RESULTS AND DISCUSSION

1- Ecological results:

The aim of the present work is to attain some ecological and biological information's about the citrus leaf miner (CLM), *Phyllocnistis citrella* for the final purpose of the possibility of reducing, persistently, the pest population density, to a degree under economic injury level, for saving such important crop from suffering from economic losses in the crop production. Thus, it was carried out according the following items:

1.1. Seasonal abundance of various developmental stages of *Phyllocnistis citrella*:

Several varieties, were tested for their susceptibility to such dangerous insect pest, which or presented in the following:

1.1.1. Navel orange [*Citrus sinensis* (Osbeck)]:

Results dealing with infestation rate of CLM to Navel orange, **Fig. (1a) and Table (1)**, indicate that, during one year from May 1997 to May 1998, 8 peaks of infestation were recorded. The first peak was shown at the 2nd week of June, while the 2nd one was observed at the middle of July (smaller peak). The 3rd peak, however, was noticed at the end of the 3rd week of August, and the 4th one was recorded at the beginning of the 2nd week of September. The 5th peak was observed at the 1st week of October, while the 6th one appeared at the first week of November and the 7th peak was recorded at the 3rd week of November, and the last one was recorded at the first week of May 1998.

According, it can be concluded that, citrus leaf miner (CLM) could have 8 generations on Navel orange under weather conditions of Qalubia Governorate.

Among the observed ones, the lowest 2 peaks seemed to occur at the middle of July, 1997 and at the 4th week of March, 98. The highest infestation rate was recorded, once at the beginning of the first week of June, 97 and the other one at the first week of May, 98.

Larval peak numbers of *P. citrella,* during the period from May, 97 to May, 98 indicated, the existence of seven peaks, the first one was recorded at the end of May, 97, while the second one was found at the second week of June. However, the third peak was recorded at the first week of July, 97, but the forth one was clear, at the end of August in the same year. The 5th peak was at the end of the 1st week of October, and the sixth one was at the third week of November. The last peak was recorded at the 1st week of May, 1998. The highest numbers of insect larvae were recorded on the second week of June. Such observations of the existence of larval stage, infesting citrus leaves indicate and assure of having, such insect pest about seven generations per year when Navel orange was utilized as a plant host.

From **Fig. (1b)**, number of pupal peaks of *P. citrella* during May, 97 to May, 98, were about eight peaks. The first one was at the first week, but the second was at the 3rd week together in June 1998 too. The third peak was recorded at the beginning of the third week of July, while the fourth one was shown at the second week of August, and the 5th one was at the middle of September, but the 6th peak was recorded at the beginning of the first week of November. The 7th and 8th peaks, were recorded at the first week and at the end of the third week of May, 98, respectively. The highest number of insect pupae as recorded at the beginning of the first week of June (About 36 pupae/20 leaves).

Such results agree with those were observed before by **Badawy (1967), Koli *et al.*, (1981)** and **Singh *et al.*, (1988).**

Table (1): Infestation rate (%) with *P. citrella* to twenty citrus varieties during 1997/1998, in Qalubia Governorate.

Date	Orange varieties																			
	Navel	Valencia	Sour	Centinial	Succari	Hamlin	Tunssy	Rouja	Balady	Tanarif	Mazizy	Sangwin	Khalily	Mozambik	Jaffa	Mafard	Balady**	Greek	Blood	Permanent*
20/5/1997	75	40	10	25	20	0	5	0	15	0	5	0	5	15	0	5	10	0	10	60
27/5	100	75	0	15	10	0	20	0	15	0	0	15	10	40	5	0	0	0	25	100
3/6	100	95	35	0	25	0	90	35	40	75	45	90	5	30	20	0	20	0	5	100
10/6	95	100	10	0	90	60	90	25	100	90	90	75	35	55	95	10	60	40	0	10
17/6	65	85	0	35	95	85	100	60	75	75	90	75	100	35	75	90	65	85	20	75
24/6	15	30	5	5	55	30	55	20	35	55	75	30	80	30	75	55	35	65	45	40
1/7	10	0	0	5	0	10	0	10	0	35	10	0	10	15	15	0	10	25	10	0
8/7	0	25	0	25	0	0	15	20	10	5	5	5	15	0	10	30	15	20	10	50
15/7	10	5	35	5	10	55	0	10	5	0	0	40	5	0	25	0	0	5	0	50
22/7	0	5	0	10	0	0	5	0	0	10	0	10	15	0	15	5	0	0	0	5
29/7	5	15	35	25	5	10	0	15	25	35	5	25	25	0	15	0	0	0	0	30
5/8	10	30	55	55	20	25	20	35	55	70	25	45	70	0	25	0	15	5	0	15
12/8	75	75	30	40	70	40	75	30	55	70	60	45	15	40	30	25	55	55	60	100
19/8	55	65	65	50	65	70	55	60	60	75	90	65	45	0	75	25	55	85	45	90
26/8	30	40	15	60	75	60	75	85	70	35	15	65	80	65	70	65	45	25	70	75
2/9	10	50	10	40	75	50	30	70	10	35	35	5	40	35	30	50	20	0	85	40
9/9	20	15	65	55	60	20	20	45	30	10	0	50	20	25	15	20	45	30	25	30
16/9	15	25	85	5	15	0	0	0	5	10	10	55	35	0	5	10	0	10	0	5
23/9	15	0	30	5	20	35	10	20	0	25	10	60	0	15	5	50	30	0	40	65
30/9	5	0	0	0	0	0	5	10	15	25	15	20	60	0	0	50	0	95	20	0
7/10	50	5	55	60	70	40	75	35	10	50	45	55	15	0	10	20	15	100	10	50
14/10	10	0	95	0	5	70	95	100	15	35	40	45	45	45	5	80	45	60	55	70
21/10	0	0	100	15	0	80	0	15	80	95	65	85	20	0	0	100	55	90	85	55
28/10	0	0	100	0	70	15	70	60	100	100	100	100	40	25	0	35	0	80	85	25
4/11	50	0	100	0	10	85	60	55	55	100	40	100	100	35	25	85	0	60	60	100
11/11	50	0	100	0	35	100	100	95	50	100	100	100	50	35	20	35	0	40	100	100
18/11	75	10	55	0	30	70	80	75	65	100	100	95	100	85	40	50	0	50	55	100
25/11	35	0	15	0	0	80	80	35	40	20	100	70	35	15	0	50	0	50	100	100
2/12	15	0	15	0	0	55	75	20	20	70	100	50	20	15	0	40	30	35	70	70
9/12	0	10	20	0	0	25	70	0	0	45	75	3	10	10	0	25	50	5	25	45
16/12	0	0	10	0	0	20	50	0	5	65	50	20	50	5	0	25	30	15	30	30
23/12	0	0	0	0	0	15	20	10	10	40	25	20	75	5	0	5	0	20	35	10
30/12	5	0	0	0	5	5	10	20	15	20	25	20	50	15	0	5	0	10	20	65
6/1/1998	0	0	0	0	0	0	5	30	15	0	25	10	35	15	0	0	0	0	0	100
13/1	0	0	0	0	0	0	15	15	5	0	10	5	15	5	0	0	0	0	0	45
20/1	0	0	0	0	0	0	15	0	0	5	0	0	5	0	0	0	0	0	0	10
27/1	0	0	0	0	0	0	25	0	0	20	0	0	20	0	0	0	0	0	0	35
3/2	0	0	0	0	0	0	25	0	0	15	0	0	10	0	0	0	0	0	0	30
10/2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20
17/2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
24/2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/3	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	15
10/3	0	10	0	0	0	0	0	0	0	15	0	5	10	0	0	0	0	15	0	15
17/3	0	0	0	0	0	0	0	0	0	15	0	0	15	0	0	0	15	0	10	15
24/3	5	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	20
31/3	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	30
7/4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
14/4	0	0	0	0	5	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0
21/4	0	0	15	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0
28/4	10	0	45	0	30	0	0	0	0	15	0	0	0	5	0	10	0	0	25	5
5/5	65	0	55	0	0	0	0	20	0	0	30	0	0	0	0	0	0	0	0	90
12/5	100	45	65	65	45	40	15	0	0	60	100	0	100	100	80	100	0	70	80	100
20/5	100	40	20	25	35	15	15	15	30	15	20	15	20	25	15	20	25	20	20	65

*Permanent bearing **Balady Blood

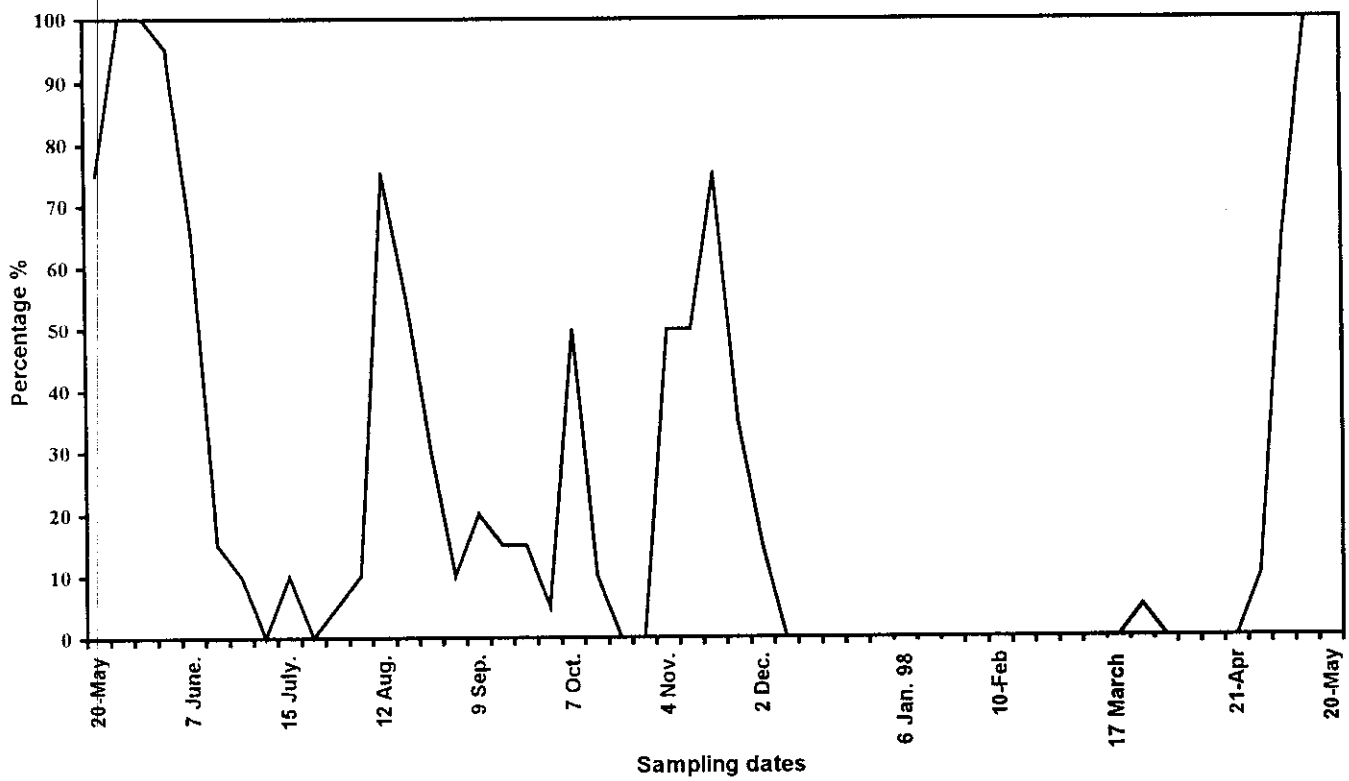

Fig. (1 a) Infestation rate (%) of Navel orange with *P. citrella* along one year (1997- 98) in Qalubia Governorate.

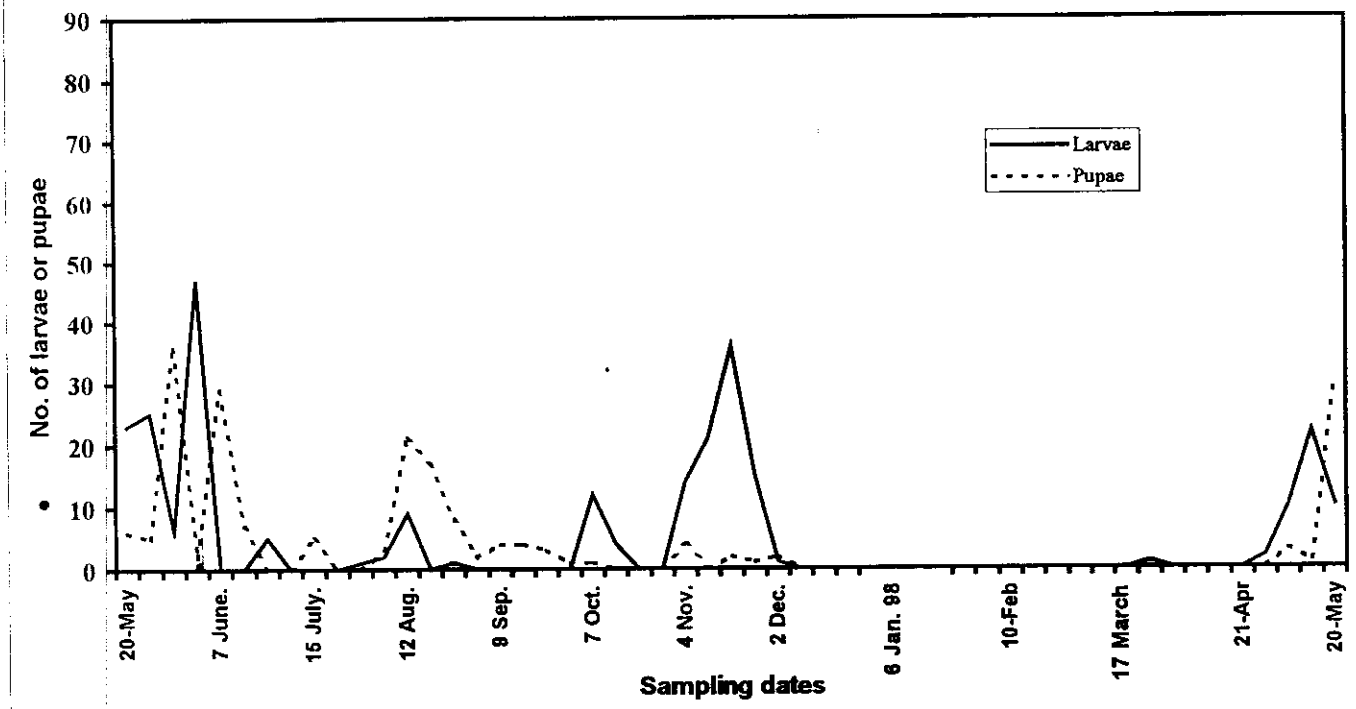

Fig. (1 b) Population dynamics of larval and pupal stages of *P. citrella* infesting Navel orange along one year (1997- 98) in Qalubia Governorate.

1.1.2. Valencia orange [*Citrus sinensis* (Osbeck)]:

Infestation was observed to begin early, but very light, in the second week of March, seeming to have low rate of only 10%, followed by a peak reaching 25% at the end of the last week of the same month. No infestation was observed during April till the middle of May, where about 48% infestation rate, was recorded, which gradually increased to 100% in the middle of June and 25% at the end of the first week of July. Other interferred peaks of infestation rate were, obvious, one, of which reached about 77%, in the second week of August, the second (50%) in the first week of September, and the third (the lower peak of 25%) in the third week of August, which suddenly was dropped to the nil level at the end of the same week. **(Fig., 2a)**

Concerning seasonal fluctuation of *P. citrella* population on Valencia orange represented in larval stage, it was found that the highest recorded number was in the first week of June when temperature and RH ranged between 16 – 31.2°C and 31 – 84% RH, followed by another peak in the second week of the same month. More than one month passed, before the observing of a third one, distinctly at the beginning of the fourth week of July, followed also by the fourth peak in the first week of August. Waiting to the middle of September the fifth peak appeared, while the sixth one was at the end of the first week of October, which seemed to be the lowest one together with each.

The descending ones till the tenth peak. These were at the third week of November (under 13.6 – 25.8°C & 30 – 77%RH), the second week of December, the second week of March 98 and at the last week of March, 98 for the seventh, eighth, ninth and tenth peaks, respectively. However, the last one, which was observed in the second week of May, was moderately higher than each of the passed 6 peaks. It is worth to observe, that the most severe infestations, reflected in the highest peaks of the larval stage numbers were at the second week of June, 97, the first week of August, 97 and at the second week of May, 98. About similar trend was also observed in both numbers of detected pupae as well as infestation rate during the experimental period on such plant host under Qalubia Governorate. **(Table, 2 and Fig., 2b)**

Table (2): Numbers of weekly detected larvae of *P. citrella* from twenty citrus varieties during 1997/1998, in Qalubia Governorate.

Date	Orange varieties																			
	Navel	Valencia	Sour	Centinial	Succari	Hamlin	Tunssy	Rouja	Balady	Tanarif	Mazizy	Sangwin	Khalily	Mozambik	Jaffa	Mafard	Balady**	Greek	Blood	Permanent*
20/5/1997	23	13	0	6	4	0	1	0	2	0	1	0	1	3	0	1	2	0	1	15
27/5	25	20	0	4	3	0	4	0	4	0	0	4	2	11	1	0	0	0	0	18
3/6	6	46	11	0	7	0	51	19	19	37	22	54	1	16	0	0	0	0	0	11
10/6	47	0	0	0	39	11	7	0	64	48	45	9	17	4	69	1	38	5	0	0
17/6	0	0	0	21	72	10	58	7	4	31	59	2	64	0	8	48	9	44	0	3
24/6	0	6	0	0	1	0	3	0	0	0	7	0	22	1	5	0	0	4	5	0
1/7	5	0	0	0	0	0	0	0	0	9	0	0	0	0	1	0	0	1	0	0
8/7	0	1	0	3	0	0	0	0	0	0	0	0	10	0	5	0	0	9	5	35
15/7	0	0	0	0	0	36	0	0	0	0	0	0	0	0	1	0	0	0	0	21
22/7	0	3	0	0	0	0	0	0	0	6	0	5	0	0	1	0	0	0	0	0
29/7	1	1	20	19	1	3	0	6	12	21	0	7	9	0	8	0	0	0	0	5
5/8	2	21	0	25	6	4	7	19	2	5	3	9	1	0	1	0	4	2	0	0
12/8	9	8	6	5	5	10	9	1	6	24	5	8	3	20	11	12	5	5	13	12
19/8	0	0	1	0	3	3	6	0	2	5	36	8	9	0	20	7	2	30	0	48
26/8	1	0	0	1	0	0	2	0	2	0	0	0	14	13	9	6	0	1	9	1
2/9	0	0	0	4	4	0	0	1	0	0	0	0	0	2	2	2	0	0	23	8
9/9	0	0	1	1	0	0	0	2	0	0	0	10	1	2	0	0	0	0	3	1
16/9	0	0	18	0	0	0	0	0	0	1	0	8	9	0	1	0	0	0	0	0
23/9	0	0	0	0	0	5	0	3	0	4	2	14	0	0	0	8	5	0	6	15
30/9	0	0	0	0	0	0	1	0	2	6	5	5	12	0	0	9	0	26	3	0
7/10	12	0	3	20	14	10	9	7	1	6	7	9	3	0	1	1	1	16	2	9
14/10	4	0	19	0	1	16	37	36	3	7	13	10	10	17	1	16	9	17	13	19
21/10	0	0	31	6	0	64	0	0	26	47	21	46	7	0	0	86	13	25	37	20
28/10	0	0	45	0	22	0	23	17	28	31	35	37	19	5	0	22	0	18	19	19
4/11	14	0	44	0	8	23	12	20	17	54	15	60	60	13	8	48	0	30	31	53
11/11	21	0	59	0	22	51	35	42	14	55	39	43	21	12	5	11	0	14	53	49
18/11	36	1	21	0	7	25	29	23	18	26	40	46	44	37	14	13	0	16	18	38
25/11	15	0	2	0	0	20	17	4	3	0	28	20	6	2	0	9	0	10	17	33
2/12	1	0	1	0	0	8	10	3	2	18	15	4	2	1	0	6	7	4	6	5
9/12	0	2	4	0	0	4	11	0	0	11	7	1	1	1	0	1	14	0	2	0
16/12	0	0	2	0	0	4	10	0	0	11	5	3	7	1	0	4	3	2	3	1
23/12	0	0	0	0	0	4	1	2	2	8	4	2	11	0	0	0	0	2	22	3
30/12	0	0	0	0	0	0	0	5	1	2	5	3	8	1	0	0	0	0	0	18
6/1/1998	0	0	0	0	0	0	0	9	2	0	1	0	6	3	0	0	0	0	0	21
13/1	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	2
20/1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
27/1	0	0	0	0	0	0	4	0	0	2	0	0	4	0	0	0	0	0	0	4
3/2	0	0	0	0	0	0	3	0	0	1	0	0	2	0	0	0	0	0	0	5
10/2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
17/2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24/2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/3	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	4
10/3	0	1	0	0	0	0	0	0	0	3	0	1	2	0	0	0	0	3	0	3
17/3	0	0	0	0	0	0	0	0	0	3	0	0	2	0	0	0	1	0	2	4
24/3	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31/3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
7/4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14/4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21/4	0	0	4	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
28/4	2	0	3	0	8	0	0	0	0	2	0	0	0	0	0	0	0	0	3	3
5/5	10	0	3	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	16
12/5	22	11	25	14	9	9	3	0	0	8	11	0	20	15	22	16	0	13	28	24
20/5	10	9	2	4	5	4	2	3	5	2	2	2	3	3	2	3	4	3	3	19

*Permanent bearing **Balady Blood

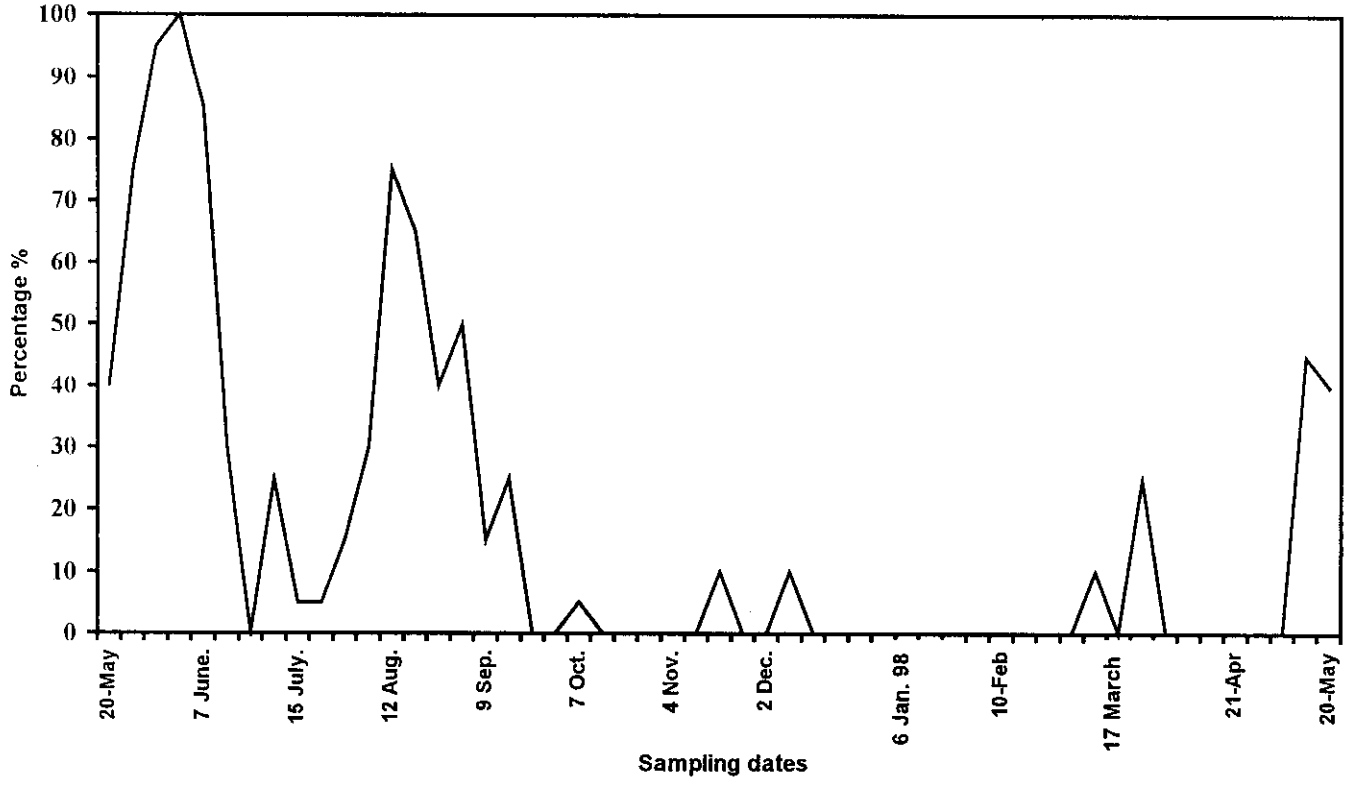

Fig. (2 a) Infestation rate (%) of Valencia orange with *P. citrella* along one year (1997- 98) in Qalubia Governorate.

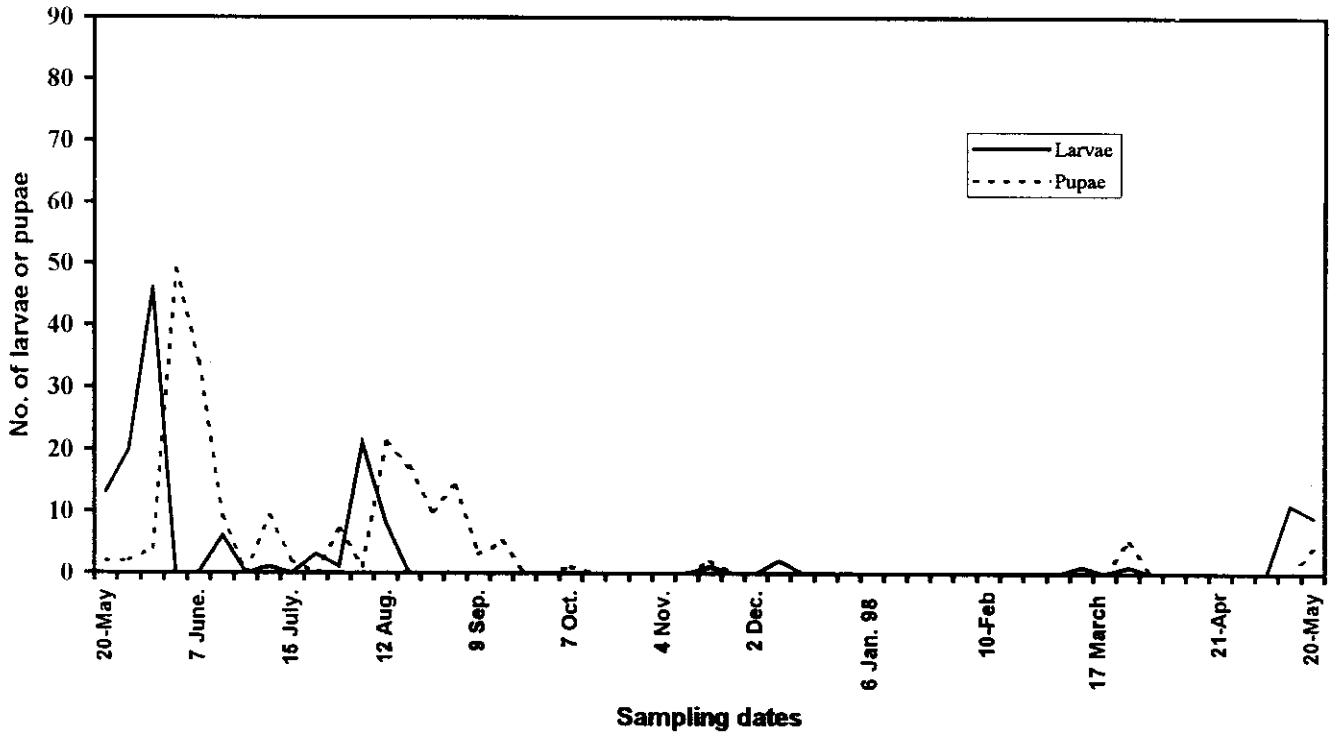

Fig. (2 b) Population dynamics of larval and pupal stages of *P. citrella* infesting Valencia orange along one year (1997- 98) in Qalubia Governorate.

1.1.3. Sour orange [*Citrus aurantium* (L.)]:

No infestation was detected from the end of December till the last week of April in the tested Sour orange, when the infestation rate began to raise up to reach a peak of about 68% at the end of the second week of May. Two peaks of 25% infestation rate, were also observed, one in the first week of June and afresh in the middle of July, after which 4 descending high interfered peaks were recorded (57% in the first week of August; 76% at the end of the third week of the same month; 87% at the beginning of the third week of September and the highest fourth one, reached 100% along one month (from the middle of October to the middle of November). Sudden drop of the highest peak, was observable, since it falled down to be only 15% at the last week of November, but raised afresh to a moderate level not more than 20%, in the second week of December to fall also down again to the nil level through the following week of the same month.

Concerning level of infestation, represented in numbers of detected larvae, and referring to **Table (2) & Fig. (3a, b),** it can be, easily observed that numbers of larval stage individual didn't surpass 20 L. per sample in the majority of the observed peaks, along the year, except 2 high peaks, which were, closely interfered. They began to raise up from the second week of October to record a relatively high number of collected larvae (46/20 leaves), distinctly at the end of October, 1997, but as started to fall down, it was tended to raise up again reaching 60/20 leaves, in the middle of November when temperature ranged between 13.6 – 25.6°C and RH of 40 – 89%, then it recorded a very low number of 3/20 leaves) at the end of the same month. Another peak of numbers of larva individuals (26/20 leaves), was also shown at the middle of May, 1998.

As numbers of collected pupae, were also concerned, as another indicator of the variability of the infestation levels along the year, about 9 peaks were observed, three of which were higher than the others. It averaged 22 P./20 leaves for each, at the first and the third week of August, and at the second week of September, 1997. Of the others, some were (14 P./20 L. at the middle of July), (9 P./20 L. at the second week of October); (11 P./20L. at the beginning of the fourth week of October) and (18 P./20L. at the first week of May, 1998). **(Table, 3)**

On such citrus variety, the insect pest seemed to have 10 generations, since obvious ten peaks of infestation rates were observed along the year.

Such obtained results seemed to be compatible with those were attained by **Badawy (1967), Koli *et al.*, (1981) and Singh *et al.*, (1988).**

Table (3): Numbers of weekly detected pupae of *P. citrella* from twenty citrus varieties during 1997/1998, in Qalubia Governorate.

Date	Orange varieties																			
	Navel	Valencia	Sour	Centinial	Succari	Hamlin	Tunssy	Rouja	Balady	Tanarif	Mazizy	Sangwin	Khalily	Mozambik	Jaffa	Mafard	Balady**	Greek	Blood	Permanent*
20/5/1997	6	2	2	3	1	0	0	0	3	0	0	0	0	1	0	0	0	0	1	4
27/5	5	2	0	0	0	0	2	0	0	0	0	0	0	2	0	0	0	0	7	42
3/6	36	4	3	0	2	0	3	0	5	7	7	11	1	2	6	0	6	0	1	52
10/6	2	49	3	0	12	19	29	9	0	12	4	22	0	15	0	2	0	14	0	5
17/6	29	34	0	0	6	30	10	21	37	12	3	31	5	13	32	6	26	6	7	27
24/6	7	9	1	2	29	16	21	12	17	26	35	12	20	12	37	37	17	25	19	19
1/7	0	0	0	2	0	4	0	5	0	13	5	0	3	9	7	0	5	8	3	0
8/7	0	9	0	9	0	0	5	6	4	2	2	2	0	0	0	12	6	0	0	0
15/7	5	2	14	2	5	3	0	4	1	0	0	13	1	0	11	0	0	2	0	9
22/7	0	0	0	4	0	0	2	0	0	0	0	0	5	0	7	1	0	0	0	3
29/7	0	7	2	1	0	1	0	1	2	5	2	12	6	0	2	0	0	0	0	8
5/8	3	1	22	5	2	7	5	2	24	24	12	14	30	0	6	0	1	0	0	7
12/8	21	21	10	13	24	11	26	11	16	9	14	12	6	1	3	1	17	21	22	38
19/8	17	17	22	12	16	23	8	17	13	18	6	13	7	0	9	0	11	9	10	3
26/8	8	10	3	14	22	17	16	27	22	9	3	15	7	5	9	10	15	6	10	20
2/9	2	14	3	6	18	16	8	17	2	8	8	1	13	6	5	12	4	0	5	4
9/9	4	3	22	17	16	4	4	8	9	2	0	3	3	3	3	4	9	6	4	7
16/9	4	5	7	1	3	0	0	0	1	1	2	9	3	0	1	2	0	2	0	1
23/9	3	0	7	1	4	8	2	1	0	3	0	3	0	3	1	4	2	0	2	9
30/9	1	0	0	0	0	0	0	2	1	0	0	0	2	0	0	6	0	6	1	0
7/10	1	1	9	1	5	1	7	0	2	4	3	4	0	0	1	3	2	8	0	1
14/10	0	0	2	0	0	3	3	3	0	0	0	1	3	0	0	2	2	0	0	0
21/10	0	0	11	6	0	0	0	3	0	4	1	1	0	0	0	6	1	16	5	6
28/10	0	0	2	0	2	5	0	0	6	8	4	1	4	0	0	8	0	6	5	0
4/11	4	0	3	0	0	10	7	7	10	6	3	3	3	0	0	3	0	0	8	2
11/11	0	0	2	0	0	6	9	6	1	4	2	5	0	1	0	0	0	0	7	7
18/11	2	2	6	0	2	5	4	3	2	10	3	3	3	3	1	0	0	1	0	2
25/11	1	0	1	0	0	10	7	4	7	7	5	6	3	2	0	4	0	4	13	13
2/12	2	0	2	0	0	6	11	2	3	4	23	12	5	3	0	8	1	8	15	21
9/12	0	0	2	0	0	3	6	0	0	0	15	2	1	1	0	4	0	1	5	13
16/12	0	0	1	0	0	2	6	0	1	11	11	4	9	1	0	4	5	2	7	7
23/12	0	0	0	0	0	1	5	0	1	3	2	4	7	1	0	1	0	2	1	1
30/12	0	0	0	0	1	2	2	1	2	3	3	2	10	4	0	1	0	3	12	8
6/1/1998	0	0	0	0	0	0	1	0	1	0	4	2	1	4	0	0	0	0	0	17
13/1	0	0	0	0	0	0	1	5	1	0	2	1	3	1	0	0	0	0	0	10
20/1	0	0	0	0	0	0	3	0	0	1	0	0	1	0	0	0	0	0	0	2
27/1	0	0	0	0	0	0	7	0	0	3	0	0	1	0	0	0	0	0	0	8
3/2	0	0	0	0	0	0	5	0	0	3	0	0	0	0	0	0	0	0	0	3
10/2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
17/2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
24/2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
17/3	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	2	0	0	0
24/3	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5
31/3	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	3
7/4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
14/4	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
21/4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28/4	0	0	17	0	5	0	0	0	0	2	0	0	0	0	0	3	0	0	11	0
5/5	3	0	11	0	0	0	0	8	0	0	7	0	0	0	0	0	0	0	0	2
12/5	1	0	1	0	0	1	0	0	0	6	10	0	0	8	4	12	0	4	2	7
20/5	30	4	3	2	3	0	1	0	2	1	2	1	1	2	1	1	1	1	1	3

*Permanent bearing **Balady Blood

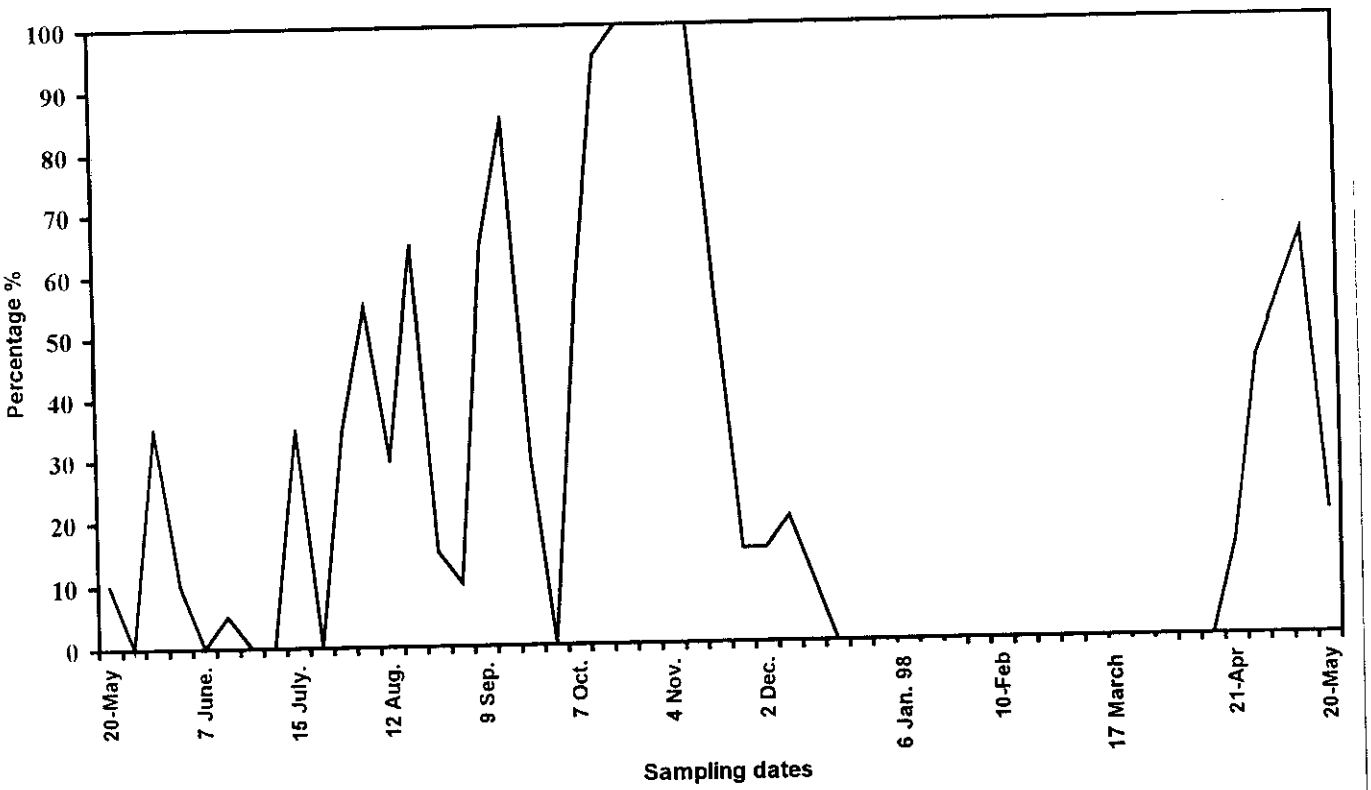

Fig. (3 a) Infestation rate (%) of Sour orange with *P. citrella* along one year (1997- 98) in Qalubia Governorate.

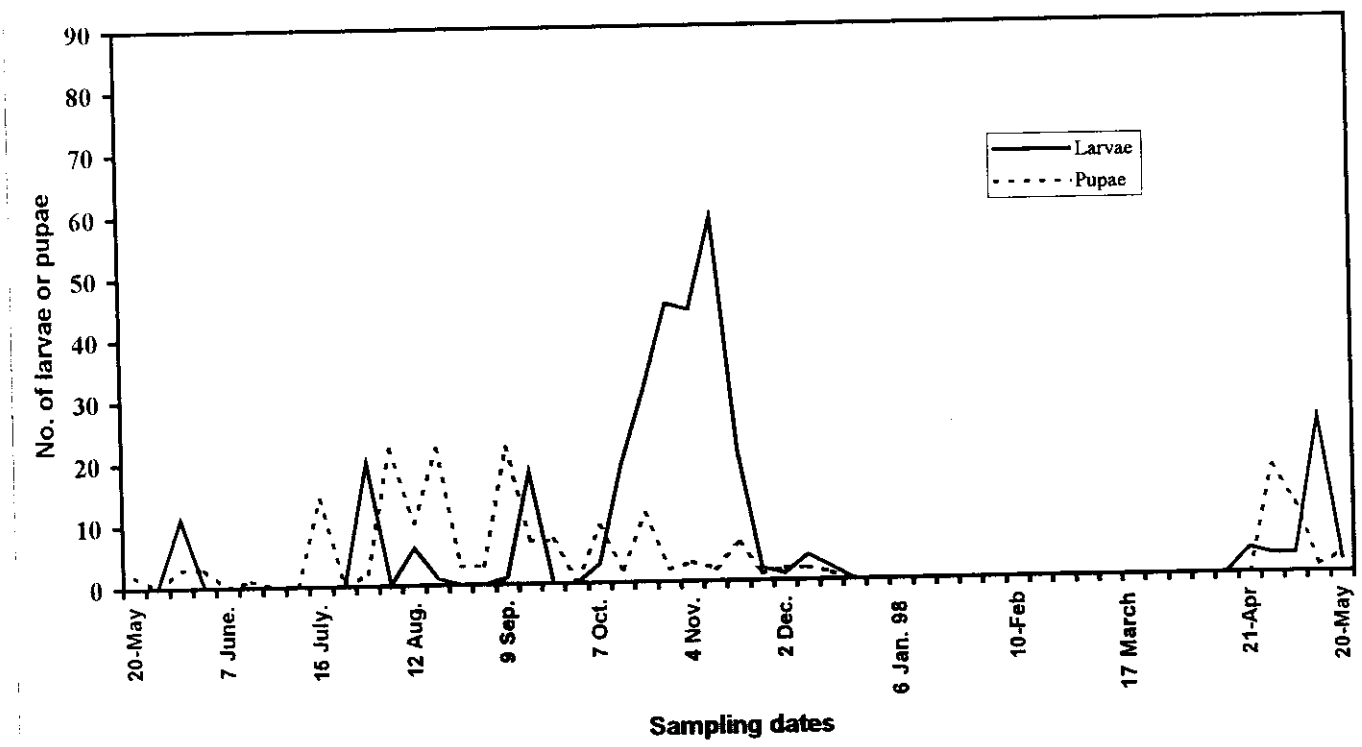

Fig. (3 b) Population dynamics of larval and pupal stages of *P. citrella* infesting Sour orange along one year (1997- 98) in Qalubia Governorate.

1.1.4. Cintinial orange [*Citrus sinensis* (Osbeck)]:

Concerning infestation rate to Cintinial orange by *P. citrella*, it was observed that, it didn't surpass 65%, which was recorded in the second week of May, 98. The detected 8 peaks of infestation rate, were successively presented as follows: The first one (35%) were shown in the third week of June, while the second (25%) appeared at the end of the first week of July, but the third one (55%) ended the first week of August. During the forth week of August, a fourth peak of 60% was explored, while the fifth one (55%) originated in the second week of September followed by the sixth peak (60%) at the end of the first week of October. However, at the end of the third week of the same month, infestation rate exhibited lower level (15%), in addition to the aforementioned highest one (65%) of the second week of May, 98. From such results, it can be revealed that *P. citrella* had generations on the present variety. **(Fig., 4a)**

Seasonal fluctuations in larval counts indicated the occurrence of 8 peaks, the first (6 L./20 leaves) and the second (21L./20 leaves) were observed firstly at the end of the third week of May and secondly in the third week of June, respectively. The highest larval count (25 L./20 leaves) was recorded in the first week of August when both temperature degrees and RH, ranged between 21.4°C – 32.2°C and 42 - 90% RH, followed by a low one (5 L./20 leaves) at the beginning of September. At the end of the first week of October, however, a high peak of larval count (19 L./20 leaves) was observed, followed by low one of also 5 L./20 leaves at the end of the third week of the same month, thereafter, no any stage (neither larvae nor pupae or adult) were detected till the second week of the May, 1998, when a peak of 17 L./20 leaves was obtained. **(Table, 2 and Fig., 4b)**

Estimating the standard of infestation, due to pupal counts it was observed that only 4 P./20 leaves were collected at the end of the third week of May, followed by constant count of only 3 P./20 leaves during the last week of June and the first week of July, 1997, then it was raised up to realize 11 P./20 leaves at the beginning of the fourth week of July. During August, 2 peaks were shown, the first at the beginning of the third week (15 P./20 leaves) and the second (17 P./20 leaves) at the end of the last week. In the second and the fourth weeks of October, the numbers of detected pupae were (2 P./20 leaves) & (7 P./20 leaves), respectively. **(Fig., 4b)**

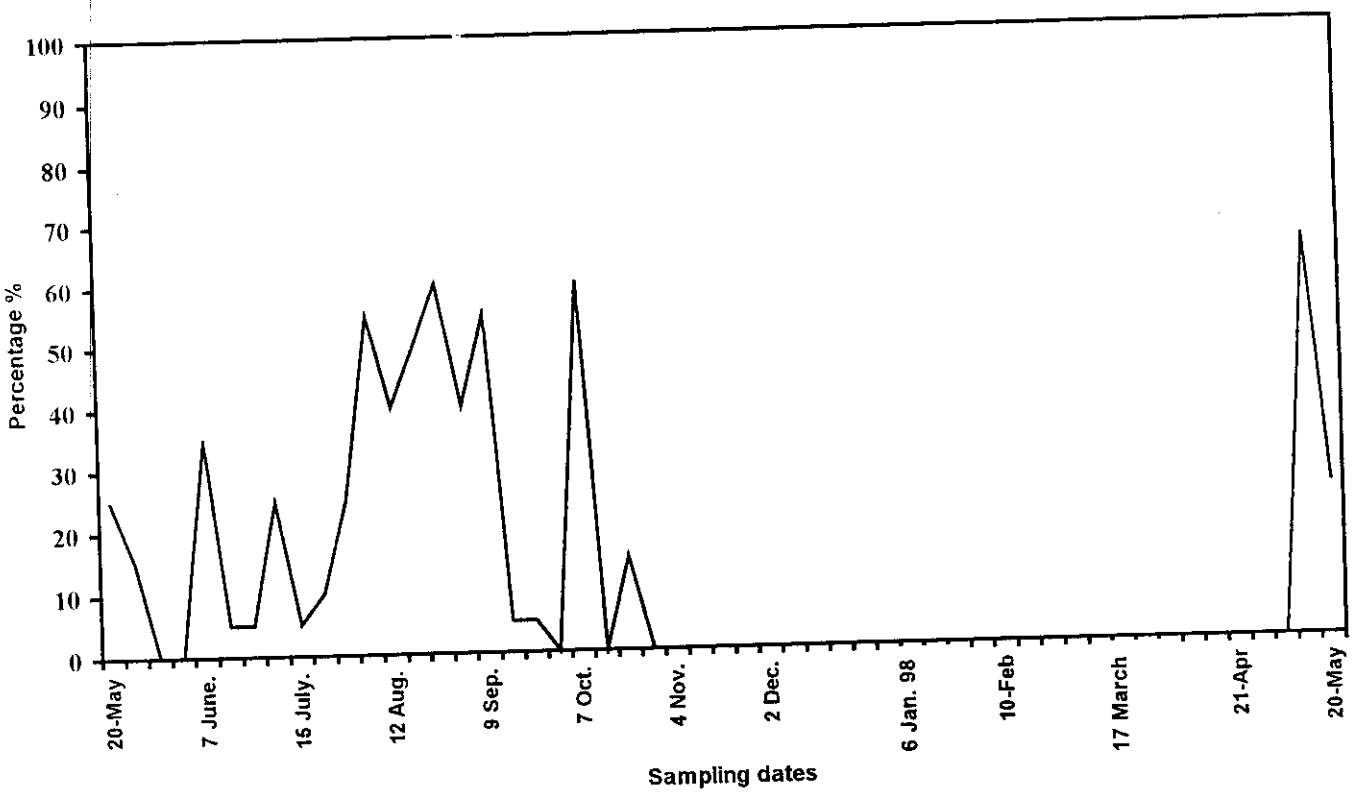

Fig. (4 a) Infestation rate (%) of Cintinial orange with *P. citrella* along one year (1997- 98) in Qalubia Governorate.

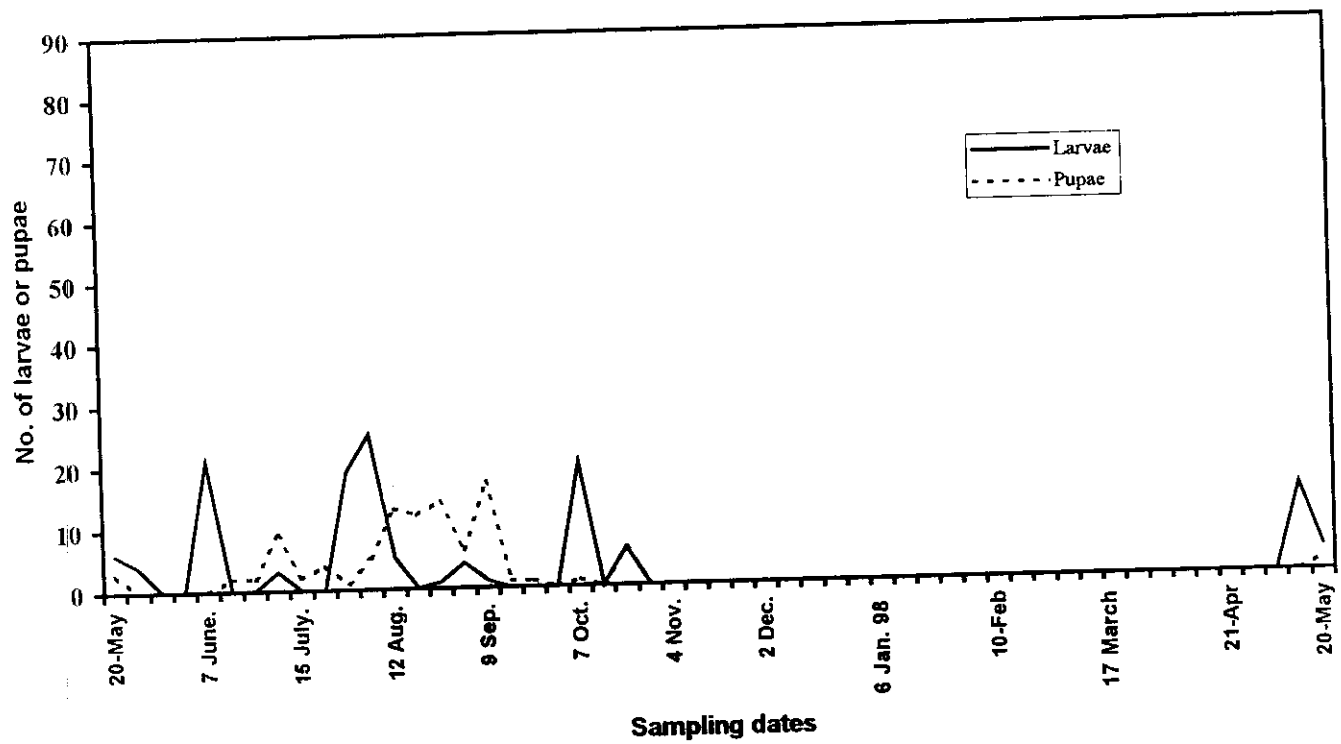

Fig. (4 b) Population dynamics of larval and pupal stages of *P. citrella* infesting Cintinial orange along one year (1997- 98) in Qalubia Governorate.

1.1.5. Succari (sweet) orange [*Citrus sinensis* (Osbeck)]:

Infestation rate of such variety, indicate that the beginning of it, was relatively early at the beginning of the second week of April to exhibit a moderately infestation rate of 30% at the end of the month, but by the end of the first week of May it was dropped to nil level, then it was, afresh raised to about 45% at the middle of the same month. Such variety appeared to be highly susceptible, especially during summer months, since, the rate of infestation was, abruptly, raised to a maximum rate of 95% at the beginning of the third week of June. However, it reached, gradually to nil level at the beginning of July, followed by a peak of 10% IR at mid-July. The most persistent level of infestation was exhibited along the two autumn months (August & September) seaming to have, thereat, very, nearly interfered 3 generations with 3 peaks, the first of 73% IR at the middle of August, the second was 89% but lasted at the same level along about 10 days and then dropped till the last week of September, including the interfered low peaks of 21% IR at the beginning of the last week of September. Other subequal 3 peaks of IR were detected, the first and the second each of 70% IR at the first third of October and at the first of November, respectively. However, the lower third one was observed at mid-November. The remaining period from the last week of November till the middle of April, 1998, about infestation-free of such pest was observed. **(Fig., 5a)**

Representing infestation level in the phase of numbers of detected larvae, it was observed that during May, 2 peaks of 8 & 9 L./20 leaves were obtained, distinctly in the first and third weeks, respectively. Then, it was, hurrily raised to reach a maximum of 73 L./20 leaves in the third week of June, but swiftly also reached nil level in the last week of the same month, representing a more dense generation. It was followed by other 5 less dense peaks, ranging between 6 – 22 L./20 leaves, in the first week of both August and September, to those of the first day, and at the end of the second week of November, after which no any infestation was observed till the middle of the spring season. **(Fig.,5b)**

Pupal stage individuals, which were detected through the period of investigation, exhibited considerable fluctuation in numbers exhibiting its highest peak (29 P./20 leaves) in the last week of June, and again during August, 2 top numbers (25 & 23 P./20 leaves), were recorded in the second and the fourth week of the month, respectively. Such findings appeared to be in agreement with the findings of **Badawy (1967), Singh, (1984), Singh & Azam (1986) and Huang *et al.*, (1989).**

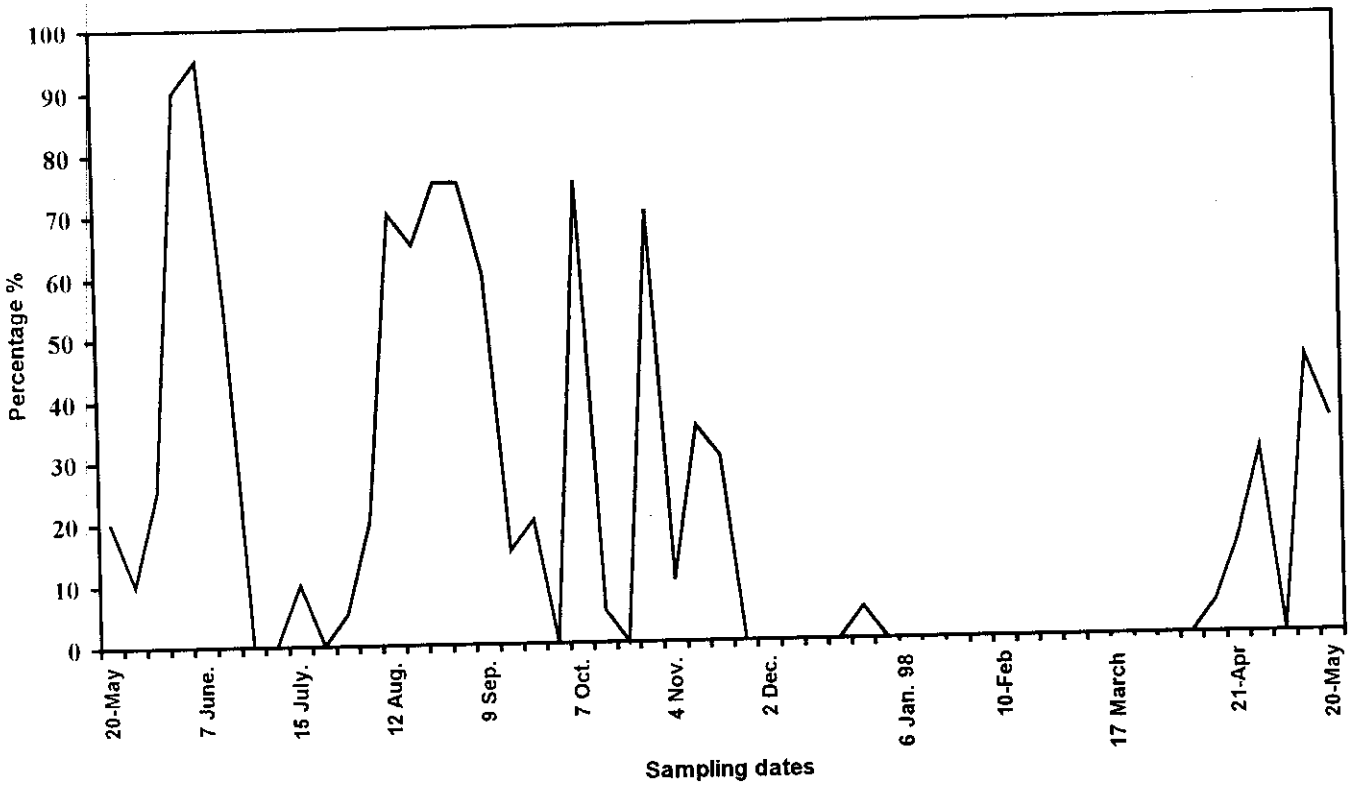

Fig. (5 a) Infestation rate (%) of Succari orange with *P. citrella* along one year (1997- 98) in Qalubia Governorate.

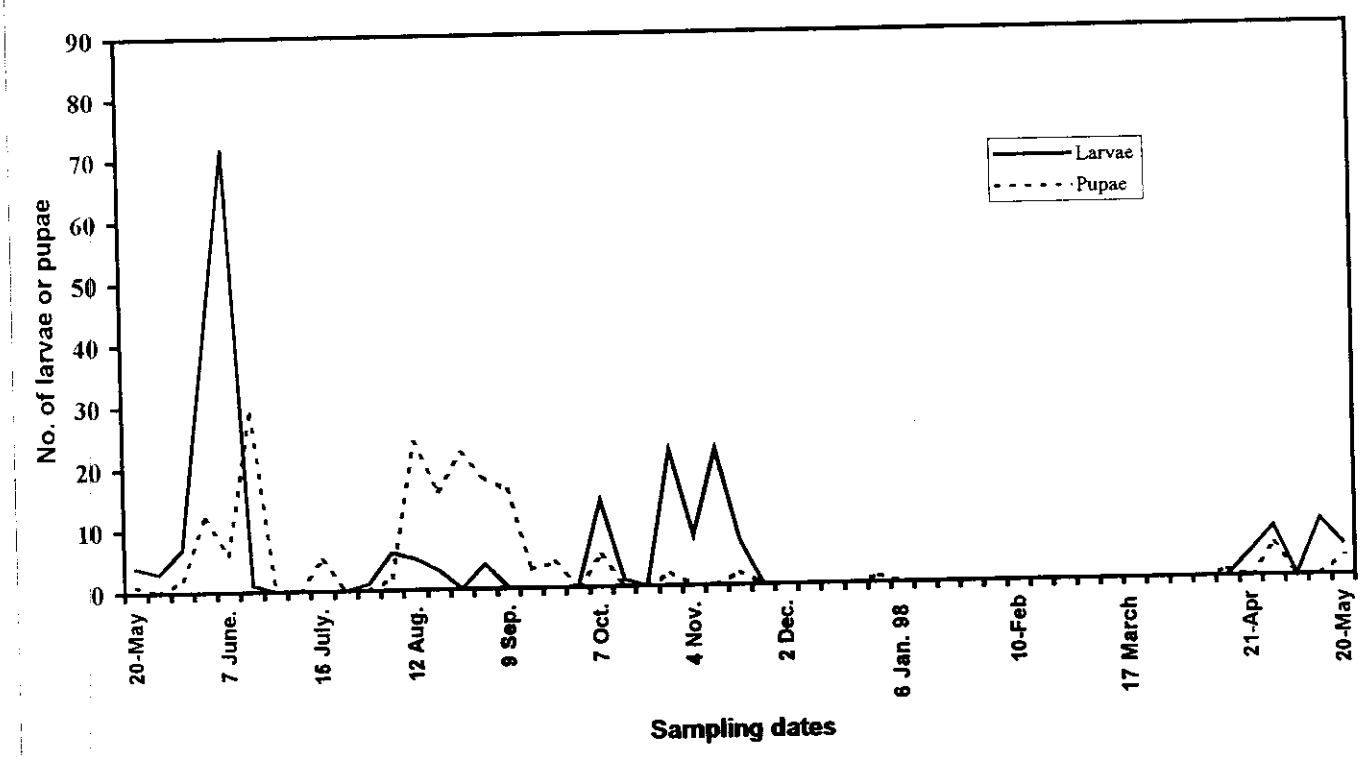

Fig. (5 b) Population dynamics of larval and pupal stages of *P. citrella* infesting Succari orange along one year (1997- 98) in Qalubia Governorate.

1.1.6. Hamlin orange [*Citrus sinensis* (Osbeck)]:

Concerning the rate of infestation of such variety with CLM along one year, it was shown that the highest rate existed in winter, while in autumn, the infestation was more lightly. From January to about the mid of May, trees weren't infested, except one peak of 15% was observed once in the first week of March, but swiftly degraded. The highest level of infestation was (100%) at the end of the first third of November, followed by an interfered one of 80% in the last week of the same month. The remaining six tops were, observed in summer and autumn seasons, exhibiting considerable variabilities, with the affectionate infestation rate, as they averaged 40% at the middle of May, 96% in the third week of June; 55% in mid-July; wide-based one of 70% in the third week of August; relatively low peak (35%) in the last week of September and relatively high one (80%) at the beginning of the fourth week of October, 1997. **(Fig., 6a)**

About numbers of detected larval individuals along the period of study, it was obvious, that the highest ones were intensed in three peaks (36 L./20 leaves; 65L./20 leaves and 50 L./20 leaves) at the mid of July; the last week of October and mid-November, respectively. Other low-leveled peaks were existing during the year, but not reaching 10 L./20 leaves.

Pupal counts, also have similar trend but it was obtainable only during summer, autumn and early winter. Only 2 peaks appeared higher than the others, one in the third week of June (29 P./20 leaves) and the second (23 P./20 leaves) was at the beginning of the fourth week of August, which were, very slowly dropped down to reach the nil level at the mid of September. Other low-leveled peaks of nymphal counts were shown, but it was ranged between (3 P./20 leaves), at both mid-July, and mid-October, to about (9 P./20 leaves) at both the first and last weeks of November, respectively. **(Fig., 6b)**

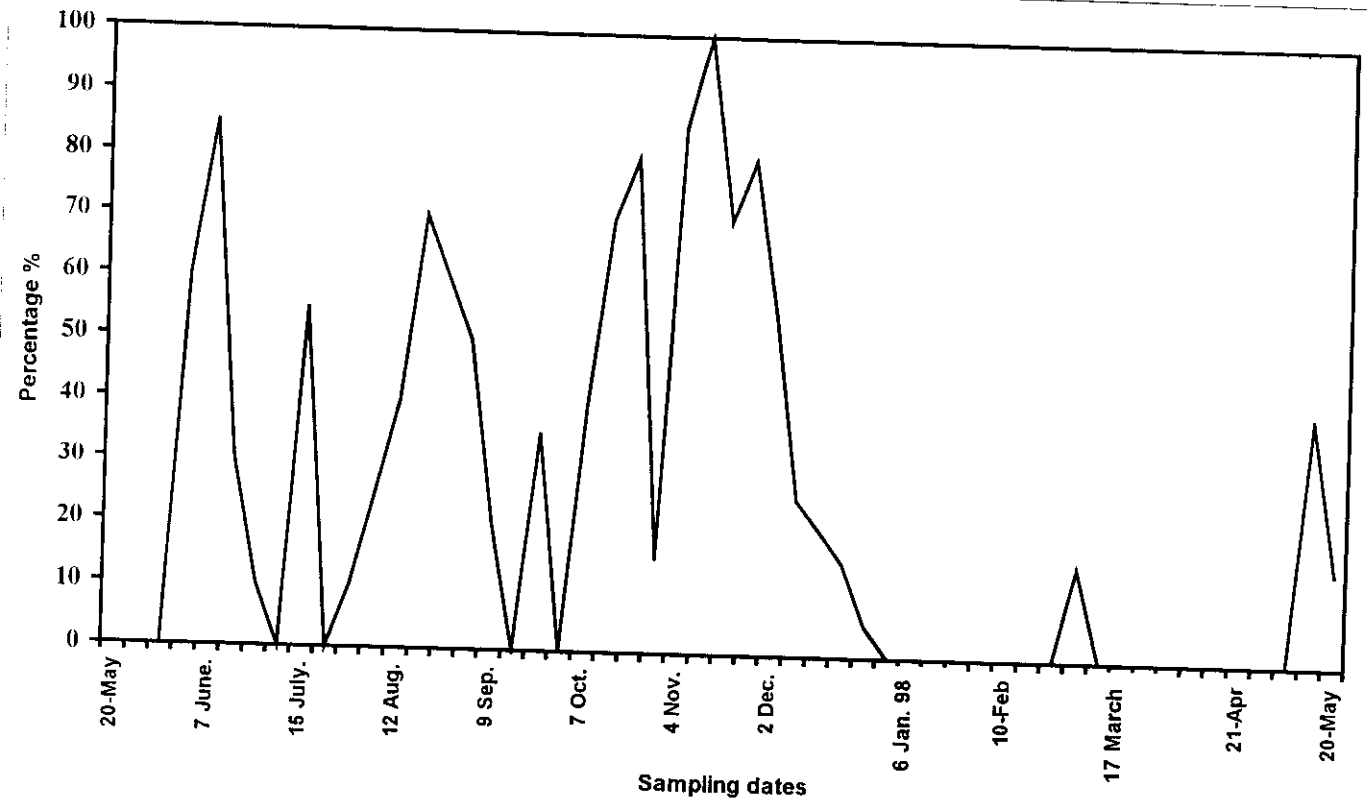

Fig. (6 a) Infestation rate (%) of Hamlin orange with *P. citrella* along one year (1997- 98) in Qalubia Governorate.

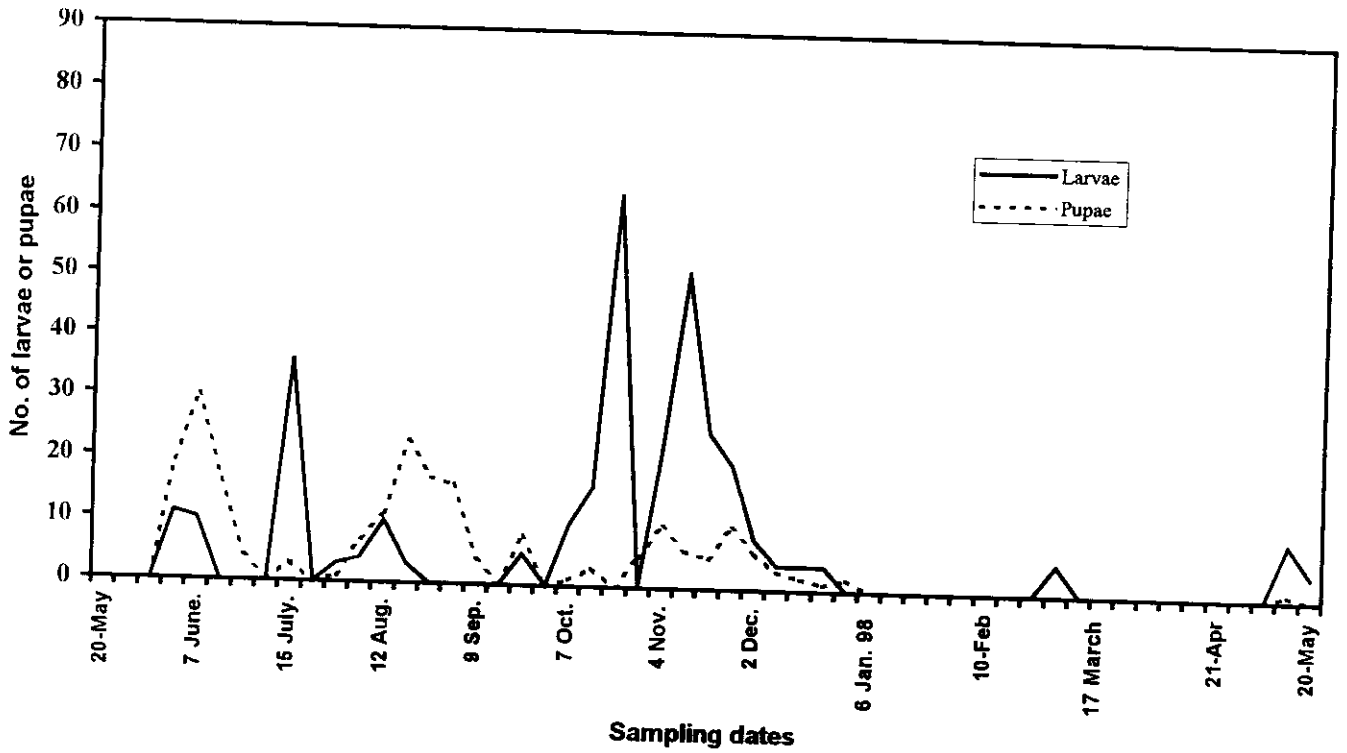

Fig. (6 b) Population dynamics of larval and pupal stages of *P. citrella* infesting Hamlin orange along one year (1997- 98) in Qalubia Governorate.

1.1.7. Tunssy orange [*Citrus sinensis* (Osbeck)]:

In such variety, it is obvious that it exhibited, a considerable level of susceptibility, since the infestation period was elongated and occurring almost the time of the year, and only three months beginning from mid-February to mid-May, trees were free of infestation. Three dates were characterized by having about 100% infestation rates, namely 90 – 100% in the first 3 weeks of June; 97% at mid-October and 100% at mid-November. The last one gradually decreased, reaching 6% in the second week of January, then it was reversed upwardly to have 15% along two weeks, then continued the raising up to be 26% along also two weeks to reach nil level at mid-February. Other low-densitied counts were also detected along the remaining period but not surpassing 15%, except two, closely interfered 2 equal peaks, were observed (70%) at both the mid- and the last week of August. **(Fig., 7a)**

Concerning the obtained numbers of larvae during the tested period, it was shown that, considerable numbers of larvae were frequently collected in high levels in different periods of the year, especially in early summer, in autumn, and in early winter. The highest peaks were recorded, once in the weeks and again in the third of June (52 L./20 leaves & 59 L./20 leaves, respectively); in the third week of October (47 L./20 leaves); at the beginning of November (23 L./20 leaves), and at mid-November (37 L./20 leaves). The last two peaks were forcedly interfered and very slowly moved, downwardly to reach nil level at the end of December. Other existing peaks were limited to a maximum number of 8 L./20 leaves and, the lowest number (3 L./20 leaves) was observed at the end of the third week of May. **(Fig., 7b)**

About the same trend of infestation was observable, also in the counts of pupae, during the experimental time. It reached its maximum number (29 P./20 leaves) in mid-June followed by that of 20 P./20 leaves, in the last week of the same month. Again, in August a number of detected pupae were 27 P./20 leaves at the end of the second week, and 17 P./20 leaves in the last week. However, other lower densities were recorded of 7 – 8 P./20 leaves in the second week of July, in the second week of October and in the last days of January, and of 9 – 11 P./20 leaves, in mid-November and at the end of the first week of December.

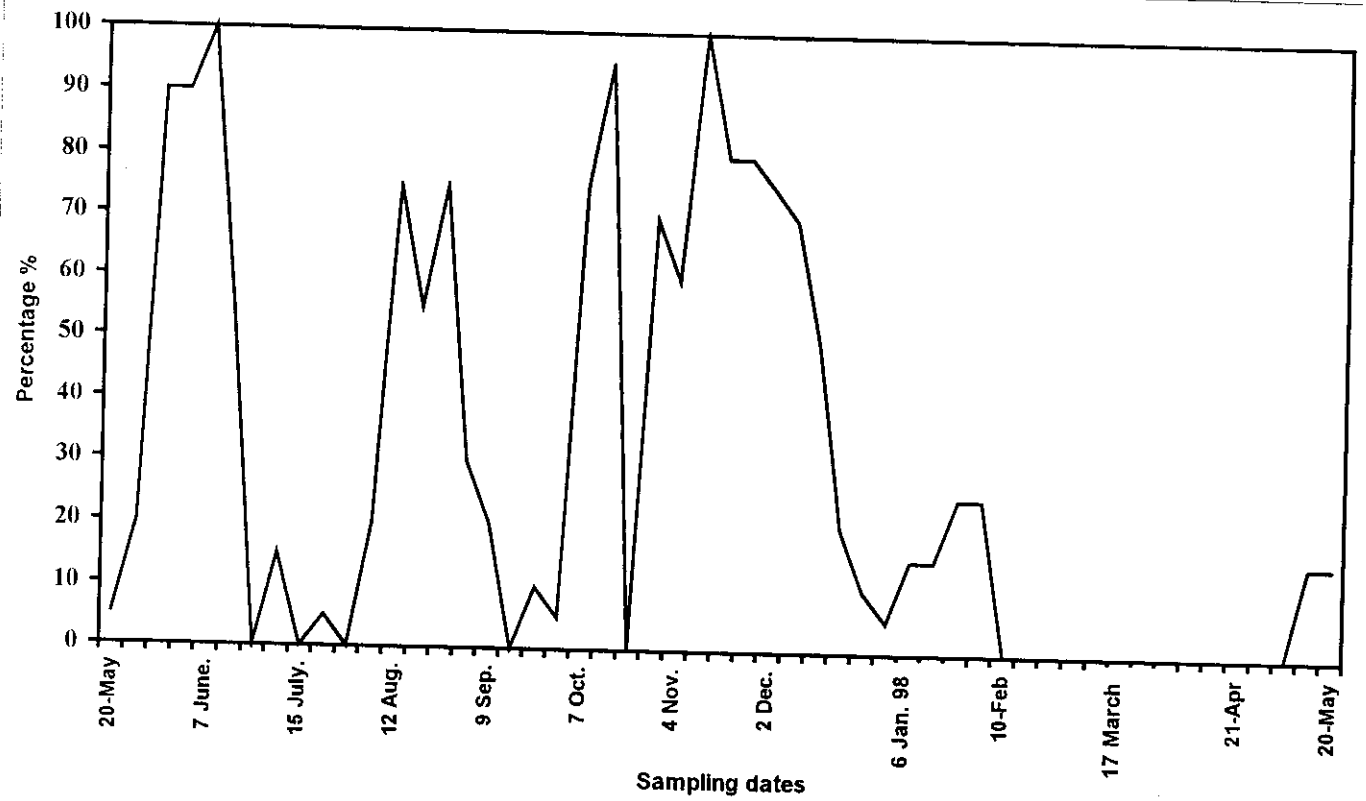

Fig. (7 a) Infestation rate (%) of Tunssy orange with *P. citrella* along one year (1997- 98) in Qalubia Governorate.

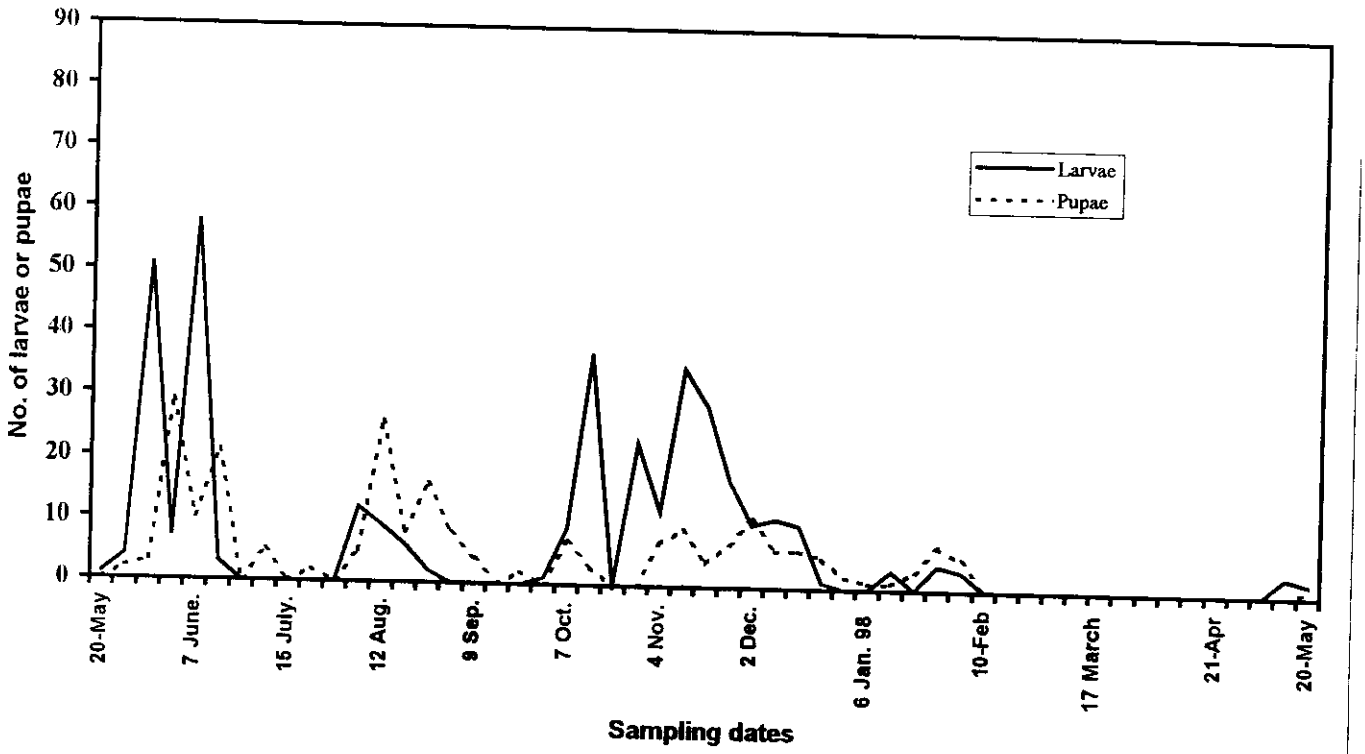

Fig. (7 b) Population dynamics of larval and pupal stages of *P. citrella* infesting Tunssy orange along one year (1997- 98) in Qalubia Governorate.

1.1.8. Rouja orange [*Citrus sinensis* (Osbeck)]:

The rate of infestation of such variety dictates the moderate susceptibility to the citrus leaf miner (CLM). At the beginning of the second week of May, about 19%-infestation rate was observed, but in June and July, 2 interfered peaks, and a low third one were also observed. The highest 3 peaks, were recorded, the first (35%) in the first week, while the second (60%) in the third week of June and the third (20%) in the second week of July. The highest 3 peaks were shown during summer, autumn and early winter. They were recorded in the last week of August (85%), in the third week of October (100%) and in the third week of November (97%). However, in the second week of January (30%), infestation rate was recorded and also other 3 moderate peaks were observed, the first (35%) was in the second week of August, which appeared to interfere with the high one of August, the second (20%) was observed in last week of September, which also interfere with the high one of October, and the third one (60%) was shown in the first of November and also interfere with the high one of the same month.

Concerning larval stage counts, it can be shown that about 18 L./20 leaves were recorded in the first week of June followed by a lower peak (8 L./20 leaves) at the middle of the same month and then dropped to nil level till the beginning of the second week of August, when, exactly similar count was recorded. The highest observed 2 peaks of numbers of larval individuals were recorded also in the third week of October and in the second week of November, followed by a low one (9 L./20 leaves) in the second week of January. **(Fig., 8 a, b)**

Pupal counts indicated moderate densities of populations, during almost of the year, of which (9 P./20 leaves) were recorded once in the second week of November and other time in the second week of May. Other low peaks ranging from 2 P./20 leaves in the first week of October to 6 P./20 leaves, both in the second weeks of July and also of November. The highest level of pupal count was recorded, once in the last week of August (27 P./20 leaves) and another of one 20 P./20 leaves in the third week of June.

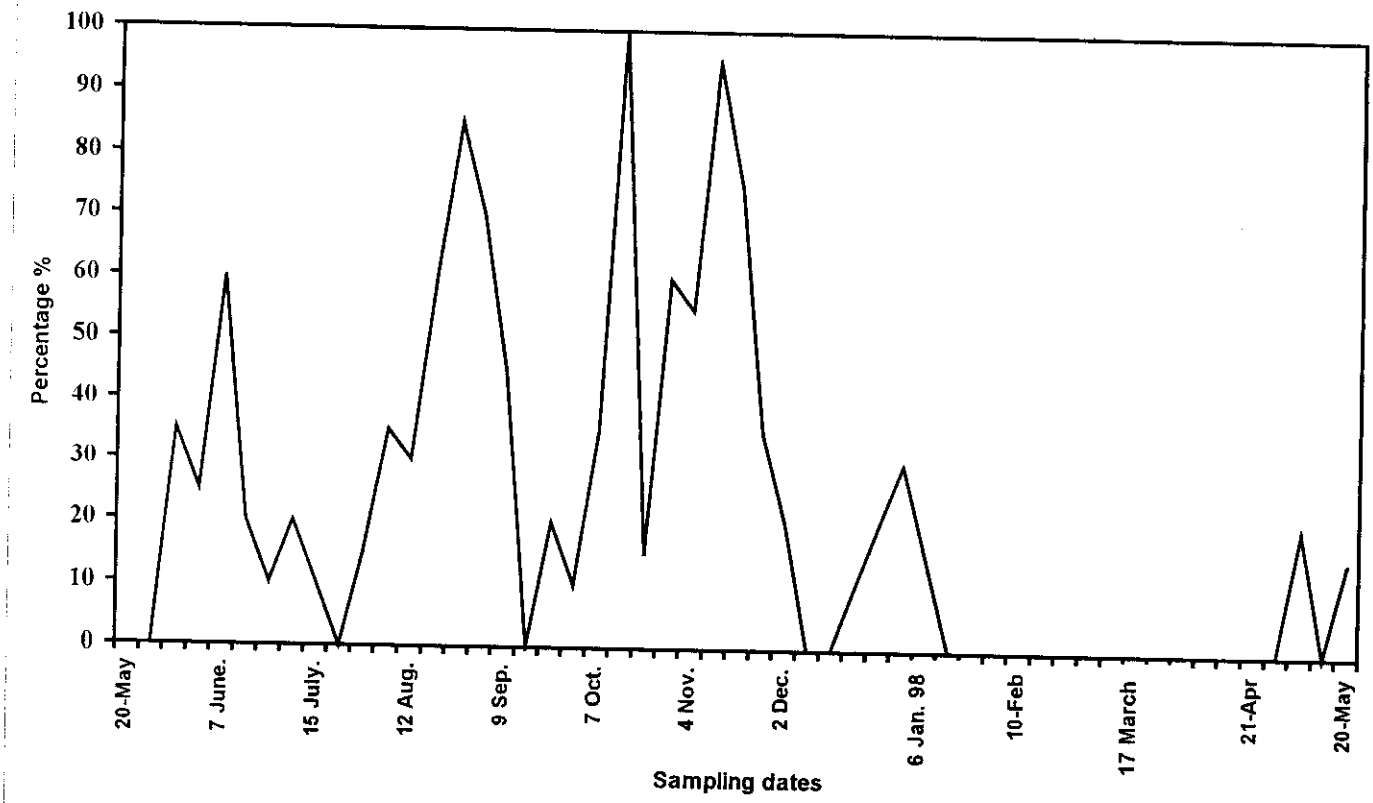

Fig. (8 a) Infestation rate (%) of Rouja orange with *P. citrella* along one year (1997- 98) in Qalubia Governorate.

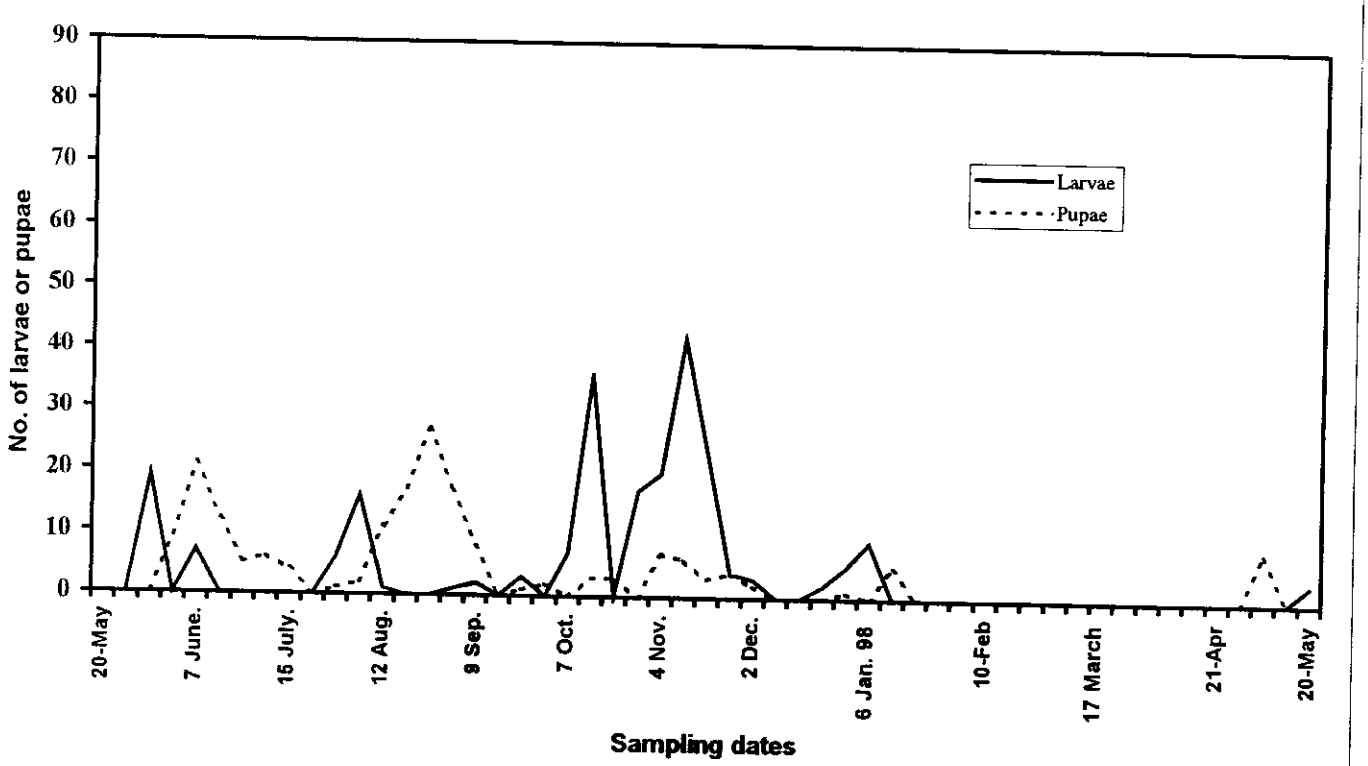

Fig. (8 b) Population dynamics of larval and pupal stages of *P. citrella* infesting Rouja orange along one year (1997- 98) in Qalubia Governorate.

1.1.9. Balady orange [*Citrus sinensis* (Osbeck)]:

The highest rate of infestation (100%) of Balady orange with *P. citrella* was recorded two times along the year, once at the middle of June and the other at the end of October, 1997. Other moderate peaks were also shown in the first week of August (55%), in the last week of the latter (70%) and in the third week of November. However, some peaks were observed of 30% in two dates namely, the second week of September and the third week of May; 25% at 2 dates, distinctly in the first week of October and along 8 days from the 5th of January till the 12th of the same month, but that of 10% was detected on the 10th of July.

Larval stage individual numbers, as indicator of the infestation level is considered here. The highest recorded peak (64 L./20 leaves) was during the second week of June, then a sudden drop was shown in the third week but reached nil level in the last week of the same month. In the last week of July, however, a peak of 12 L./20 leaves, followed by another one (8 L./20 leaves) in the second week of August were observed. Later, at the end of the third week of October (26 L./20 leaves), followed by a higher one (28 L./20 leaves) at the beginning of November, was shown to be, more early than that of the third week of November (18 L./20 leaves). Little numbers were frequently recorded, but all not surpassing 3 L./20 leaves. **(Fig., 9a,b)**

Infestation, represented in pupal count, indicated that the highest level recorded for pupal numbers (37 P./20 leaves) was in the third week of June, but very low number (4 P./20 leaves) and about 9 P./20 leaves, were observed in the second week of July and in the second week of September, respectively. The highest pupal numbers were detected in August, the first in the second week (24 P./20 leaves) and the second in the last week of the same month. Moderate level of pupal count was shown in November, once in the first week (10 P./20 leaves) and the other was (7 P./20 leaves).

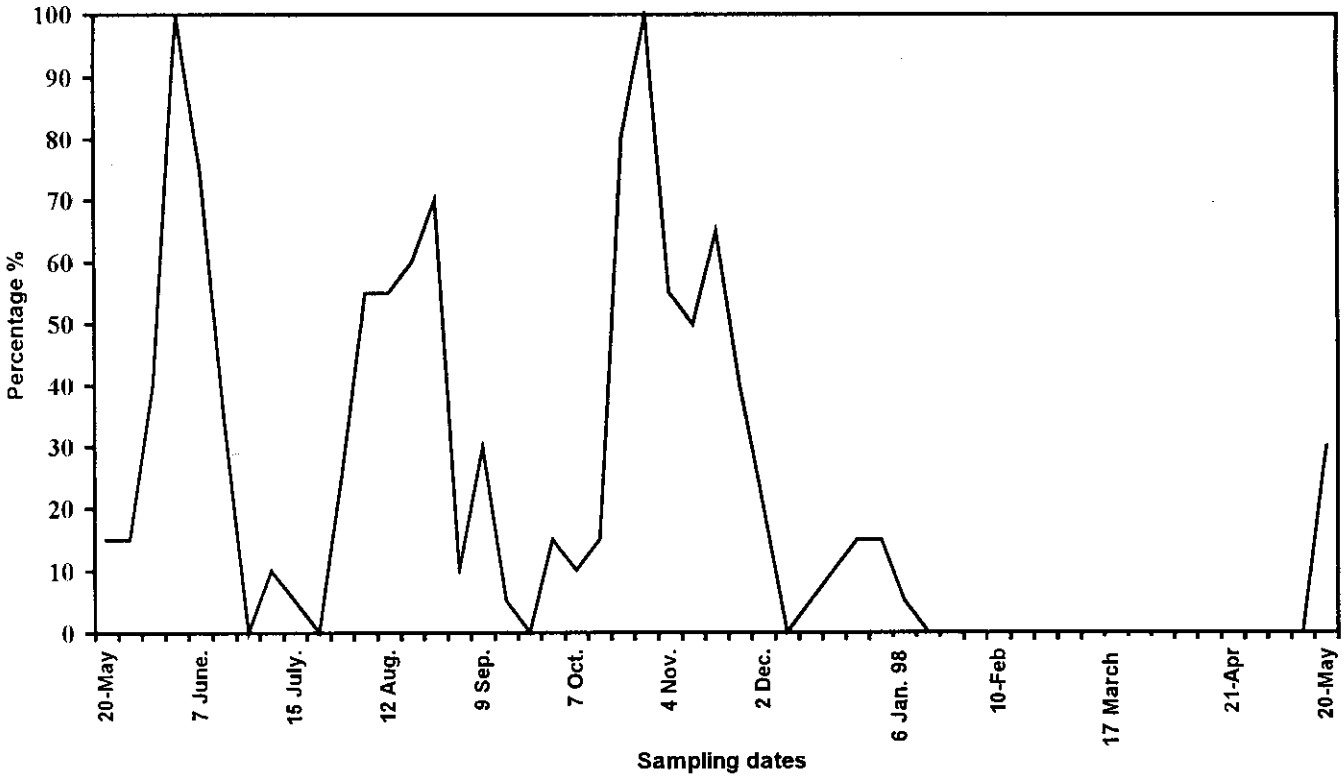

Fig. (9 a) Infestation rate (%) of Balady orange with *P. citrella* along one year (1997- 98) in Qalubia Governorate.

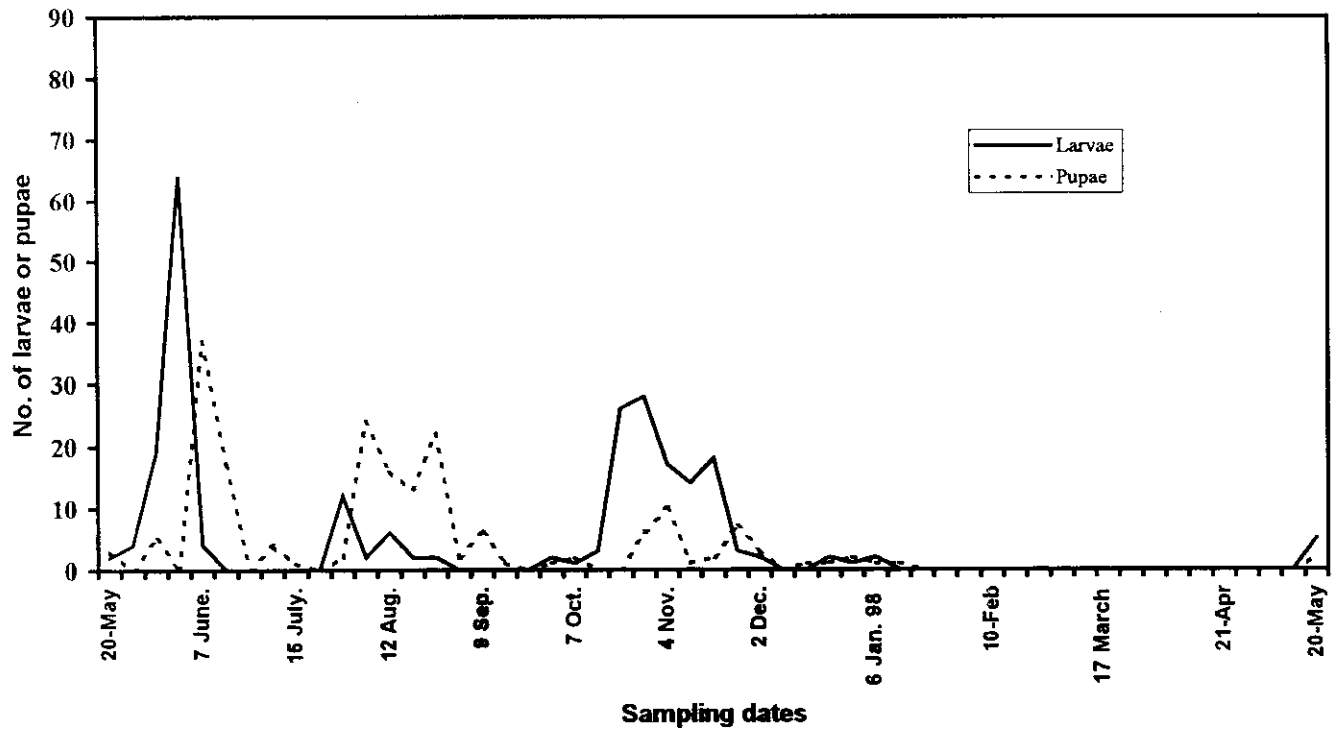

Fig. (9 b) Population dynamics of larval and pupal stages of *P. citrella* infesting Balady orange along one year (1997- 98) in Qalubia Governorate.

1.1.10. Tanarif orange [*Citrus sinensis* (Osbeck)]:

Such variety seemed to exhibit, relatively high level of susceptibility, since the infestation rate were as high as reaching high rate, almost the period of the year, including also winter months. It reached 90% in the second week of June but gradually, randown to reach nil level in the middle of July. Then it was reversed up to reach 70%, which durated, so far another week and raised up till the level of 75% in the third week of August. As it was fallen down, it didn't reach nil point but, it was reversed up at the level of 10% then to 50%, at the end of the first week of October. The latter peak was interfered with the highest one, which was recorded as 100% infestation rate along more than one month from 21st October to 25th of November. As infestation began to be heightened, it didn't exhibit lower standard than 20% in the last week of November, then it was raised again to be 70% in the first week of December. Such peak appeared to interfere with another one (65%) also at mid-December. Although, it was so cold in winter, Tanarif trees were also infested during winter months at moderate levels of 20%, 15% and 15%, at the last week of January, during the second and third weeks of March, and at the end of the last week of April. It is of surprising to observe, that infestation rate was raised up in the second week of May to reach again 60%IR.

The detected individuals of larvals stage indicated also considerable level of susceptibility of such variety, since about 8 L./20 leaves were observed in May, distinctly in the third week; 48 L./20 leaves, which exhibited a considerable high number of larvae in the

second week of June. During the second half of October and all November, the highest level of larval stage individual numbers were shown to exhibit 3 closely, interfered peaks (47, 54 & 55 L./20 leaves) at the end of the third week of October; at the end of the first week and at the end of the second week of November, respectively. Also, a detected number of larvae (30 L./20 leaves) was shown at the first week of November. Moderate standards of infestation represented in larval counts were explored, one (9 L./20 leaves) in the first week of July, the second (21 L./20 leaves) at the end of February, the third (24 L./20 leaves) in the second week of August, and the fourth (18 L./20 leaves) were recorded in the first week of December. **(Fig., 10 a,b)**

Estimating infestation level, represented in pupal number, it can be observed that, frequently pupal numbers didn't show systematic compatibility with larval individual numbers because of the fluctuating rate of larval mortality, either naturally or due to the activity of the natural enemies.

Number of collected pupae, which was similarly recorded in the second and third weeks of June was 12 P./20 leaves, then it was raised up to 26 P./20 leaves, at the first week of June. Again it recorded 24 & 18 P./20 leaves in the first week of August and afresh in the third week of August. However, less numbers of pupae, were frequently detected, one of 8 P./20 leaves, the second of 8 P./20 leaves; the third of 10 P./; the fourth of 11 P./, all per 20 leaves, at the beginning of September; at the beginning of November; in about mid-November, and mid-December, for the, aforementioned counts, respectively.

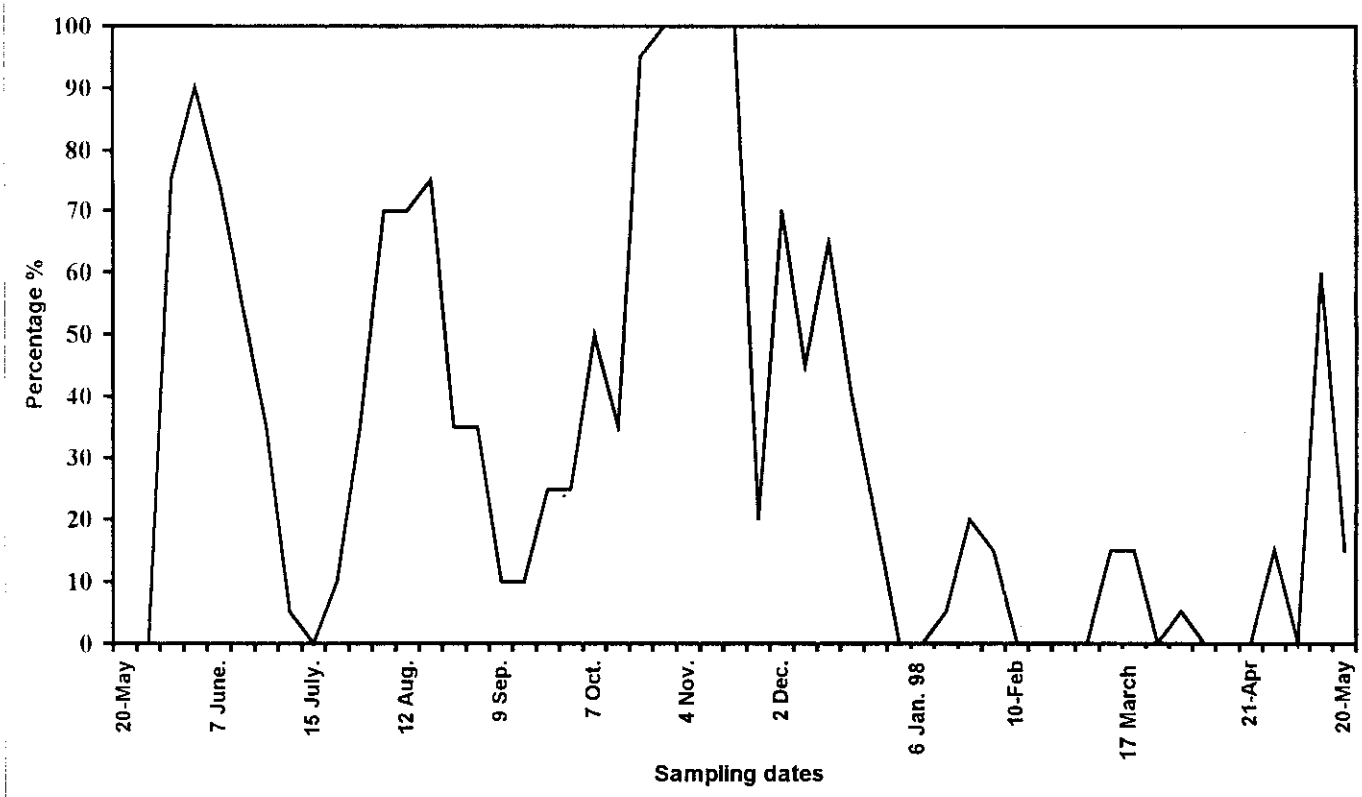

Fig. (10 a) Infestation rate (%) of Tanarif orange with *P. citrella* along one year (1997- 98) in Qalubia Governorate.

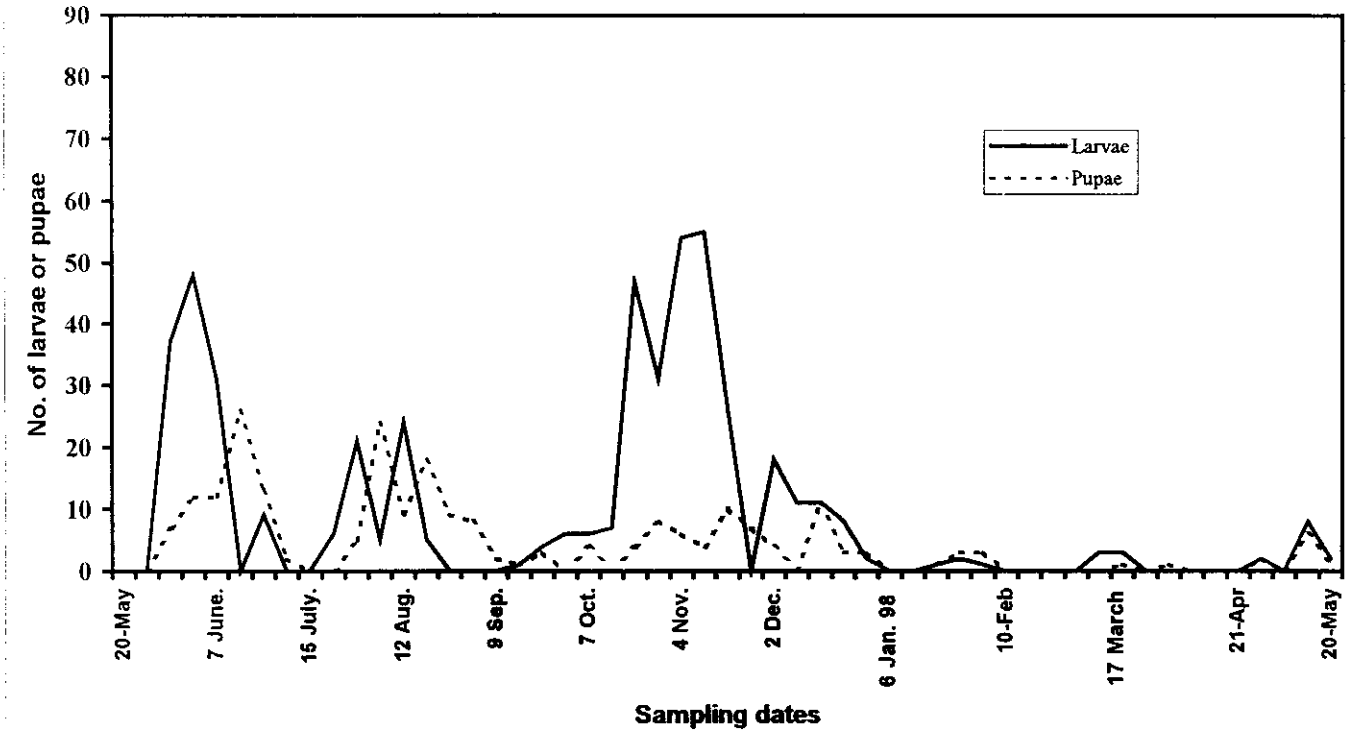

Fig. (10 b) Population dynamics of larval and pupal stages of *P. citrella* infesting Tanarif orange along one year (1997- 98) in Qalubia Governorate.

1.1.11. Mazizy orange[*Citrus sinensis* (Osbeck)]:

Mazizy orange seemed to be, susceptible citrus variety *to P. citrella*, as frequently high infestation rates were recorded, of 100% IR at the beginning of November, then 97% at mid-November, which durated at the same level till the end of the first week of December, 1997, and again at the mid-May, 1998. High rates were also observed, of 90% during the second and third week of June and similar one at the beginning of the third week of August, 1997. The moderate IR was shown in different dates; of 37% in the second and third weeks of October 1997; and of 25% during the period from the last week of December till the end of the second week of January. It is obvious that the highest rates of infestation were recorded during the late months of autumn and the early months of winter, followed by that of summer months (in June and again in August). **(Table, 1 & Fig., 11a).**

For the standard of larval infestation, as indicator of the infestation with *P. citrella*, the highest count peak (of 58 L./20 leaves) occurred in the third week of June, but after reaching nil level it was raised up again during August to attain 37 L./20 leaves in the fourth week of the same month, then to nil again, but gradually raised up to reach the level of 36 L./20 leaves, which was followed by a considerable decrease of larvae to be only 15 L./20 leaves, in the second week of November. Again, it was increased to 39 L./20 leaves from the end of the second week of November to the last of the third week of it, thereafter it, gradually decreased to be 4 L./20 leaves in the first week of January, then to the nil level. **(Table, 2 & Fig., 11b).**

Pupal counts indicate some consequence about the activity of the natural enemies, in different periods of the year, when some species were, frequently detected through such periods, therefore the counts of pupae was, almost not normally propositioned with larval counts. In such variety, only 7 P./20 leaves, in the first week of June followed by that of 35 P./20 leaves at the first of July, and again of 14 P./20 leaves at mid-August, were observed. However, very few numbers were obtained during autumn months, since they were 7, 2, 3, 4 and 5 P./20 leaves, in the first week of September, in the third week of the last month, in the second week of October; in the first of November and at the beginning of December, respectively. Although, at the end of the first week of December, a number of 23 P./20 leaves were detected it was gradually decreased to 4 P./20 leaves in the second week of January. It is worth noting, that during the, third week of May 1998, a peak of 10 P./20 leaves represented the thereat pupal count.

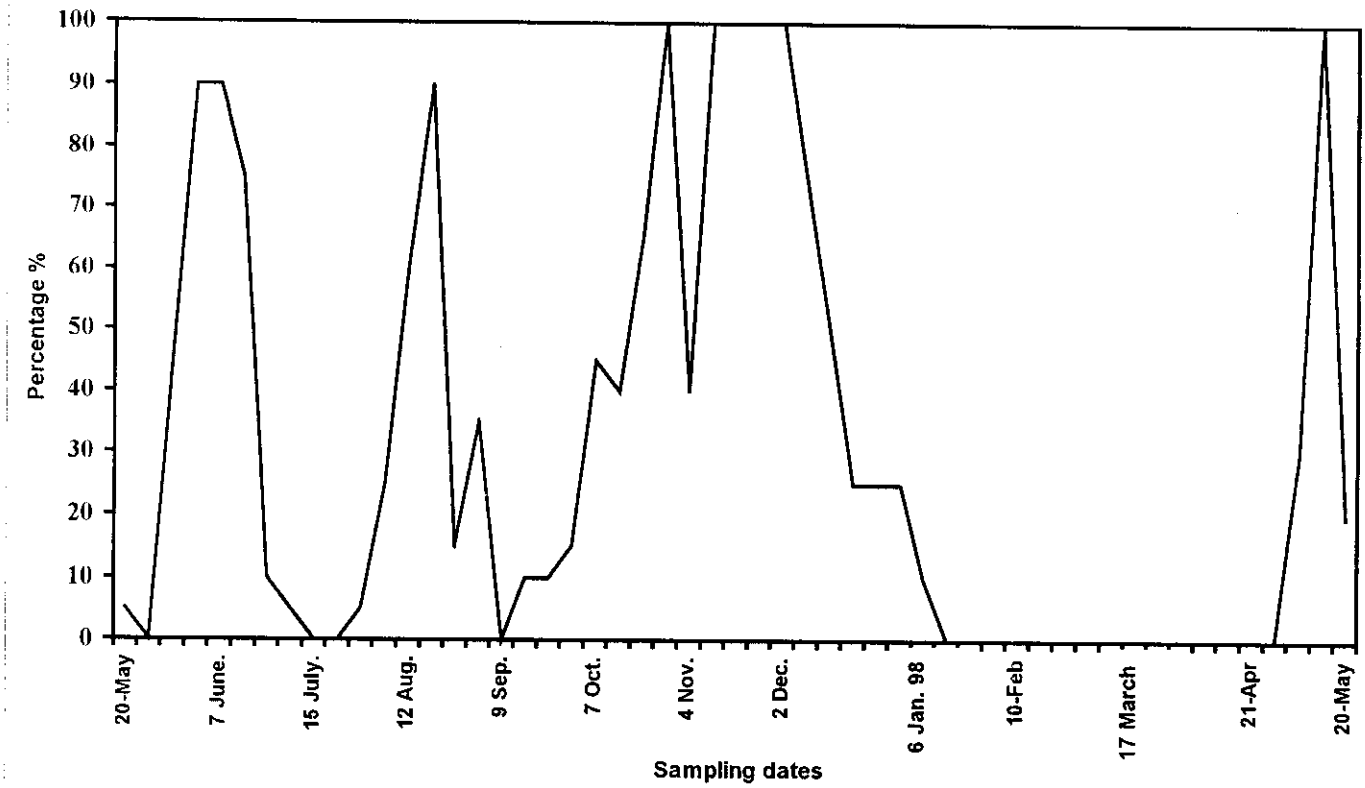

Fig. (11 a) Infestation rate (%) of Mazizy orange with *P. citrella* along one year (1997- 98) in Qalubia Governorate.

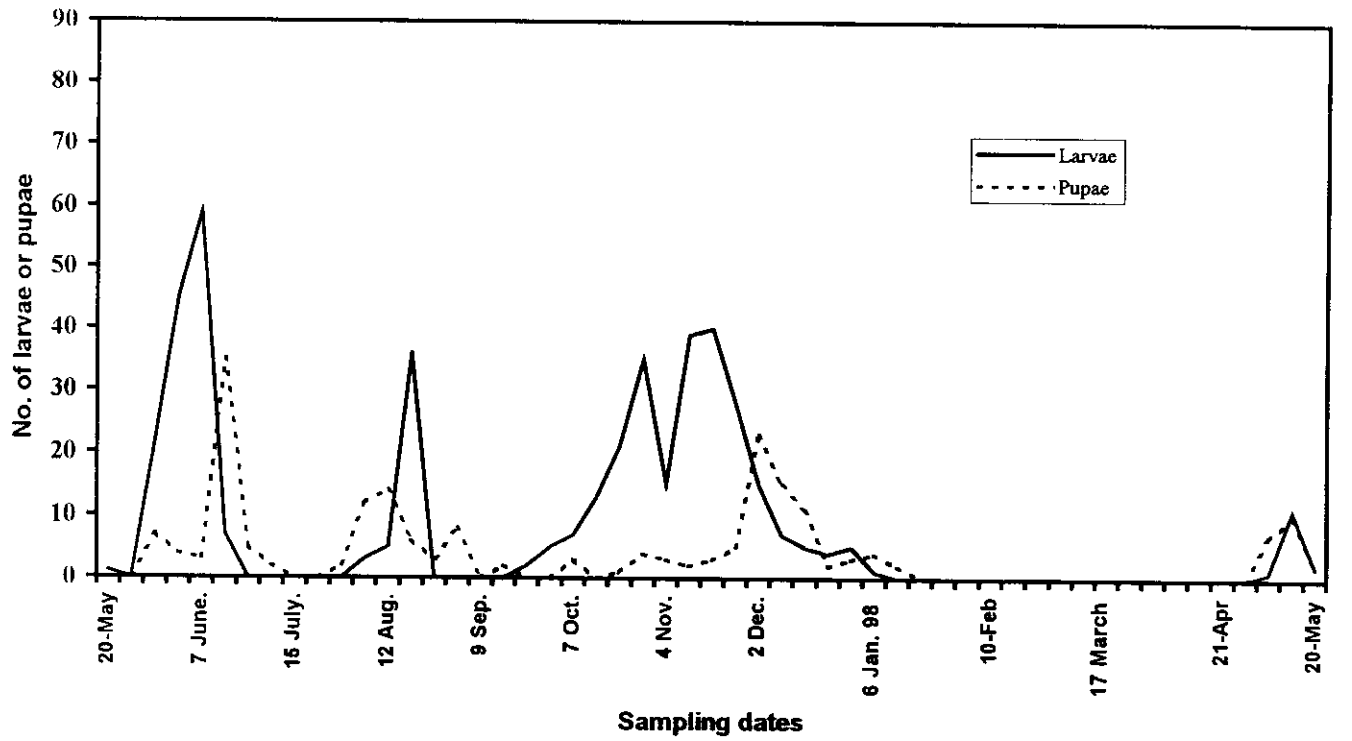

Fig. (11 b) Population dynamics of larval and pupal stages of *P. citrella* infesting Mazizy orange along one year (1997- 98) in Qalubia Governorate.

1.1.12. Sangwin orange[*Citrus sinensis* (Osbeck)]:

Considerable level of susceptibility, wasn't hidden from our observation through the infestation rate of such variety to *P. citrella*. During the tested period, it reached 90% in the first week of June, then, slightly downwardly to 86% in the second week, which constantly, durated to the third week of the same month, before the sudden decrease to nil level in the first week of July. Six following variable leveled peaks before that recording the maximum rate (100% during the period from the last week of October to the end of the third week of November) were shown to exhibit 40%, 46%, 66%, 52%, 60%, and 55%, at mid-July; the beginning of the second week of August till the end of the second week form the beginning, to the end of the fourth week of the last month; in the second week of September; the last week of the same month and during the second week of October, respectively. Other low, two peaks, were also observed, of 20% along the period from the mid of the third week of December to the first week of January and the second of 6% at mid-March, 1998.

Numbers of detected larvae, were the highest during two periods, the first (55 L./20 leaves) in the first week of June and the second were consisted of 3 overlapped peaks from the last week of October (47 L./20 leaves) to that of 60 L./20 leaves in the second week of November and of 47% at the beginning of the third week of the same month. Other low leveled peaks of counts were, obviously shown; of 8 – 9 L./20 leaves, during the last week of July to the end of August when reached nil standard; of 10 L./20 leaves in three dates, distinctly in the second week of September; in the second week and in the third week of October, and in the third week of May, respectively. A moderate one of 15 L./20 leaves, was shown in the last week of September and not, worried ones near nil level were also detected. **(Fig., 12 a,b)**

Pupal counts, in most cases, were shown to be not proportioned with that of larval stage. In the third week of June, a number of 30 P./20 leaves was shown to record the highest number of detected pupae, from such variety, along the investigated period. From mid-July (13 P./20 leaves) to the last week of August (16 P./ 20 leaves), another peak of 15 P./ 20 leaves was observed in the first week of last month. In the following months, it was, as low as not surpassing 9 P./20 leaves in the third week of September; about 4 P./ 20 leaves in the second week of October, of 6 P./20 leaves in mid-November and 5 P./20 leaves in the fourth week of December, but it was, slightly raised up to reach 12 P./20 leaves at the second week of December, 1997.

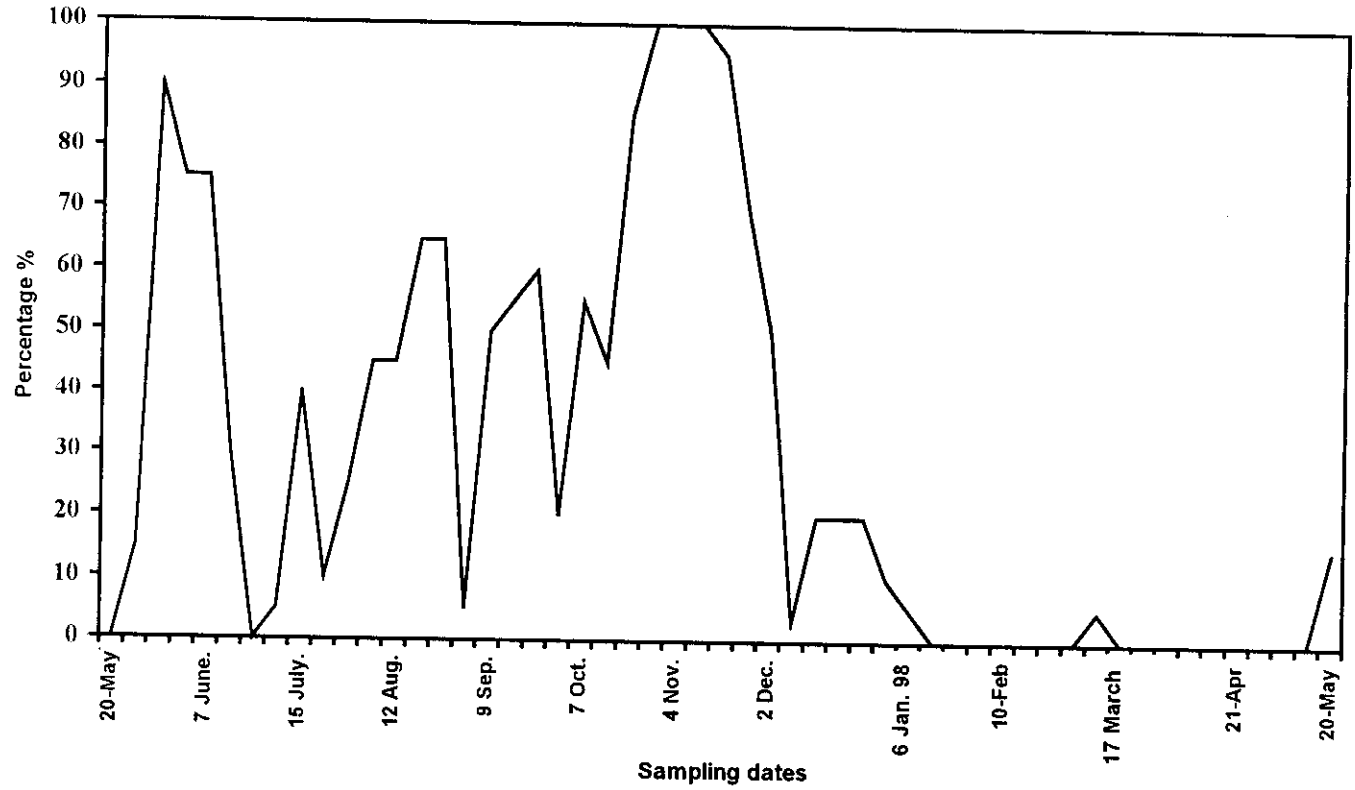

Fig. (12 a) Infestation rate (%) of Sangwin orange with *P. citrella* along one year (1997- 98) in Qalubia Governorate.

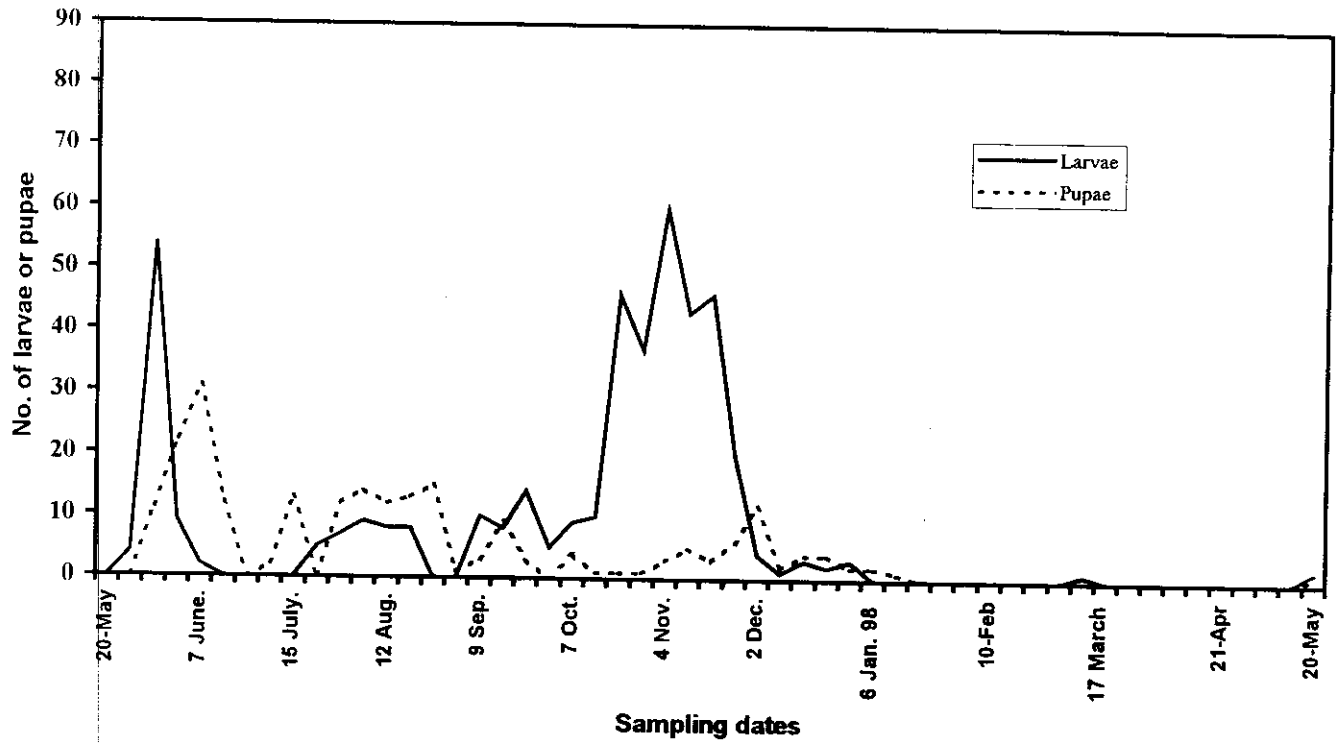

Fig. (12 b) Population dynamics of larval and pupal stages of *P. citrella* infesting Sangwin orange along one year (1997- 98) in Qalubia Governorate.

1.1.13. Khalily orange[*Citrus sinensis* (Osbeck)]:

In accordance with CLM infestation rate, Khalily orange seems to be, moderately susceptible, but with special pattern of infestation, as CLM was occurring nearly during the whole year. Infestation rate reached its maximum (100%) in four dates, at mid-June, in the first week of November, in the third week of the last same month, and in the third week of May. Similar trend was observed in larval counts as they were 63, 59, 44 and 19 L./20 leaves, in the aforementioned dates, respectively. High peaks of 70, 79, 60 and 75% infestation rates were observed in the first week of August, the fourth week of the same month, the first week of October and the last week of December. Furthermore, moderate counts were detected; 34% in the fourth week of September, and 45% in the third week of October. However, relatively low rates of infestation were, frequently shown along the year (9% in the last week of May; 13% in the second week of July and again in the third week of August; 18% in the second week of September; 15% in the second week of October, 19% in the fourth week of October, too; 10% in the second week of December; 19% in the last week of January; 15% in the third-fourth week of March and finally 5% in the third week of April, 1998.

Other than the highest peaks of larval counts, mentioned with infestation rate, moderate numbers of larvae were frequently collected along the year. About 9, 8, 14, 8, 11, 7, 18, 20, 11, 4, 3 & 20 larvae/20 leaves, were detected in the second week of July; in the last week of the same month, in the first week of October, in the 3rd week of the same month, in the fourth week of the same month also, in the 2nd week of November, in the last week of December, in the last day of January, in the second week of March, but the letter durated to the end of the 3rd week, and finally, in the third week of May, 1998. **(Fig., 13 a,b)**

Concerning pupal counts, as a picture of infestation, it was observed that, pupal numbers in proportion to larval counts, is relatively low, and that because of the, observed activity of natural enemies in summer, autumn and early winter months. The highest pupal numbers (29 P./20 leaves) was collected in the first week of August, after that was detected in the last week of June (20 P./20 leaves). The other obtained peaks of pupal counts, were as low as not surpassing 13 P./20 leaves in the first week of September and reached nil level in mid-November, when infestation was at maximum standard, because of the, thereat natural enemies activity.

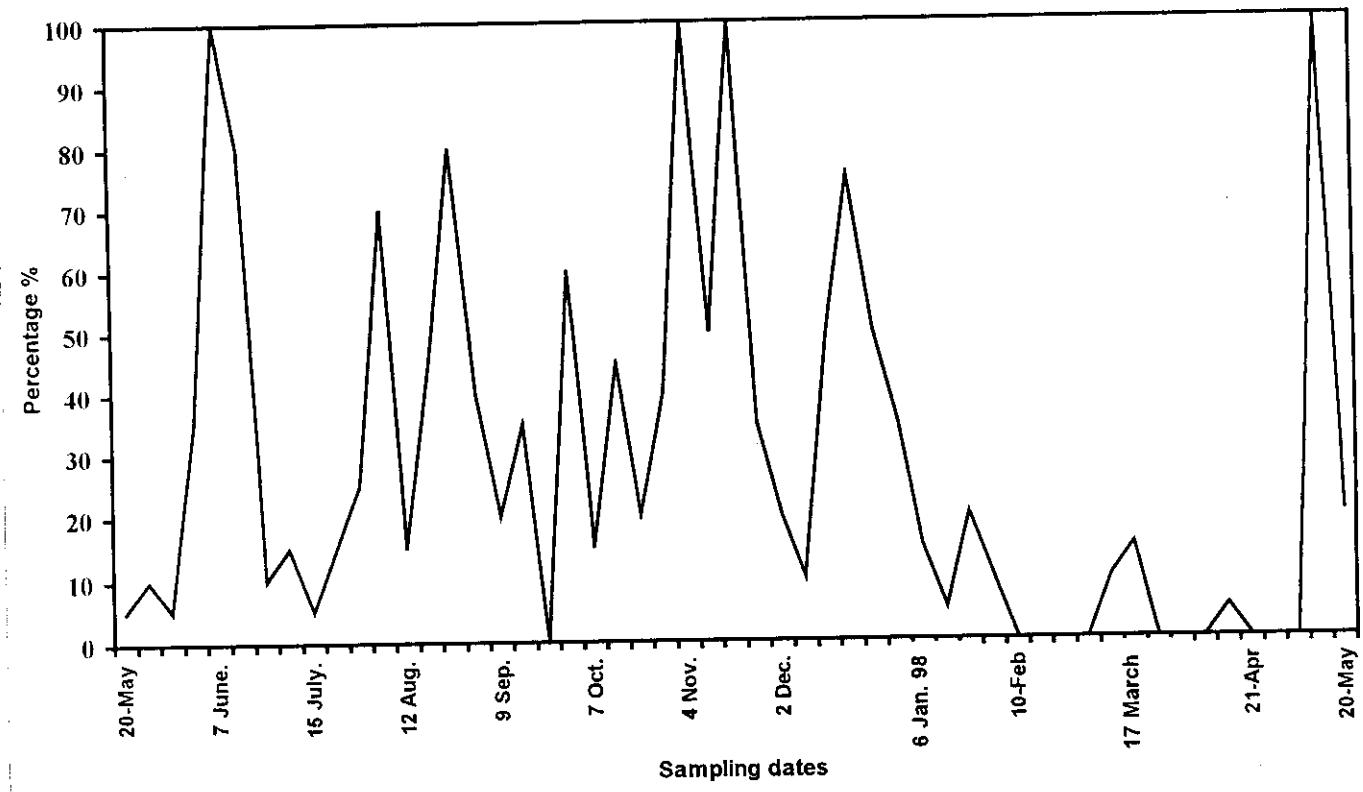

Fig. (13 a) Infestation rate (%) of Khalily orange with *P. citrella* along one year (1997- 98) in Qalubia Governorate.

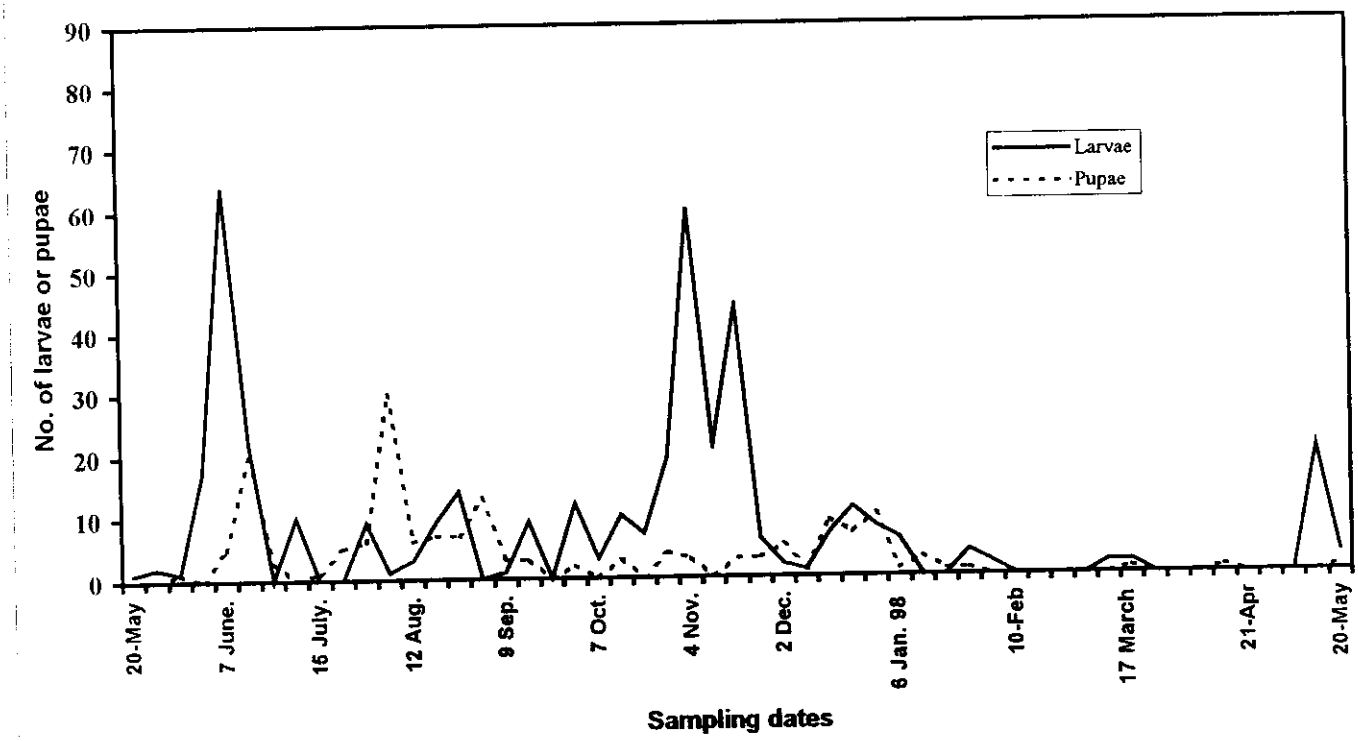

Fig. (13 b) Population dynamics of larval and pupal stages of *P. citrella* infesting Khalily orange along one year (1997- 98) in Qalubia Governorate.

1.1.14. Mozambik orange[*Citrus sinensis* (Osbeck)]:

Prior to infestation rate, such variety appears to be, relatively resistant to CLM infestation, where only a single maximum peak of infestation (100%) was observed in the third week of May 98, which was, suddenly dropped down to reach nil within one week. The following high peak (85%) was shown in the third week of November and other one (65%) in the last week of August. Fluctuation of infestation rate, other than what have been mentioned, was observed to average 40, 30, 55, 40, 15, 45, 36, 36, 16, and 7%; in the last week of May 97, in the 1st week of June, in about mid-August, in the 4th week of September, in the 2nd week of November, which durated so, till mid-November, the first of December, and during one week within the first 2 weeks of January and the last one in the first week of May 1998.

Concerning larval numbers, it was relatively low in almost the whole year except that of the third week of November, when about 37 L./20 leaves were collected. The observed other larval counts ranged between 3 L./20 leaves in the second week of January to 19 L./20 leaves in mid-August. **(Fig., 14 a,b)**

Pupal counts, followed about similar trend, except in autumn and summer months. During June, 97, 15, 13 & 12 P./20 leaves were collected in the first, second and third weeks, respectively. Again in September about 7 P./20 leaves was detected in the first week and only 4 P./20 leaves in the last week of the same month.

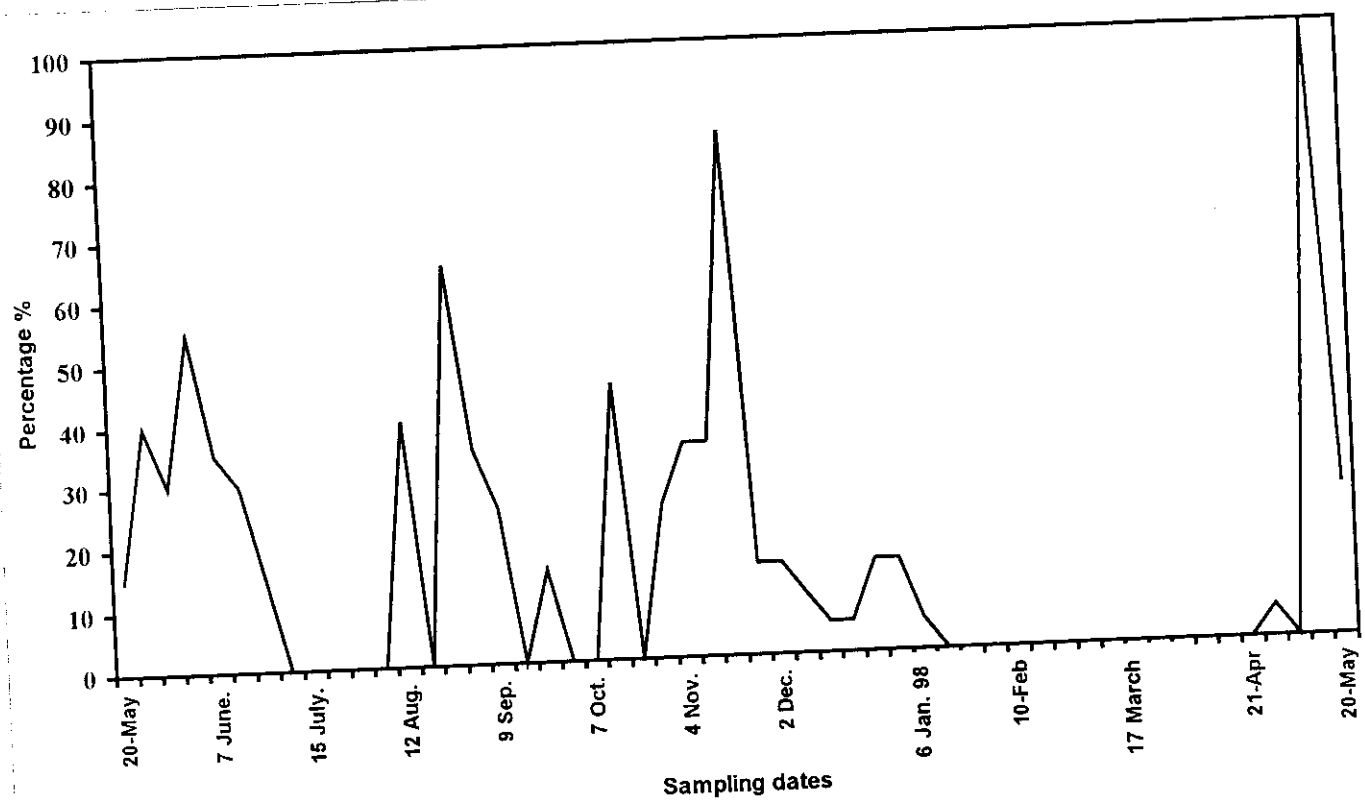

Fig. (14 a) Infestation rate (%) of Mozambik orange with *P. citrella* along one year (1997- 98) in Qalubia Governorate.

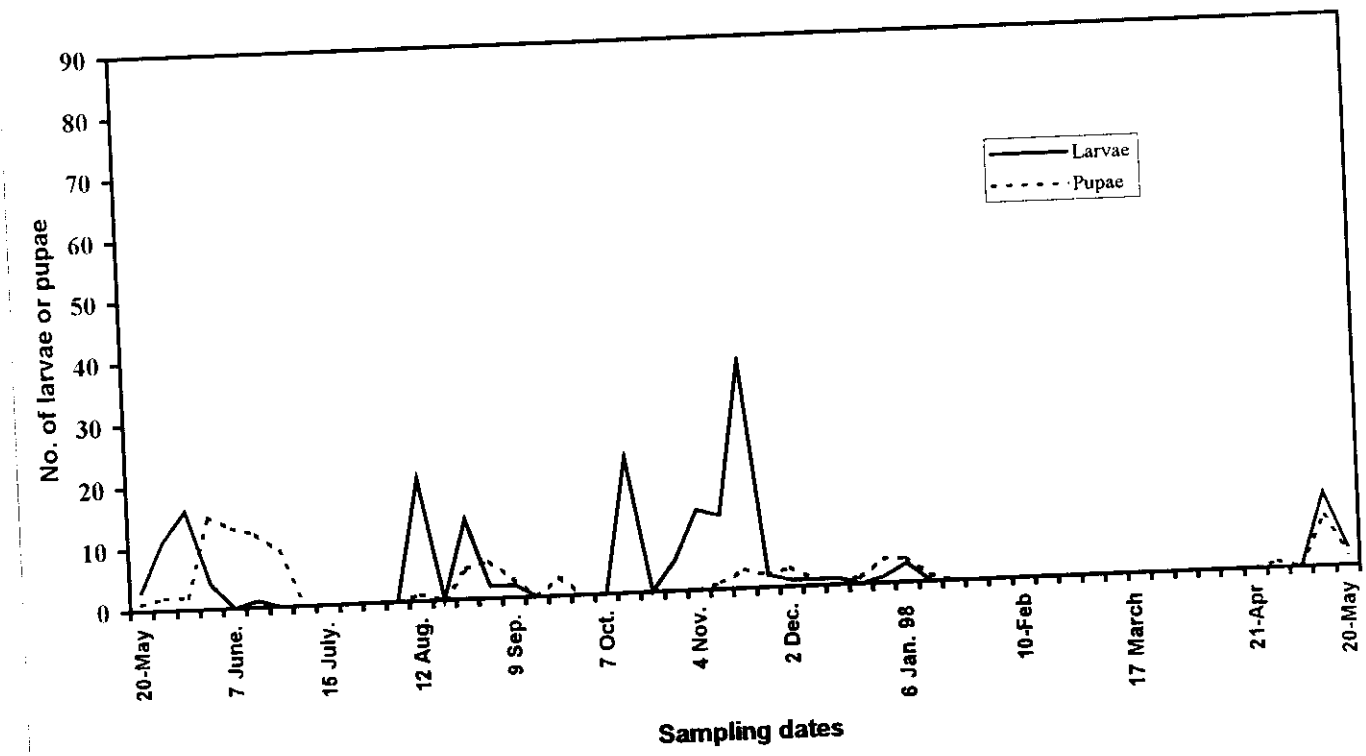

Fig. (14 b) Population dynamics of larval and pupal stages of *P. citrella* infesting Mozambik orange along one year (1997- 98) in Qalubia Governorate.

1.1.15. Jaffa orange[*Citrus sinensis* (Osbeck)]:

Jaffa orange appear to be resistant against *P. citrella*, since it was completely free from infestation along about the half of the year, from the beginning of December till mid-May of the following year. The exhibited, infestation rate reached its maximum (95%) in the first week of June, then it was decreased to a level of 75% at the beginning of the third week of the same month, but continued at the same level till the half of the forth week of June, too. Another low peak (25%) was observed in mid-July, which ran downwardly towards the end of the month (15%), but it was raised up again to reach 75% at the beginning of the 4th week of August, and then, afresh dropped to reach nil level in the first week of October. During the second week of the aforementioned month, only 10% IR was attained in November, however three moderate counts were observed (25%), in the 2nd week; (20%) at the beginning of the third week and 40% at the beginning of the fourth week of the month, within a very short period (one week) in May 1998, the infestation rate reached 80%, but sudden fall was also observed.

Concerning larval counts, as a phase of infestation, similar trend of IR was obtained here, where the highest peak was also recorded during the 2nd week of June, followed by a low one (6 L./20 leaves) in the second week of July, then (8 L./20 leaves) at the end of the month, but it was gradually raised up, again to record 20 L./20 leaves in the 4th week of August. During September and October, very few numbers of larvae (2 L./20 leaves) were frequently collected. However, in November, also, relatively low numbers were collected (8; 6 and 14 L./20 leaves) in the 1st, in the 2nd and in the third week of the same month, respectively. Later, in May 1998, one peak of 22 L./20 leaves was also recorded. **(Fig., 15a, b)**

About pupal collection, the highest numbers were shown during June 1997, 32 and 37 P./20 leaves was obtained in the third and last week. Again in mid-July, in the 2nd , 3rd and 4th weeks of August and in the third week of May 1998, pupal counts were 10, 7, 4, 8, 8 and 5 P./ 20 leaves, respectively.

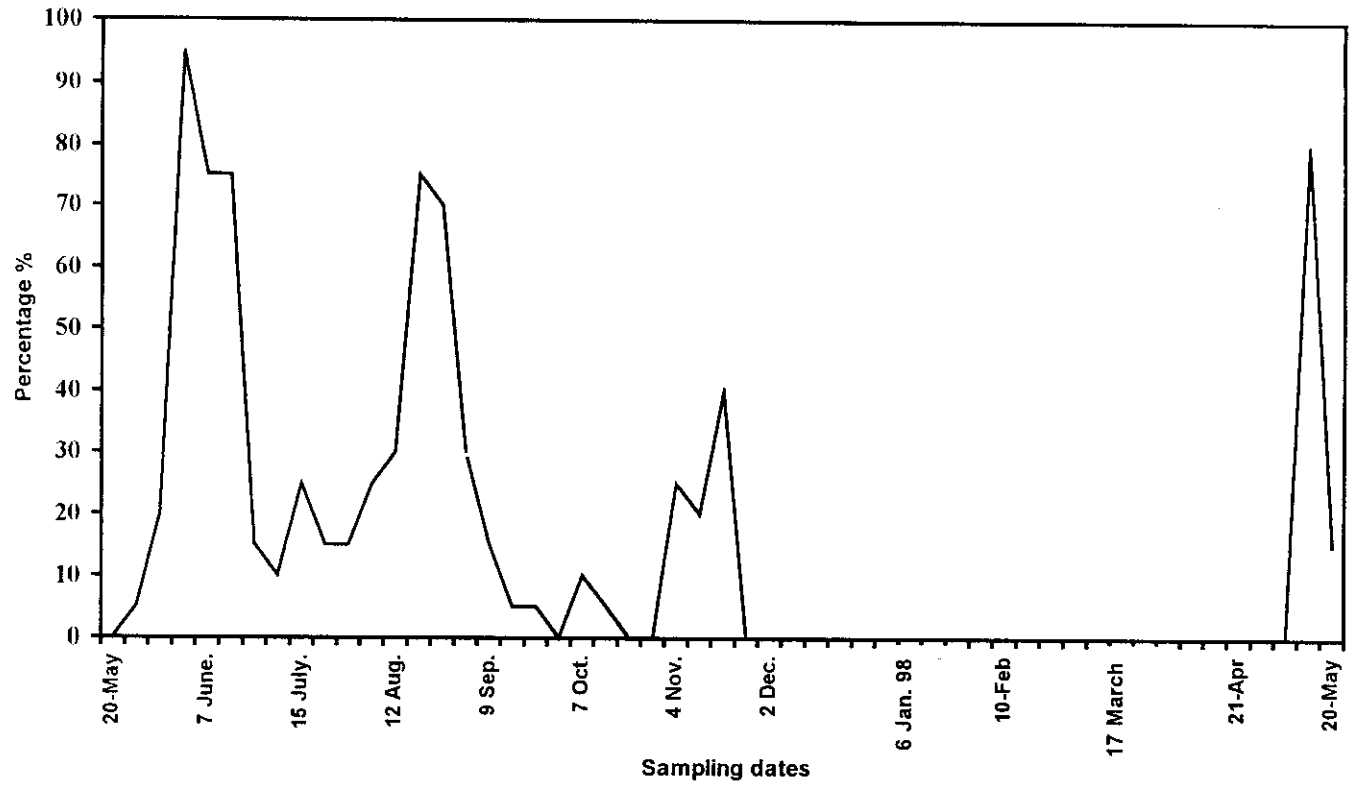

Fig. (15 a) Infestation rate (%) of Jaffa orange with *P. citrella* along one year (1997- 98) in Qalubia Governorate.

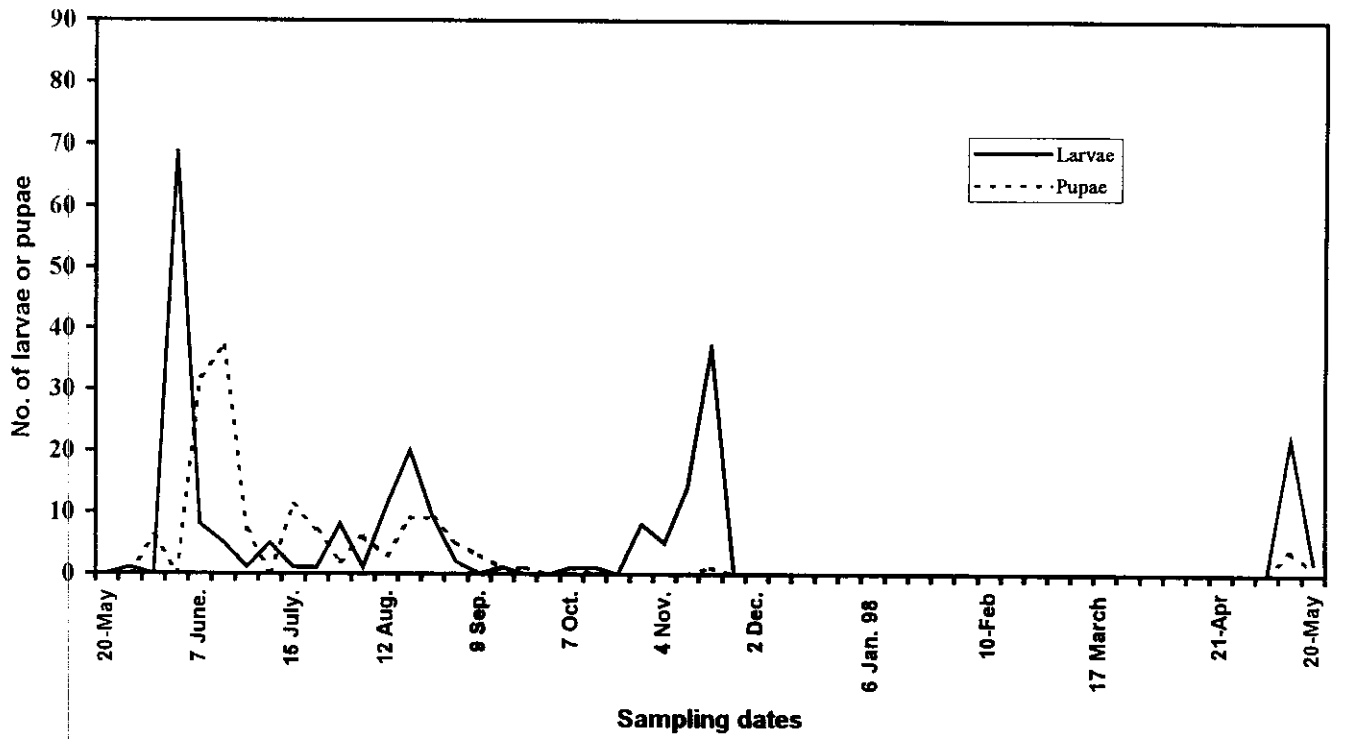

Fig. (15 b) Population dynamics of larval and pupal stages of *P. citrella* infesting Jaffa orange along one year (1997- 98) in Qalubia Governorate.

1.1.16. Mafard orange[*Citrus sinensis* (Osbeck)]:

For the Mafard orange, it is obvious that such variety exhibits a moderate level of susceptibility to *P. citrella*. The highest rates of infestations (100%) were recorded 2 time a year, once in the 4th week of October and the other at mid-May, 1998. The descended ones were 90% at the end of third week of June, 65% in the last week of August, 50% along one week between the end of September and the beginning of October, and similar level along the last 10 days of November. Also, relatively high peak was recorded in the second week of the same month.

The lowest infestation ratio were shown, 30% in the 2nd week of July, 25% along one week at mid-August, 11% in mid-September, 20% in the 2nd week of October, 35% in 2 dates during November, (in the 1st and 3rd weeks), 25% along one week balancing Dee and 10% in the first week of May 1998.

About similar trend of larval counts distribution was observed, in the third week of June (48 L./20 leaves) occurred, then it was decreased to nil level by the end of the month, then raised up again in mid-August, but not more than 12 L./20 leaves in the second week, 8 and 7 L./20 leaves in the 3rd & 4th weeks, respectively. Larval population was, maximally increased during the 4th week of October to reach 97 L./20 leaves, thereafter was decreased to 22 L./20 leaves, at the end of the

month, but it was increased again to be 48 L./20 leaves in the 2nd week of November, during which other counts of 11, 13 and 9 L./20 leaves were obvious shown at mid-November, the end of the 3rd week and in the last week of the same month. Although, 7 L./20 leaves, was observed in the first week of December. It was very near to nil level at mid of the month. It is not forgather to note that also 16 L./20 leaves were collected during the third week of May 1998. **(Fig., 16 a,b)**

When numbers of collected pupae are concerned so as to reflect the standard of infestation, it can be said that, similar trend, as shown with other varieties is shown also here, although a number of 38 P./20 leaves was observed in the last week of June followed by a count of 12 P./20 leaves in the 2nd week of July. Very scarce numbers, were rarely detected until, on the last week of August and the first week of September; 2 counts of 10 & 12 P./20 leaves were observed, respectively. Fluctuating numbers were presented, also in the 1st and last weeks of October, at the beginning of November and at the beginning of the 2nd week, mid- and in the 3rd week of December of 7, 7, 8, 9, 5 & 5 P./20 leaves, respectively. It is not neglectiable to recorded the collected numbers of pupae in May 1998, , which was once about 5 and the other (12 P./20 leaves) in the 1st & 3rd weeks, respectively.

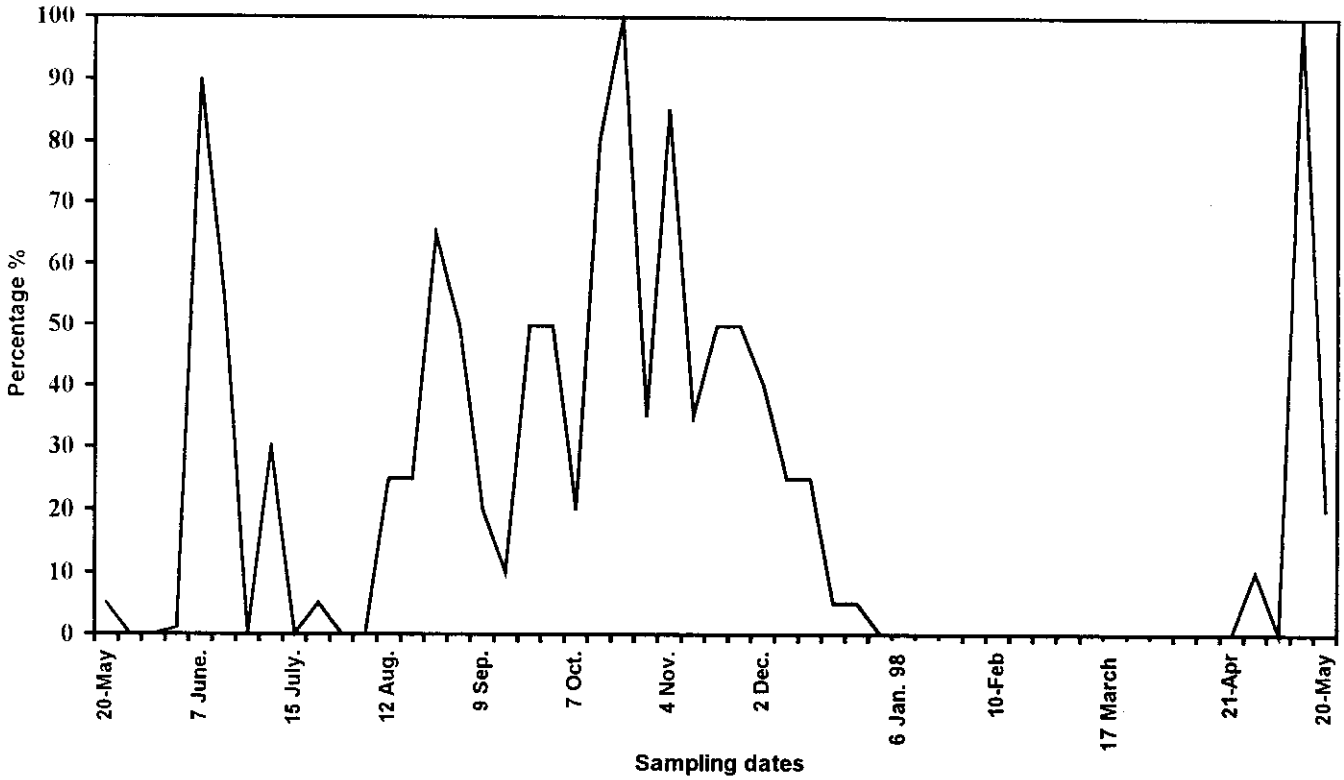

Fig. (16 a) Infestation rate (%) of Mafard orange with *P. citrella* along one year (1997- 98) in Qalubia Governorate.

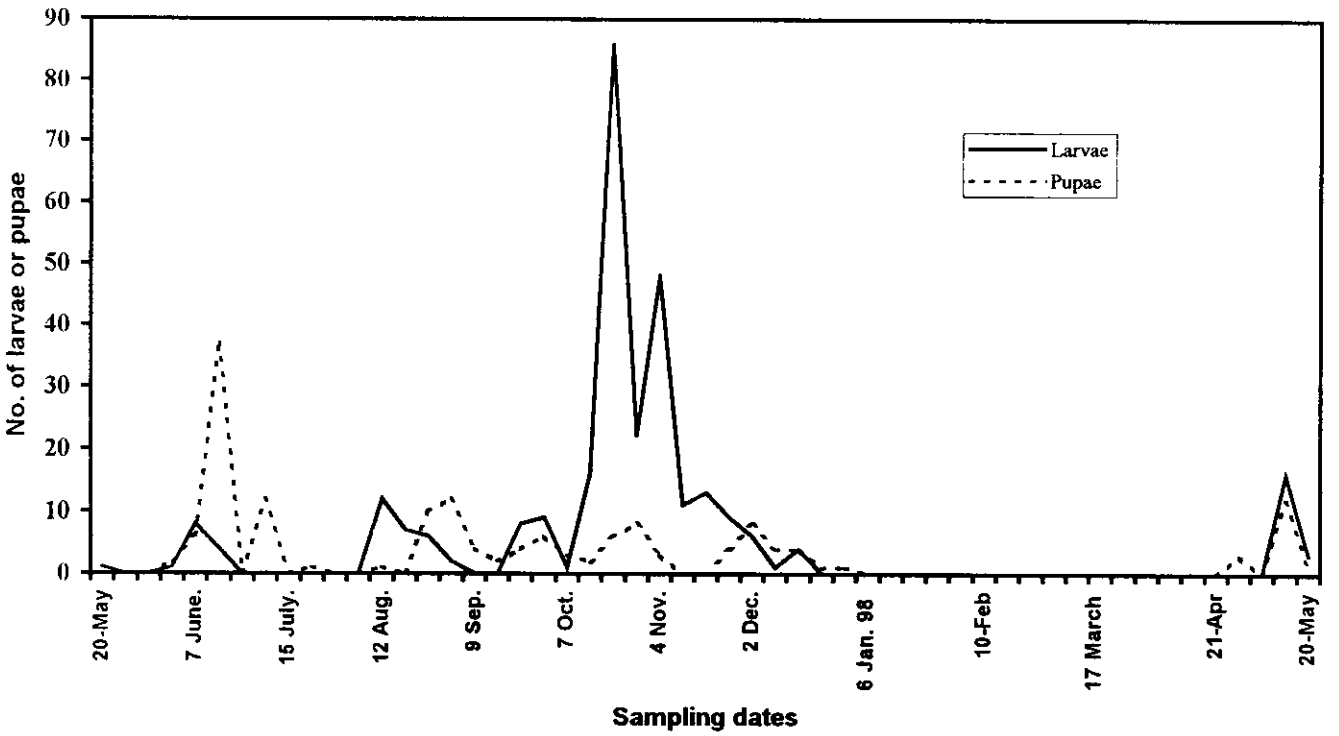

Fig. (16 b) Population dynamics of larval and pupal stages of *P. citrella* infesting Mafard orange along one year (1997- 98) in Qalubia Governorate.

1.1.17. Balady blood orange[*Citrus sinensis* (Osbeck)]:

Balady blood orange appeared, from general observation, to attain, a considerable level of resistance to *P. citrella*, since the infestation rate didn't exceed 65% in the third week of June, which was decreased to only 11% at the beginning of July and increased again to 15% in the second week of the same month. It was followed by, a relatively higher infestation, reaching to 55% at the second week of August, which was suddenly raised up from nil level, however, durated at that level for about one week and then gradual decrease, was shown to record 20% in the first week of September, during which other 2 peaks of infestation rate were detected, namely 45% & 30% in the second and 4th weeks of the aforementioned month. About three weeks have passed from the recording of nil level at the beginning of October to reach 55% infestation rate, which dropped down to nil level again. Although, November was about completely free from infestation, December head a considerable higher infestation rate of 55% at the end of the first week, but it was afresh reversed downwardly to the nil level in the fourth week of the month. However, in March, about 17% infestation rate was shown, in the third week of the month, and subsequently another, moderately leveled peak of 26% in May 1998, were revealed.

When larval counts are concerned with, as to provide some informations about the rate and severity of infestation with *P. citrella*, about similar trend was exhibited, appearing to attain the highest number of 38 L./20 leaves in the second week of June, and again less count of 9

L./20 leaves was observed in the third week of the same month, but it was completely lack, from the last week of June till the end of July. Larval count during August didn't exceed 4 –5 L./20 leaves, as was also shown at the fourth week of September. In contrast, 2 counts obviously characterized October month, since about 11 & 14 L./20 leaves were recorded in the second and third weeks of such month, respectively. After the, about complete absence of the pest during almost the period, a peak of 15 L./20 leaves was recorded at the end of the first week of December. In the same month, another count of 3 L./20 leaves, in addition to a very low one L./20 leaves in mid-March and another one of 5 L./20 leaves in the third week of May 1998. **(Fig., 17 a,b)**

Concerning pupal counts, as indicator of the infestation rate, it can be indicated, that a highest peak of 26 P./20 leaves was obtained in the scarce of natural enemies in the second week of June, and another count of 18 P./20 leaves in the last week of the same month. In the second week of July, however, a low peak of 6 P./20 leaves was recorded, thereafter, entirely disappeared from samples. It was then exhibited in three interfered tops, 2 of which belonged to August, the first (18 P./20 leaves) in the second week and the second (16 P./20 leaves) in the last week, while the third one (9 P./20 leaves) represented September, which was also followed by some low counts of about only two pupae per 20 leaves in the fourth week of the same month, and again in the second and third weeks of October, in the fourth week of December (5 P./20 leaves) and at mid-March (2 P./20 leaves).

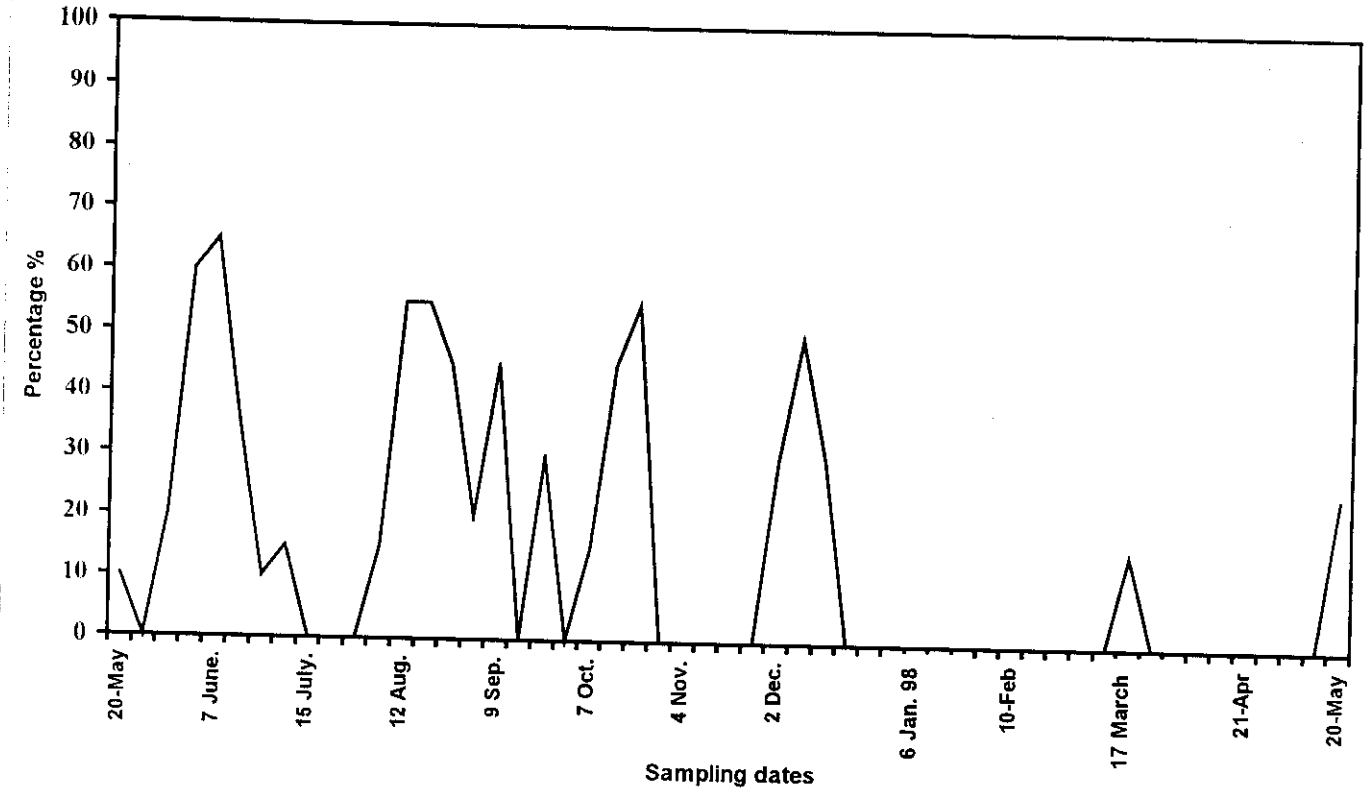

Fig. (17 a) Infestation rate (%) of Balady blood orange with *P. citrella* along one year (1997- 98) in Qalubia Governorate.

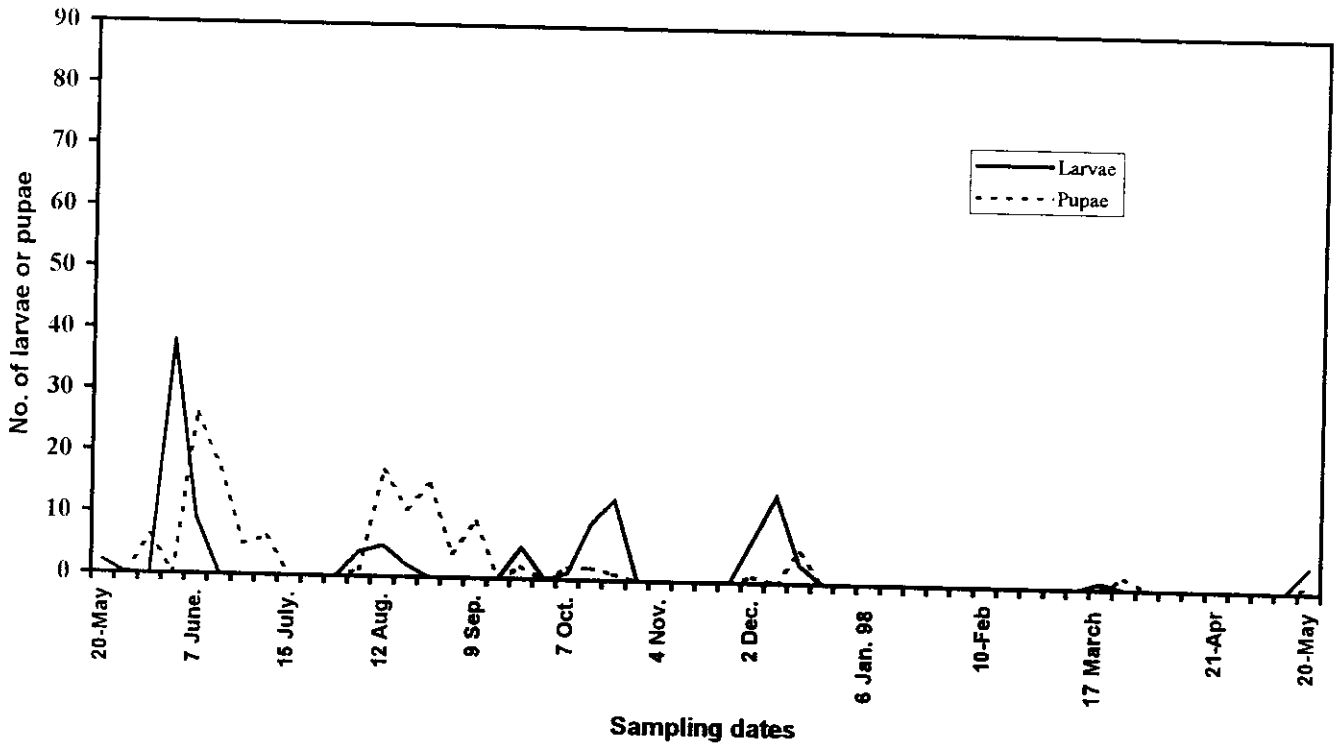

Fig. (17 b) Population dynamics of larval and pupal stages of *P. citrella* infesting Balady blood orange along one year (1997- 98) in Qalubia Governorate.

1.1.18. Greek orange[*Citrus sinensis* (Osbeck)]:

Greek orange appears to exhibit considerable level of susceptibility, being, slightly more than the moderate standard. Only during early autumn, distinctly at the end of the 1st week of October, the infestation rate reached maximum standard (100%). Other high rates were recorded along the investigated year, 87% in the third week of June and again in the third week of August. Also, 62% and 90% infestation rates were recorded at the end of the second week and again at the end of the fourth week of October, 1997, while 40% & 50% were observed in the second week of November and along the last week of the same month, respectively. The relatively high and sharp one was, also shown by the end of the 2nd week of May 1998. Moderate level of infestation was recorded also in the second week of September; in the last week of December and in the second week of March 1998, which were represented by 30%; 20% and 15%, respectively.

Larval counts, as indicator of the level of infestation were shown to belong to, a nearly, similar trend. It reached 45 L./20 leaves in mid-June, but failed down swiftly to be only 5 L./20 leaves in the last week of the same month too and 1 in the first week of July, during which it was, slightly raised up to a relatively low level of 9 L./20 leaves in the second week. The following peak of infestation rate (30%) was seen, at the beginning of the fourth week of August. During October and November months, surprising fluctuating interfered peaks of counts were observed. It recorded about 27 L./20 leaves in the first week of the former one, decreased to 17 L./20 leaves at the beginning of the second week, exhibiting very slight raising towards the third week (18 L./20 leaves), then hurried up by the fourth week of the same month to record 27 L./20 leaves. The latter month was begun with the decreased number of larval

stage (18 L./20 leaves), but was raised up to 30 L./20 leaves by the end of the first week, to be dropped again to 14 L./20 leaves in the second week. At the end of the third week of such month, population had, slightly, increased only to realize 17 L./20 leaves, which was lowned to the level of 10 L./20 leaves in the last week. Larval count curve then was downwardly running but with normal rate to reach nil level at the second week of December 1997. The December counts were, as low as recording only 2 L./20 leaves along the third week and that was repeated again at a rate of 4 L./20 leaves in the second week of March and a rate of 13 L./20 leaves in mid-May 1998. **(Fig., 18 a,b)**

Concerning pupal counts, about similar trend was also seen, but the natural enemies weren't active except during the first 3 weeks of November. The shown peaks of pupal counts, were, systematically recorded along the year. From nil level at the beginning of June, it reached 14 P./20 leaves at the end of the second week, but it was downwarded, to only 6 P./20 leaves in the third week and again a rapid increase of pupae, was shown in the last week of the same month. Only, one peak was observed during August (20 P./20 leaves) in the second week, then it was fallen down to 9 & 7 pupae in the third and fourth weeks. September also, was represented by, relatively low number of 7 pupae and October with relatively more numbers during 2 dates once (8 P./20 leaves) at the second week and the higher (17 P./20 leaves) in the fourth week of the month. Although, 7 P./20 leaves was detected at the beginning of November, it was, almost represented, frequently by nil or very small numbers, and the sole raise of pupal density was in the first week (9 P./20 leaves) and another one (4 P./20 leaves) at the end of December. In May 1998, also 5 P./20 leaves was shown to be exhibited.

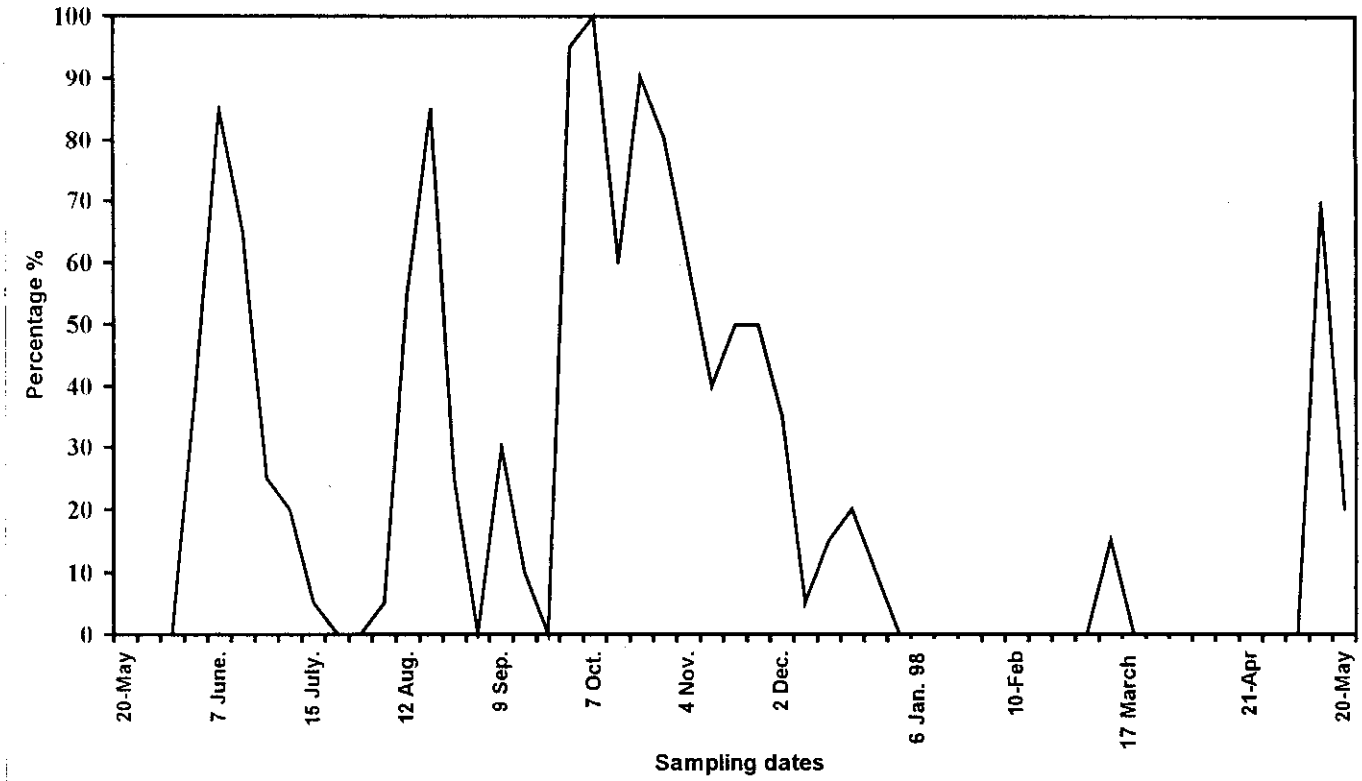

Fig. (18 a) Infestation rate (%) of Greek orange with *P. citrella* along one year (1997- 98) in Qalubia Governorate.

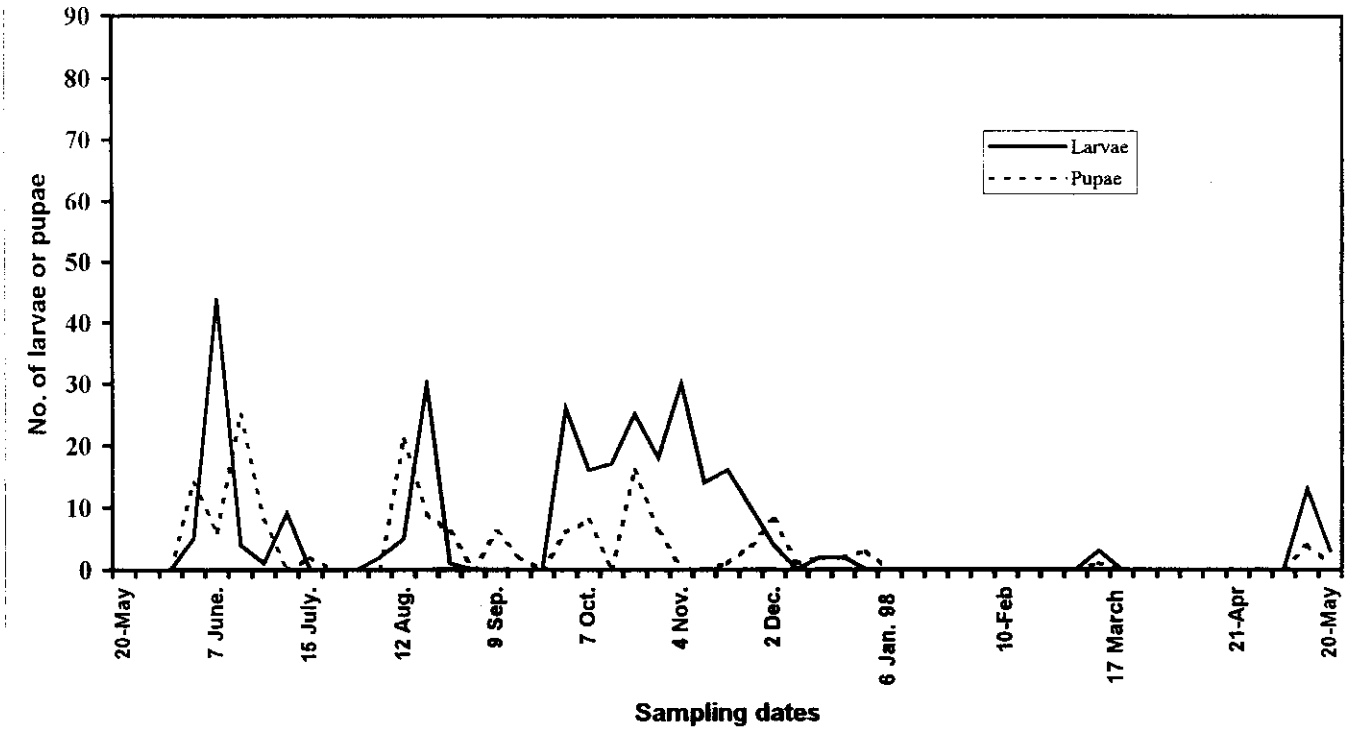

Fig. (18 b) Population dynamics of larval and pupal stages of *P. citrella* infesting Greek orange along one year (1997- 98) in Qalubia Governorate.

1.1.19. Blood orange[*Citrus sinensis* (Osbeck)]:

Such citrus variety is considered as moderately susceptible one. Maximum rate of infestation (100%) existed only during November in overlapping two peaks, during the second and the last week, which overlapped at 55% IR in the third week of the same month. The descending high peak as shown two times (85%), once in the first week of September and the second was continued at such rate along the last week of October. Another one of 80%, was also observed in the second week of May 1998 and a third overlapped one of 60% IR was also shown during the second week of August 1997. Moderate tops of infestation were frequently observed along the year, 23% in the last week of May 1997; 45% in the last week of June; 39% in the last week of September; an overlapped one of 34% at the last week of December; in early spring one 9% IR along one week of the last third the last of month, and the last one (25%) in the first week of May 1998.

Larval counts indicated that, the highest populations, represented in total numbers of larvae were recorded during one month beginning from the last week of October (37 L./20 leaves) till the end the third week of November, during which the highest peak of 53 L./20 leaves were observed at the middle of the month. Moderate peaks were also shown along the year; 5 L./20 leaves in the last week of June; in the

second week of July; and in the last week of September; 12 L./20 leaves in the second week of August 22 L./20 leaves in the first week of September, and 21 L./20 leaves in the last week of December. Other low counts, not surpassing 3 L./20 leaves were also shown in the same dates along the year, except in January, February and mid-March. However, in mid-May 1998, larval population was 28 L./20 leaves. **(Fig., 19 a)**

Pupal counts exhibited about similar trend, as that was shown before with other varieties and following both, the rate of infestation and the larval count, which was observed during certain periods to be not proportioned with each other, because of the efficient activities of natural enemies of *P. citrella*. Pupal counts didn't exceed 20 P./20 leaves which was recorded in the second week of August. It was numerically descended as follows: 18, 15, 12, 10, 9, 8, 6, 5, 2 P./20 leaves in the last week of June; in the first week of December; in the last week of November; in the first week of January and again in the first week of May 1998; along the fourth week of August; in the second week of November; at the end of the second week of November and again at mid-December, at the end week of May 1997 and in other different dates along the year (**Table, 3 & Fig., 19b**); during the fourth week of March and the second week of May 98, respectively,

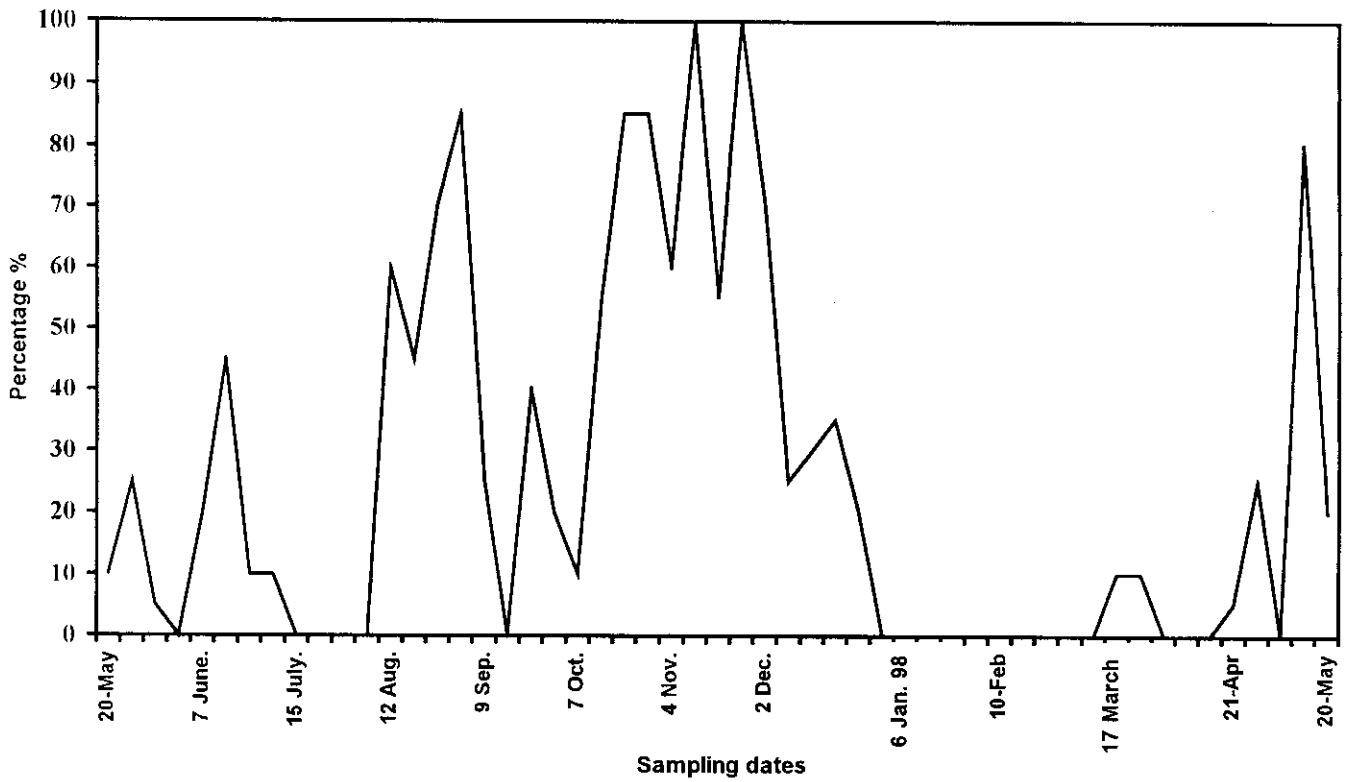

Fig. (19 a) Infestation rate (%) of Blood orange with *P. citrella* along one year (1997- 98) in Qalubia Governorate.

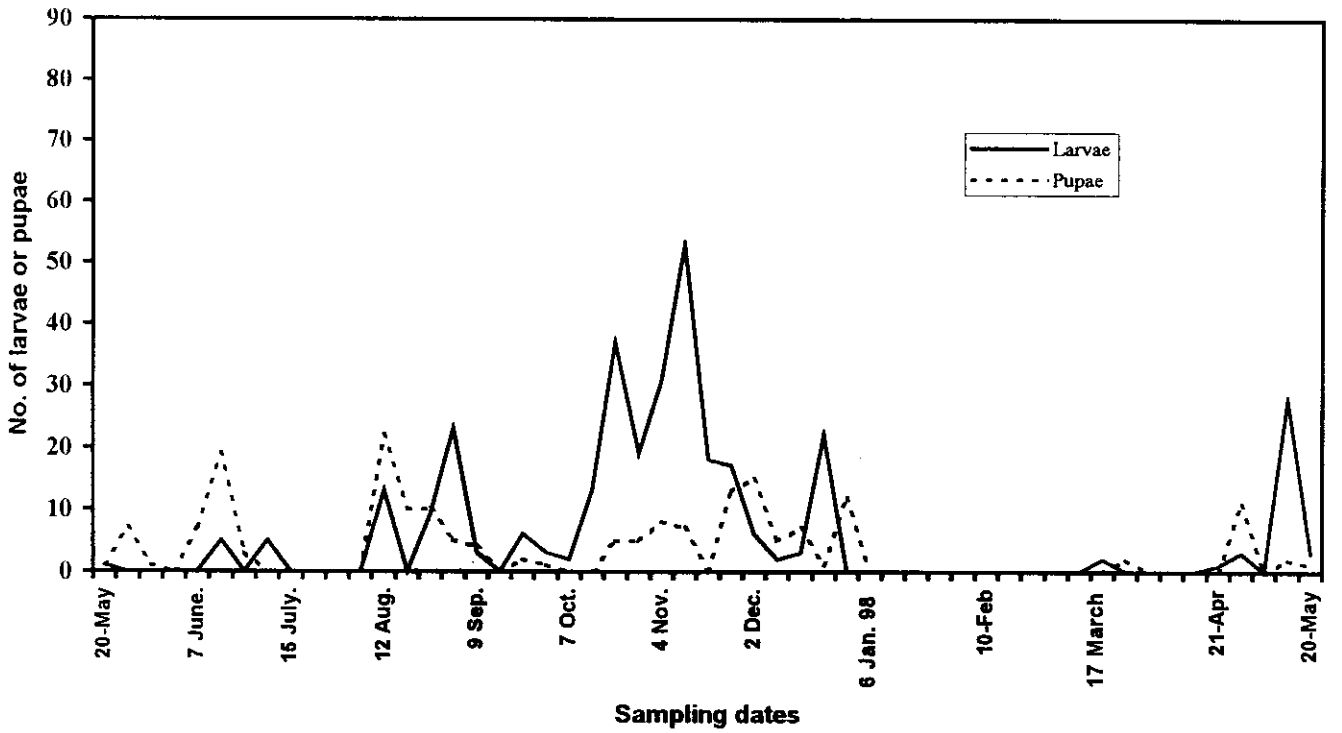

Fig. (19 b) Population dynamics of larval and pupal stages of *P. citrella* infesting Blood orange along one year (1997- 98) in Qalubia Governorate.

1.1.20. Permanent bearing orange[*Citrus sinensis* (Osbeck)]:

Permanent bearing orange appears to be, absolutely the most susceptible citrus one, to the citrus leaf miner *P. citrella* among all the tested twenty varieties. The level of infestation, recorded maximum rates (100%) in frequent periods of the year, and majority of peaks was interfered with each other and rarely lowered to nil level.

The first recorded rate of infestation, at the beginning of the present item of the work was, at the beginning of the fourth week of May 1997, which was about 60%, but it was hurrily raising up to reach 100% after one week and durated at such level for another week, which interfered with the first week of June. Such standard of infestation (100%) was repeated frequently, once in the second week of August, other one during a period of about 3 weeks, from the 4th to the 25th of November, 1997; the third was at the end of the first week of January, and finally during the second week of May 1998. Less than the maximum level, but higher than a medium standard, 3 peaks were recorded, the first (76%) during the third week of June, the second (65%) in the last week of September, and the third (70%), at the beginning of the third week of October. Exactly a medium infestation rate (50%) was shown along the second week of July. Those were beneath the medium rate were also frequently recorded even in the winter and spring months, which were 30% at the end of July; 36% in the last week of January and 16% during the first 2 weeks of March which was raised up again to reach 30% at the beginning of April 1998.

Concerning larval counts, to reflect the standard of infestation it is obvious, that, comparatively large numbers were detected from such citrus variety. It can be suggested here, to assume that, a single larva per one leaf, as a standard of moderate infestation level, to which other levels, can be compared. Higher than the assumed standard were, periodically descended

as 35; 48; 54; 49; 38; 33 and 25 L./20 leaves, in dates of, the second week of July; at the end of the third week of August, in the first week of November, in the second week; in the third and in the fourth week of the same previously mentioned month; and in the second week of May 1998. At the assumed and beneath, standards, numbers of the transferred larvae were, 18; 3; 6; 8; 15; 9; 19; 18; 20 L./20 leaves, in the periods of, the beginning of June, the third week of the same month; at the end of July; in the first week of September; in the fourth week of the last month; during two weeks from the beginning of the second week of October, till the beginning of November; at the end of December and at the end of the first week of January, 1998, in addition to those of about 5 L./20 leaves, which were existing during January, February, March and the first week of April 1998.

Concerning pupal counts, it was observed that pupae were frequently detected in considerable numbers in all months, along the year. However, in the period of the activity of the natural enemies, in addition to the natural mortality of larvae, pupal numbers weren't proportioned with, neither infestation rates, nor larval counts. Likely, we can also assume that 10 P./20 leaves as a standard of infestation level, to which other standards can be compared, thereupon, the periodical counts of pupae began with 42 and 52 pupae per 20 leaves in two successive weeks, namely the last one of May 1997, and the first one of July 1997, seeming to record the highest numbers of all others. During the same month, 2 counts of 27 & 19 P./20 leaves were shown, at the third and the fourth week. Going on with the, relatively high collections of pupae, 39; 20 and 18 P./20 leaves were recorded in the last week of July; in the last week of August and again in the first week of December and at the beginning of the second week of January, respectively. The relatively low pupal counts indicate that, *P. citrella* were

present and quite dispersed along the year on such citrus variety, since all stages were present along the year. For instance, 5; 9; 9; 7; 7; 7; 8; 8; 5 & 8 P./20 leaves of pupal counts were obtained during the whole year; in the second week of June, which was repeated in the fourth week of August, in the first week of September and in the last week of March; at mid-July; at the last week of the month; in the first week of August, in the fourth week of and October; in the third week of November. **(Fig., 20 a,b)**

Along one year, that was begun on 20th May, 1997 and ended on 20th May, 1998, the observed ecological trends of ***P. citrella*** represented in the seasonal abundance of both larvae and pupae in addition to the determination of the infestation rates, using 20 host varieties of citrus plants, interesting results were detected. Significant variability in population density of ***P. citrella***, was, obviously observed to be, closely related to the variability in citrus varieties and, partially to some weather conditions in the environment, especially temperature. As the existence of peaks in the collected numbers of both larvae and/or pupae, in addition to the variability in infestation rate can express the presence of different generations during certain period, and dictate that about 8 – 15 of density-variable generations of ***P. citrella,*** could be detected from the various twenty citrus variables. The relatively, highest generations ranged from 4-9 ones and the relatively or absolutely, high ones, were 1-5 generations, on different citrus varieties, such findings coordinate with those were found by **Badawy (1967); Bhumannavar & Singh (1983); Singh (1984); Hung *et al.*, (1989); Ujije (1990); and Abo-Sheaesha (1997).**

Not all varieties were the same in peaks time, and that may be due to the variability in flush period in different varieties, where infestation rate was 100% in May and June in Washington Navel orange. In the present work, it was at similar highest level in October & November in Sour

orange. Likely, Hamlin orange reached 100% infestation rate in November, while it was in June with the Khalily orange. However, different citrus varieties conflicted with each other in both infestation severity and numbers of both collected larvae and pupae. In spite of exhibiting infestation rate not surpassing 60% in Cintinial orange and partially Mozambik orange, it reached its maximum (100%) frequently in both summer and autumn seasons, some varieties were liable to the maximum rate of infestation (100%) in each of Hamlin orange, Tunssy, Rouja, Tanarif, Mazizy, Sangwin, Mozambik, Mafard, Greek, Blood and Hamlin oranges during winter months.

Such observations may be assured by those were detected by **Badawy (1967); Koli *et al.*, (1981); Singh & Azam (1986); and Oschlund & Davenport (1987).**

Concerning numbers of detected larvae and pupae, it could be observed that, generally peaks of pupal counts followed numerically, that of the larval stage, only during summer and early autumn seasons, but *vice versa* during late autumn and early winter months. That may be due to the activity of the, thereat numerous natural enemies, which had to attack the larvae before reaching pupal or prepupal stage (4^{th} instar larvae). Such phenomenon was, clearly detectable with all the tested citrus varieties, irrespect of relative tolerencery, otherwise, resistance to such insect pest. Such findings can open the door of the hope of utilizing some of the observed active natural enemies in the management of its population, to threshold level for preventing environment from pollution with the probably used pesticides and saving the agro-ecosystem from being more liable to destroy.

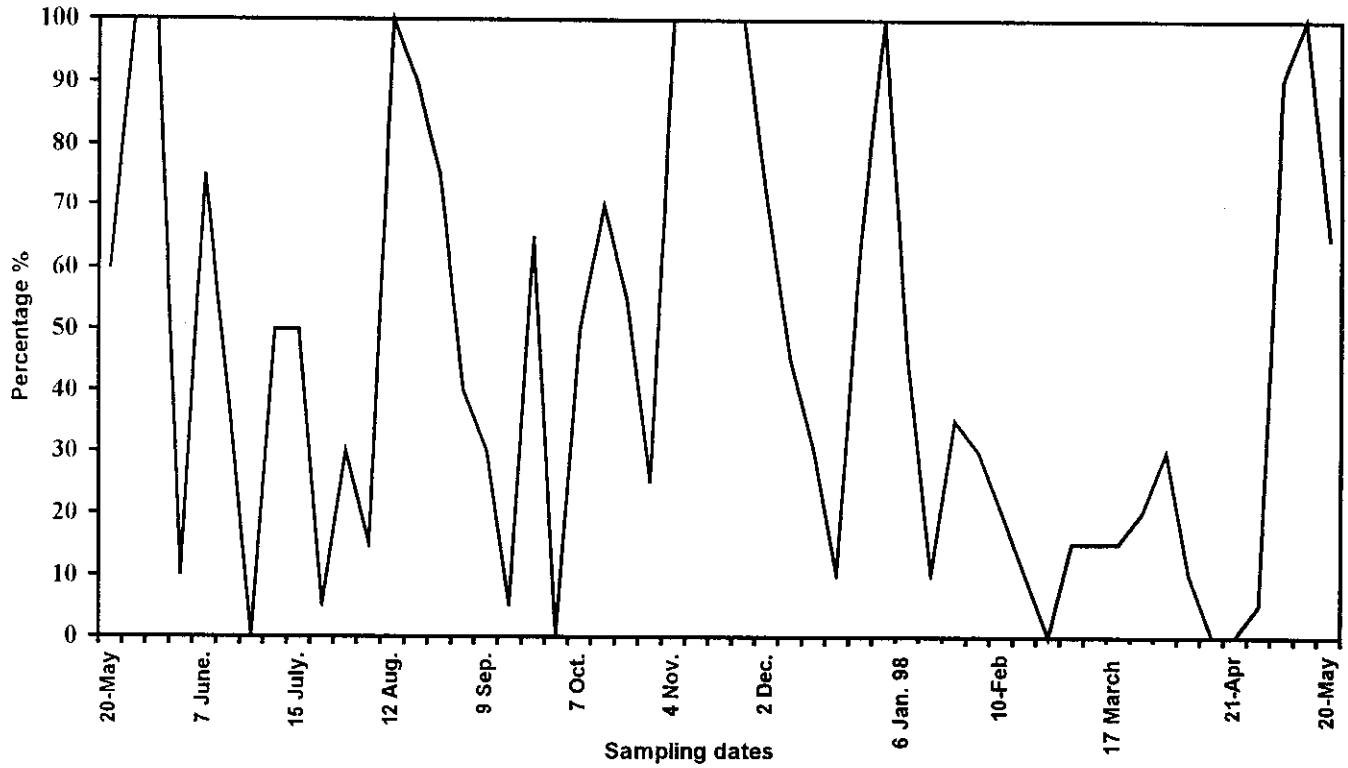

Fig. (20a) Infestation rate (%) of Permanent bearing orange with *P. citrella* along one year (1997- 98) in Qalubia Governorate.

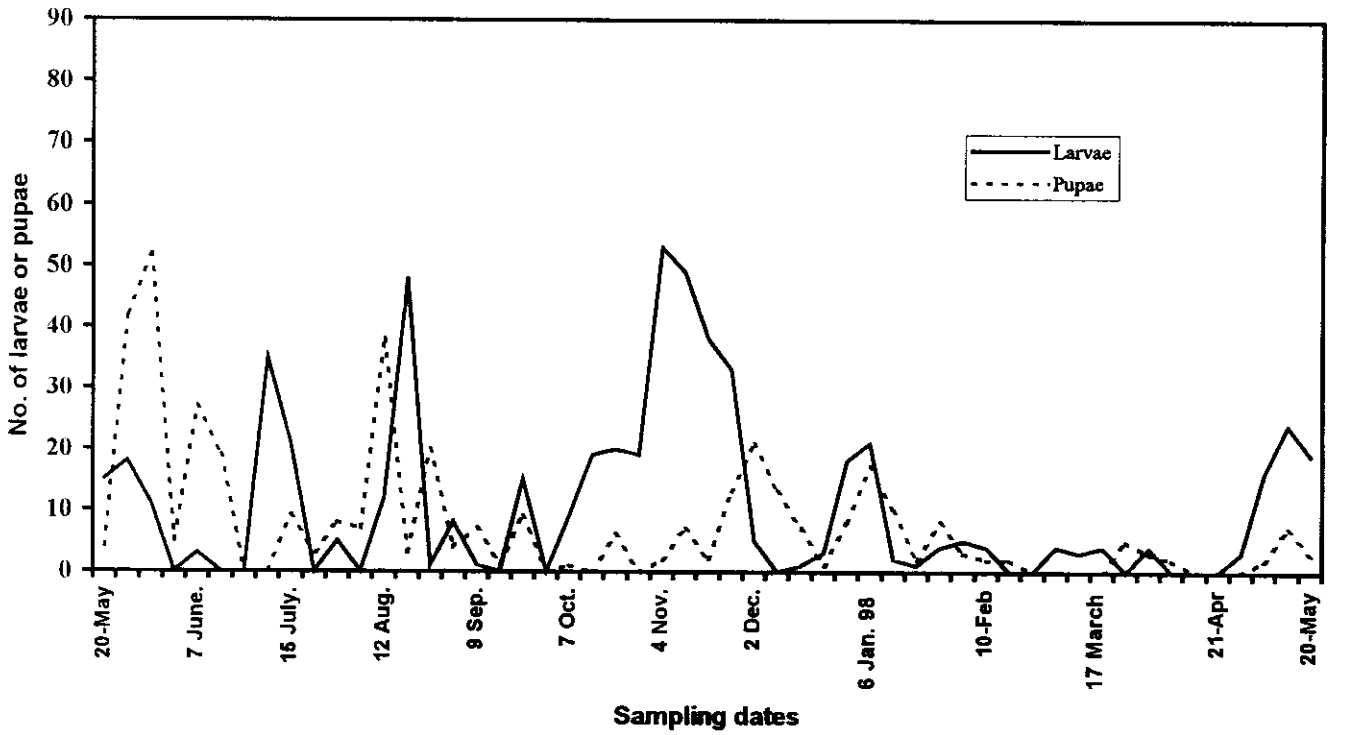

Fig. (20b) Population dynamics of larval and pupal stages of *P. citrella* infesting Permanent bearing orange along one year (1997- 98) in Qalubia Governorate.

1.2. Infestation features, damage and interaction with tree growth aspects:

As CLM larvae hatch, it immediately bore in the leaf epidermis using their sharp mandibles, then ingest cell sap. Such infested area becomes as chlorotic patch, which transform to necrotic one. By feeding and transforming to the following instars a serpentine mine, that having, special pattern, can be observed. However, mines frequently were present on leaves, it also existed on new stems and fruits. Infestation features, can be, obviously observed, especially on leaves having more than 4 mines, and including both larval and pupal stages, on the same one. Curling up of leaf edges, in addition to its deformation and turning its color to brown, which may, therewith full, could be, easily detected. Its mines can be seen on both leaf surfaces, the upper as well as the lower ones, in addition to the, newly, grown succulent branches of all citrus species and its varieties.

The observed reduction in leaf area can't be neglected as a reason and primary factor of capturing energy, required for tree growth. As the infestation becomes heavier, larvae of CLM prevent the expanding of newly emerging leaves, and leaves may remain twisted and curled. The smaller, the size of the infested tree, the more the suffer from CLM injuries, thus the young and the newly planted trees in the grove, may suffer more, in case of heavy infestation, represented in reduced growth and expanding.

The reduction of the leaf surface area, due to CLM infestation and the also feeding of larvae reduce the rate of photosynthesis. Thus, in order to save yield from economic losses, the annual leaf flushes require to be, efficiently protected from CLM attack. According to the variability in leaf miner populations, the size of trees, the variety of citrus species, the flushing aspects, the severity of infestation and the level of damage are, significantly, dependant. Not only leaves are liable to CLM attack, but also, as discussed above, succulent branches of green shoots may be also attacked, and both larvae and pupae may complete their development on the same green twigs. As population pressure become high, twigs also exhibit various levels of damage.

Additionally, larvae of *P. citrella* were frequently observed to infest various areas of fruits, especially the immature ones. However, mining in fruit occur, only at heavy infestation, but entirely without pupation.

1.3. Host Range of CLM (*P. citrella*):

Species belonging to genus *Citrus* and related ones of the family Rutaceae, appear to be the principal host plant of CLM (*P. citrella*). Other hosts were mentioned in literature such as Jasmine, Mistletoe, some legumes and willow, but these hosts had not been observed in Egypt. From the published accounts, as well as the results obtained in the present work, all citrus cultivars are, variously attacked by such pest. From literature, grapefruit and Tangasine seemed to be the most susceptible. Also, severe damage was recorded in lime and sour orange varieties. Although, resistance of some cultivars have been suggested in some research works, caution ought to be taken about such informations. Resistance to such insect may be confused with a special pattern of escaping from infestation, which, likely appearing to be only a pattern of pseudoresistance. That is, some cultivars may manage to escape from infestation with CLM by flushing early, which must be correctly known as escapies and not resistance. Through the present study, three wood plant species of genus *Salix* namely *S. tetrasperma* **(Fig., 21)** were discovered to act as a secondary hosts of CLM, since it exhibited a high level of susceptibility to such insect pest, which could survive and reproduce, normally on such host. The importance of such secondary host, in that the insect pest is able to infest it along the year, including winter months when the weather and other environmental conditions, especially temperature was, as low as not suitable for survivor of the insect pest. The rate of infestation appeared to be of considerable level, especially during January & February, thereat it is impossible to invest any citrus species because of the lack of newly emerged host appendages. It is worth noting, that, no quiescent stages of the insect were detected for overwintering, so its activity appeared to be continuous along the year. It is considered here, to be firstly recorded in Egypt, which no any recording for such plant species as a secondary host of *P. citrella* St. was detected to have been performed in any part of the world.

(a)

(b)

Fig. (21): The secondary host (*Salex tetrasperma*) of CLM.
a- Full grown tree. b- Infested leaves.

1.4. Habits and behavior of *P. citrella*:

The citrus leaf miner (CLM) appeared to have some special behavioral characteristics, by which it can be, easily characterized. Adults, as well as the developmental stages, exhibit special behavior during its life span, which are summarized in the following:

Larvae: As egg hatch to the very small larval stage, it can, easily mine through the epidermal layer to reach the mesophyll one. Then it immediately begins feeding on the cell sap, of the mesophyll, in special pattern, as it suck the cell sap anteriorly as well as bilaterally, which result in, relatively wide mine. The zigzag appearance, result from the corrugated excrement line just behind the larvae. It passes through three instars, in the fourth one, it is known as, prepupae. Larvae, feed on a, relatively lot of food, which cause great injuries, in a short time. Larvae never come out from the mine, along its larval stage, till the pupation, which exist also inside it. Larvae walk inside the leaf between the epidermis and the mesophyll layer, but never penetrate, or mine, in the mesophyll layer.

As larvae complete feeding, the third instar usually forms a mine, that in many cases, it was directed to the leaf margin. However, considerable numbers of larvae didn't direct mine towards leaf margin and it was able to make silken coccoon within the mine. As the silk

dries, both sides of leaves were curled over the pupae in the middle of the leaf and not always at leaf margins then transforms, through prepupae to the pupal stage. For the emergence to adult stage, pupae were able to use, a special spine on its head for making an anterior opening through which forces its body anteriorwards for emergence.

Adult stage: Male age, significantly shorter than that of female. Copulation exist 14 – 42 hours from emergence, and female deposit their eggs, just after copulation. Female may deposit a number of egg reaching a maximum of 50 eggs or more during oviposition period. Adults are most active from dusk to early morning, and spend the daytime resting on the lower surfaces of leaves. It feeds on flower nectar and life from 2 – 12 days. It, never deposit eggs on mature leaves, but only on newly grown ones. It may deposit eggs also on succulent stems and immature fruits in case of heavy infestation. Adult moth, relatively week and slow in flying. Adult female deposit their eggs in most cases individually, but rarely in small groups of not more than 2 – 3 eggs. In cold weather, like in Russian, *P. citrella* overwinters as pupal or adult stage (**Bhumannavar and Singh, 1983; Huang *et al.*, 1989**). In the present study, it was active during winter, except that the developmental periods and life cycle were, significantly longer than during other annual seasons.

1.5. Host preference of *P. citrella* to different citrus varieties, as indicator of their relative resistance or susceptibility to the insect pest (CLM):

During such course of investigation, it is observable that the citrus leaf miner (CLM), preferred some citrus varieties to the others. Such phenomenons could be indicated, from both the relative rate of infestation, and the numbers of detected larvae and pupae, through such period of research work.

As shown in **Table (4),** in which varieties are presented in descending order, according to its suitability to such insect pest, or in other words, according to the relative preference of ***P. citrella*** to the different varieties of citrus species, under study.

Concerning the infestation percentage, for each citrus variety, it was shown that, the permanent bearing orange, was significantly the most preferred one, to such insect pest than any of the other varieties, where, generally, averaged 44.31%. Then such variety represents the first category among the other varieties of citrus species. The second category of susceptibility are represented by the following five varieties, namely, Tanarif, Mazizy, Sangwin, Tunssy, and Khalily, oranges. Their infestation ratio, ranged from 28.58% to 32.83%. However, the third category exhibited their infestation rate less than the latter, since ranged from 23.86% to 25.47%. It is also represented by the following varieties: Sour, Blood, Hamlin, Navel and Greek, oranges. Descendingly, the fourth

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categorial group, which ranged between 20.09% - 22.16% infestation rate, are Mafard Rouja, Balady and Succari (Sweet), oranges. The fifth preferred group is represented by Valencia, Mozambik, Jaffa and Balady, which were infested by ***P. citrella*** at, slightly different rates, appeared to between 14.05% to 17.35%IR. The last preferred one, are represented by only one variety distinctly Cintinial orange, which reflect an infestation rate of only 11.79%. **(Fig., 22)**

Additionally, another important indicator of host preference of the first group could be, easily utilized here, certainly the numbers of detected developmental stages (larvae & pupae). The average numbers of detected larvae and pupae from the permanent bearing variety, seemed to record its highest standard of infestation (10.66 larval and 7.96 pupal stages). However, the aforementioned categories are characterized by both numbers of larval and pupal stages, which can be differentiated, by the different ranges of detected larval and pupal stages. They were 6.75 & 7.79 larvae and 3.60 – 3.71 pupal, individuals, respectively.

Also, numbers of both stages **(Figs. 23, 24 & Table, 4)** for the following second group could be presented here as, 5.66 – 6.22 larvae & 3.77 – 4.39 pupae, 5.66 – 6.22 larvae & 3.60 – 3.05 pupae, 4.32 – 5.03; 3.05 pupae; 2.50 – 3.69 larvae; 1.96 – 2.96 pupae and 2.20 larvae & 1.9 pupae for the previously mentioned categories, respectively.

Table (4): Total numbers and means of each of the infested leaves, larval and pupal stages, and rate of infestation with *P. citrella*, during 1997/1998 in Qalubia Governorate.

No.	Orange varieties	Total				Mean					
		Infested leaves	Larva	Pupa	Infestation rate (%)	Infested leaves	Larva	Pupa	Infestation rate (%)	100 %	Generation
1	Navel	255	267	197	1275	4.81	5.03	3.71	24.05	2	8
2	Valencia	179	135	193	920	3.37	2.54	3.64	17.35	1	10
3	Sour	270	325	194	1350	5.09	6.13	3.66	25.47	2	9
4	Cintinial	140	133	101	625	2.64	2.50	1.90	11.79	-	8
5	Succari (Sweet)	213	245	179	1065	4.01	4.62	3.37	20.09	-	9
6	Hamlin	256	329	214	1280	4.83	6.20	4.03	24.15	1	9
7	Tunssy	314	358	226	1570	5.92	6.75	4.26	29.62	2	9
8	Rouja	230	229	185	1150	4.33	4.32	3.49	21.69	1	11
9	Balady	227	241	194	1135	4.28	4.54	3.66	21.41	2	10
10	Tanarif	348	495	233	1740	6.56	9.33	4.39	32.83	2	11
11	Mazizy	327	434	200	1635	6.16	8.18	3.77	30.84	4	8
12	Sangwin	329	430	225	1573	6.20	8.11	4.24	29.67	2	11
13	Khalily	312	413	169	1515	5.88	7.79	3.18	28.58	3	14
14	Mozambik	168	183	104	840	3.16	3.45	1.96	15.84	-	10
15	Jaffa	160	196	146	800	3.01	3.69	2.75	15.09	-	8
16	Mafard	235	330	157	1175	4.43	6.22	2.96	22.16	1	10
17	Balady Blood	143	117	133	745	2.69	2.20	2.50	14.05	-	9
18	Greek	273	300	162	1265	5.15	5.66	3.05	23.86	1	9
19	Blood	270	328	191	1350	5.09	6.18	3.60	25.47	2	12
20	Permanent Bearing	475	565	405	2315	8.96	10.7	7.64	44.81	7	15

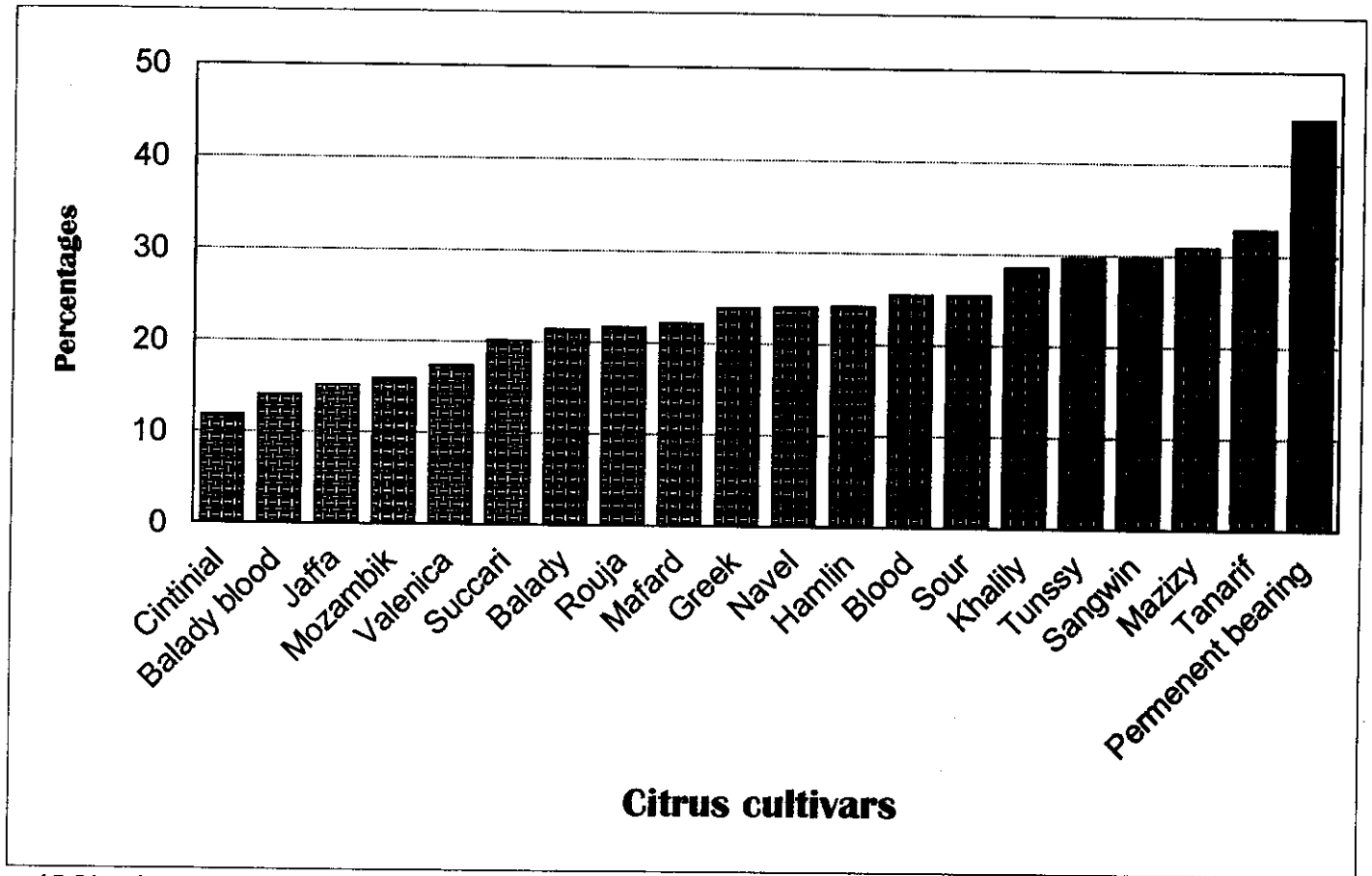


Fig. (22): Annual percemtage of infestation of twenty citrus varieties with *P. citrella*, in Qalubia Governorate, during 1997/98.

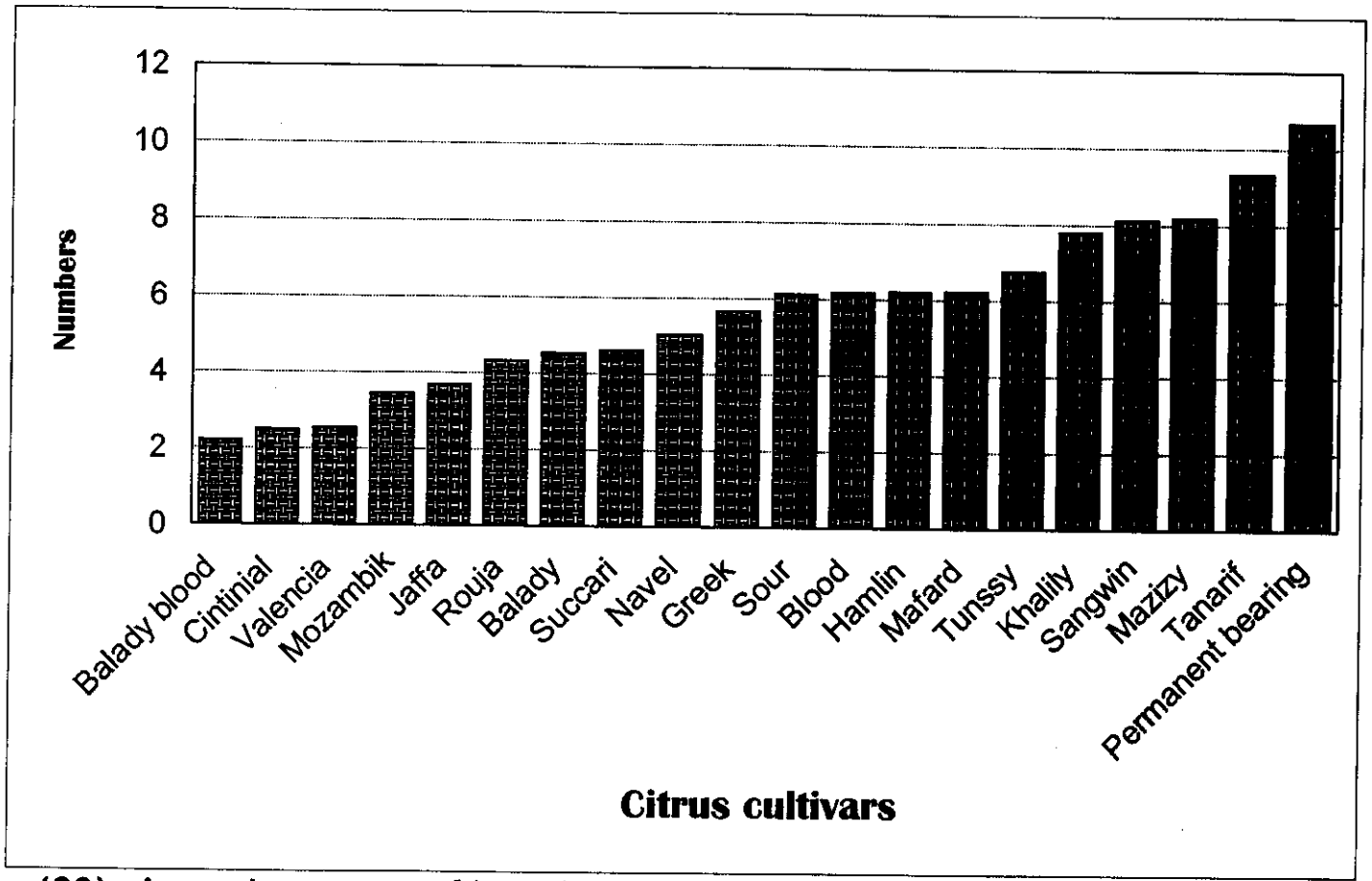


Fig. (23): Annual average of larval stage numbers of *P. citrella*, infesting twenty citrus varieties in Qalubia Governorate, during 1997/98.

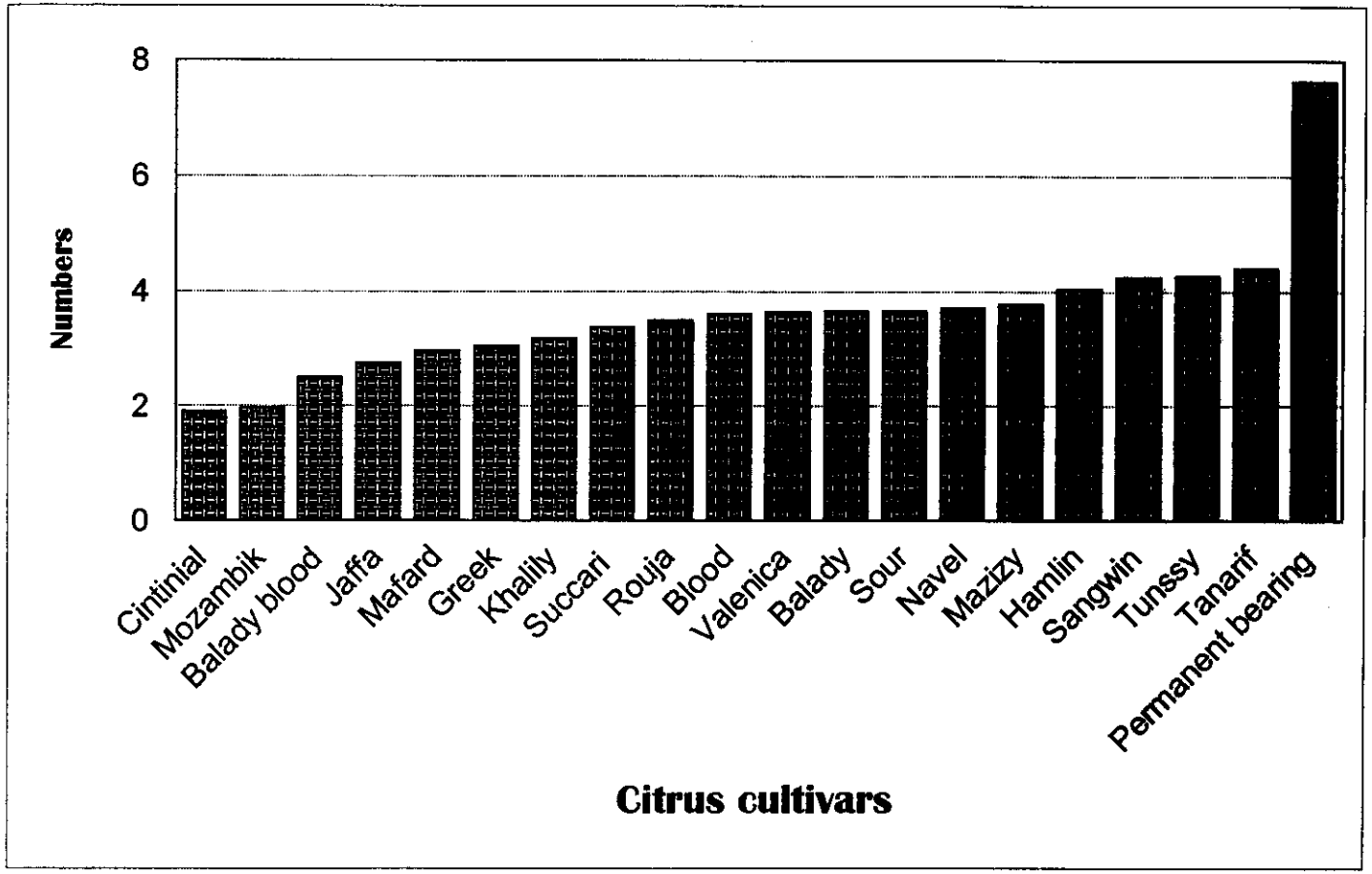


Fig. (24): Annual average of pupal stage numbers of *P. citrella*, infesting twenty citrus varieties in Qalubia Governorate, during 1997/98.

On the other hand, such variety, in host preference, reflect an important criteria, dealing with the possibility of such varieties to have considerable levels of resistance to such insect pest. Accordingly, the aforementioned grouping can be applied as follows:

The first one, which is represented by, only a single variety (permanent bearing orange) is considered as highly susceptible one, the following group (Tanarif, Mazizy, Sangwin, Tunssy and Khalily oranges) can be categorized as, susceptible group. The third group (Sour, Blood, Hamlin, Navel, and Greek oranges) may be estimated as tolerant, while the following group (Mafard, Rouja, Balady and Succari (sweet), oranges may be classified, as highly tolerant category. In the same way, the fifth group of the citrus varieties, which is represented by Valencia, Mozambik, Jaffa and Balady blood, oranges is considered as resistant group, while the last variety, which represents the sixth category, can be systematized as highly resistant one.

Such findings, which seem to be compatible with those of **Ayoub (1960); Rajput & Haribabu (1985); Singh *et al.*, (1988); Wilson (1991); Abdel-Aziz (1995); Abassi & Harchaoui (1997) and Abo-Sheaesha (1997),** are considered of great importance. The injuries caused by such insect pest are in harmony with utilizing the biological control agents, as a unilateral safe method of pest control.

2- Biological results:

Like others, of the Lepidopterous leaf mining moths, ***P. citrella*** appeared to follow, similar biological trend, but exhibiting some special biological characteristics, especially in the wide range in periods needed for different developmental stages, due to the various abiotic factors, which predominate in different seasons.

In the present work, life cycle as well as other biological phenomena, were observed during summer season of the year 1998. Under the green house condition, such biological results are presented in **Table (5)**. The description and developmental periods of various stages are exhibited in the following:

2.1. Egg stage (Fig., 25):

Egg small, oval shaped, very soft, looking like tiny droplets of fluid, appearing to be covered with special secretion film, measuring about 0.3 mm in length and about 0.2-mm width in average. They are often, transparent when newly-deposited, seeming to have, firstly the light green color, but by the development, it becomes yellowish green and then yellowish colored. They also transform to the opaque shape within two days.

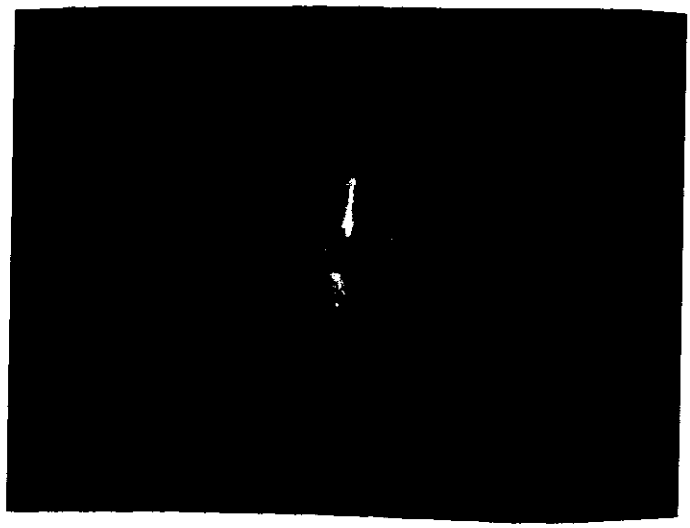


Fig. (25): Egg stage of CLM.

***Hatchability rate:**

The rate of hatchability was also concerned, to explore one item of the reproductive potentiality. It was investigated during the last third of July, when temperature ranged from 22 – 26°C for the minimum and from 36 – 38°C for the maximum, and relative humidity of 61 – 69%RH. Under such environmental conditions, hatchability rate, was estimated, which was found to reach 81.73% in average.

2.2. Larval stage (Fig., 26):

As, already, larvae were emerged it began the approach of penetrating the leaf epidermal layers, using the blade-like, fine toothed mandibles, which are specially adapted for cutting cells to allow fluiding of the cell sap. Larvae usually leave a part of the eggshell at the beginning of the mine, then they begin feeding on the liquid contents of the leaf cells beneath the epidermis forming, firstly, about invisible mine. As it was determined before by **Badawy, (1967),** three sap-feeding instars, in addition to a single non-feeding one, were observed. The latter may be known as prepupal stage. Each of the first three successive instars exhibited, in the same descending order, highly significantly wider frequency distribution of the head capsule. The first instar larvae were as minute as appearing, slightly different in shape from the last three instars. The latter 3 stages seemed similar in form but different in size, and the width of head capsule, otherwise the lateral outgrowths of body segments, and the shape of the terminal abdominal segments.

Larva flattened, having about greenish yellow, color of shining glossy feature. As the larvae of about 1 – 2 mm long in the first instar, feed they produce firstly about invisible mine, afterwards become visible in a form of serpentine-like one, having a central trail within the mine, formed from larval excrements. Larval development, was as rapid as pupating within 4 days during summer months, but it may be prolonged to 20 days in winter. The four larval instars, were separated by a moult between each two ones, in which larvae stop feeding and appear quite sluggish one. Then head was hindwardly contracted, thereafter protruded out from the anterior portion of the exuvia, and by the aid of contraction-relaxation alternating movements of the larval body, the exuvia was backwardly transferred.

The duration of the first three larval instars averaged 5.5 days with a range of 5 – 6 days.

Larvae feed only on the plant cell sap without any part of the solid matter of leaves, thus, the resulting mine seemed, extremely shallow with transparent epidermal shelter.

2.3. Prepupal stage (Fig., 27):

As larval feeding was completed at, the end of the larval third instar, which was observed to form its mine, in a direction towards the leaf margin, it molts to the non-feeding fourth instar, that is known as the prepupa. It is pale in color and about cylindrical in form, and in spite of no feeding, it remains quite active, spinning the silken cocoon within the mine. By the dryness of silk, the leaf curl over the pupal cell (cocoon).

Prepupal stage durated 1.98 days in average and ranged within 1.5 – 2.5 days.

Fig. (27): Pre-pupal stage of CLM

2.4. Pupal stage (Fig., 28):

As previously mentioned, pupal cell is made by the 4th instar larvae (prepupa), within the mine at the leaf margin, which is curled by the action of the dryness of the secreted silk. The pupal stage develops within about 6 – 22 days, dependant on season and weather conditions. CLM pupae are of the obtect type having spindle shape. Pupae have yellowish-brown color, turning to darker with pupal age, provided with sharp stout process, which is pointed and located at the tip of the head. It is believable, that it may help in making an opening in the anterior of the pupation chamber just before the emergence of the moth.

As a pupae, *P. citrella,* in the present study, exhibited a range of 7 – 8.5 days with an average of 7.7 days.

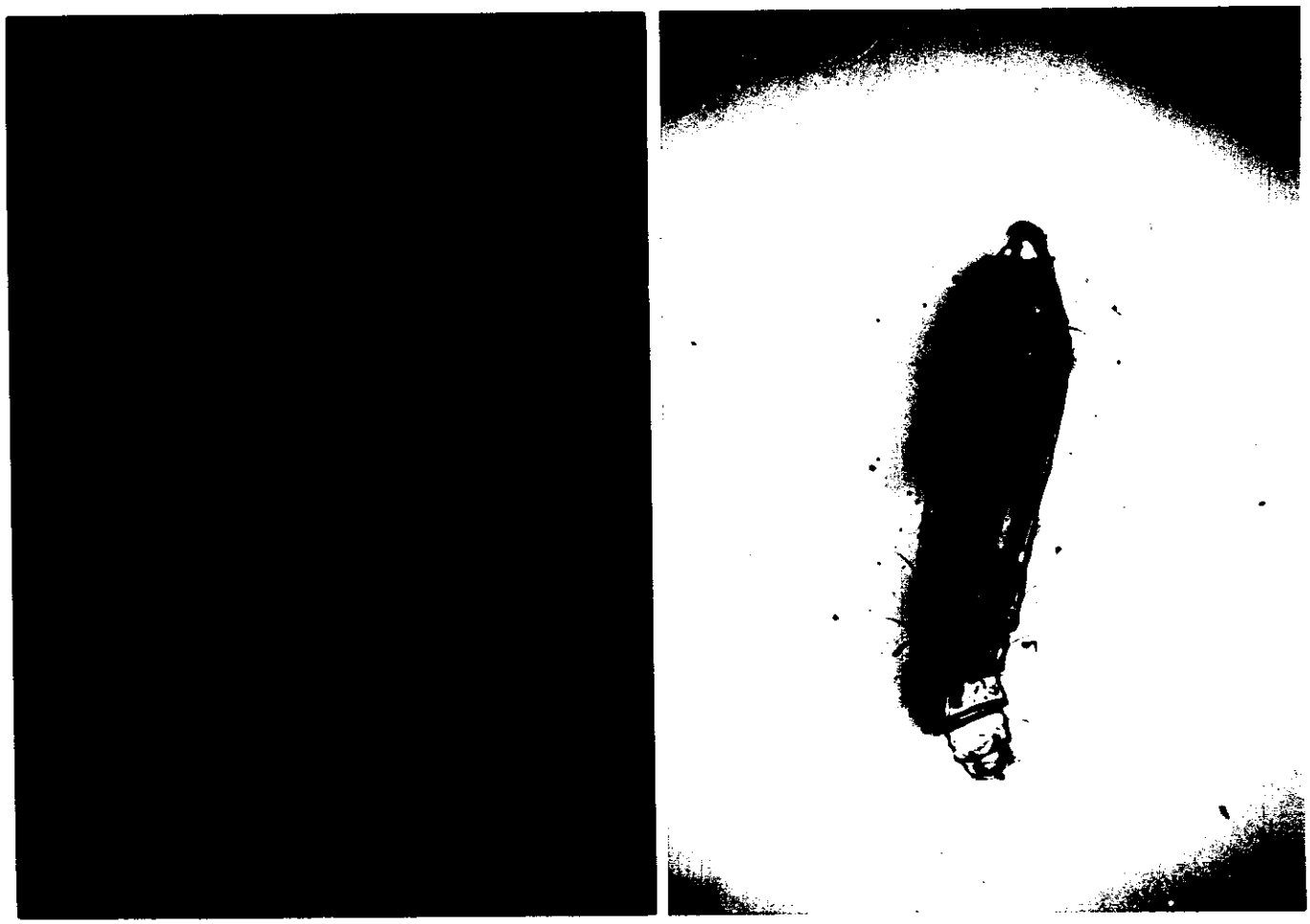
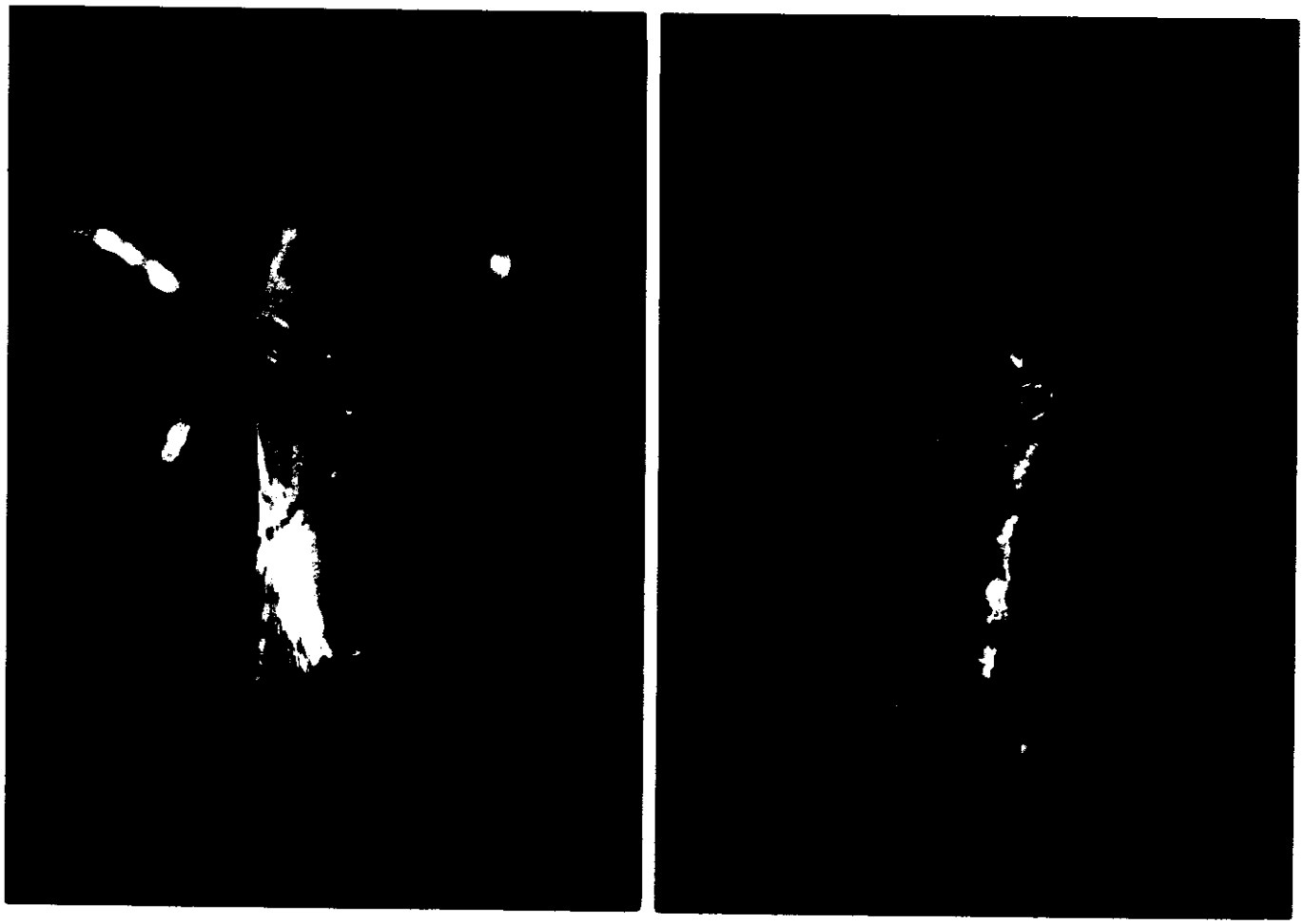


Fig. (28): Pupal stage of CLM

2.5. Adult stage (The moth) (Fig., 29):

The CLM adult is too small that belong to the Microlepidopterous group, measuring about 2 mm in length and having a wingspan of about 4 mm, delicate moth, having long narrow fringed fore-wings **(Fig., 29)** of silvery color, distinct black spot present at the tip of wings, having brown and white patches. Mouth parts, normally of the sucking type. Fore-wings have irregular dark line, which divide wings into two separated area, the based parts covered with silvery scales, while the terminal one is clothed with variant shaped and colored scales. Hind wings and body, are silvery in color and covered with overlapped scales and also fringed with minute setae. Adults emerge about dawn, moths activities, are associated with the morning time and at dusk or during the night. Also, oviposition, frequently exist in the evening and at night. Male longevity reached 3.6 days, while that of female was 4.9 days in average, seeming to range between 3 – 4 & 4.5 – 5.5 days, for the two sexes, respectively. Moths spend all the day long, hiding on the lower surfaces of leaves for resting, and feed on flower nectar. Longevity, durates between two to twelve days. Such observations are, compatible with those of **Badawy (1967) and Beattie (1989)**.

Adults capulate within the 24 hours after emergence frequently at night or in early morning, then oviposition instantaneously exist. It is observable, that female fecundity plays, around 50 eggs per female, during the oviposition period. Male, in summer season slightly smaller than female and adult of both sexes live for, only few days or about one week, in average.



(a) (b)

Fig. (29): Adult stage of CLM moth.
a- Female **b**- Male

2.9. Generation (From egg to egg):

As the immature stages of ***P. citrella*** reach the adulthood, male searches for female for copulation, which exist within 24 hours after which female begin to lay its first egg. It was found that the pre-oviposition period was, also affected by the different weather conditions in different seasons. Generation period can be estimated by adding the period of pre-oviposition to that of life cycle. In the present study, it was shown to have 17.55 days with a range of 15.66 – 19.98 days in average, during summer season.

2.10. Oviposition period:

As, the adult female began to lay its first egg, it continued laying eggs, along 3 – 7 days, due to the different seasons, having various weather conditions. In the present work, such point was conducted during summer, and the period of oviposition seemed to average 2.6 days, and ranging from 2.4 to 3 days in different replicates.

2.11. Post-oviposition period:

After the female had been deposited its last egg, it durated alive for about 1.5 – 4 days among different seasons, after which it was died. For, summer season only, during which the present work was concerned with, it was found that female durated alive for a very short time ranging from 0.95 – 1.30 days, while averaged 0.98 days.

2.12. Adult longevity (From Adult to death):

Reaching adulthood, CLM male lasted alive for 3.6 days, while female died after 4.9 days in average. Such period of longevity appeared to range between 3-4 & 4.5-5.5 days, for male and female, respectively.

2.13. Life span: (From egg to death):

The total period, which the (CLM) female, required from egg stage to the end of life (life span) was estimated and found to be 21.13 days in average, and ranging between 19 – 24 days in summer months.

2.14. Sex Ratio:

From the detected results of the present work, sex ratio was concerned and found to be about 1 : 1.1 male : female.

The biological course of investigation was carried out during the most important season, through which the citrus leaf miner (CLM) reached its maximum of activity, therewith, highly affected both growth of young citrus trees and reduced the final yield of the fruiting ones. The presented parameters, express both, ranges and averages during such season only and not among various seasons. Results of such item were extracted from, not less than 10 replicates, in case of the adult stage and 34, 55 and 39 replicates for larval, prepupal and pupal stages, respectively. Results, in general, agree with most of those were detected by several research workers, seeming to have, only slight differences (**Ayyoub, 1960; Pandy & Pandy, 1964; Badawy, 1967; Rajput & Haribabu, 1985; Radke & Kandalkar, 1987; Wilson, 1991; Heppner, 1993; Knapp *et al.*, 1994 and Mahmoud *et al.*, 1997).**

2.15. Field observations:

To check, what is carried out in the greenhouse, dealing with the biology of such pest, about 40, newly appearing tree branches were chosen and labeled on large trees of Navel orange variety, having only one egg on a single leaf. The other leaves were frequently excluded and the 4-times daily-observation was done. Both larval, prepupal and pupal stages were observed for periods, needed for each stage under field conditions. Results showed that no any significant difference were revealed among periods of larval, prepupal and pupal, stages, comparatively with those were under greenhouse conditions. These were 5.25, 1.35, and 7.22 days, in average for the aforementioned developmental stages.