Larvae	Duration	10.46	7.96	6.56	5.30	4.22
	Mortality %	4.00	7.00	9.00	10.00	26.80
Pupal period		14.26	10.52	8.45	6.89	5.11
Adult emergence %		96.00	95.00	96.00	94.00	90.00
Sex ratio (male : female)		1:1.63	1:3	1:5.25	1:6.69	1:6.14
Adult female	Pre-oviposition period	2.25	2.19	2.10	1.96	1.60
	Ovipostion period	19.33	14.97	10.40	8.64	5.35
	Post-ovipostion period	2.30	1.75	1.45	1.43	1.20
	Total longevity	23.88	18.91	13.95	12.03	8.22
Male longevity		20.25	14.89	11.78	9.02	5.85
Mean No. of eggs/♀		165.67	176.00	156.00	128.70	50.60
Life-cycle		29.86	22.99	18.93	15.67	12.08

Table (5): Effect of different constant temperatures on developmental rate and thermal heat units (DD) for different developmental stages of *Dibrachys cavus* (field strain).

Stage	Rate of developmental					Thermal heat units (DD)				
	19°C	22°C	25°C	28°C	31°C	19°C	22°C	25°C	28°C	31°C
Egg	34.60	43.10	54.95	65.79	86.96	22.98	25.40	25.39	25.76	22.94
larva	9.56	12.56	15.24	18.87	23.70	83.16	87.16	91.51	89.84	84.19
pupa	7.01	9.51	11.83	14.51	19.57	113.37	115.19	117.88	116.79	101.94
Pre-oviposition	44.44	45.66	47.62	51.02	59.88	17.89	23.98	29.30	33.22	33.32
Oviposition	5.20	7.16	8.76	11.27	16.78	152.88	152.97	159.17	150.35	118.90
Post-oviposition	43.48	57.14	68.97	69.93	83.33	18.29	19.16	20.23	24.24	23.94
Female longevity	4.19	5.29	7.17	8.31	12.17	189.85	207.06	194.60	203.91	163.99
Male longevity	4.94	6.72	8.49	11.09	17.09	160.99	163.05	164.33	152.89	116.71
Life-cycle						237.39	251.74	264.07	265.61	241.00

19, 22, 25, 28 and 31°C and (65-75% R.H.). The eggs hatched after the respective periods of 2.89, 2.32, 1.82, 1.52 and 1.15 days (Table, 4). These data indicated that the incubation period of ***D. cavus*** eggs decreased by increasing temperature from 19 to 31°C. The shortest incubation periods (1.15 days) was obtained at 31°C, while the longest was 2.89 days at 19 °C.

The thermal heat units as degree- days (DD) required to complete development of the eggs were 22.98, 25.40, 25.39, 25.76 and 22.94 DD for 19, 22, 25, 28 and 31 °C, respectively. The rates of development for the above different temperatures were 34.60, 43.10, 54.95, 65.79 and 86.96 for the respective different constant temperatures (Table, 5).

The development rate was the lowest at 19 °C (34.60) for ***D. cavus*** eggs, and the required time duration in days for completeness the embryogenesis decreased as temperature increased.

Upper and lower developmental temperature thresholds for the parasitoid eggs were calculated by the liner regression between the developmental period or the rate of development (1/ duration X100) and the corresponding temperature. From the relationship between the rate of development and temperature, the lower developmental temperature threshold of the parasitoid egg was 11.87 °C. opposed to 38.59 °C for the upper temperature threshold (Table, 6 and Fig., 10).

2.1.2. Hatchability percentage:

Data in Table (4) show that the highest percentage of hatchability was 96 % at 19 °C, while the lowest one was 86% at 31 °C. It means that the hatchability percentage of the parasitoid eggs was decreased when the temperature increased.

2.2. Larval stage:

2.2.1. Duration and thermal heat units required:

Larval durations of the parasitoid ***D. cavus***, when reared on full grown larvae of pink bollworm were given in Table (4). These durations were 10.46, 7.96, 6.56, 5.30 and 4.22 days at 19, 22, 25, 28 and 31 °C, respectively. On the other hand, data in Table (5) revealed that the developmental rates of the parasitoid larvae increased with the increasing of temperature, while larval durations decreased. The respective development rates were 9.56, 12.56, 15.24, 18.87 and 23.7 at 19, 22, 25, 28 and 31 °C.

The thermal heat units required for the parasitoid larvae to complete their development from hatching to pupation when fed on the pink bollworm full grown larvae were 83.16, 87.16, 91.51, 89.84 and 84.19 DD at 19,22, 25, 28 and 31 °C, respectively.

The lower developmental threshold temperature for parasitoid larvae was 11.13 °C, while the upper threshold was 38.67 °C (Table, 6 and Fig., 11).

2.2.2. Larval mortality:

Data shown in Table (4) cleared that percentage mortality of the parasitoid larvae ranged between 4-10%, when

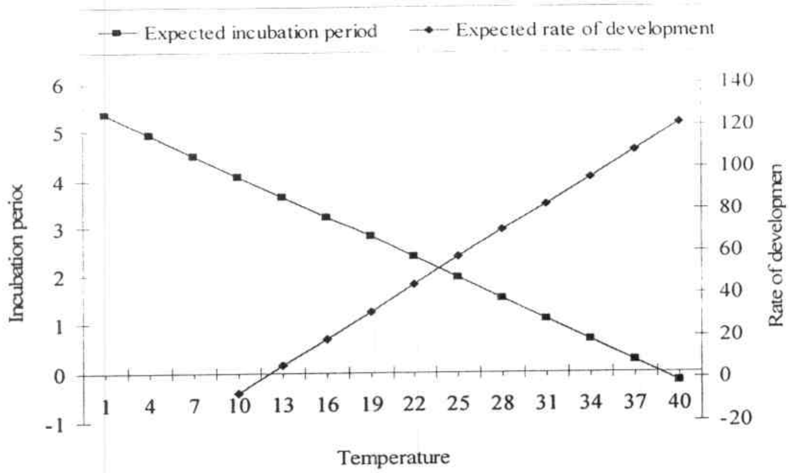


Fig (10): Incubation period and rate of development for the parasitoid, ***D. cavus*** eggs under constant temperatures.

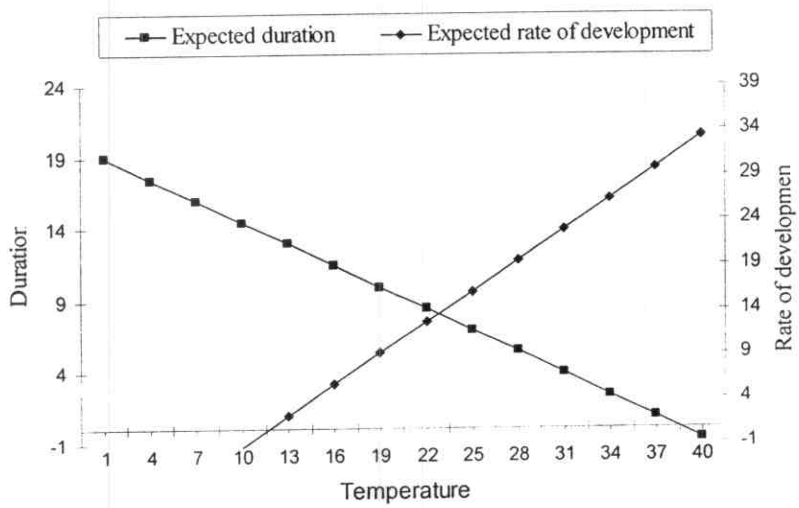


Fig (11): Larval duration and rate of development for the parasitoid, ***D. cavus*** under constant temperatures

Table (6): Upper and lower developmental temperature thresholds for different stages and life-cycle of *D. cavus* under constant temperatures.

Stage	Upper	Lower
Egg	**38.59**	**11.87**
Larva	**38.67**	**11.13**
Pupa	**37.37**	**12.56**
Adult female	**37.09**	**13.26**
Adult male	**35.69**	**14.89**
Life-cycle	**38.93**	**11.05**

temperature increased from 19 to 28 °C. The highest mortality percentage (26.8%) was recorded at 31 °C.

2.3. Pupal stage:

At constant temperatures of 19, 22, 25, 28 and 31 °C, data in Table (4) clear that the duration of the parasitoid pupae lasted 14.26, 10.52, 8.45, 6.89 and 5.11 days, respectively. being shorter as the temperature increases.

The thermal heat units required for pupal duration completion till adult emergence were 113.37, 115.19, 117.88, 116.79 and 101.94 DD at 19, 22, 25, 28 and 31 °C, respectively. The rate of pupal development increased with temperature increase (Table, 5).

The lower development threshold temperature for pupal stage was 12.56 °C, while the higher threshold was 37.37 °C (Table, 6 and Fig., 12).

Kandil (2001) found that the incubation periods of ***Dibrachys* sp.** were 3.14, 1.54 and 0.71 days, the larval periods were 8.79, 7.5 and 3.72 days and the pupal duration was 8.09, 6.2 and 3.4 days when reared on pink bollworm under constant temperatures 22,26 and 30°C, respectively.

2.4. Adult stage:

Data presented in Table (4) show that percentages of adults' emergence of the parasitoid when reared on pink bollworm larvae were 96, 95, 96, 94 and 90 % at 19, 22, 25, 28 and 31 °C, respectively. These results indicated that the lowest percentage was recorded at the highest temperature.

2.4.1. Sex ratio:

The obtained data revealed that the sex ratio (male: female) of emerged adults were 1:1.63, 1:3, 1:5.25, 1:6.69 and 1:6.14 male: female at 19, 22, 25, 28 and 31 °C (Table, 4). Data cleared that the number of females increased when temperature increased. While, sex ratio under the natural conditions (the adult collection from dry cotton bolls) was 1:3.25 male: female.

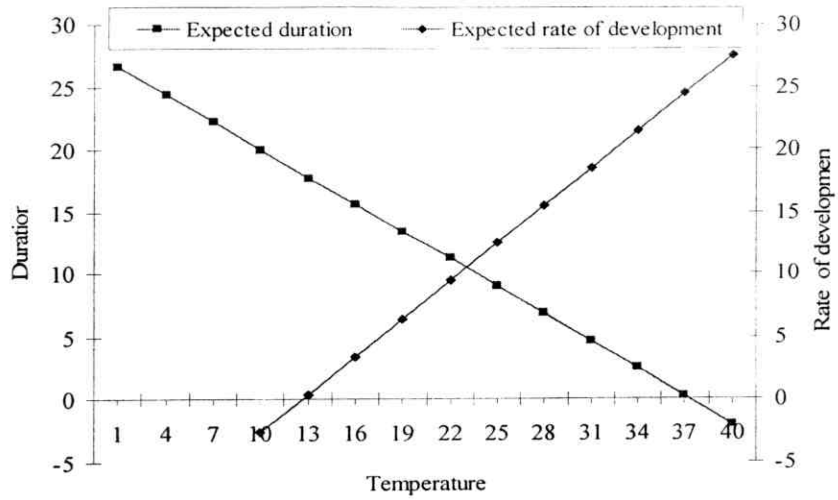


Fig (12): Pupal period and rate of development for the parasitoid, ***D. cavus*** under constant temperatures.

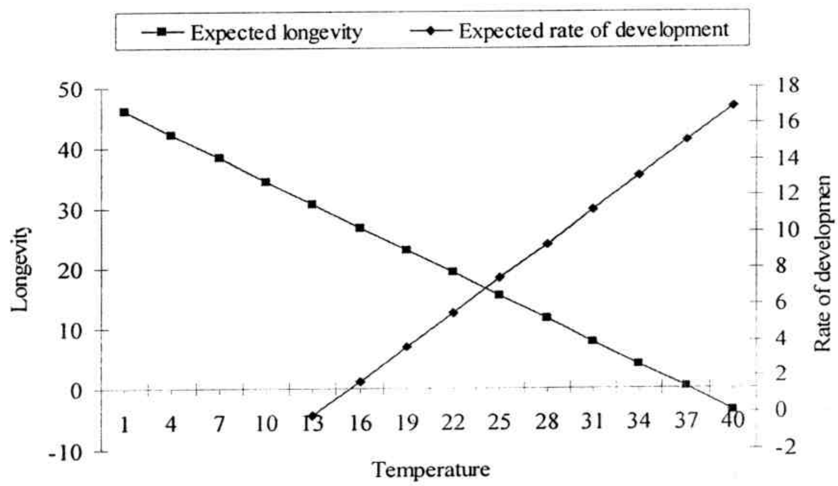


Fig (13): Female longevity and rate of development for the parasitoid, ***D. cavus*** under constant temperatures.

Hekal (1990) found that the ratio of males to females of ***Dibrachys* sp**. was 1:2.8. Adult parasites emerged from ***P. gossypiella*** cocoon through a hole made by emerged males and subsequently enlarged by females, which required 1-2 days more for development. Mating occurred immediately after emergence and both sexes mated more than once. Females stung prey several times to paralyse them, and deposited eggs singly or in groups on the host body. Oviposition period and fecundity were greater in mated than in virgin females, which produced only male offspring.

2.4. 2. Female's duration:

Results in Table (4) clear that the averages of mated females' longevity were 23.88, 18.91, 13.95, 12.03 and 8.22 days, when reared at 19, 22, 25, 28 and 31 °C, respectively. This means that the longevity of female decreased when temperature increased. But, the rates of development of the parasitoid females were increased as temperatures increased, where the rates of development ranged between 4.19- 12.17 days at temperature ranged between 19-31 °C. The thermal heat units required for female parasitoid were 189.85, 207.06, 194.60, 203.91 and 163.99 DD when females were reared at 19, 22, 25, 28 and 31 °C, respectively. The lower developmental threshold for female was 13.26 °C, while the upper threshold was 37.09 °C (Table, 6 and Fig., 13).

2.4.2.1. Pre-oviposition period:

Data in Table (4) show that the shortest pre-oviposition period for ***D. cavus*** mated females was associated with the highest temperature. It was appreciably clear that means of time required for maturation of the parasitoid female ovaries and starting deposition were 2.25, 2.19, 2.10, 1.96 and 1.60 days at 19, 22, 25, 28 and 31°C, respectively. The rate of development increased as temperature increased, it ranged between 44.44-59.88, when temperature ranged between 19-31°C (Table, 5).

Regarding the averages of the thermal heat units required for development of female's ovaries, data in Table (5) indicated that those were 17.89, 23.98, 29.30, 33.22 and 33.32 DD at 19, 22, 25, 28 and 31 °C, respectively.

2.4.2.2. Oviposition period:

The egg laying periods at different constant temperatures are shown in (Table, 4) and it was clear that the oviposition periods averaged 19.33, 14.97,
10.40, 8.86 and 5.35 days at 19, 22, 25, 28 and 31 °C, respectively. It means that the oviposition period decreased with temperature increase and the numbers of deposited eggs were decreased. The development rates for female oviposition were 5.30, 7.16, 8.76, 11.27 and 16.78 at 19, 22, 25, 28 and 31 °C, respectively.

The thermal heat units required for egg laying periods were 152.88, 152.97, 159.17, 150.35 and 118.90 when adult was reared at 19, 22, 25, 28 and 31 °C, respectively. It was clear that as the temperature was increased, the oviposition period and the eggs laying decreased.

2.4.2.3. Post oviposition period:

The post oviposition period (in days) at different constant temperatures are shown in Table (4). The shortest post oviposition period (1.2 days) was recorded at 31 °C. While the longest one was (2.3 days) was at 19 °C. It means that the post oviposition period decreased with temperature increase. On the contrary, the rate of development increased as temperature increased to reach the highest rate (83.33) at 31 °C. The thermal heat units required for post oviposition period till adult mortality were 18.29, 19.16, 20.23, 24.24 and 23.94 DD when adults of parasite were reared at 19, 22, 25, 28 and 31°C, respectively (Table, 5).

2.4.2.4. Egg laying activity:

When ***D. cavus*** was reared on ***P. gossypiella*** larvae, data in Table (4) showed that the adult female of the parasitoid deposited the averages of 165.67, 176, 156, 128.7 and 50.6 eggs at 19, 21, 25, 28 and 31 °C, respectively. It can be concluded that the favorable temperature for the best egg laying capacity of the parasitoid ***D. cavus*** ranged from 19-25°C.

2.4. 3. Male longevity:

Data in Table (4) indicate that the male longevity of the parasitoid averaged 20.25, 14.89, 11.78, 9.02 and 5.85 days at 19, 22, 25, 28 and 31 °C, respectively when fed on bee honey. It was evident that the longest male longevity was obtained at the lowest temperature and vice versa. The male developmental rate increased as temperature increased. The thermal units required for the males of the parasitoid were 160.99, 163.05, 164.33, 152.89 and 116.71 DD, when reared at 19, 22, 25, 28 and 31 °C, respectively (Table, 5). The lower development temperature was 14.89 °C, while the upper was 35.69 °C (Table, 6 and Fig., 14).

2.5. Life-cycle:

The averages of duration of life-cycle for ***D. cavus*** at different constant temperatures were calculated as the total of mean durations of different developmental stages, (incubation period, larval period, pupal period and pre oviposition period).

Data given in Table (4) clear that means of life-cycle for the parasitoid ***D. cavus*** were 29.86, 22.99, 18.93, 15.67 and 12.08 days when the parasitoid was reared on pink bollworm full grown larvae at temperature ranged from 19 to 31 °C. The thermal units required for parasite to complete one life-cycle at different constant temperatures were 237.39, 251.74, 264.07, 265.61 and 241.00 DD at 19, 22, 25, 28 and 31 °C, respectively. The lower threshold for life-cycle was 11.05 °C and the upper was 38.92 °C (Table, 6 and Fig., 15).

3. Effect of temperature on some biological aspects of the predator, *H. tredecimpunctata,* fed on *P. gossypiella* eggs:

The effects of constant temperatures (25 and 31 °C) and (65-75% R.H.) on some biological aspects of ***H. tredecimpunctata*** were studied as follows:

3.1.Egg stage:

As shown in Table (7), the incubation period of ***H. tredecimpunctata*** eggs averaged 3.48 and 2.71 days at 25 and 31 °C, respectively.

3.2. Larval stage:

In this stage, the study included the duration (in days) and mortality percent.

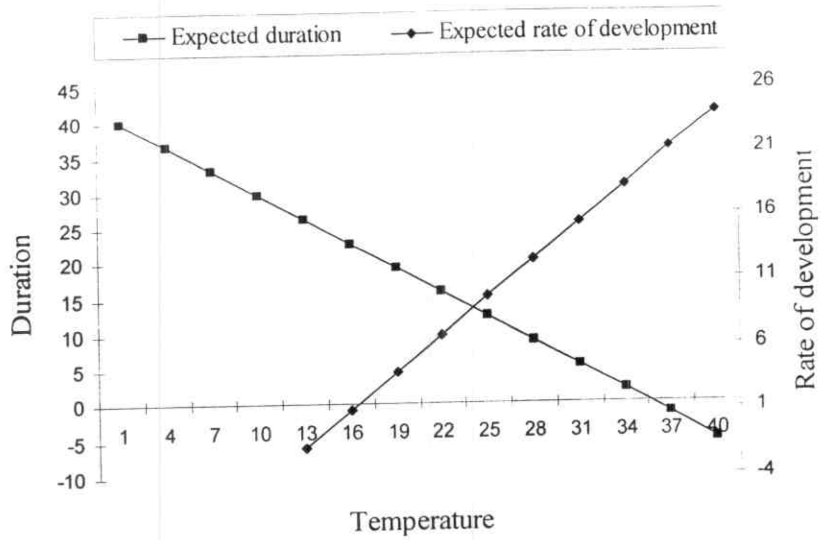


Fig (14): Male longevity and rate of development for the parasitoid, ***D. cavus*** under constant temperatures.

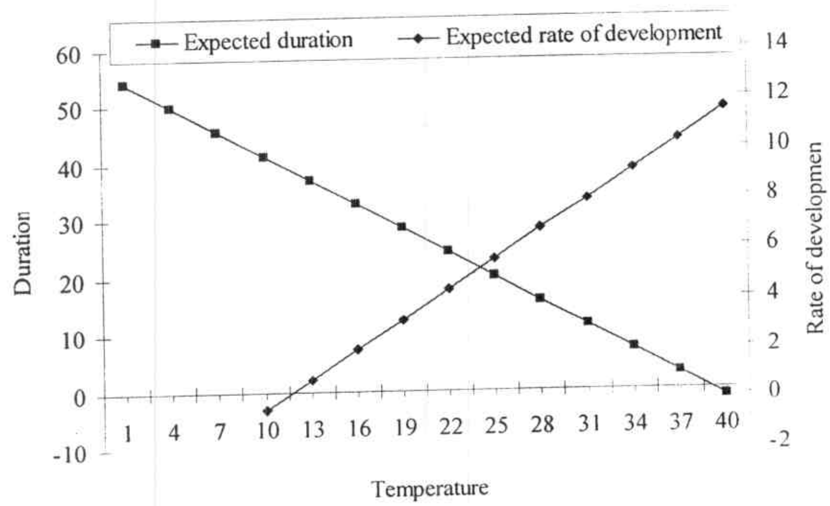


Fig (15): Life-cycle period and rate of development for the parasitoid, ***D. cavus*** under constant temperatures.

3.2.1. Larval duration:

The experiment started with 100 newly hatched larvae of ***H. tredecimpunctata*** that were supplied daily, individually, by enough quantity of pink bollworm eggs for feeding. Durations of larval instars were 3.56, 3.43, 4.20 and 5.20 days for the 1st, 2nd, 3rd and 4th instar larvae, respectively at 25 °C., opposed to 2.34, 2.10, 3.20 and 3.85 days at 31 °C (Table,7) Consequently, the corresponding total larval period averaged 16.39 and 11.49 days.

3.2.2. Larval mortality:

Data in Table (7) clear that, high larval mortality rates of the ***H. tredecimpunctata*** occurred when fed on pink bollworm eggs under both the two tested temperatures. Mortality percentages were 93 and 94 % of larvae at 25 and 31 °C, respectively.

3.3. Pre-pupal period:

Few numbers of ***H. tredecimpunctata*** larvae entered the pre pupal stage. Pre-pupal duration lasted 2.5 and 1.66 days at 25 and 31 °C, respectively.

3.4. Pupal period:

Data recorded in Table (7) show that the pupal period of ***H. tredecimpunctata*** was 5.64 days, and 4.10 days when reared on the pink bollworm eggs at 25 and 31 °C, respectively.

3.5. Adult's emergence:

Data obtained from rearing ***H. tredecimpunctata*** confirmed that ***P. gossypiella*** eggs are not the suitable prey for

Table (7): Effect of rearing at constant temperatures on some biological aspects of the predator, *Hippodamia tredecimpunctata*, fed on pink bollworm eggs (results from 100 larvae)

Stage			Temperature	
			25C°	31C°
Egg			3.48	2.71
Larva	Larval duration	1st	3.56	2.34
		2nd	3.43	2.10
		3rd	4.20	3.20
		4th	5.20	3.85
		Total larval period (days)	16.39	11.49
	larval mortality %		93.00	94.00
Pre-pupal period (days)			2.10	1.36
Pupa	Pupal period (days)		5.64	4.10
	Pupal mortality		2.00	4.00
No. of emerged adults			5.00	2.00

Table (8): Consumption of *P. gossypiella* eggs by larvae of *H. trdecimpunctata* at constant temperatures.

Instars	Mean No. of consumed eggs/larva			
	No. of larvae	25C°	No. of larvae	31C°
1st	57	76.85 (67-89)	43	64.28 (53-73)
2nd	32	132.42 (113-145)	24	119.58 (98-227)
3rd	15	215.87 (206-221)	9	225.63 (207-234)
4th	7	256.86 (241-274)	6	239.67 (222-257)
Total		682.0 (632-721)		649.1 (597-778)
Mean daily		41.6		56.5

successful development of this predator. Only 5 and 2 % of the reared individuals succeeded to develop to the adult stage. This was in agreement with conclusion of **Ali (2003)** who reported that larvae of ***Coccinella undecimpunctata*** failed to reach the 4th instar when fed on eggs of ***P. gossypiella.***

3.6. Feeding capacity of *H. tredecimpunctata*:

Data of the consumption rates of ***H. tredecimpunctata*** larvae on the pink bollworm eggs under 25 and 31 °C were presented in Table (8). At 25 °C and the larvae consumed 76.85, 132.42, 215.87 and 256.86 eggs at 1st , 2nd , 3rd and 4th instars, respectively. The corresponding figures at 31 °C were 64.28, 119.58, 225.63 and 239.67 eggs, respectively. But, the respective total eggs consumed were 682.0 and 649.1 eggs, with daily rates of 41.6 and 56.5 eggs (Table, 8).

Henneberry and Clayton (1984) found that, during the whole larval period of ***Hippodamia convegrens***, the larvae consumed from 633 to 777 eggs of ***P. gossypiella*** eggs. **Kandil (2001)** found that the 1st, 2nd, 3rd and 4th instars of ***H. tredecimpunctata*** consumed 59.98, 144.70, 254.66 and 602.26 of pink bollworm eggs, respectively. The male consumed 3171.9 eggs, while the female consumed 4480.89 eggs of pink bollworm.

3.6.1. Adult stage:

Under laboratory conditions of 25 and 31 °C and by feeding ***H. tredecimpunctata*** adults on eggs of pink bollworm, the adult male lived for 45.20 days , while the female lived for 54.60 days when reared on 25 °C. While, in case of 31 °C, the

Table (9): Feeding capacity of *Hippodamia tredecimpunctata* adult, fed on *P. gossypiella* eggs in laboratory at 25 °C.

Adult replicate	Males			Adult replicate	Females		
	Longevity (days)	Total No. of consumed eggs	Mean consumed eggs/day		Longevity (days)	Total No. of consumed eggs	Mean consumed eggs/day
1	39	1867	47.87	1	47	2214	47.11
2	46	2152	46.78	2	62	2758	44.48
3	48	2139	44.56	3	54	2487	46.06
4	46	1978	43.00	4	45	2287	50.82
5	47	2107	44.83	5	57	2593	45.49
6	41	1742	42.49	6	53	2478	46.75
7	44	1806	41.05	7	49	2340	47.76
8	46	2045	44.46	8	52	2471	47.52
9	48	2147	44.73	9	58	2647	45.64
10	45	1981	44.02	10	56	2520	45.00
11	47	2001	42.57	11	53	2458	46.38
12	45	1821	40.47	12	52	2385	45.87
13	47	2102	44.72	13	61	2786	45.67
14	43	1813	42.16	14	59	2513	42.59
15	46	2019	43.89	15	61	2745	45.00
Total	678	29720	657.61		819	37682	692.13
Mean	45.2	1981.33	43.83		54.6	2512.13	46.01

Table (10): Feeding capacity of *Hippodamia tredecimpunctata* adult, fed on *P. gossypiella* eggs in laboratory at 31°C.

Adult replicate	Males			Adult replicate	Females		
	Longevity (days)	Total No. of consumed eggs	Mean consumed eggs/day		Longevity (days)	Total No. of consumed eggs	Mean consumed eggs/day
1	**39**	**1856**	**54.6**	**1**	**34**	**2113**	**54.2**
2	**41**	**1945**	**49.9**	**2**	**39**	**2214**	**54.0**
3	**36**	**2012**	**47.9**	**3**	**42**	**1980**	**55.0**
4	**33**	**1952**	**43.4**	**4**	**45**	**1895**	**57.4**
5	**45**	**1678**	**46.6**	**5**	**36**	**2256**	**50.1**
6	**31**	**2006**	**48.9**	**6**	**41**	**2015**	**65.0**
7	**44**	**1523**	**52.5**	**7**	**29**	**2156**	**49.0**
8	**37**	**1984**	**43.1**	**8**	**46**	**1987**	**53.7**
9	**46**	**1976**	**41.2**	**9**	**48**	**2235**	**48.6**
10	**42**	**2019**	**43.0**	**10**	**47**	**2145**	**51.1**
11	**38**	**1987**	**50.9**	**11**	**39**	**1980**	**52.1**
12	**41**	**2106**	**42.1**	**12**	**50**	**2156**	**52.6**
13	**35**	**1984**	**47.2**	**13**	**42**	**2069**	**59.1**
14	**43**	**1856**	**43.2**	**14**	**43**	**2305**	**53.6**
15	**41**	**2078**	**49.5**	**15**	**42**	**2118**	**51.7**
Total	**592**	**28962**	**704.00**		**623**	**31624**	**807.20**
Mean	**39.47**	**1930.80**	**48.92**		**41.53**	**2108.27**	**50.76**

adult male lived for 39.46 days, while the longevity of female was 41.53 days.

Also, as shown in Tables (9 and 10) and throughout adult longevity, the adult male of consumed a mean total number of 1981.33 pink bollworm eggs, while the female consumed a total mean of 2512.133 eggs when reared on 25 °C. The average daily consumption was 43.83 and 46.01 eggs for male and female, respectively. At 31°C, the adult male consumed 1930.8 of pink bollworm eggs, while the female consumed 2108.26 eggs of pink bollworm. The average daily consumed was 48.92 and 50.76 eggs for male and female, respectively.

Ali (2003) reported that the adult male of ***Coccinella undecimpuctata*** devoured 1701.83 eggs, while the female consumed 2295.00 eggs of ***P. gossypiella***.

II. FIELD STUDIES:

1. Seasonal fluctuation of *P. gossypiella*, male moths:

The main objective of this work was to study the seasonal fluctuation of male moths of ***P. gossypiella*** under field conditions using sex pheromone traps, to estimate the peak occurrence of moths captured, number of the field generations and the effect of some weather factors during the two successive season of 2002 and 2003.

1.1 First season (2002):

Data in Table (11) and Fig. (16) show the numbers of pink bollworm male moths captured in the sex pheromone traps throughout the period from January, 7th to the end of December. The first capture was recorded at the 2nd week of February. The number of pink bollworm male moths fluctuated slightly during February and March, then, increased gradually from April until reaching the first peak at the 1st week of June with 47 male moths/trap/wee; representing. the lowest peak in number during the season. In the period from first occurrence to the first peak, accumulated number of pink bollworm male moths represented 5.5 % of the total number captured during the season. Captured male moth numbers fluctuated until the second peak at the beginning of July with 97 moths/ trap/week. The difference in the accumulated moths' percent between first peak and second peak consists of about 6% of the final total captured. The third peak occurred at the 2nd week of August with 133 male moth/trap/week (16% of the total number of captured moths during the season). The fourth peak occurred at the 3rd week of

Table(11): Number of pink bollworm male moths caught in pheromone traps during 2002 season.

Date	No. of caught moths/trap			Weather factors			Heat units	
	Mean No.	Accumulated		Temperature		Mean R.H.%	Weekly DD	Accumulated DD
		No.	%	Max.	Min.			
7/1	0.0	0.0	0.0	18.2	11.2	60.9	17.9	17.9
14/1	0.0	0.0	0.0	16.4	10.9	66.4	11.4	29.3
21/1	0.0	0.0	0.0	19.6	7.3	63.1	16.8	46.1
28/1	0.0	0.0	0.0	20.3	9.9	64.2	22.5	68.6
4/2	0.0	0.0	0.0	21.4	11.4	63.4	27.8	96.4
11/2	0.5	0.5	0.0	21.3	12.0	66.6	31.1	127.5
18/2	0.0	0.5	0.0	20.5	11.6	61.5	26.5	154.0
25/2	0.0	0.5	0.0	23.4	10.0	53.1	26.6	180.6
4/3	1.0	1.5	0.0	19.7	11.1	61.8	22.4	203.0
11/3	1.5	3.0	0.1	27.8	17.4	63.7	69.4	272.4
18/3	1.0	4.0	0.1	20.2	12.4	58.9	26.9	299.4
25/3	0.5	4.5	0.1	21.5	15.6	56.6	41.2	340.6
1/4	3.0	7.5	0.2	19.2	13.3	54.9	26.8	367.4
8/4	2.5	10.0	0.3	29.5	23.3	60.4	91.9	459.3
15/4	2.0	12.0	0.4	31.5	23.2	48.0	96.9	556.3
22/4	4.0	16.0	0.5	26.8	21.7	53.4	80.3	636.6
29/4	4.5	20.5	0.6	23.4	18.4	54.6	57.7	694.3
6/5	20.0	40.5	1.2	29.9	15.9	51.6	70.3	764.5
13/5	23.5	64.0	2.0	34.3	18.1	50.6	87.8	852.4
20/5	22.5	86.5	2.7	31.2	18.5	54.7	83.6	936.0
27/5	44.5	131.0	4.0	33.6	19.3	53.0	90.8	1026.7
3/6	47.0	178.0	5.5	33.2	20.8	55.5	94.9	1121.6
10/6	35.5	213.5	6.6	34.7	20.8	53.4	96.2	1217.8
17/6	45.5	259.0	8.0	35.8	22.3	56.9	102.3	1320.1
24/6	27.0	286.0	8.8	34.7	22.9	54.1	104.4	1424.5
1/7	97.0	383.0	11.8	35.2	25.1	58.9	111.5	1536.0
8/7	86.0	469.0	14.4	34.1	24.3	58.1	105.1	1641.1
15/7	47.5	516.5	15.9	32.8	24.1	61.4	105.2	1746.4
22/7	49.0	565.5	17.4	34.1	26.0	61.4	112.5	1858.9
29/7	73.0	638.5	19.6	33.9	23.8	60.1	106.0	1964.8
5/8	131.0	769.5	23.6	34.1	23.9	61.0	106.0	2070.9
12/8	133.0	902.5	27.7	33.4	23.8	61.9	105.2	2176.1
19/8	127.5	1030.0	31.6	32.9	23.5	58.1	102.5	2278.6
26/8	106.5	1136.5	34.9	31.8	22.1	59.9	97.0	2375.6
2/9	102.0	1238.5	38.0	33.2	23.2	58.9	103.8	2479.4
9/9	132.0	1370.5	42.1	31.8	21.9	59.8	95.5	2575.0
16/9	459.5	1830.0	56.2	33.0	20.9	56.2	95.9	2670.8
23/9	150.5	1980.5	60.8	31.8	20.8	56.5	90.3	2761.2
30/9	162.0	2142.5	65.8	33.5	20.3	56.7	95.0	2856.2
7/10	217.5	2360.0	72.5	29.7	24.8	58.4	81.2	2937.4
14/10	227.5	2587.5	79.5	30.6	25.6	61.3	90.0	3027.3
21/10	209.5	2797.0	85.9	28.9	24.3	58.7	77.9	3105.3
28/10	172.0	2969.0	91.2	28.5	23.3	61.1	74.2	3179.4
4/11	113.0	3082.0	94.7	27.2	22.1	61.1	66.9	3246.3
11/11	86.0	3168.0	97.3	26.5	21.1	56.8	57.4	3303.8
18/11	52.0	3220.0	98.9	26.9	22.2	56.9	66.1	3369.9
25/11	17.0	3237.0	99.4	25.6	19.4	55.9	44.4	3414.2
2/12	15.0	3252.0	99.9	23.9	18.6	60.1	40.9	3455.1
9/12	4.0	3256.0	100.0	23.5	17.5	52.4	34.9	3490.1
16/12	0.0	3256.0	100.0	20.6	16.4	63.9	28.4	3518.5
23/12	0.0	3256.0	100.0	18.2	16.0	59.6	24.2	3542.7
30/12	0.0	3256.0	100.0	20.3	16.1	62.1	25.3	3568.0

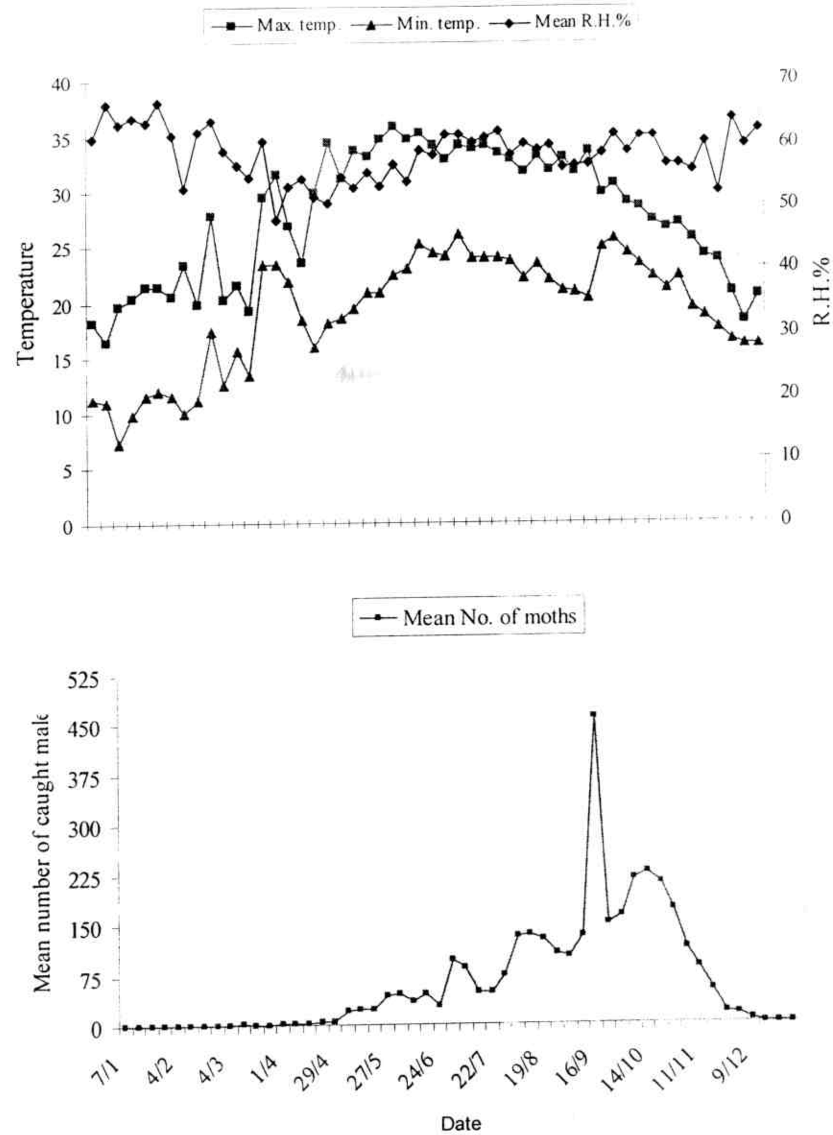


Fig (16): Seasonal fluctuations of pink bollworm male moths caught in pheromone traps during 2002 season.

September with 459.5 moths/trap/week; being the highest peak. The accumulative percentage of captured moths for the fourth peak between the 3rd peak and 4th peak consisted about 22% from the accumulated number of moths captured during 2002 season. The fifth peak was detected in mid- October, with 227.5 male moths/trap/week. The difference in accumulated moths' percentage between the fourth peak and the fifth peak consisted about 23%. The population of pink bollworm male moths in sex pheromone trap decreased gradually thereafter, until the 2nd week of October. No more moths were captured from mid-December until the end of February.

1.2. Second season (2003):

Data in Table (12) and Fig. (17) show that ***P. gossypiella*** male moths started to appear in the pheromone traps during the second week of March, and continued until the first week of December. The numbers of male moths captured in sex pheromone traps fluctuated until reaching the first peak during the 2nd week of June (89 male moths/trap/week). Accumulated number of moths from the first appearance until the first peak represented about 12.6% from the total moths captured throughout the season. The second peak was detected at the end of June (37 male moths/trap/week). The accumulated number of captured moths of pink bollworm from the first peak until the second one was 3.6% from the total captured. The third peak occurred on July, 28th , with 181 male moths/trap/week. Captured of moths from the second peak until the third peak included about 11.4% from the total number during the season. The fourth peak of pink bollworm male moths appeared in sex

Table (12): Number of pink bollworm male moths caught in pheromone traps during 2003 season.

Date	No. of caught moths/trap			Weather factors			Heat units	
	Mean No.	Accumulated		Temperature		Mean R.H.%	Weekly DD	Accumulated DD
		No.	%	Max.	Min.			
6/1	0.0	0.0	0.0	21.9	11.9	55.3	26.6	26.6
13/1	0.0	0.0	0.0	23.0	10.3	61.4	31.7	58.2
20/1	0.0	0.0	0.0	18.6	10.3	67.4	16.8	75.1
27/1	0.0	0.0	0.0	20.5	10.0	58.4	24.4	99.5
3/2	0.0	0.0	0.0	20.1	9.1	51.6	20.1	119.6
10/2	0.0	0.0	0.0	19.0	9.7	56.9	17.8	137.4
17/2	0.0	0.0	0.0	19.3	8.7	59.3	18.2	155.6
24/2	0.0	0.0	0.0	18.3	9.5	52.7	14.4	170.0
3/3	0.0	0.0	0.0	19.5	8.6	56.4	20.9	190.9
10/3	1.0	1.0	0.0	23.5	12.7	51.1	38.7	229.6
17/3	1.0	2.0	0.1	24.6	12.4	52.1	44.7	274.3
24/3	0.0	2.0	0.1	23.1	12.4	48.6	36.1	310.4
31/3	0.0	2.0	0.1	22.7	11.6	50.8	33.3	343.7
7/4	1.0	3.0	0.1	29.2	17.2	49.3	70.8	414.6
14/4	2.0	5.0	0.1	25.0	11.3	56.4	38.3	452.9
21/4	3.0	8.0	0.2	26.2	13.9	55.7	55.7	508.5
28/4	21.0	29.0	0.8	29.8	14.6	52.0	60.5	569.0
5/5	37.0	66.0	1.9	33.4	13.6	47.5	71.9	640.9
12/5	48.0	114.0	3.3	35.4	15.9	38.3	81.5	722.3
19/5	73.0	187.0	5.3	37.9	16.0	29.4	88.4	810.7
26/5	79.0	266.0	7.6	37.4	18.9	38.1	93.9	904.6
2/6	86.0	352.0	10.0	35.9	20.7	40.9	98.5	1003.1
9/6	89.0	441.0	12.6	33.8	21.5	51.6	96.4	1099.5
16/6	57.0	498.0	14.2	35.2	21.5	53.0	101.3	1200.7
23/6	34.0	532.0	15.2	33.6	22.5	54.3	98.6	1299.4
30/6	37.0	569.0	16.2	34.9	23.1	54.7	104.0	1403.4
7/7	15.0	584.0	16.7	35.4	24.3	58.6	107.3	1510.7
14/7	93.0	677.0	19.3	32.1	23.6	57.7	100.9	1611.6
21/7	122.0	799.0	22.8	33.8	23.1	61.3	104.7	1716.3
28/7	181.0	980.0	28.0	33.9	24.5	62.1	108.0	1824.2
4/8	177.0	1157.0	33.0	36.7	21.6	52.9	99.9	1924.1
11/8	108.0	1265.0	36.1	37.4	21.4	51.0	101.7	2025.8
18/8	101.0	1366.0	39.0	34.8	20.4	50.0	95.2	2121.0
25/8	115.0	1481.0	42.3	38.1	19.9	47.4	98.0	2218.9
1/9	179.0	1660.0	47.4	37.6	20.1	49.9	98.6	2317.6
8/9	177.0	1837.0	52.4	36.1	20.8	49.1	95.1	2412.7
15/9	163.0	2000.0	57.1	36.5	18.7	47.6	91.9	2504.6
22/9	165.0	2165.0	61.8	36.4	19.3	47.6	92.2	2596.8
29/9	169.0	2334.0	66.6	32.1	16.1	51.3	76.1	2672.9
6/10	173.0	2507.0	71.5	29.7	19.2	58.1	100.3	2773.3
13/10	196.0	2703.0	77.1	30.4	20.2	60.0	106.7	2880.0
20/10	205.0	2908.0	83.0	29.3	20.0	60.1	97.3	2977.3
27/10	209.0	3117.0	88.9	28.7	18.3	60.4	92.7	3070.0
3/11	162.0	3279.0	93.6	27.2	16.8	60.6	84.0	3154.0
10/11	121.0	3400.0	97.0	26.5	16.0	57.5	77.8	3231.8
17/11	63.0	3463.0	98.8	27.0	17.3	57.7	83.1	3314.9
24/11	32.0	3495.0	99.7	25.8	13.7	55.6	68.8	3383.7
1/12	10.0	3505.0	100.0	24.2	13.3	59.1	60.3	3444.0
8/12	0.0	3505.0	100.0	23.6	11.6	53.3	55.0	3499.0
15/12	0.0	3505.0	100.0	20.8	11.4	62.9	40.7	3539.7
22/12	0.0	3505.0	100.0	18.6	14.7	60.0	28.2	3567.9
29/12	0.0	3505.0	100.0	19.7	11.8	62.4	40.0	3608.0

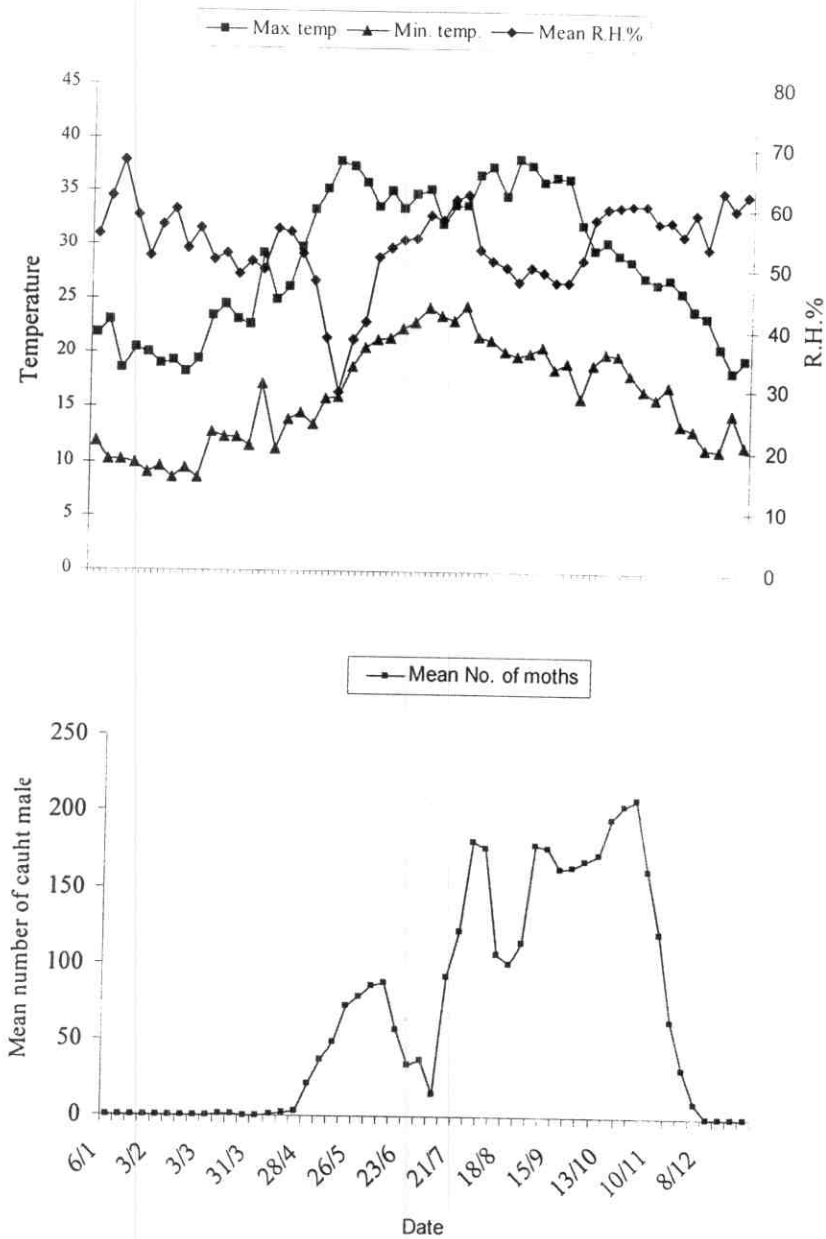


Fig (17): Seasonal fluctuations of pink bollworm male moths caught in pheromone traps during 2003 season.

pheromone traps at the beginning of September, with 179 male moths/trap/week. Captured of pink bollworm male moths between the third peak and the fourth peak consist of about 15.4% from the total male moths captured during the season. The fifth peak occurred on October, 27th, with 209 male moths/trap/week; representing the highest peak. Male moths captured between the fourth and fifth peak consisted about 37.4% of the total male moths during the season. After this peak, the number of male moths decreased gradually until disappeared during the 2nd week of December.

Generally, it could be deduced from the demonstrated results that the pink bollworm moths had five peaks during each of 2002 and 2003 season. These results agree with those of **El-Deeb *et al.* (1995)** who stated that there were five peaks for pink bollworm caught in pheromone traps sited in Sharkia region during 1989 and 1990 seasons. The accumulated number of moths caught was 3256 at the first year 2002, opposed to 3505 male moths in 2003 season. During the first season the first peak was the weakest, while the fourth was the highest one during the two seasons. The number of male moths differed from one season to another, and during the same season. This may be due to the moths emergence from larval diapause which is normally affected by weather factors and crop rotation. In contrast to the present results, **Guirguis *et al.* (1991) and Moawed *et al.* (1994)** reported that the pink bollworm captured in pheromone traps showed 3 peaks in Egypt during May-October. **Amin *et al.* (1999)** stated that PBW had three peaks during July, August and September.

1.3. Fruiting structure of cotton variety Giza 85 and seasonal fluctuation of pink bollworm adult males:

This work aimed to study the relationship between cotton structures; *i.e.* squares, flowers & cotton bolls and numbers of caught male moths.

The cotton plants were planted on April, 4^{th} during the two successive cotton seasons 2002 & 2003. Numbers of cotton structures were recorded weekly (Tables, 13 & 14). Data indicated that cotton buds need about 644 and 427 DD to first appear during the first and second seasons, respectively. The mean numbers of buds were 0.44 and 0.35buds/plant, respectively. The average numbers of fruit branches were 0.64 and 0.47 branch/plant in 2002 and 2003, respectively. The first appear of buds occurred after 55 and 48 days from planting date during the first and second season, respectively (Tables, 13 and 14). The first peak of pink bollworm catch in pheromone traps coincided with the first appear of the fruiting structures. The first peak of pink bollworm male moths caught in pheromone traps started to appear after one and two weeks after the first appearing of fruiting structures at the first and second seasons, respectively. The peak of moths emergence from overwintring larvae was at the second and third weeks of May during 2002 and 2003 cotton seasons, respectively (Tables,11 & 12). The average numbers of buds increased to reach the peak at the second and third weeks of July and then decreased during the two cotton seasons 2002 and 2003. The first appearance of the cotton flowers was at the 3rd week of June (0.08 and 0.44 flower

Table (13): Average numbers of fruiting structures / cotton plant, variety Giza 85 during season 2002.

Date	Fruit branches	Squares (buds)	Flowers	Green bolls	Open bolls	Accumulated DD
29/5	0.64	0.44				644
6/6	2.17	1.2				719
13/6	4.04	5.36				792
20/6	6.84	11.04	0.08			877
27/6	10.6	19.4	0.6	0.64		1060
4/7	11.48	24.24	1.44	2.2		1191
11/7	13.12	36.76	1.68	6.76		1296
18/7	15.08	28.52	2.96	9		1404
25/7	15.36	25.56	3.72	13.44		1514
1/8	16.64	19.6	2.52	15.2		1620
8/8	17.6	12.6	1.8	18		1727
15/8	18.44	5.25	1.24	24.2	0.12	1812
22/8	19.16	3.48	1.4	24.36	2.4	1931
29/8	19.56	3	1.28	24	6.68	2029
5/9	19.8	3.04	0.64	22.2	10.16	2131
12/9	20.16	3.12	0.68	20.76	16.8	2225
19/9	20.17	3.2	0.45	15.23	21.26	2320

Table(14): Average numbers of fruiting structures/cotton plant, variety Giza 85 during season 2003.

Date	Fruit branches	Squares (buds)	Flowers	Green bolls	Open bolls	Accumulated DD
22/5	0.47	0.35				427
29/5	0.917	1.08				568
6/6	2.24	2.52				680
13/6	4.96	6.33				779
20/6	7.12	10.52	0.44			877
27/6	9.28	14.08	1.4	0.16		957
4/7	9.69	14.42	1.24	1.4		1087
11/7	11.76	14.08	1.08	2.92		1175
18/7	13.84	14.88	1.04	5.64		1292
25/7	13.77	14.39	1.46	9		1400
1/8	16.67	12.42	1.042	16.92		1491
8/8	18.48	12	1.36	19.38		1605
15/8	19.88	5.48	0.92	22.72	0.76	1705
22/8	20.04	6.44	0.84	24.67	2.64	1800
29/8	20.96	5.68	0.8	25.08	6.08	1897
5/9	21.48	2.28	0.36	22.16	13.88	1999
12/9	21.43	3.27	0.32	21.63	18.42	2088
19/9	21.46	4.06	0.34	17.22	25.33	2184

/ plant after 76 days from sowing during the two seasons, respectively). The flowers needed to about 877 DD to first appear in either of the two seasons. The green cotton bolls needed about 1060 and 957 DD from the date of planting (Tables, 13&14). The green cotton bolls started to appear after 83 days from sowing, showing 0.64 and 0.16 green cotton bolls/plant during the first and second seasons, respectively. The first appearance of cotton bolls coincided with the 2nd and 3rd generations of pink bollworm (Table, 16). The number of green cotton bolls increased to reach their peaks (24.36 & 25.08 bolls/plant) on August, 22nd & 29th during the first and second seasons, respectively. The appearance of the peak of green cotton bolls coincided with the 4th generation of the pink bollworm male moths caught in pheromone traps during the two cotton seasons. The first open bolls appeared after 131 days after sowing during the two cotton seasons. The open cotton bolls needed about 1812 and 1705 DD. The numbers of open bolls increased until the end of cotton season.

Sevacherian and El-Zik (1983) found that the square initiation for Acal SJ-2 at 500 DD, blooms at 740 DD, green bolls at 830 DD and first open bolls at 1800 DD from planting. **Nada (2001)** found that the peak in numbers of squares and green bolls in Gharbia governorate occurred after 84, 72 and 66 days for the three successive cotton seasons (1998, 1999 and 2000, respectively), while these periods were 48, 60 and 54 days from beginning cotton squares formation in Sharkia governorate, for the same cotton seasons, respectively.

1.4. Effect of climatic factors on the population density of *P. gossypiella*:

The aim of this work was to study the fluctuations in numbers of ***P. gossypiella*** male moths caught in sex pheromone traps in relation to maximum temperature, minimum temperature and mean relative humidity (R.H. %) during the two successive cotton seasons, 2002 and 2003.

1.4.1. Maximum temperature:

Data of the simple correlation "r", simple regression "b" between Max. temp. and population of male moths captured in sex pheromone traps were given in Table (15).The correlation was positive and highly significant during the whole two seasons. The simple correlation coefficient "r" was 0.489 and 0.699 in 2002 and 2003, respectively. The simple regression was significant during the two seasons. The "b" values were 0.256 and 0.493 during 2002 and 2003, respectively.

1.4.2. Minimum temperature:

Results in Table (15) cleared that values of simple correlation "r" between Min. temp. and number of male moths caught in sex pheromone traps were 0.536 and 0.726 during the first and the second seasons, respectively; indicating positive correlation during the two years. The simple regression "b" values were also significant (0.304 and 0.537 in 2002 and 2003, respectively).

Table (15): Simple correlation (r) and multiple regression (b) and explained variance (E.V.%) of the effect of temperature and R.H.% on the population of captured *P. gossypiella* male moths, during 2002 and 2003 seasons.

Season	Weather Factor	Simple correlation		Simple regression			Multiple regression		E.V%
		r	p	a	b	P	R2	P	
2002	Max. temp.	0.489	0.00**	- 454.24	0.256	0.00**	0.322	0.003**	32.21
	Min. temp.	0.536	0.00**	27.6	0.304	0.00**			
	Mean R. H.	-0.0007	0.995ns	- 5178.8	0.142	0.228*			
2003	Max. temp.	0.699	0.00**	- 257.25	0.493	0.00**	0.521	0.00**	52.15
	Min. temp.	0.726	0.00**	-29.09	0.537	0.00**			
	Mean R. H.	-0.0575	0.685ns		0.003	0.921ns			

r=Correlation coefficient
p= Probability
a=Constant
R^2= Multiple correlation
b= Slope
Significant at 5% confidence level
E.V.%= Explained variance

1.4.3. Relative humidity:

Data given in Table (15) show the simple correlation "r" between weekly R.H. % and population number of male moths captured in pheromone traps. It was found that the mean R.H% had negative correlation, where the "r" values were -.0007 and – 0.057 in 2002 and 2003 year, respectively. But, the simple regression "b" values were 0.142 and 0.003 during 2002 and 2003 years.

1.4.4. Interaction of the three climatic factors:

Data in Table (15) show that the explained variance (E.V. %) values of the three weather factors was significant during the two successive years of study. The "R^2" was 0.322 and 0.521 during 2002 and 2003 year, respectively. E.V. % values were 32.21% and 52.15%, respectively. Several authors studied the relationship between weather factors and pheromone trap catches of pink bollworm such as **Adams *et. al.* (1986), Chu and Henneberry (1990), Adams *et al.* (1995) and Beasly and Adams (1996)** in USA. They indicated positive correlation between both of Min. and Max. temperatures and numbers of pink bollworm moths caught in traps. **Hossain (1990)** found positive and significant effect of Max. and Min. temperatures on pink bollworm moths caught in traps, while R.H.% had negative and insignificant effects. **El-Mezayyen *et al.* (1997), El-Sayed (2001) and Amer (2004)** reported positive correlation between pink bollworm moths catch/trap and the combined three weather factors.

Generally, temperature can be considered the main factor affecting the seasonal fluctuation of the pink bollworm male moths. However, the R.H. % had the lowest effect on the population fluctuation of pink bollworm male moth.

1.5. Number of generations:

Number and duration of the annual field generations of ***P. gossypiella*** moths captured in pheromone traps were calculated according to **Audemard and Milaire (1975) and Jacob (1977).** The data were plotted on semigaussion (Scale Gauss) and regression line (Figs., 18 and 19) representing each generation.

Data given in Table (16) and Figs. (18 and 19) clear the duration and number of estimated generations during 2002 and 2003 years. The first generation of pink bollworm occurred at the first week of March and the 2^{nd} week of April during 2002 and 2003 seasons and continued for 9 and 7 weeks until the end of April, 2002 and 4^{th} week of May, 2003. The accumulated percentages of moths captured were 0.62 and 7.53 % in 2002 and 2003, respectively. The second generation appeared at the 1^{st} week of May and 1^{st} week of June in 2002 and 2003 and continued for about 5 and 7 weeks until 1^{st} week of June, 2002 and 2^{nd} week of July, 2003. The second generation included about 4.84 % and 11.77 % from the total pink bollworm moths captured in pheromone traps (3251.5 & 3492 male moths during 2002 and 2003, respectively). The third generation started at 2^{nd} week of June and 3^{rd} week of July in both studied years and continued for about 7 and 6 weeks until 4^{th} week of July, 2002 and 4th week of August, 2003. The third generation included about 11.92 and 22.92 % of all captured moths during 2002 and 2003, respectively. The fourth generation started at the end of July and the beginning of September in the two years,

Table (16):Approximate generations and numbers of captured pink bollworm male moths during 2002 and 2003 cotton season.

Year	Generation number							
			1st	2nd	3rd	4th	5th	6th
2002	Duration	From	4/3	6/5	10/6	29/7	9/9	28/10
		To	29/4	3/6	22/7	2/9	21/10	2/12
	Duration in weeks		9	5	7	7	6	6
	Total captured moths	Number	20	157.5	387.5	673	1558.5	455
		%	0.62	4.84	11.92	20.69	47.94	13.99
2003	Duration	From	14/4	2/6	21/7	1/9	13/10	-
		To	26/5	14/7	25/8	6/10	24/11	-
	Duration in weeks		7	7	6	6	7	-
	Total captured moths	Number	263	411	804	1026	988	-
		%	7.53	11.77	22.94	29.38	28.29	-

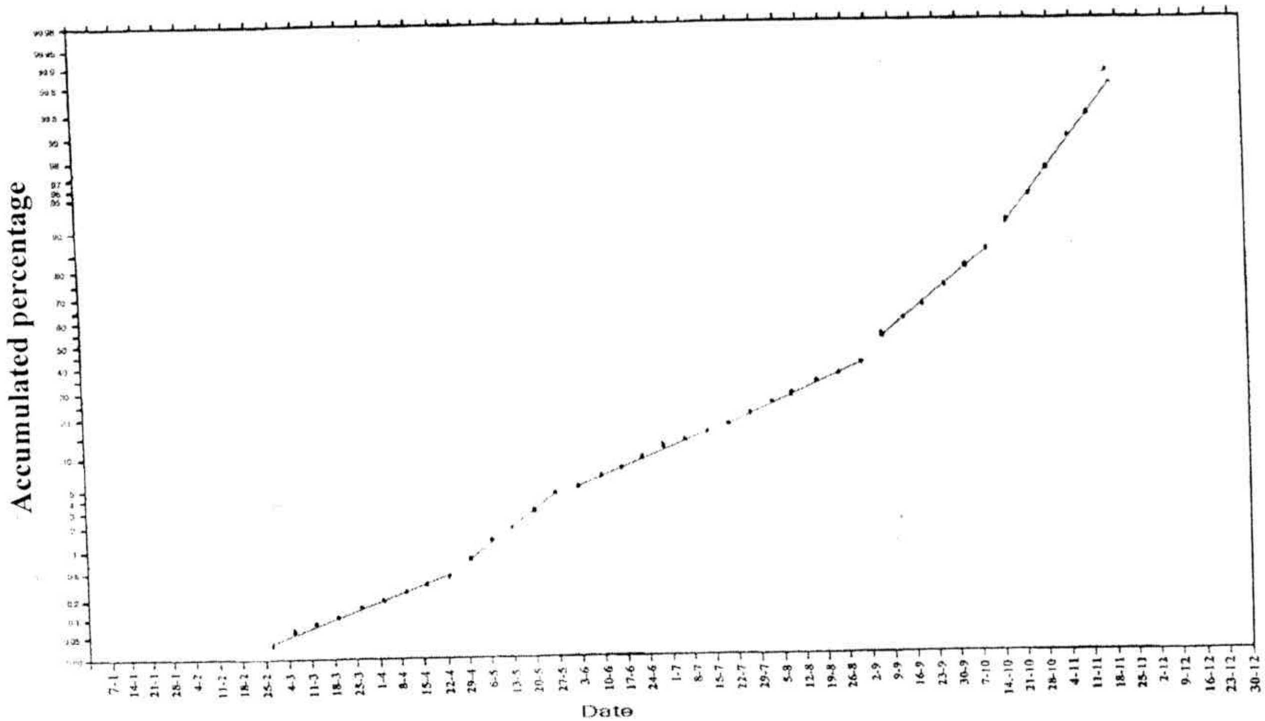


Fig (18): Annual generations of *P. gossypiella* male moths caught in sex pheromone traps and their durations in Sharkia Governorate during season 2003.

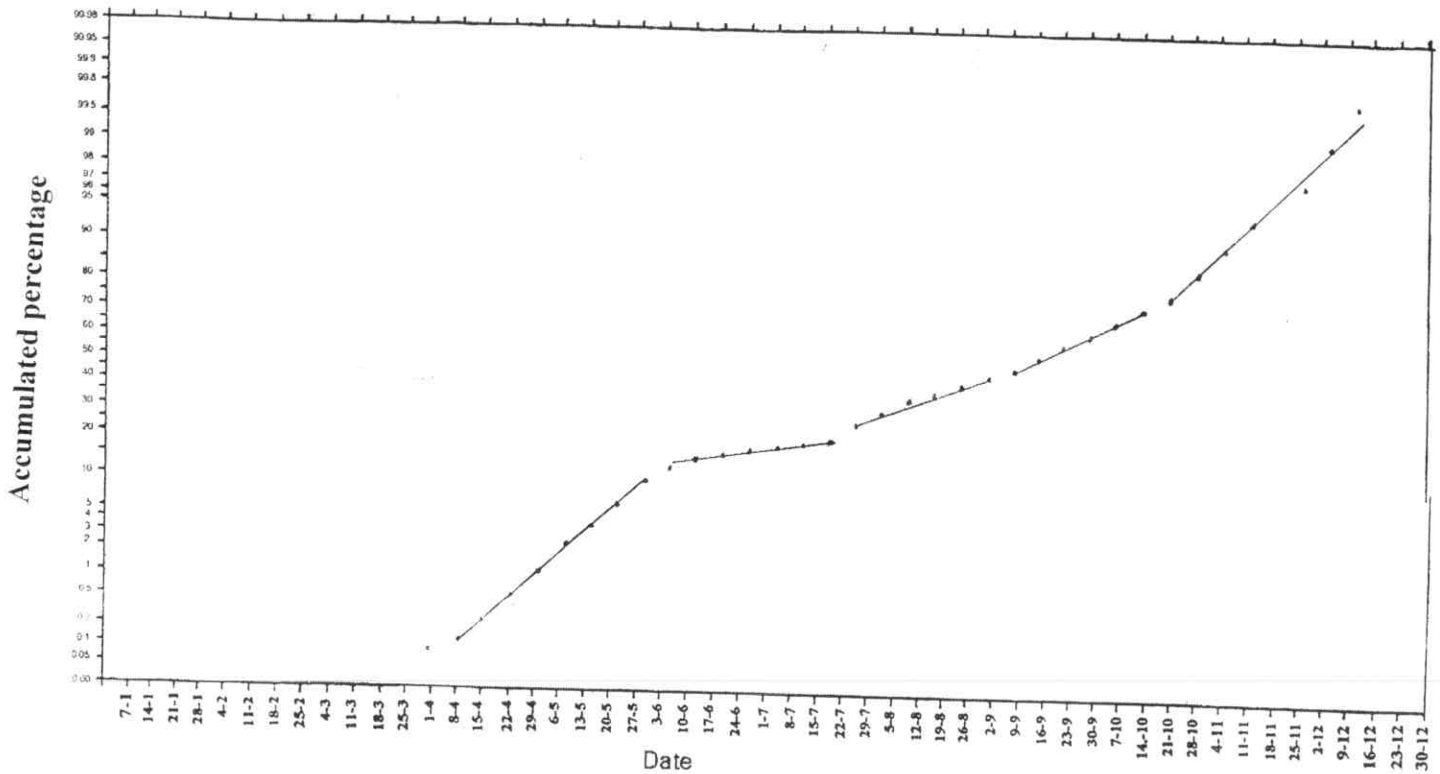


Fig (19): Annual generations of *P. gossypiella* male moths caught in sex pheromone traps and their durations in Sharkia Governorate during season 2003.

respectively and continued for about 7 and 6 weeks until 1st week of September, 2002 and 1st week of October, 2003. Percentages of captured moths were 20.69 and 29.38% from the total captured male moths (3251.5 & 3492 in 2002 and 2003, respectively). The fifth generation appeared at 2nd week of September and 2nd week of October and continued for about 6 and 7 weeks until the 3rd week of October and 4th week of November during 2002 and 2003, respectively. In the fifth generation, the percentages of moths occupied 47.94 % and 28.29 % of total moths. The six generation was only detected during year 2002 and appeared at the end of October and continued for about 6 weeks up to the 1st week of December. The total numbers of captured moths from this generation occupied 13.99% of the total captured moths.

Generally, data concerning the captured male moths manifested 6 generations in 2002 and 5 generations in 2003. The size of generation varied from one to another and from season to another, where the fifth generation was the highest in the first season (47.94 % of total captured moths), while the fourth one was the highest in second one (29.38% of total moths).

The present findings agree with those of **Hossain (1990), El-Deeb *et al.* (1995), El-Mezayyen *et al.* (1997) and Abd El-Hamid *et.al.* (1999)** who reported that there were 5 generations of pink bollworm. However, **Amin *et al.* (1999)** reported 4 generations/ year.

1.6. Relationship between number of pink bollworm male moths and accumulated heat units:

Heat units (The total amount of heat required, between the lower and upper thresholds, for an organism to develop from one point to another in its life cycle is calculated in units called degree-days) for each season calculated to the single sine method with horizontal cut off upper/lower temperature thresholds were 30.0/12.66 °C (**Fry (1983)** and **Zalom *et al.* (1983)**). Degree days were accumulated from January, 1st to December, 31st for each season.

Data in Table (17) show the correlation coefficient between pink bollworm male moths trap catches in relation to accumulated heat units. Correlation coefficient for weekly number of pink bollworm moth catches versus to mean weekly degree days were 0.502 and 0.75 in the first and second season, respectively. Correlation coefficient was significant during the two seasons The coefficients of determination (R^2) for simple regression were 0.267 and 0.575 at 2002 and 2003 seasons, respectively. Explained variance values were 26.74 and 57.48% at the first and second seasons, respectively.

Correlation coefficients for the accumulated of pink bollworm male moth catches versus to the accumulated degree days were 0.94 and 0.97 during 2002 and 2003 years, respectively. Correlation coefficient was significant during the two seasons. The coefficients of determination (R^2) for simple regression were .099 and 0.991, respectively. Explained variance values were 99.0 and 99.1% during 2002 and 2003 seasons, respectively.

Table (17): Simple correlation "r" and regression between heat unit and both seasonal fluctuation and accumulated number of pink bollworm male moths caught in pheromone traps.

Male moths	Parameters		Year	
			2002	2003
accumulated	Simple correlation	r	0.94	0.97
		p	0.000***	0.000***
	Simple regression	R^2	0.99	0.991
		p	0.000***	0.000***
	E.V.%		99	99.1
Number	Simple correlation	r	0.502	0.75
		p	0.000***	0.000***
	Simple regression	R^2	0.267	0.575
		p	0.0001***	0.0000***
	E.V.%		26.74	57.48

r=Correlation coefficient
p= Probability
R^2= Simple regression
Significant level 1%
E.V.%= Explained variance

Generally, the accumulated trap catches and accumulated degree days may be a useful tool for predicting the number of pink bollworm male catches as an indicator of seasonal population increase.

Heat unit accumulations have been used to characterize the relationship between plant growth and development and also have been used to estimate the time of occurrence of early season pink bollworm moth overtime trapping emergence. **Fry (1983), Sevacherian *et al.* (1977)** and **Chu and Henneberry (1992)** suggested that trap catch data, as related to degree days, may be used to describe seasonal increasing of pink bollworm populations.

2. Percentage of infestation by pink bollworm to fruiting structures of cotton plants:

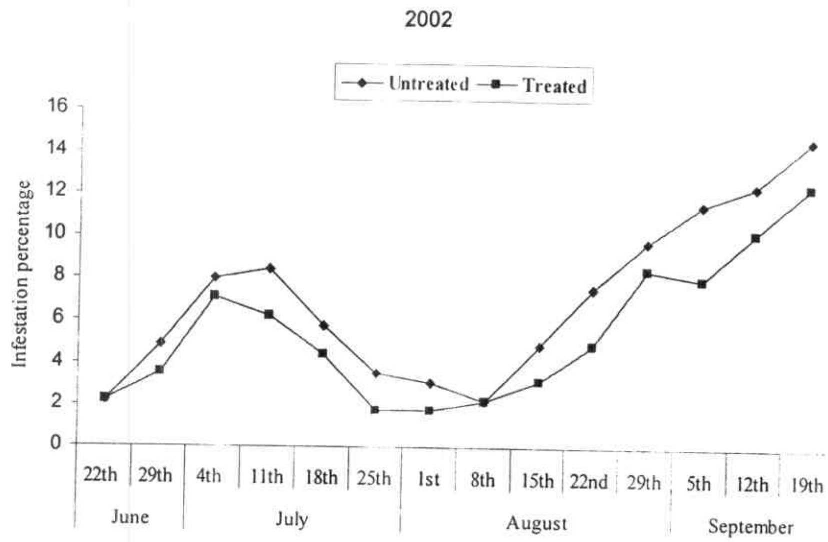
These experiments were carried out in two cotton fields; one of them didn't receive any pesticides, while the other one was treated by conventional programme of recommended insecticides. These experiments were carried out at El-Ebrahemia district, Sharkia Governorate..

2.1. Infestation in squares:

Data in Table (18) and Fig. (20) indicate that the overall mean percentages of infested squares by pink bollworm larvae during the whole season in untreated cotton field were 6.95 and 4.82 % during 2002 and 2003 cotton season, respectively. The corresponding values in the treated cotton field were 5.40 and 3.97 %. The rate of infestation in untreated cotton field was relatively higher than in the treated one.

Table (18): Percentage of infestation by pink bollworm larvae to squares in treated and untreated cotton fields during 2002 and 2003 cotton seasons in El-Ebrahemia, Sharkia governorate.

Sampling date	2002		2003	
	Untreated	Treated	Untreated	Treated
	%	%	%	%
20/6	2.23	2.23	5.33	4.89
27/6	4.89	3.56	5.77	5.77
4/7	8.00	7.11	7.56	4.89
11/7	8.44	6.23	8.44	4.44
18/7	5.77	4.44	5.33	3.56
15/7	3.56	1.77	3.56	4.00
1/8	3.11	1.77	2.67	2.67
7/8	2.23	2.23	1.77	1.33
14/8	4.89	3.17	1.77	0.89
21/8	7.56	4.89	2.67	1.77
28/8	9.77	8.44	1.77	2.67
4/9	11.56	8.00	6.23	4.89
11/9	12.44	10.23	6.67	6.67
18/9	12.89	11.56	8.00	7.11
Total	97.35	75.63	67.55	55.56
Mean	6.95	5.40	4.82	3.97



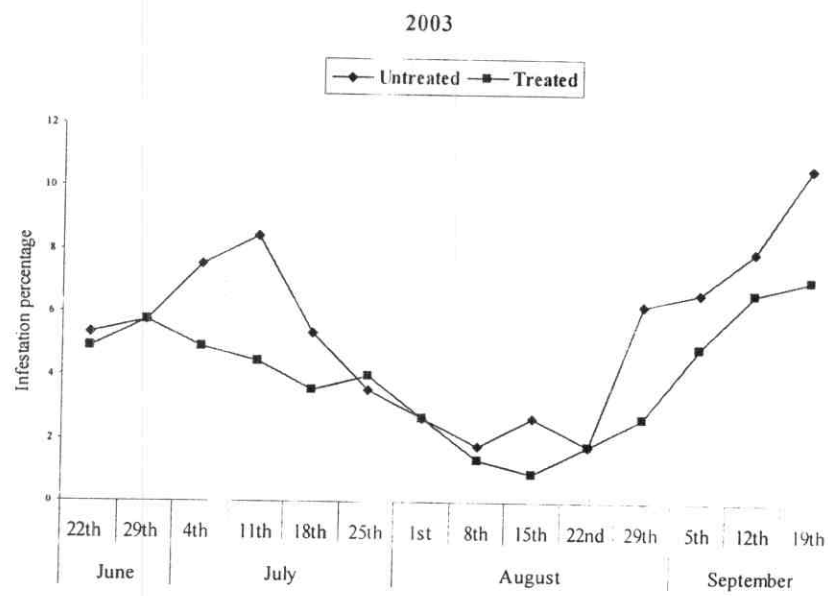


Fig (20): Infestation percentages in squares by pink bollworm larvae in treated and untreated cotton fields during 2002 and 2003 cotton seasons.

Two peaks of infestation on squares were recorded; the first was during 2nd week of July with 8.44 % during the two seasons, while the second peak was at the end of cotton season on the 3 rd week of September during 2002 and 2003 cotton seasons beings represented by the respective percent of 12.89 and 8.0%. In case of treated cotton field, two peaks of infestation were also recorded, the first peak was at the 4th week of July with 7.11 % and at the last week of June with 5.77 % during 2002 and 2003 seasons, respectively. The second one was at the end of cotton season at the 3rd week of September with 11.56 and 7.11 %, respectively.

Regarding, the weekly percentage of squares infested by pink bollworm on untreated cotton filed (Table, 18), data indicated that the percentage of infestation increased from the 3 rd week of June till the peak of infestation during 2nd week of July (the susceptible bolls were absent) and decreased during the period of the green bolls available and return to increase during September (the susceptible bolls were decreased). The same trend of squares, infestation was observed on treated cotton field.

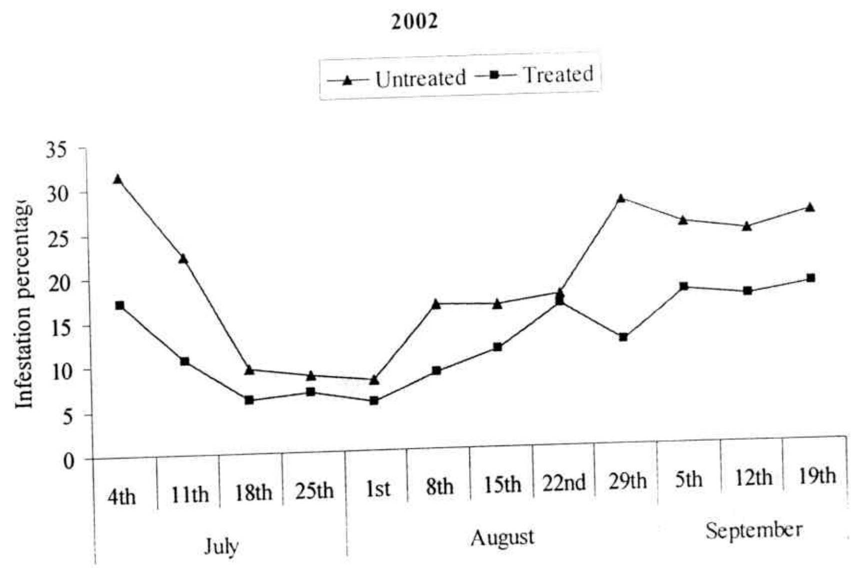
2.2. Infestation in flowers:

Results on the incidence of pink bollworm larvae in blooms of cotton plant (Rosetted Flowers) throughout the two successive cotton seasons of 2002 and 2003 (Table, 19 & Fig., 21) indicated that the percentages of infestation varied between untreated and treated cotton fields.

The overall mean of infestation percentages during the two seasons were (21.1 & 22.30 %) and (13.2 & 8.9 %) in untreated and treated cotton fields, respectively (Table, 19 and

Table(19): Percentages of infestation by pink bollworm larvae in cotton blooms in untreated and treated cotton fields throughout 2002 and 2003 cotton seasons in El-Ebrahemia, Sharkia governorate.

(results from 25 plants)				
Sampling date	**2002**		**2003**	
	Untreated	**Treated**	**Untreated**	**Treated**
4/7	**31.4**	**17.1**	**26.7**	**18.2**
11/7	**22.2**	**10.5**	**20.5**	**9.1**
18/7	**9.6**	**6.1**	**20.5**	**7.9**
25/7	**8.6**	**6.8**	**22.9**	**6.9**
1/8	**8.0**	**5.4**	**18.8**	**5.3**
8/8	**16.3**	**8.7**	**13.6**	**3.5**
15/8	**16.1**	**11.1**	**13.8**	**2.1**
22/8	**17.1**	**16.0**	**20.9**	**4.3**
29/8	**27.6**	**11.8**	**23.3**	**6.7**
5/9	**25.0**	**17.4**	**25.0**	**9.0**
12/9	**24.0**	**16.7**	**25.9**	**13.6**
19/9	**26.0**	**17.9**	**35.7**	**19.7**
Total	**231.9**	**145.4**	**267.6**	**106.2**
Mean	**21.1**	**13.2**	**22.3**	**8.9**



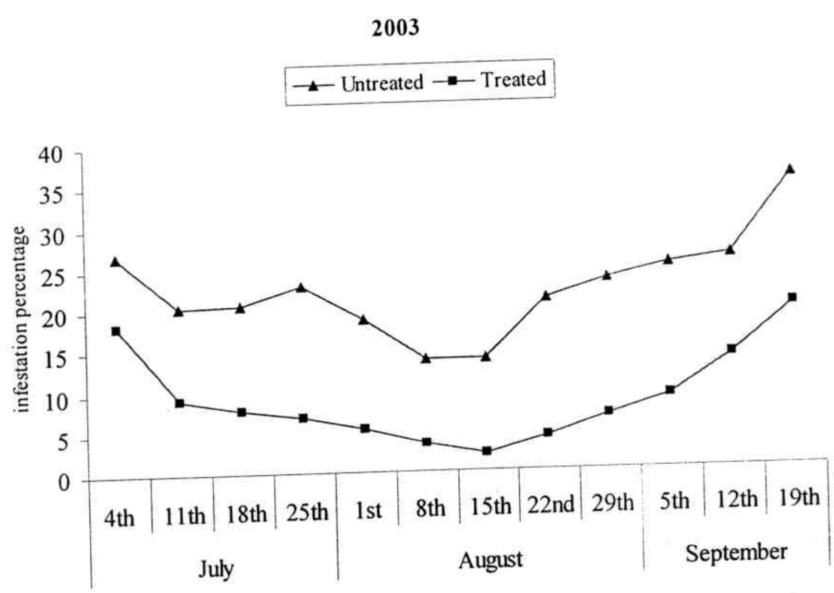


Fig (21): Percentages of infestation to cotton blooms by pink bollworm larvae in treated and untreated cotton fields during 2002 and 2003 cotton seasons.

Fig., 21). From the same table, data indicated that in untreated fields, there were three peaks of blooms, infestation during 2002 season (31.4, 27.6 and 26 % on 1st week of July, 4th week of August and the 3rd week of September, respectively). In 2003 cotton season, three peaks of blooms infestation also occurred, being 26.7, 22.9 and 35.71 % at 1st & 4th weeks of July and 3rd week of September, respectively. In treated cotton field there were three peaks also of blooms infestation (17.1, 16.00 and 17.90 %) on 1st week of July, 4th week of August and 3rd week of September during the first season. The second season showed two peaks also of blooms, infestation, the first at the 1st week of July with 18.2% and the second at the 3rd week of September with 19.72 %.

Generally, squares and blooms infestation started to appear at the beginning of cotton season and continued throughout the whole season, but decreased during the presence of susceptible cotton bolls, then return to increase at the end of cotton season.

2.3. Infestation in green bolls:

Data in Table (20) indicate that the infestation of green cotton bolls with pink bollworm began to appear at the 2nd week of July when bolls were 2 to 3 weeks old (susceptible bolls) during 2002 and 2003 cotton seasons. Percentages of infested green cotton bolls at the second week of July were 3.00 and 2.33 %, respectively in untreated cotton field, in both seasons, opposed to 2.33 and 2.00 % in treated cotton field. The infestation to cotton bolls on untreated cotton field increased steadily from the second week of July to the end of cotton

Table (20): Percentages of infested green cotton bolls by pink bollworm larvae during 2002 and 2003 cotton seasons.

(results from 300 green cotton bolls)				
Sampling date	**2002**		**2003**	
	Untreated	**Treated**	**Untreated**	**Treated**
11/7	**3.00**	**2.33**	**2.33**	**2.00**
18/7	**6.33**	**5.33**	**6.67**	**5.33**
25/7	**14.33**	**2.67**	**11.67**	**3.00**
1/8	**32.00**	**4.00**	**19.00**	**5.67**
8/8	**56.67**	**13.00**	**25.00**	**8.67**
15/8	**77.33**	**12.33**	**48.33**	**6.67**
22/8	**84.00**	**21.33**	**66.67**	**8.33**
29/8	**90.33**	**29.67**	**79.67**	**11.67**
5/9	**96.00**	**39.33**	**90.33**	**24.67**
12/9	**98.33**	**60.00**	**93.67**	**35.33**
19/9	**98.43**	**63.33**	**94.33**	**43.67**
Overall	**656.75**	**253.32**	**537.67**	**155.01**
Mean	**59.70**	**23.03**	**48.88**	**14.09**

season. The mean bolls, infestation reached 14.33 and 11.67 % at the end of July of the two seasons in untreated cotton field. While, in treated cotton field, those reached 2.67 and 3%, respectively.

The percentages of infestation increased gradually until reaching 90.3 and 79.7 % at the end of August during 2002 and 2003 cotton seasons in untreated cotton field, opposed to 29.7 and 11.7% in treated one. The highest % of infestation were recorded at the end of cotton season (at the 3rd week of September) (98.4 & 94.3 %) in the untreated cotton field and 63.3 & 43.7 % in the treated cotton field during the two cotton seasons, respectively. The overall means of bolls infestation % were 59.7 and 48.88 % in untreated cotton field and 23.02 and 14.09 % in the treated one during 2002 and 2003 cotton seasons, respectively.

Generally, it could be concluded that the percentage of cotton bolls infestation by ***P. gossypiella*** increased steadily from the beginning of cotton bolls appearance until the end of season (at the 3rd week of September) during the two cotton seasons in untreated cotton field. While, in treated cotton field, the infestation fluctuated after the insecticides application. Generally, infestation washigher in untreated than treated cotton fields during the two cotton seasons.

2.4. Pink bollworm larval counts in green bolls:

Data in Table (21) and Fig. (22) show that the mean numbers of pink bollworm larvae were 0.04 and 0.02 larvae/ boll at the 2nd week of July during 2002 and 2003 seasons, Table (21): Mean numbers of pink bollworm larvae per green boll during 2002 and 2003 cotton seasons.

Sampling date	2002		2003	
	Untreated	Treated	Untreated	Treated
11/7	0.04	0.03	0.02	0.02
18/7	0.06	0.06	0.08	0.05
25/7	0.18	0.03	0.11	0.03
1/8	0.43	0.04	0.22	0.06
8/8	0.66	0.14	0.28	0.09
15/8	0.87	0.17	0.32	0.07
22/8	1.17	0.27	0.44	0.08
29/8	1.62	0.57	0.69	0.18
5/9	2.01	0.74	1.13	0.24
12/9	2.29	1.15	1.34	0.36
19/9	2.34	1.17	1.64	0.73
Overall	11.67	4.36	6.28	1.91
Mean	1.06	0.40	0.57	0.17

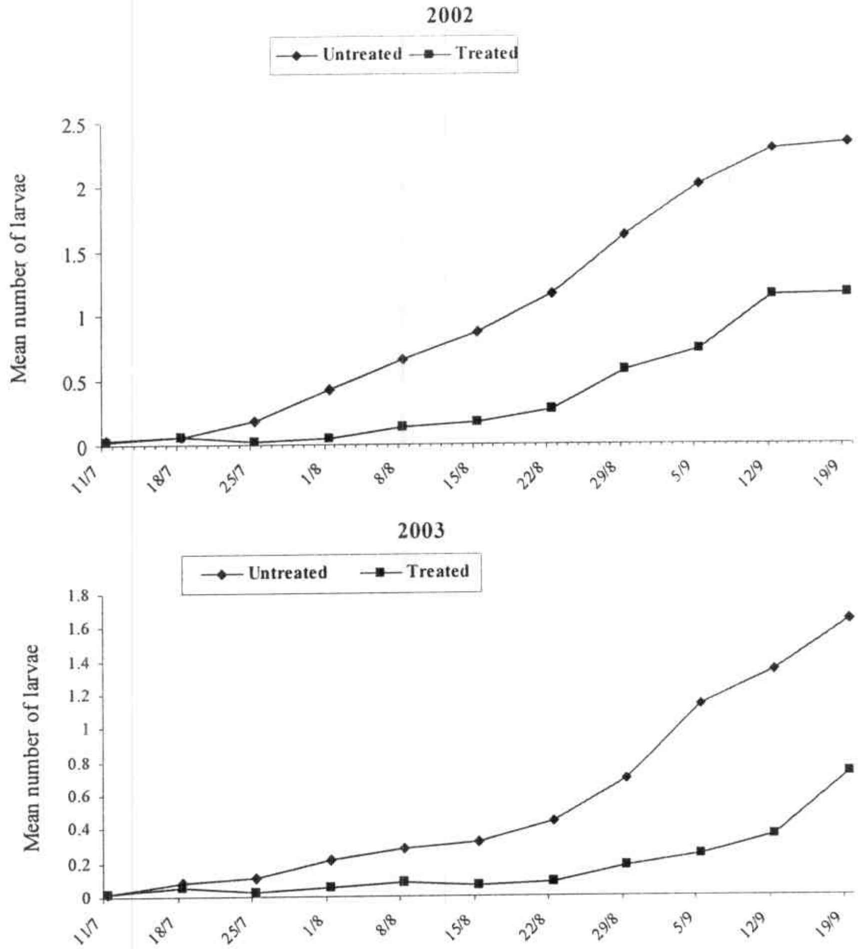


Fig (22): Mean numbers of pink bollworm larvae in green cotton bolls in treated and untreated cotton fields throughout 2002 and 2003 cotton seasons.

respectively, in untreated cotton field. These numbers increased gradually and steadily towards the end of cotton season showing 2.34 and 1.64 larvae/boll at the 3^{rd} week September in 2002 and 2003 cotton seasons, respectively. In case of treated cotton field, mean number of larvae/ boll were 0.06 and 0.05 larva /boll at the 2^{nd} week of July during the two previous cotton seasons, and this number increased during the season to reach the maximum number of larvae/ boll at the 3^{rd} week of September with 1.17 and 0.73 larvae/ boll in 2002 and 2003 cotton seasons, respectively. The mean numbers of larvae/ boll were higher in untreated cotton field than in treated one during the two cotton seasons.

2.5. Relationship between the captured numbers of pink bollworm male moths and infestation percentages in green cotton bolls:-

The simple correlation coefficient between the weekly numbers of captured pink bollworm male moths and percentage of infestation in green cotton bolls in the same week of capturing was analyzed statistically.

Data obtained (Table, 22) cleared that the percentage of infestation in bolls differed sharply from season to another, but a correlation between the means of bolls infestation and number of pink bollworm captured moths was evident. The results showed that the correlation coefficients "r" were 0.795 and 0.42 in untreated cotton field during 2002 and 2003 cotton seasons, respectively.

Table (22): Correlation coefficient and simple regression for pink bollworm male moths caught in pheromone traps in relation to cotton bolls infestation % during 2002 and 2003 seasons.

Year	statistical parameters		untreated	treated
2002	Simple correlation	r	0.795	0.57
		b	0.91	0.32
		p	0.005**	0.08ns
	Simple regression	a	-71.78	-23.95
		p	0.02*	0.25ns
2003	Simple correlation	r	0.42	0.42
		b	0.44	0.165
		p	0.198ns	0.20ns
	Simple regression	a	-418.9	-216.56
		p	0.25	0.14

r=correlation coefficient
p= probability
a=constant
b= slope
Significant level 5%

While, in treated one, those were 0.57 and 0.42, respectively. The correlation between bolls infestation and captured moths was positively significant in 2003 and insignificant in 2002 in untreated cotton field, while in the treated one was positively insignificant during the two cotton seasons. Regression coefficient values "b" were significant and insignificant in untreated cotton field during 2002 and 2003 cotton seasons, respectively, while in treated one, those were insignificant during the two cotton seasons.

Abul-Nasr *et al.* (1979) found that ***P. gossypiella*** was dominant in cotton squares, flowers and green bolls. The rate of infestation increased gradually from 1-12 % in July to 33-92.3 % in September. The percentage of damage to bolls at the end of the second season ranged from 47 to 70%, most of damage being caused by ***P. gossypiella***. **Westphal *et al.* (1979)**, in India, found that the incidence of pink bollworm in flowers was greater in the early sown crop than in the late sown one. The greatest incidence of pink bollworm in bolls was recorded in the late sown crop. **Kostandy (1992)** investigated the relationship between infestation of cotton flowers by the 1^{st} generation of ***P. gossypiella*** and bolls infestation. The author found that early in the season, larvae fed on buds and flowers moving to green bolls later in the season. **Youssef (1997)** found that infestation with pink and spiny bollworms during flowering and fruiting stages, significantly and negatively, affected cotton yield. Percentages of infestation ranged between 4.5-12.8% in July, 6.9-24.2% in August and 12.1-34.6% in September. **Gomaa (1999)** found that from infested bolls by pink and spiny bollworms, the population showed 3-4 peaks during the period extended from first of June to the first 10 days of September.

3. Pink bollworm, *Pectinophora gossypiella*, larvae entering diapause:

Samples of cotton bolls were collected from first week of August until the first week of November during the two successive seasons (2002&2003). Numbers of diapausing and active larvae were counted.

Data in Tables (23 & 24) and Figs. (23 & 24) indicate that 0.8 and 0.8% of ***P. gossypiella*** larvae started diapause at the end of August during 2002 and 2003 cotton seasons, respectively. The percentage of pink bollworm larvae which entered diapause increased gradually from the first week of September (3.3 and 4.5 %) to reach 36.3% in 2002 and 28.5 % in 2003 with the end of September. Then, the number of diapaused larvae increased sharply to reach 93.8 and 91.1% at the end of October during the two cotton seasons, respectively. On November, 11^{th}, the majority of larvae were found in diapause (95.1 and 96.1%, respectively).

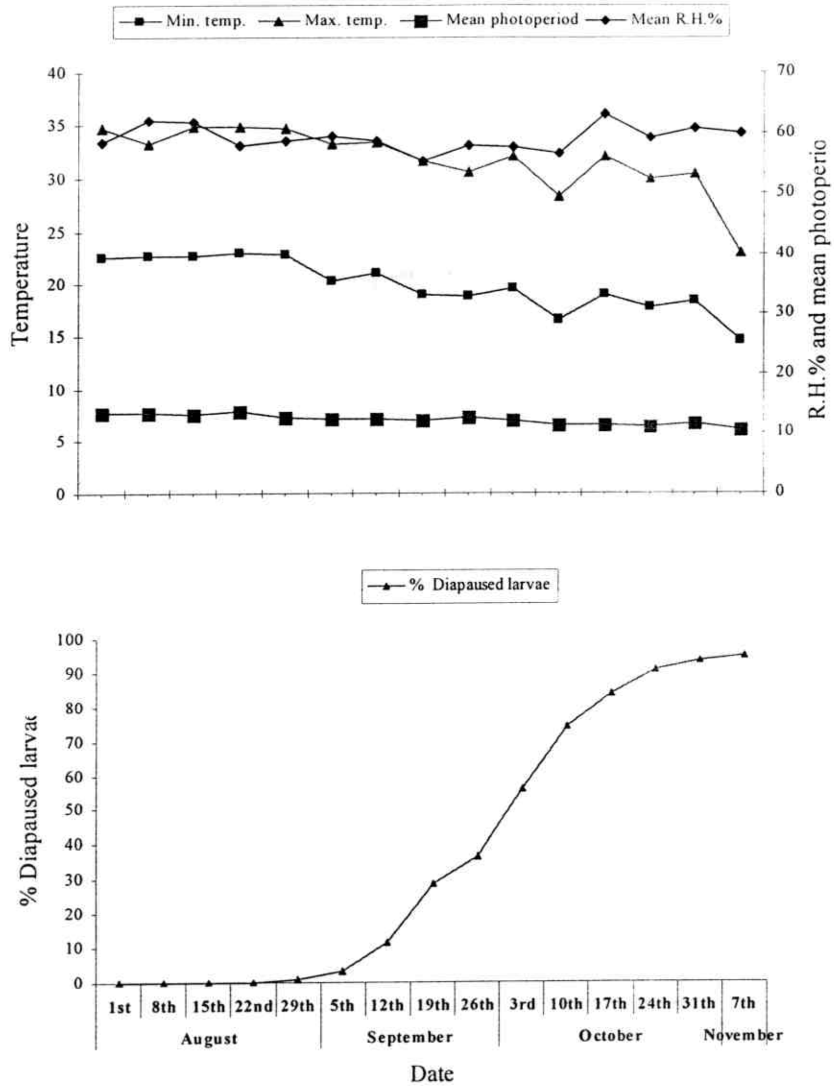
Khalifa, *et al.* (1975) reported that the relatively small percentage of ***P. gossypiella*** larvae that entered diapause in August remained resting for a longer period than those entered diapause in subsequent months. **Metwally and Hosny (1972b)** found that the date of initiation of diapause was the most important factor affecting duration; larvae that entered diapause early had a shorter diapause period than did larvae that entered late.

Table (23): Total numbers of active and diapausing *P. gossypiella* larvae and weather factors during 2002 cotton season.

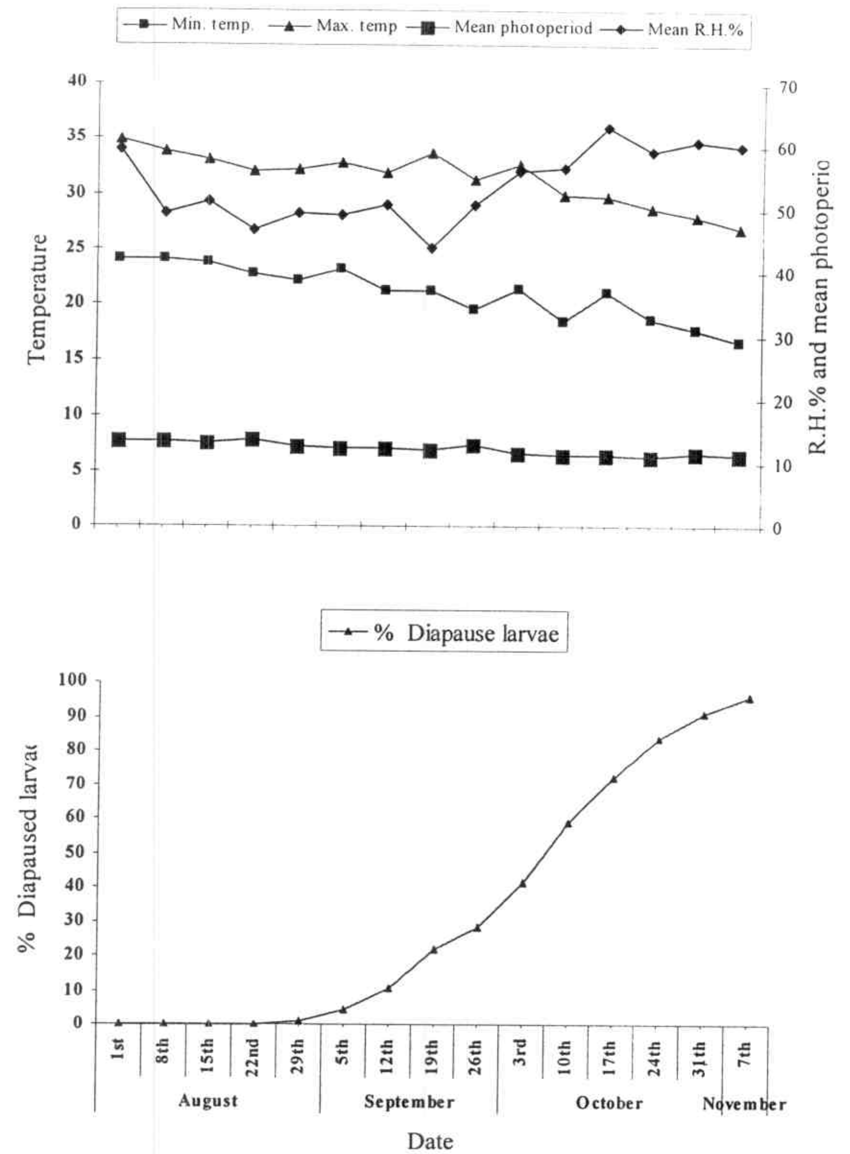
Sampling date	Total No. of larvae	No. of active larvae	No. of diapausing larvae	% of diapausing larvae	Temperature		Mean R.H.%	Mean photoperiod
					Min.	Max.		
1/8	163	163	0	0.0	22.5	34.8	58.5	13.4
8/8	498	498	0	0.0	22.7	33.3	62.0	13.3
15/8	581	581	0	0.0	22.7	34.9	61.7	13.2
22/8	778	778	0	0.0	22.9	34.8	57.9	13.8
29/8	1124	1115	9	0.8	22.8	34.7	58.6	12.6
5/9	1263	1221	42	3.3	20.4	33.2	59.5	12.4
12/9	1378	1220	158	11.5	21.0	33.3	58.6	12.3
19/9	1415	1010	405	28.6	19.0	31.6	55.2	12.2
26/9	1423	906	517	36.3	18.8	30.5	57.9	12.7
3/10	1520	667	853	56.4	19.5	32.0	57.6	12.0
10/10	1463	372	1091	74.6	16.6	28.2	56.5	11.4
17/10	1467	226	1241	84.1	19.0	32.0	63.1	11.3
24/10	1503	141	1362	90.8	17.7	29.9	59.3	11.2
31/10	1521	94	1427	93.8	18.3	30.3	60.7	11.6
7/11	1562	77	1485	95.1	14.6	23.1	60.0	10.5

Table (24):Total numbers of active and diapausing *P. gossypiella* larvae and weather factors during 2003 cotton season.

Sampling date	Total No. of larvae	No. of active larvae	No. of diapausing larvae	% of diapausing larvae	Temperature		Mean R.H.%	Mean photoperiod
					Min.	Max.		
1/8	127	127	0	0.0	24.0	34.9	59.4	13.4
8/8	141	141	0	0.0	24.1	33.8	49.4	13.3
15/8	163	163	0	0.0	23.8	33.1	51.4	13.2
22/8	195	195	0	0.0	22.7	32.1	46.7	13.7
29/8	252	250	2	0.8	22.1	32.2	49.4	12.6
5/9	420	401	19	4.5	23.2	32.7	49.3	12.4
12/9	715	640	75	10.5	21.2	31.8	50.9	12.3
19/9	895	700	195	21.8	21.2	33.7	44.0	12.2
26/9	1014	725	289	28.5	19.6	31.3	50.9	12.8
3/10	1120	657	463	41.3	21.4	32.6	56.0	11.6
10/10	1220	497	723	59.2	18.5	29.9	56.5	11.4
17/10	1315	363	952	72.4	21.0	29.8	63.1	11.3
24/10	1372	219	1153	84.0	18.7	28.7	59.3	11.2
31/10	1401	125	1276	91.1	17.8	28.0	60.7	11.6
7/11	1430	56	1374	96.1	16.6	26.9	60.0	11.2



Fig(23): Percentage of pink bollworm larvae entered diapause in relation to certain climatic factors during 2002 cotton season.



Fig(24): Percentage of pink bollworm larvae entered diapause in relation to certain climatic factors during 2003 cotton season.

3.1. Relationship between climatic factors and percentage of pink bollworm larvae entering diapause stage:

The initiation of diapause in the pink bollworm was related to one or more of the following 4 factors; temperature, relative humidity (or moisture), photoperiod and food **Gough (1916), Willcocks (1916) and El-Sayed and Rustom (1960a).**

The relationship between certain climatic factors (Maximum (Max.), Minimum (Min.) temperatures, relative humidity (R.H. %) and the photoperiod) and the percentage of pink bollworm larvae that entered diapause was estimated.

3.1.1. Temperature:

- Maximum temperature:

Data in Table (25) show the relationship between pink bollworm larvae entered diapause and Max. temperature during 2002&2003 cotton seasons. Simple correlation coefficient values (r) were significantly negative (-0.86 and -0.81) during the first and second cotton seasons, respectively). The simple regression (b) values were highly significant (b= -996.59 and P= 0.0001) and (b= 321.9 and P= 0.0009) in 2002 and 2003 cotton seasons, respectively. Also, from these data, it was clear that the Max. temperature when decreased, the percentage of pink bollworm larvae entered diapause increased.

- Minimum temperature:

Simple correlation coefficient values "r" were highly significant during the two cotton seasons. The correlation coefficient values "r" were -0.88 and -0.88 in 2002 and 2003 cotton seasons, respectively. The simple regression "b" values

Table (25): Relationship between certain weather factors and pink bollworm larvae entered diapause during 2002 and 2003 cotton seasons.

Year			Weather factors			
			Max.	**Min.**	**R.H.%**	**Photoperiod**
2002	**Simple correlation**	r	-0.88	-0.88	0.12	-0.9
		p	0.000***	0.000***	0.67ns	0.000***
	Simple regression	b	-996.59	-306.99	-1282	-3143.4
		R2	0.78	0.78	0.024	0.84
		p	0.000***	0.000***	0.87ns	0.000***
	Multiple regression	R2	0.8918			
		p	0.000***			
	E.V.%		89.18			
2003	**Simple correlation**	r	-0.81	-0.88	0.76	-0.84
		p	0.000***	0.000***	0.000***	0.000***
	Simple regression	b	321.9	-307.94	-365.26	-8025.16
		R2	0.69	0.72	0.63	0.83
		p	0.000***	0.000***	0.002**	0.000***
	Multiple regression	R2	0.8843			
		p	0.000***			
	E.V.%		88.43			

between Min. temperature and the percentage of diapaused larvae were (b= -306.99 and P= 0.0001) in 2002 and (b=-307.94 and P= 0.0005) in 2003 (Table, 25). It was clear that when the Min. temperature decreased the percentage of diapaused larvae increased (Table, 25).

Generally, from the previous results, it could be concluded that the role of temperature is in its effect on the rate of larval development and consequently the amount of ingested food. High temperature speeds rate of development, shortens larval duration and consequently percent of formation. The percentage of pink bollworm larvae that entered diapause increased towards the end of cotton season when the temperature decreased.

3.1.2. Effect of relative humidity:

Data presented in Table (25) clear the relationship between R.H.% and the percent of pink bollworm larvae that entered diapause. The simple correlation coefficient "r" between RH % and percentage of diapaused larvae was insignificant in 2002 and significant in 2003 cotton season. The " r" values were 0.12 and 0.76, respectively. The simple regression "b" values were 0.023 and 0.66 for the two cotton seasons, respectively. These data indicated that relative humidity plays a minor role on larval diapause of ***P. gossypiella***.

3.1.3. Effect of photoperiod:

As shown in Table (25). The simple correlation "r" values were significantly negative. The "r" values were -0.90 and -0.84 during 2002 and 2003 cotton seasons. The simple regression values "b" was significant during the two cotton seasons (-3143.4 % -8025.16). A negative relationship is clear as when photoperiod decreased the percentage of pink bollworm larvae entered diapause increased. This related to the infra red radiation **Callahan (1965).**

3.1.4. Joint effect of the three climatic factors:

Data in Table (25) show that the "R2" was highly significant during the two cotton seasons. The "R2" values were 0.8918 and 0.8843 in 2002 and 2003 seasons, respectively. The explained variance values (E.V. %), showing the effect of the combined three weather factors altogether; respective percents of 89.18 and 88.43% were reported.

It could be fairly concluded that weather factors play an important role on the number of diapaused larvae.

El Sayed and Rustom (1960a and b) mentioned that the percentage of pink bollworm larvae that entered diapause increased towards the end of seasons

and temperature inversely affects this correlation. **Gutierrz *et al.* (1981) and Butler *et al.* (1987)** mentioned that decrease in photoperiod and lower temperatures beginning in mid-September in USA induce pink bollworm diapause.

3.2. Duration of larval diapause:

The period during which diapaused larvae remained until pupation occurred was estimated.

Data in Table (26) clear that the pink bollworm larvae remained for different periods in the diapausing stage according to the date in which diapause started. It was 151 days for the diapausing larvae in sample collected at the end of August in 2002 cotton season. The larval diapause period become longer until reached the maximum (202.5 days) when sample collection

Table (26): Duration (day) of larval diapause and pupal period of pink bollworm at different sample collection dates during 2002/2003 and 2003/2004 years.

Sample collection date (2002/2003)	Duration of larval diapause		pupal period	
	2002/2003	2003/2004	2002/2003	2003/2004
29/8	151.0	146.0	30.0	26.0
5/9	190.6	201.0	29.0	32.0
12/9	202.5	202.5	25.3	30.2
19/9	195.0	205.2	25.0	28.9
26/9	193.0	199.4	25.0	28.4
3/10	186.7	196.5	25.0	27.5
10/10	181.0	195.4	25.7	26.3
17/10	176.0	189.2	24.1	22.6
24/10	173.0	184.6	21.8	21.7
31/10	167.2	179.3	22.1	20.6
7/11	165.7	178.2	19.9	18.5

date was at the 2^{nd} week of September in 2002 cotton season. The period became shorter (195 days) when sample was collected in the 3^{rd} week of September, then shortened gradually until the end of season (at the first week of November) with 165.7 days in the first season. During the second season (2003), the shortest period of diapause (146 days) was recorded when larvae started diapause at the end of August. The period of diapause larvae became longer from the first week of September until reached the maximum period 205.23 days when diapause started at the 2^{nd} week of September. The period of larval diapause decreased with the 4^{th} week of September; 199.4 days to reach 178.2 days at the first week of November in 2003 season. The averages in mean duration of pink bollworm larvae remained in diapause were 180.15 and 188.84 days during 2002/2003 and 2003/2004 cotton seasons, respectively, (Table , 26).

Generally, duration during which the pink bollworm diapausing larvae remained in this phase was shortened when larvae entered diapause early (4th week of August). While the longest period was 202.5 and 205.2 days when diapause started at the 2^{nd} and 3^{rd} weeks of September in 2002 and 2003 seasons, respectively. **El Sayed and Rustom (1960a and b)** mentioned that the average durations of ***P. gossypiella*** larval diapause were 161, 136 and 94.8 days from larvae enter diapause during September, October and December.

3.3. Pupal period after larval diapause:

The duration of pupal stage of pink bollworm after diapause and under natural conditions ranged between 19.9-

30.00 days in the first season and 18.5 – 32.2 days, in second one (Table, 26). Duration of pupal period was prolonged as the temperature decreased between January-May (14.5-27.5°C in 2003 and 13.7-27.0 in 2004).

4. Emergence of *P. gossypiella* moths during the subsequent season:

The moths emergence of ***P. gossypiella*** was studied under two measurements, calendar date and accumulated heat units as follows:

4.1. Relationship between sample collection dates of diapaused larvae and emergence dates of moths:

Samples of pink bollworm diapaused larvae were collected in weekly samples of cotton bolls from the end of August to the first week of November. Diapaused larvae were kept in glass tubes to be examined weekly to estimate moths' emergence for each date of larval diapause during 2002 and 2003 cotton seasons.

Data in Tables (27 and 28) show that the emergence of moths from larvae that started diapause during the last week of August emerged during the 3rd week of January and the 3rd week of February in 2003 and 2004 years, respectively, and the moths continued to emerge until the 4th week of March.

Moths' emergence, from pink bollworm larvae that entered diapause during the 1st week of September, started to appear at the 4th week of February and the 4th week of March in 2003 and 2004 years, respectively. The moths continued to emerge till the first and third weeks of May during 2003 and 2004 year, respectively.

From samples collected at the 2nd week of September, moths of pink bollworm started to appear in the 2nd and 3rd weeks of April during 2003 and 2004 years, respectively. The moths' emergence increased until reaching the peak during the 1st and 2nd weeks of May during the first and second season, respectively. Then the emergence of moths decreased.

Entrance of larvae in diapause stage at the 3rd week of September led to moths beginning emergence during the 4th and 1st weeks of April. The number of emerged moths increased until reaching the peak during the 1st and 2nd weeks of May at 2003 and 2004, respectively. The emergence of moths decreased after peaking until no emergence occurred during the 3rd week of May, 2003 and first week of June, 2004 (Table, 27 and 28).

From larvae that started diapause during the 4th week of September, the pink bollworm moths started to emerge during the 3rd week of May of the two seasons. The emerged moth counts increased until reaching their peaks during the 2nd and 3rd weeks of May at 2003 and 2004, respectively. The end of moths emergence occurred during the 4th week of May, 2003 and the 2nd week of June, 2004.

Pink bollworm larvae that entered diapause at the beginning of October resulted moths' emergence during the 3rd and the 2nd weeks of April and increased to reach the maximum during the 3rd week of May of the two seasons. The moths' emergence decreased until the end of moths' emergence in the first and second weeks of June (Tables, 27 and 28).

Entrance of larval diapause at the 2nd week of October resulted moths that started to emerge during the 3rd and the 2nd weeks of April of 2003 and 2004, respectively.

Table (27): Numbers of moths emerged from overwinted pink bollworm larvae that entered diapause in the previous cotton season at different sample collection dates during 2002/2003 season.

	Sample collection dates in the previous cotton season (2002)												Accumulated moths counts	% of emergence moths	Accumulated DDU
Number of diapaused larvae	9	42	158	405	500	500	500	500	500	500	500	500			
emergence date (2003)	29/8	5/9	12/9	19/9	26/9	3/10	10/10	17/10	24/10	31/10	7/11	Total			
1/1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	35.6
8/1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	63.1
15/1	1	0	0	0	0	0	0	0	0	0	0	1	1	0.1	84.4
22/1	0	0	0	0	0	0	0	0	0	0	0	0	1	0.1	104.9
29/1	0	0	0	0	0	0	0	0	0	0	0	0	1	0.1	122.8
5/2	0	0	0	0	0	0	0	0	0	0	0	0	1	0.1	142.1
12/2	0	0	0	0	0	0	0	0	0	0	0	0	1	0.1	163.0
19/2	0	0	0	0	0	0	0	0	0	0	0	0	1	0.1	171.7
26/2	1	1	0	0	0	0	0	0	0	0	0	2	3	0.2	211.5
4/3	0	0	0	0	0	0	0	0	0	0	0	0	3	0.2	247.9
11/3	0	0	0	0	0	0	0	0	0	0	0	0	3	0.2	288.4
18/3	2	1	0	0	0	0	0	0	0	0	0	3	6	0.3	319.8
25/3	2	1	0	0	0	0	0	0	0	0	0	3	9	0.5	367.6
1/4	-	1	0	0	0	0	0	0	0	0	0	1	10	0.5	429.4
8/4	-	2	1	0	0	0	0	0	0	0	0	3	13	0.7	472.8
15/4	-	2	2	0	2	1	5	9	0	0	0	21	34	1.8	536.8
22/4	-	4	3	6	5	7	10	17	18	8	0	78	112	5.8	592.3
29/4	-	10	14	36	26	41	17	25	23	23	2	217	329	17.0	669.3
6/5	-	10	27	65	30	28	29	49	46	46	25	355	684	35.4	752.1
13/5	-	-	19	37	65	44	40	37	48	38	60	388	1072	55.5	840.1
20/5	-	-	19	19	20	57	63	35	50	49	49	361	1433	74.1	910.0
27/5	-	-	-	-	15	28	37	56	63	68	51	318	1751	90.6	936.4
3/6	-	-	-	-	-	5	9	27	31	37	29	138	1889	97.7	1033.7
10/6	-		-	-	-	-	-	9	8	7	20	44	1933	100.0	1132.9
total	6	32	85	163	163	211	210	264	287	276	236	1933			

Table (28): Numbers of moths emerged from overwinted pink bollworm larvae that entered diapause in the previous cotton season at different sample collection dates during 2003/2004 season

	Sample collection dates in the previous cotton season (2003)											Accumulated moths counts	% of emergence moths	Accumulated DDU
Number of diapaused larvae	2	19	75	195	289	463	500	500	500	500	500	500			
Emergence date (2004)	29/8	5/9	12/9	19/9	26/9	3/10	10/10	17/10	24/10	31/10	7/11	Total			
1/1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25.2
8/1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	60.8
15/1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	88.3
22/1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	109.6
29/1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	130.1
5/2	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	148.0
12/2	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	167.3
19/2	1	0	0	0	0	0	0	0	0	0	0	1	1	0.0	188.2
26/2	0	0	0	0	0	0	0	0	0	0	0	0	1	0.0	195.8
4/3	0	0	0	0	0	0	0	0	0	0	0	0	1	0.0	226.9
11/3	0	0	0	0	0	0	0	0	0	0	0	0	1	0.0	264.8
18/3	0	0	1	0	0	0	0	0	0	0	0	1	2	0.1	309.2
25/3	0	1	0	0	0	0	0	0	0	0	0	1	3	0.1	342.4
1/4	0	0	2	1	0	0	0	0	0	0	0	3	6	0.2	384.5
8/4	0	0	0	1	0	1	1	0	0	0	0	3	9	0.4	450.3
15/4	0	0	4	6	5	4	2	0	0	2	0	23	32	1.3	489.4
22/4	0	2	2	5	19	5	2	10	5	9	3	62	94	3.7	549.4
29/4	0	1	0	15	38	29	17	32	19	16	17	184	278	11.0	606.5
6/5	0	2	7	23	46	38	25	47	51	45	35	319	597	23.7	683.4
13/5	0	0	8	37	58	69	56	61	54	66	56	465	1062	42.2	764.3
20/5	0	1	6	35	61	72	66	75	83	79	69	547	1609	63.9	854.3
27/5	0	0	1	15	35	46	78	86	89	82	77	509	2118	84.1	947.7
3/6	0	0	0	7	16	18	49	23	36	46	86	281	2399	95.2	1045.6
10/6	0	0	0	0	3	10	12	16	11	21	35	108	2507	99.5	1144.3
17/6	-	-	-	-	-	-	-	-	-	2	10	12	2519	100.0	1241.8
total	1	7	31	145	281	292	308	350	348	368	388	2519			