IV. RESULTS AND DISCUSSION

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4.1. Ecological studies :

4.1.1. Preference of the potato tuber moth to solanaceous crops :

a) First experiment :

Infestation of the four kinds of solanaceous vegetable crops, potato (Solanum tuberosum var. alfa), tomato (Lycopersicum esculentum var. cerasiforme), eggplant (Solanum melongena serpentinum var. barbentance) and pepper (Capsicum annum var. grossum) under laboratory conditions (25 ± 1°C and 70 ± 2 % R.H.) were recorded every 5 days from the beginning of March. Obtained results are shown in Table (1). It is worthy to note that the data of pepper infestation were negligible in the statistical analysis during the two experiments, 1981 and 1982. The total number of larvae found on the potato, tomato and eggplant were moderate high during the experiments.

Table (1) : Numbers of P. operculella larvae found in 10 leaflets of potato, tomato and in 10 leaves of eggplant and pepper (first experiment).

Successive inspections	Potato		Tomato		Eggplant		Pepper	
	Total 50	Mean/ 10	Total/ 50	Mean/ 10	Total/ 50	Mean/ 10	Total/ 50	Mean/ 10
1	36	7.2	13	2.6	6	1.2	0	0.0
2	70	14.0	26	5.2	13	2.6	0	0.0
3	100	20.0	39	7.8	28	5.6	2	0.4
4	59	11.8	15	3.0	13	2.6	0	0.0
5	91	18.2	41	8.2	19	3.8	0	0.0
6	88	17.6	16	3.2	15	3.0	0	0.0
7	45	9.0	17	3.4	7	1.4	1	0.2
8	14	2.8	11	2.2	5	1.0	0	0.0
Mean	62.9	12.58	22.25	4.45	13.25	2.65	0.38	0.08

"F" value between infestations = 83.98 (highly significant)

$L.S.D._{0.05}$ between means = 4.85

$L.S.D._{0.01}$ between means = 6.37

Statistical analysis for data showed the existence of significant differences between infestations of the tested plants, giving a highly significant "F" value of 83.98 with $L.S.D._{0.05}$ 4.85 between means and $L.S.D._{0.01}$ 6.37. The insect's preference to potato was unlimited as it was harbouring a total number of insects about two folds of those found on tomato and eggplant. Significant differences occurred between potato, tomato and eggplant infestations. Tomato was more infested than eggplant, harbouring a mean number of 22.25 larvae while the latter harboured 1ȝ.25 larvae during the same period (Table, 1).

b) Second experiment :

The same experiment was carried out in the same period and the same place in 1982 to ensure the results obtained from the experiment in 1981. Results obtained is presented in Table (2).

Analysis of variance to results of 1982 showed clearly the presence of significant differences between infestation rate of the plants, being pepper the last infested one, while potato was highly infested, with the total larval numbers found more than those detected on

Table (2) : Numbers of P. operculella larvae found in 10 leaflets of potato, tomato and in 10 leaves of eggplant and pepper (Second experiment).

Successive inspections	Potato		Tomato		Eggplant		Pepper	
	Total/ 50	Mean 10	Total/ 50	Mean 10	Total/ 50	Mean 10	Total/ 50	Mean/ 10
1	56	11.2	8	1.6	1	0.2	0	0.0
2	112	22.4	36	7.2	3	2.6	1	0.2
3	75	15.0	22	4.4	22	4.4	0	0.0
4	43	8.6	8	1.6	11	2.2	2	0.4
5	119	23.8	38	7.6	18	3.6	0	0.0
6	94	18.8	20	4.0	7	1.4	2	0.4
7	43	8.6	14	2.8	8	1.6	0	0.0
8	14	2.8	9	1.8	3	0.6	0	0.0
Mean	69.5	13.9	19.38	7.18	9.13	2.08	0.63	0.13

"F" value between infestations = 95.0 (highly significant)

$L.S.D._{0.05}$ between means = 5.16

$L.S.D._{0.01}$ between means = 6.78

the three other hosts (Table, 2). Although tomato harboured much more larvae than those of egg-plant, the difference in the mean number of infesting larvae was, statistically, insignificant.

According to these results;the four solanaceous crops, i.e., potato, tomato, eggplant and pepper are attacked by the potato tuber moth and this results agree with Chittenden (1912), Bartoloni (1951), Stanev and Kaitazov (1962), Dorestes and Nieves (1968), Broodryk (1971), Traynier (1975) and Shaheen (1978-1979) as they reported that the insect attacks the fore mentioned crops throughout the year.

The present data (Tables 1&2)indicate also that the descending order of susceptibility to P.operculella infestation is potato, tomato, eggplant and pepper. However, Attia and Matter (1939) indicated that the insect, apparently, does not attack tomatoes. In contrast to the present results, Assem (1966) reported that the eggplant is much more liable to infestation than tomato. But, in agreement with the same author, pepper infestations were negligible. Doss (under publication) in Kaha (Qaliobia Governorate) found that tomato is much more liable to infestation than eggplant and pepper.

4.1.2. Susceptibility of different potato varieties to potato tuber moth infestation :

1. Infestation of the foliage :

a. First experiment (summer 1982) :

Since the potato yield is a function to several factors, it may be more efficient to select plants on the basis of resistance to the infestation by P. operculella.

The range of variability in susceptibilities of the varieties of potato (Kondor, Gracia, Renska, Monalisa and Vulkano) are shown in Table (3). Analysis of variance revealed significant differences between infestations of the five potato varieties giving a highly significant "F" value amounting to 12.4. Monalisa variety was the most susceptible showing, significantly, higher rates of infestation than the remaining varieties. Renska was not significantly different with Vulkano but it was significantly different with Gracia and Kondor. While there was no significant difference between means of infestations of both Volkano and Gracia, yet it was present between Volkano's and

Table (3) : Weekly numbers of P. operculella larvae infesting leaves of five potato varieties; during 1982 summer season.

Varieties	Mean number of larvae per 25 potato leaves at dates of inspection								General mean
	April			May			June		
	21	28	5	12	19	26	2	9	
Monalisa	1.8	3.0	5.2	2.6	1.8	7.4	8.0	11.8	5.2
Gracia	1.2	1.4	2.4	2.2	2.0	4.6	5.2	7.4	3.3
Kondor	0.4	1.0	1.8	1.2	0.8	3.2	3.2	5.2	2.1
Renska	0.8	1.8	4.2	2.4	2.4	7.0	8.4	9.0	4.5
Vulkano	1.0	1.8	3.2	2.0	1.4	6.2	8.0	8.2	4.0

"F" value between varieties = 12.4 (highly significant).

$L.S.D._{0.05}$ between means = 0.971

$L.S.D._{0.01}$ between means = 1.31

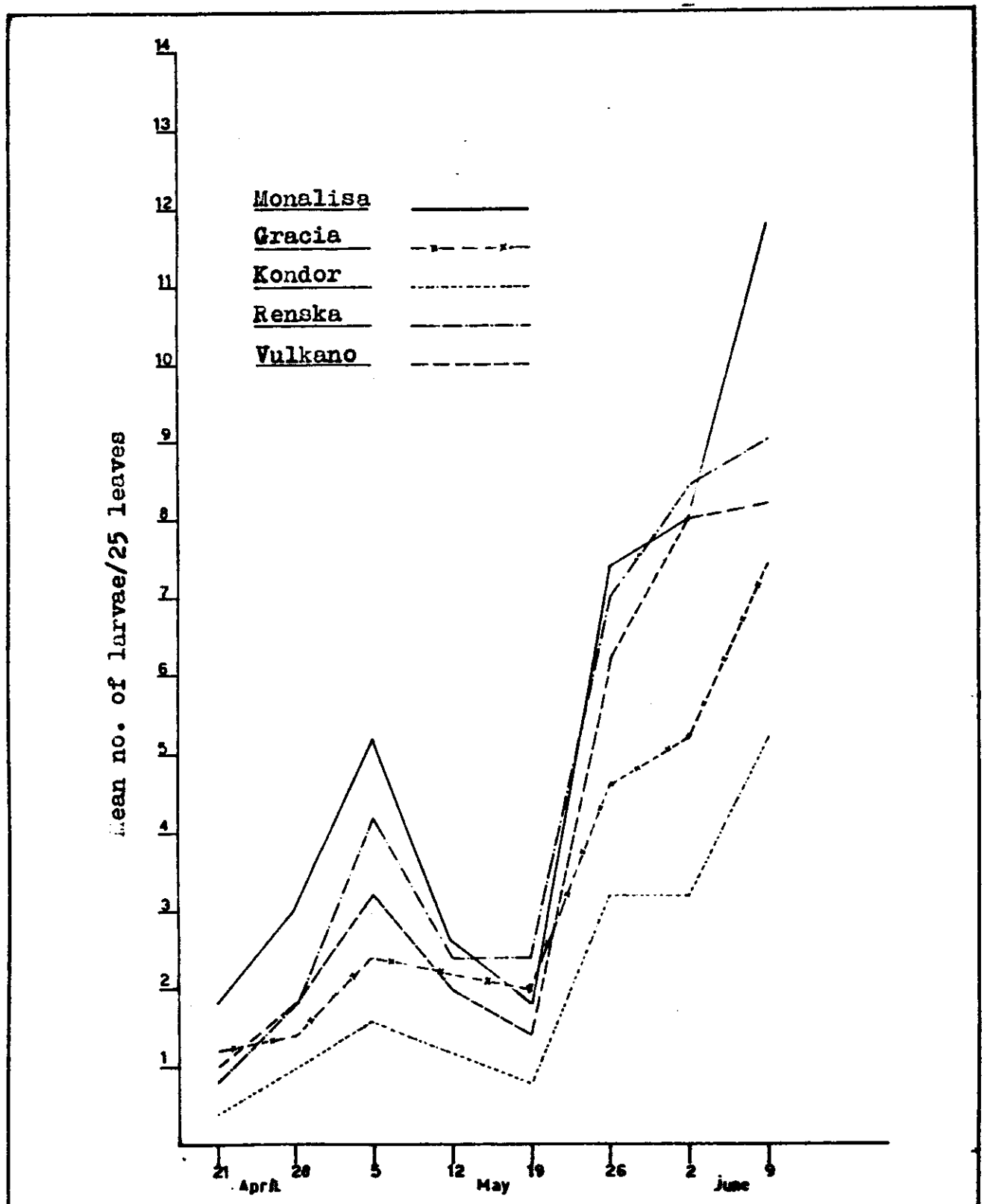

Fig. (1) : Mean no. of larvae of P. operculella infesting five potato varieties, summer season, 1982.

Kondor's. The least infestation by the potato tuber moth was associated with the Kondor variety (Table, 3) and Fig. (1).

b. Second experiment (winter 1982/1983) :

The same potato varieties were cultivated on October 1st 1982, from tubers kept under cool storage for winter plantation. There was no sign of leaves or tuber infestation during the whole season.

Thus, it is obvious that the winter potato plantation is much less infested by the potato tuber moth compared with the summer plantation. The same observation was previously reported by Assem (1966) and Abdel-Aziz (1983).

c. Third experiment (summer, 1983) :

The same experiment of summer 1982 was carried out in summer 1983 and the obtained results are shown in Table (4) and Fig. (2).

Statistical analysis between infestation degree of the five potato varieties pointed out that they

Table (4) : The weekly numbers of P. operculella larvae infesting leaves of five potato varieties; during 1983 summer season.

Varieties	Mean number of larvae per 25 potato leaves at dates of inspection									General mean
	April			May					June	
	10	17	24	1	8	15	22	29	5	
Monalisa	1.4	1.8	2.0	6.0	3.8	1.6	6.0	9.4	13.4	5.0
Gracia	1.0	1.6	2.4	3.6	1.6	2.2	5.2	6.8	6.2	3.4
Kondor	0.4	0.4	0.8	1.2	1.0	1.0	3.4	4.4	5.6	2.0
Renska	0.8	0.8	2.0	3.0	1.8	2.4	5.2	6.8	9.6	3.6
Vulkano	1.2	1.0	1.6	3.6	2.0	1.6	6.8	7.2	8.0	3.7

"F" value between varieties = 22.68 (highly significant).

$L.S.D._{0.05}$ between means = 1.10

$L.S.D._{0.01}$ between means = 1.48

Table (5) : Factors could affect the infestation of different potato varieties by P.operculella.

Potato varieties	General mean number of larvae per 25 leaves		Hairs		Leaves	
	1982	1983	Density/ 1/8 square inch	Length/ micron	Moisture content %	Protein content %
Kondor	2.1	2.0	202	393.60	86.50	24.282
Gracia	3.3	3.4	263	252.70	86.66	20.634
Vulkano	4.0	3.7	192	269.06	87.10	25.650
Renska	4.5	3.6	272	250.88	85.96	23.655
Monalisa	5.2	5.0	268	264.80	85.56	23.199

out. The obtained results are shown in Table (5). This data indicate, that the density of leaf hairs, leaf moisture and protein content had no effect on the preference of the insect to infest the various potato varieties. While there was a slight positive correlation between insect abundance and the length of hairs. That was clear in Kondor variety where the rate of infestation was lower as the leaflets of this variety are characterized by the longest hairs (Table, 5).

2. Tubers infestation :

a. First experiment (summer 1982) :

Results of this experiment are shown in Table (6). Data obtained during 1982 from tubers in shallow position, indicated the presence of significant differences between means of infestations of the potato varieties, with highly significant "F" value amounted to 22.68. No significant difference was detected between Monalisa, Kondor and Gracia, while each of them was, significantly, less infested than Vulkano and Renska (Table, 6).

Table (6) : Numbers of P. operculella larvae and pupae found in 50 potato tubers of different varieties planted during summer 1982.

Variety	Position				Average/ 50 tubers
	Shallow		Deep		
	Total/ 250 tubers	Mean/ 50 tubers	Total/ 250 tubers	Mean/ 50 tubers	
Monalisa	20	4.0	6	1.2	2.6
Kondor	16	3.2	8	1.8	2.5
Gracia	21	4.2	9	1.8	3.0
Vulkano	38	7.6	10	2.0	4.8
Renska	37	7.4	14	2.8	5.1
Mean	26.4	6.7	9.5	1.9	3.6

F value between varieties = 22.68**

F value between positions = 204.5**

F value between Var. x Pos. = 42.1**

$L.S.D._{0.05}$ between means = 1.10

$L.S.D._{0.01}$ between means = 1.42

** highly significant value.

Kondor variety was least infested one followed by both Monalisa and Gracia while Renska and Vulkano showed high infestation rate.

The same order of varietal infestation degree was also observed with the deep position tubers where Kondor showed also the least infestation rate, followed by Monalisa and Gracia varieties, and then came the highly infested ones, namely; Renska and Vulkano.

Larval numbers in tubers of deep position was low in contrary to the numbers found in tubers of shallow positions. Statistical analysis revealed the presence of a highly significant difference between the larval numbers of shallow position and those of deep position. The effect of the interrelation between the varieties and the position on the infestation was highly significant. This means that the infestation of the potato by P. operculella varied according to the varieties, on one hand, and the position of tubers embeded in soil, on the other hand.

b. Second experiment (summer 1983) :

The second experiment during 1983, was conducted at the same period of the first experiment (during summer 1982), and the obtained results are shown in Table (7). Analysis of variance to infestations recorded of the different varieties indicated the presence of significant differences with 34.01 "F" value. Monalisa, Kondor and Gracia were not significantly different in their infestation rate, but each was, significantly, less infested than Vulkano and Renska varieties. Inspections of shallow position tubers indicated much infestations than those of deep position. Highly significant differences were found among the two groups of infestations.

Kondor tubers in both positions contained the least larval numbers . In case of shallow position, the highest rate of infestation was found in Renska variety (8.4/50 potato tubers) followed by Vulkano variety (7.4/50 tubers). The same tendency was also obtained in case of deep position tubers. As shallow position tubers were more subjected to infestation than the deep ones.

Table (7) : Numbers of P. operculella larvae and pupae found in 50 potato tubers of different varieties, planted during summer 1983.

Variety	Possition				Average/ 50 tubers
	Shallow		Deep		
	Total/ 250 tubers	Mean 50 tubers	Total/ 250 tubers	Mean/ 50 tubers	
Monalisa	25	5.0	12	2.4	3.7
Kondor	19	3.8	9	1.8	2.8
Gracia	21	4.2	10	2.0	3.2
Vulkano	37	7.4	13	2.6	5.0
Renska	42	8.4	17	3.4	5.9
Mean	28.8	5.76	12.2	2.44	4.12

F value between varieties = 34.013**

F value between positions = 232.105**

F value betwen Var. x Pos. = 7.763**

$L.S.D._{0.05}$ between means = 1.00

$L.S.D_{0.01}$ between means = 1.33

** highly significant value

Analysis of variance also revealed the presence of direct correlation between the number of larvae and pupae infesting the tubers and their depth regardless of particular variety.

Working on the varietal susceptibility of potato to potato tuber moth infestation, Assem (1966) found that Surprise and Record varieties were less susceptible to tuber moth infestations among the tested varieties. He tested also 31 potato varieties, results showed that Fina and King Edward were susceptible to infestation while Aran bannar was the lowest infested one on the foliage. However, the tuber infestation on Alpha and King Edward had the lowest level, Gevont and Previosnek varieties were severely infested. Heedar (1983) recorded that on foliage, the variety Jaerla was highly resistant to potato tuber worm infestation, general mean of larvae per 100 leaves was 9.5, while it was 16.2 larvae in the heavily infested variety Culba. On tubers Winalda was the light infested, where only 5.0

larvae were recorded per 100 tubers, however, it was 15.0 in Culba variety. Abdel-Aziz (1983) recorded in summer 1980 that Ostara variety showed the highest level of infestation, while Blanka variety was the lowest one. In summer 1981, King Edward variety was the most susceptible, while Atica was the lowest. On tubers, Granola and Desirée were highly susceptible, while Dunja and King Edward were lightly susceptible varieties in seasons 1980, 1981, respectively.

4.2. Biological studies :

4.2.1. Infestation and type of injury :

The potato tuber moth, Phthorimaea operculella (Zell.) actually attacks the foliage and tubers of the potato plants.

Females lay their eggs singly or, rarely, in small groups of 2-4 eggs on the leaf-surface. Using their mandibles, the newly hatched larvae cut the leaf epidermis, boring in the mesophyll tissue. They continue boring and feeding on the mesophyll forming, at the beginning, very narrow linear mines which enlarge gradually as the larvae grow older, turning the mines to the bloch type.

At the time of boring, the larva, mostly, starts spinning a tent of silk between the veins and the leaf surface.

Excessive formation of such empty blotches on the leaf blades cause them to become rather translucent and at the end may be destroyed. As the larvae grow, the leaves become too thin for mining, so they may try to tie together several near by leaves or may roll the tops of the infested leaves, or they may enter the petioles for pupation.

The tuber feeding larvae cause injury to the potato tubers by tunnelling through them. The larvae usually begin tunnelling on the same spot where the eggs were laid (on the eyes of tubers). The entrance holes of hatching larvae are very small and webbed over, making it too difficult to detect the infested potatoes (Fig.,3-A). Infestation of potato tubers mostly induce decay which turn their contents to brownish-black tint. Portions of the tubers, recently occupied by the larvae, appear fresh and white, but the old infested parts are usually moulded and filled with the larval excrement.

As the larva reaches its full size, it leaves the host to seek hiding places where it can settle down. Its colour assumes a pinkish or a greenish shade in case of larvae feeding on potato tubers and pinkish in case of larvae feeding on tomato or eggplant fruits; before it starts spinning the cocoon.

Pupation takes place inside a silken cocoon; either in the soil or inside the tuber near the tunnel opening.

On tomato fruits, the eggs are laid under the calyces of fruits, the newly hatched larva burrows beneath the calyx (Fig. 3-C) and starts a surface feeding for a short time before working into the fruit flesh.

Infestation to eggplant fruits is characterized by the presence of number of small holes in the calyx end (Fig. 3-B), representing the entrance holes. Inside the fruits, the larvae of the pest keep tunnelling through the fruit bulb to cause partial or complete ruin of the fruit, depending on the number of feeding larvae. The previous observations agree with those recorded by El-Sherif (1962), and Assem (1966).

4.2.2. Breeding of *P. operculella* on different host plants at different temperatures :

a. The first generation :

The larval stage :

Experiments carried out to determine the duration of each of the four larval instars of *P.operculella* as

well as the duration of the whole larval stage were carried out on three different kinds of food (potato tubers, and tomato and eggplant fruits), and under four temperatures (19.6±0.03, 24.5±0.05, 29.4±0.04 and 34.3±0.05°C). Results are shown in Tables (8, 9, 10 and 11).

Results obtained from rearing P. operculella larvae on potato, tomato and eggplant at 19.6°C and 68 % R.H. are shown in Table (8). The duration of the 1st instar larva was found shorter by feeding on potato tubers. It ranged from 5 to 7 days with an average of 5.6 ± 0.13 days. On tomato fruits, this period was (6-8) days and averaged 6.92±0.14. Feeding on eggplant fruits was, on the other hand, associated with the longest 1st instar larval period (averaging 7.32 ± 0.15 with a minimum of 6 and a maximum of 8 days) (Table, 8).

Statistical analysis between effects of the three hosts showed a highly significant shorter period on potato tubers than that occurred on tomato or eggplant fruits. However, the difference between feeding on tomato and eggplant was only significant (Table, 8).

Table (8) : Durations of larvae, prepupae and pupae, larval mortality and adults emergence by rearing larvae of P.operculella on various kinds of food at (temp.=19.6°C and R.H.=68 %) (1st generation).

Larval food	Larval duration / days					Prepupal period/ days	Larval mortality %	Pupal period/ days	Adults emergence %
	1st instar	2nd instar	3rd instar	4th instar	Total active larval period				
Potato tubers	5.6 ±0.13 (5-7)	4.16±0.13 (3-5)	4.56±0.13 (4-6)	6.6±0.19 (5-8)	20.92±0.24 (19-23)	3.36±0.11 (3-5)	23.4	13.4±0.14 (12-14)	97.3
Tomato fruits	6.92±0.14 (6-8)	4.6±0.1 (4-5)	5.72±0.14 (5-7)	8.0±0.14 (7-9)	25.24±0.22 (24-27)	4.36±0.11 (3-5)	31.8	15.32±0.15 (14-16)	89.8
Eggplant fruits	7.32±0.15 (6-8)	5.08±0.15 (4-6)	6.12±0.15 (5-7)	8.5±0.14 (7-9)	27.04±0.29 (25-30)	4.68±0.23 (3-6)	36.0	16.32±0.13 (15-17)	90.6
F value	43.93**	11.5**	30.94**	32.0**	148.9**	16.8**		148.8**	
L.S.D.$_{0.05}$	0.386	0.386	0.414	0.499	0.733	0.476		0.346	
L.S.D.$_{0.01}$	0.515	0.515	0.552	0.665	0.977	0.634		0.461	

** Highly significant.

As for the 2nd instar larva, its duration averaged 4.16 ± 0.13 days with a minimum of 3 and a maximum of 5 days; 4.6 ± 0.1 (4-5) days by feeding on tomato, and 5.08 ±0.15 (4-6) days when larvae were fed on eggplant. As shown in Table (8), the duration of the second larval instar was, significantly, on potato than on tomato, but the effect of larval feeding on potato was highly significant when compared with those fed on eggplant. Significant difference could be also detected between tomato and eggplant. The same trend of food efficiency on the previous larval instars was observed also on the 3rd one. The recorded durations for this instar were 4.56 ± 0.13 (4-6), 5.72 ± 0.14 (5-7) and 6.12 ± 0.15 (5-7) days when larvae were fed on potato tubers, tomato and eggplant fruits, respectively.

Analysis of variance to results on the three hosts revealed highly significant shorter period for larvae fed on potato tubers, than those fed on tomato or eggplant fruits. Also, feeding on tomato fruits shortened the third instar

larval period than feeding on eggplant fruits, but the difference was found, statitically , not significant. The duration of the fourth larval instar was the longest than all other instars, even when larvae were fed on either of the three kinds of food. This may be due to self tendency for storing exess of food to be used in the following stages. Accordingly, it ranged from 5 to 8 days on potato with an average of 6.6 ± 0.19, 7 to 9 days on tomato (average 8.0 ± 0.14 days), and 7 to 9 days on eggplant with an average 8.52±0.14 days. Thus, also, showing, highly significantly shorter period on potato tubers than on the other two kinds of food.

The data of the total larval period (Table, 8) indicated that this period was significantly, affe-cted by the kind of larval food. This period reeded

averaged 20.92 ± 0.24 (19-23) days, 25.24 ± 0.22 (24-27) days and 27.04 ± 0.29 (25-30) days when larvae were fed on potato, tomato and eggplant, respectively.

Data on the effect of larval feeding on the mentioned kinds of food, but at 24.5°C and 68 % R.H., on the duration of each of the four larval instars, are recorded in Table (9). The first instar larval period estimated 4.0 ± 0.14 (3-5), 4.92 ±0.14 (4-6) and 5.52 ± 0.18 (4-7) days when larvae were fed on potato, tomato and eggplant, respectively. The periods for the remaining three instars on the same hosts were as follows : 2.8 ± 0.15 (2-4), 3.6 ± 0.14 (3-5) and 3.76 ± 0.13 (3-5) days for the second instar; 3.72 ± 0.15 (2-5), 4.2 ± 0.13 (3-5) and 4.92 ± 0.14 (4-6) days for the third instar, and 6.0 ± 0.14 (5-7), 6.2 ± 0.13 (5-7) and 7.6 ± 0.17 (6-9) days for the fourth instar, respectively. Thus, also indicating that the shortest larval duration were associated with feeding on potato tubers and the longest ones were recorded on larvae fed on eggplant fruits. At 24.5°C and 68 % R.H., the total larval period averaged 16.52 ± 0.3 (15-20) days, 18.92 ± 0.25

Table (9) : Durations of larvae, prepupae and pupae, larval mortality and adults emergence by rearing larvae of P.operculella on various kinds of food at(temp.=24.5 C and R.H.=68 %) (1st generation).

Larval food	Larval duration / days					Prepupal period/ days	Larval mortality %	Pupal period/ days	Adults emergence %
	1st instar	2nd instar	3rd instar	4th instar	Total active larval period				
Potato tubers	4.0 ±0.14 (3-5)	2.8±0.15 (2-4)	3.72±0.15 (2-5)	6.0±0.14 (5-7)	16.52±0.30 (15-20)	3.0 ±0.14 (2-4)	22.0	9.0±0.17 (8-10)	98.0
Tomato fruits	4.92±0.14 (4-6)	3.6±0.14 (3-5)	4.2 ±0.13 (3-5)	6.2±0.13 (5-7)	18.92±0.25 (17-21)	3.92±0.14 (3-5)	28.57	11.0±0.17 (10-12)	85.7
Eggplant fruits	5.52±0.18 (4-7)	3.76±0.13 (3-5)	4.92±0.14 (4-6)	7.6±0.17 (6-9)	21.8± 0.33 (19-25)	4.48±0.12 (3-5)	32.6	11.68±0.18 (10-13)	90.4
F value	18.33**	13.22**	22.24**	30.64**	72.7**	27.8**		60.5**	
L.S.D.0.05	0.509	0.402	0.364	0.448	0.881	0.402		0.496	
L.S.D.0.01	0.678	0.536	0.485	0.597	1.183	0.598		0.660	

** Highly significant.

(17-21) days and 21.8 ± 0.33 (19-25) days for larvae fed on the mentioned hosts, respectively (Table, 9). Statistical analysis, showed highly significant effect of the kind of larval food on the total larval duration.

Rearing of the newly hatched larvae of the potato tuber moth on potato tubers, tomato and eggplant fruits at 29.4°C and 68 % R.H., indicated that the durations of each of the four larval instars were, affected by the offered food (Table, 10). The first larval instar elapsed 2.96 ± 0.12 (2-4) days for larvae fed on potato, 3.4 ± 0.18 (2-5) days on tomato and 4.0 ± 0.20 (3-6) days when larvae were fed on eggplant. The recorded periods for the second larval instar were 2.08 ± 0.06 (2-3), 2.32 ± 0.13 (2-4) and 2.64 ± 0.13 (2-4) days. The respective averages for the durations of the third larval instar were 2.4 ± 0.10 (2-3), 3.04 ± 0.14 (2-4) and 3.8 ± 0.14 (3-5) days. These estimations were 4.08 ± 0.11 (3-5), 4.6 ± 0.13 (4-6) and 5.6 ± 0.18 (4-7) days, respectively for the fourth

Table (10) : Durations of larvae, prepupae and pupae, larval mortality and adults emergence by rearing larvae of P.operculella on various kinds of food at (temp.=29.4°C and R.H.=68 %) (1st generation).

Larval food	Larval duration / days					Prepupal period/ days	Larval mortality %	Pupal period/ days	Adults emergence %
	1st instar	2nd instar	3rd instar	4th instar	Total active larval period				
Potato tubers	2.96±0.12 (2-4)	2.08±0.06 (2-3)	2.4 ±0.10 (2-3)	4.08±0.11 (3-5)	11.52±0.18 (10-13)	1.4±0.10 (1-2)	19.5	6.8±0.14 (6-8)	100.0
Tomato fruits	3.4±0.18 (2-5)	2.32±0.13 (2-4)	3.04±0.14 (2-4)	4.6 ±0.13 (4-6)	13.36±0.22 (12-15)	1.52±0.10 (1-2)	30.6	8.2±0.19 (7-10)	81.5
Eggplant fruits	4.0±0.2 (3-6)	2.64±0.13 (2-4)	3.8 ±0.14 (3-5)	5.6 ±0.18 (4-7)	16.04±0.31 (13-18)	1.48±0.10 (1-2)	36.0	8.04±0.17 (7-9)	93.7
F value	8.41**	5.156**	31.48**	34.69**	86.0**	0.55		17.9**	
L.S.D.0.05	0.512	0.321	0.355	0.373	0.696			0.515	
L.S.D.0.01	0.682	0.428	0.473	0.497	0.928			0.686	

** Highly significant.

larval instar . The total larval period lasted 11.52 ± 0.18 (10-13), 13.36 ± 0.22 (12-15) and 16.04 ± 0.31 (13-18) days, respectively (Table, 10).

Statistical analysis revealed the existence of significant differences between the effects of the three different hosts on the duration of each larval instar and also on the period of the total larval stage.

At 34.3°C and 68 % R.H., (Table, 11), the durations of the first instar larvae ranged from 2-3 days when feeding on either of the three hosts, but the obtained averages were 2.12 ± 0.07, 2.4 ± 0.10 and 2.32 ± 0.1 days for larvae fed on potato tubers, and tomato and eggplant fruits, respectively. For the 2nd instar larvae, the obtained periods lasted 1.36 ± 0.1 (1-2), 1.6 ± 0.10 (1-2) and 1.8 ± 0.12 (1-3), respectively. The respective durations for the third instar larvae were 2.0, 2.2 ± 0.08 (2-3) and 2.0 days. However, these durations were 2.88 ± 0.07 (2-3), 3.2 ± 0.08 (3-4) and 3.28 ± 0.14 (2-4) days, respectively, for the fourth instar

Table (11) : Durations of larvae, prepupae and pupae, larval mortality and adults emergence by rearing larvae of P.operculella on various kinds of food at(temp.=34.3°C and R.H.=68 %) (1st generation).

Larval food	Larval duration / days					Prepupal period/ days	Larval mortality %	Pupal period/ days	Adults emergence %
	1st instar	2nd instar	3rd instar	4th instar	Total active larval period				
Potato tubers	2.12±0.07 (2-3)	1.36±0.1 (1-2)	2.0±0.0 (2)	2.88±0.07 (2-3)	8.36±0.16 (7-10)	1.04±0.04 (1-2)	31.0	4.12±0.11 (3-5)	72.0
Tomato fruits	2.4± 0.10 (2-3)	1.6±0.10 (1-2)	2.2±0.08 (2-3)	3.2±0.08 (3-4)	9.4 ±0.16 (8-11)	1.28±0.09 (1-2)	34.2	4.6 ±0.13 (4-6)	58.0
Eggplant fruits	2.32±0.1 (2-3)	1.8±0.12 (1-3)	2.0±0.0 (2)	3.28±0.14 (2-4)	9.4 ±0.18 (7-11)	1.28±0.09 (1-2)	49.36	5.44±0.13 (4-6)	75.0
F value	2.43	3.81*	7.0**	4.30*	15.0**	3.69*		28.6**	
L.S.D.$_{0.05}$		0.321	0.127	0.290	0.440	0.205		0.307	
L.S.D.$_{0.01}$		0.429	0.169	0.387	0.587	0.273		0.473	

* Significant

** Highly significant

larvae. The total larval period, for larvae fed on the mentioned hosts at the same temperature was 8.36 ± 0.16 (7-10) , 9.4 ± 0.16 (8-11) and 9.4 ± 0.18 (7-11) days, respectively.

Statistical analysis showed the presence of significant differences between the means of the larval periods, except in the case of 1st larval instar. The obtained values of L.S.D. at 0.05 and 0.01 probability levels were 0.321 and 0.429, 0.127 and 0.169, 0.290 and 0.387 and 0.440 and 0.587 for the 2nd, 3rd and 4th larval instars and the total periods, respectively (Table, 11).

Similar results were obtained by El-Sherif (1961) when the larvae of P. operculella were fed on potato tubers, she reported that the average durations of the four larval instars were 3.0, 2.0, 2.3 and 4.3; and 7.1, 5.2, 5.9 and 8.3 days at 28.9 and 19.2°C, respectively, and the total larval period were 11.6 and 26.5 days at the two temperatures. Salama et al.

(1972) mentioned that the larval stage lasted about 17.6, 11.1 and 8.7 days at 25, 30 and 35°C. Attalah et al. (1981) found that the means of larval periods were 10.5, 13.7 and 16.0 for larvae reared on potato tubers and tomato and eggplant fruits at 27.1°C.

The prepupal stages :

Full grown larvae mostly leave the host to search for a convenient place for pupation. Some few larvae, however, may pupate within the host. The larvae that leave the tubers for pupation appear, usually, sluggish. These larvae may settle down to spin their cocoons at different places; over the tuber eyes, in old burrows, under the dry skin of potatoes, between adjacent potato tubers, between accumulated dirt or in cracks at the bottom of the breeding cages. The cocoons were formed between the edge of the specimen tubers and muslin covers.

The prepupa is, subsequently, changed to pupa when the skin on the dorsum of the thorax and the anterior part of the abdomen splits, and

the pupa slips out of the larval skin which is then casted at the posterior end of the cocoon.

Concerning the prepupal stage, data in Table (8) indicate that the period of this stage (at 19.6°C) was highly significantly, affected by the kind of food on which the larvae were fed. This period averaged 3.36 ± 0.11 (3-5), 4.36 ± 0.11 (3-5) and 4.68 ± 0.23 (3-6) days when the insect larvae were fed on potato tubers, and tomato and eggplant fruits, respectively.

At 24.5°C, Table (9) shows that the prepupal stage lasted 2-4 days with an average of 3.0±0.14 days, 3-5 (average 3.92 ± 0.14) days and 3 to 5 with an average of 4.48 ± 0.12 days, when the previous larvae were fed on potato, tomato and eggplant, respectively. Statistical analysis of these data, also, indicated highly significant effect of the larval food on the prepupal period.

At 29.4°C, the prepupal stage lasted 1 to 2 days on potato (average 1.4 ± 0.10), 1 to 2 (1.52 ± 0.1) days on tomato and 1 to 2 days (average 1.48 ± 0.10) on eggplant (Table, 10). The calculated "F" value (0.55) was not significant

indicating insignificant effect of the larval food on the prepupal period, at this temperature.

When the larvae were reared on the three kinds of food at 34.3°C and 68 % R.H., the subsequent prepupal stage lasted 1.04 ± 0.04 (1-2), 1.28±0.09 (1-2) and 1.28 ± 0.09 (1-2) days, respectively (Table, 11). Statistical analysis showed that, at this temperature , the prepupal duration was, significantly, shorter for larvae fed on potato tubers than for larvae fed on tomato or eggplant fruits, but no significant difference was found for the effect of the last two kinds of food.

Larval mortality :

During the courses of healthy breedings, percentages of mortality amongst P. operculella larvae were recorded separately on each of the offered kinds of food. The obtained data (Tables 8, 9, 10 & 11) indicate that, the percentages of total mortality for the larvae fed on potato tubers was 23.4,22.0,19.5 and 31.0% at 19.6,24.5,29.4

and 34.3°C, respectively. The respective mortality percentages were 31.8, 28.57, 30.6 and 34.2 % for larvae fed on tomato fruits. However, for feeding on eggplant fruits, these percentages were, 36.0, 32.6, 36.0 and 49.36 %, at 19.6, 24.5; 29.4 and 34.3°C, respectively. These data indicate that the most suitable food for survival of P. operculella larvae was potato tubers where the least mortality percentages were recorded. Tomato fruits came the next, however, eggplant fruits showed the highest larval mortality.

As for temperature, the presented data indicate that 29.4°C seemed to be generally the optimum temperature for rearing of the insect larvae on potato (the lowest percentage of mortality 19.5% was obtained), followed by 24.5°C, and then the lower temperature of 19.6°C. However, on the other hand, the higher temperature of 34.3°C seemed unsuitable for the insect rearing where the highest mortality percentage (31.0%) was obtained.

Concerning this data, Cardona et al.(1975), found that the percent of immature mortality were 24.5,20.4 and 41.8 at 25,30 and 35°C,respectively. Also, Briese(1980)mentioned that the survival from egg hatching to adult emergence was 80 % at 20°C, 90 % at 24°C and 60 % at 34°C.

The pupal stage :

The period of pupal stage was estimated when the potato tuber moth larvae were reared on the aforementioned three kinds of food, at the four constant temperatures; 19.6, 24.5, 29.4 and 34.3°C, and 68 % R.H. (Tables; 8, 9, 10 and 11).

At 19.6°C, the pupal period lasted 13.4 ± 0.14 (12-14) days when larvae were fed on potato tubers, 15.32 ± 0.15 (14-16) days as feeding occurred on tomato fruits, and 16.32 ± 0.13 (15-17) days for pupae reared from larvae fed on eggplant fruits (Table, 8).

At this temperature, highly significant differences were detected between the host's effect, where the L.S.D.0.01 value between their means amounted to 0.461 (Table, 8).

At 24.5°C (Table, 9), the estimated periods for the pupal period were 9.0 ± 0. 17 (8-10) , 11.0 ± 0.17 (10-12) and 11.68 ± 0.18 (10-13) days when larvae were fed on potato, tomato and egg-plant, respectively. Statistical analysis of this period at this temperature (Table, 9) revealed the presence of highly significant differences between means as the calculated L.S.D.0.01 was 0.66.

At 29.4°C, the pupae developing from larvae fed on potato showed a pupal period ranging from 6 to 8 days with an average of 6.8 ± 0.14 days. The period of pupae induced from larvae reared on tomato lasted 7-10 days (average 8.2 ± 0.19 days). However, that for those fed on eggplant was 8.04± 0.17 (7-9) days (Table, 10). The calculated L.S.D. values between the obtained means, at this temperature were 0.515 and 0.686, respectively (Table, 10) indicating highly significant effect of larval feeding on potato tubers, compared with feeding on the two other hosts; and insignificant effect of larval feeding on either of tomato or eggplant fruits on this period.

With regard to the pupae resulting from larvae reared at 34.3°C and 68 % R.H. (Table, 11). The obtained pupal periods averaged 4.12 ± 0.11 (3-5), 4.6 ± 0.13 (4-6) and 5.44 ± 0.13 (4-6) days, when larvae were fed on potato, tomato and eggplant, respectively. The calculated L.S.D. values at 0.05 and 0.01 probability levels were 0.305 and 0.473, respectively (Table, 11), indicating that the offered larval food had, highly significantly affected the period of the resulting pupae.

From the previously elucidated data, it could be generally concluded that, the period of P. operculella pupal stage is affected by the kind of food on which the larvae were fed (on one hand) and by the thermal conditions on which the insect was reared, on the other hand. The shortest pupal period was associated by larval feeding on potato tubers, followed by feeding on tomato, however, the longest period was associated with feeding on egg-plant fruits. As for the effect of temperature, it is clear the presence of a negative relationship between this period and the available temperature for the insect rearing.

Effect of nutrition on the pupal weight :

Data recorded in (Table, 12) show the relationship between the kind of larval food and the weight of the resulting pupae when the pest larvae were reared at the aforementioned temperatures and relative humidity.

Rearing larvae at 19.6°C resulted in female pupae weighing 10.9 ± 0.83 (9.8-13.0) mg. for larvae fed on potato, 8.7 ± 0.57 (7.1-11.0) mg. when larvae were fed on tomato, and 7.9 ± 0.46 (6.3-8.9) mg. for rearing on eggplant. The corresponding estimations for males were 8.6 ± 0.34 (7.1-10.0), 6.2 ± 0.42 (5.1-7.4) and 5.2 ± 0.29 (4.1-6.3) mg., respectively.

Results on pupae from larvae reared at 24.5°C, show that the respective weights for female pupae resulting from larvae fed on the three hosts were, 11.1 ± 0.68 (8.0-13.0), 9.5 ±0.67 (7.2-12.6) and 7.6 ± 0.57 (5.7-10.0) mg., however those of males were 8.3 ± 0.28 (7.0-9.0), 5.9 ± 0.46 (4.0-7.5) and 5.7 ± 0.26 (4.5-6.8) mg., respectively.

Table (12) : Effect of larval food on the pupal weight of both sexes of P. opercu-lella at different temperatures and 68 % R.H. (1st generation).

Larval food	Pupal weight (mg.)							
	19.6°C		24.5°C		29.4°C		34.3°C	
	♀	♂	♀	♂	♀	♂	♀	♂
Potato tubers	10.9±0.83 (9.8-13.0)	8.6±0.34 (7.1-10.0)	11.1±0.68 (8.0-13.0)	8.3±0.28 (7.0-9.0)	11.0±0.73 (9.4-12.6)	8.2±0.28 (7.0-9.0)	10.0±0.79 (9.0-12.0)	8.0±0.34 (7.9-10.0)
Tomato fruits	8.7±0.57 (7.1-11.0)	6.2±0.42 (5.1-7.4)	9.5±0.67 (7.2-12.6)	5.9±0.46 (4.0-7.5)	8.7±0.33 (8.0-9.4)	6.1±0.37 (5.5-7.6)	7.2±0.35 (6.5-8.8)	6.0±0.18 (5.5-6.8)
Eggplant fruits	7.9±0.46 (6.3-8.9)	5.2±0.29 (4.1-6.3)	7.6±0.57 (5.7-10.0)	5.7±0.26 (4.5-6.8)	6.1±0.50 (5.0-7.0)	5.6±0.57 (3.0-7.5)	6.6±0.45 (4.2-8.1)	4.9±0.28 (4.1-6.0)
F value	7.21**	41.8**	22.5**	25.0**	19.06**	10.0**	11.58**	8.34**
L.S.D.$_{0.05}$	2.07	0.69	0.68	0.69	1.96	1.19	2.07	0.72
L.S.D.$_{0.01}$	2.89	0.97	0.96	0.97	2.96	1.67	2.90	1.09

** Highly significant.

At 29.4°C, the obtained weights for P. operculella pupae were 11.0 ± 0.73 (9.4 -12.6), 8.7 ± 0.33 (8.0-9.4) and 6.1 ± 0.50 (5.0 -7.0) mg. in case of females, respectively. However, the respective averages for male pupae were 8.2 ± 0.28 (7.0-9.0), 6.1 + 0.37 (5.5-7.6) and 5.6 ± 0.57 (3.0-7.5) mg. (Table, 12).

As for the higher temperature of 34.3°C, the obtained average weights of female pupae were 10.0 ± 0.79 (9.0-12.0), 7.2 ± 0.35 (6.5-8.8) and 6.6 ± 0.45 (4.2-8.1) mg., respectively. In case of males, these values were 8.0 ± 0.34 (7.9-10.0), 6.0 ± 0.18 (5.5-6.8) and 4.9 ± 0.28 (4.1-6.0) mg., respectively.

Analysis of variance of the previously mentioned data (Table, 12) revealed the presence of significant differences between weights of female pupae resulting from the different kinds of food at the different temperatures . where the $L.S.D._{0.05}$ and $L.S.D._{0.01}$ values were 2.07 and 2.89 (at 19.6°C), 0.68 and 0.96 (at 24.5°C), 1.96 and 2.96 (at 29.4°C) and

2.07 and 2.90 (at 34.3°C). In case of males the obtained L.S.D.0.05 and L.S.D.0.01 values were 0.69 and 0.97, 0.69 and 0.97, 1.19 and 1.67 and 0.72 and 1.09, respectively, indicating also significant differences between mean weights of male pupae. These data clearly indicated that pupae obtained from larvae fed on potato tubers manifested generally, the highest weights. However, on the contrary, those resulting from larvae fed on eggplant fruits showed the lowest weights.

Concerning the effect of temperature, it is also clear that, with the exception of the highest temperature (34.3°C), temperature did not greatly affect the weight of resulting pupae.

It could be also, generally, stated that in all cases, weights of the female pupae were, markedly, higher than those of males.

Percentage of moth emergence :

Although moth's emergence usually occurs during the night, yet some moths have been observed emerging by daytime. The process of emergence takes only 3 to 5 minutes.

Data in Tables (8, 9, 10 & 11) indicate that, at all of the four temperatures, the highest percentages of emergence were always associated by rearing the hatching larvae on potato tubers (97.3, 98.0, 100.0 and 72.0 %, for rearing at 19.6, 24.5, 29.4 and 34.3°C, respectively). Egg-plant fruits came the next in their effect on the percentage of adult emergence (90.6, 90.4, 93.7 and 75 % at the mentioned thermal conditions, respectively). The lowest percentages of emergence (89.8, 85.7, 81.5 and 58.0 %, respectively) were on the other hand, associated with rearing the insect on tomato fruits.

It is also obvious from Tables (8-11) that the highest temperature used (34.3°C) was unsuitable for the pupal development and subsequently, adults emergence (72, 58 and 75 %) for insects reared on potato, tomato and eggplant, respectively), were relatively, lower than those obtained at the three other temperatures. The temperatures 19.6, 24.5 and 29.4°C were suitable for the adults

emergence where the percentages of emergence were, relatively, high, ranging from 81.5 to 100.0 %.

In comparison between the present data and those recorded by other investigators, El-Sherif (1961), found that the pupal periods were 13.4 and 5.9 days at 20.4 and 28.9°C, for larvae reared on potato tubers. Salama et al. (1972), reported that the periods of the pupal stage were 8.8, 6.8 and 4.2 days at 25, 30 and 35°C, respectively. Driese et al. (1980), mentioned that the level of pupal mortality was 1.8 ± 0.3 % (at 20-32°C), but it rose to 6.6 % (at 34°C) when using potato tubers for rearing larvae. Attalah et al. (1981), found that the pupal period lasted 6.7, 8.4 and 8.6 days when the larvae were fed on potato tubers and tomato and eggplant fruits at 27.1°C.

The adult stage :

Oviposition :

The female moth usually prefers the eyes of the tubers, beneath the calyx of tomato and

eggplant fruits; for laying her eggs. Smooth surfaces are usually not suitable for oviposition. Eggs are deposited either singly, in a line or in groups of 2-20 eggs. After laying few eggs on the same spot, the female begins to wander again on the surface looking for another place to continue egg-laying. In many cases, the same moth deposits most of its eggs in one night in the same place.

Oviposition periods and egg-laying capacity :

The pre-oviposition, oviposition and post-oviposition periods, and egg-laying capacity of mated P. operculella female moths resulted from larvae reared on potato tubers, tomato and eggplant fruits at 19.6, 24.5, 29.4 and 34.3 °C as well as 68 % R.H. are shown in Tables (13, 14, 15 and 16). Results indicated that the pre-oviposition period ranged from 1 to 4 days (average 2.2 ± 0.29) days/female, 2 to 4 (2.4 ± 0.22) days and from 2 to 4 (2.5 ± 0.22) days when larvae were fed on potato, tomato and eggplant, respectively at 19.6 °C.. Statistical analysis showed that there

were no significant difference between these data (Table, 13).

At 24.5°C, the pre-oviposition period avaraged 2.0 ± 0.15 (1-3), 2.1 ± 0.18 (1-3) and 2.2 ± 0.13 (2-3) days, respectively, with also no significant difference between treatments (Table, 14).

At 29.4°C, the respective averages for the pre-oviposition period were 1.5 ± 0.17 (1-2), 1.9 ± 0.18 (1-3) and 2.0 ± 0.21 (1-3) days. The shortest period occurred for females resulting from larvae fed on potato tubers, but with significant difference than those fed in the larval stage on tomato and highly significant difference than those fed on eggplant fruits (Table, 15). When the insect was reared at 34.3°C, this period averaged 2.5 ± 0.22 (2-3), 2.3 ± 0.21 (2-3) and 2.5 ± 0.22 (2-3) days for potato, tomato and eggplant, respectively, with no significant difference between treatments (Table, 16).

From the previous data, it could be concluded that P. operculella larval food did not affect

Table (13) : Oviposition period , adult longevity and average number of eggs/female from P. operculella larvae fed on various food. Rearing at (temp. = 19.6°C and R.H. = 68 %) (1st generation).

Offered food	Periods of/days			Longevity/days		Average no. of eggs laid/♀
	Pre-oviposition	Oviposition	Post-oviposition	♀	♂	
Potato tubers	2.2±0.29 (1-4)	8.9±1.17 (5-15)	7.2±0.63 (3-10)	18.3±0.78 (14-22)	15.6±0.64 (11-18)	87.7±4.68 (72-110)
Tomato fruits	2.4±0.22 (2-4)	7.3±0.76 (5-13)	6.2±0.68 (3-9)	15.9±0.38 (14-18)	13.9±0.67 (10-16)	50.9±4.33 (32-76)
Eggplant fruits	2.5±0.22 (2-4)	6.5±0.56 (4-10)	5.4±0.52 (3-9)	14.4±0.45 (12-16)	14.2±0.65 (10-16)	43.8±4.88 (25-63)
F value	0.5	1.8	2.1	13.34**	1.6	21.10**
L.S.D.0.05				1.600		15.266
L.S.D.0.01				2.19		20.912

** Highly significant.

Table (14) : Oviposition period , adult longevity and average number of eggs/female from P. operculella larvae fed on various food. (Rearing at temp. = 24.5°C and R.H. = 68 %) (1st generation).

Offered food	Period of /days			Longevity/days		Average no. of eggs laid/♀
	Pre-oviposition	Oviposition	Post-oviposition	♀	♂	
Potato tubers	2.0±0.15 (1-3)	6.9±0.68 (4-10)	6.0±0.52 (4-9)	14.9±0.66 (11-17)	12.8±0.55 (11-15)	104.0±6.19 (79-132)
Tomato fruits	2.1±0.18 (1-3)	5.9±0.41 (5-8)	6.4±0.54 (4-10)	14.4±0.72 (12-18)	11.9±0.59 (9-14)	62.8±6.56 (36-92)
Eggplant fruits	2.2±0.13 (2-3)	6.1±0.48 (5-9)	6.1±0.35 (5-8)	14.4±0.56 (11-17)	12.3±0.63 (9-15)	49.8±6.12 (28-80)
F value	0.4	0.8	0.2	0.2	0.9	16.77**
$L.S.D._{0.05}$						19.233
$L.S.D._{0.01}$						26.345

** Highly significant.

Table (15) : Oviposition period , adult longevity and average number of eggs/female from *P. operculella* larvae fed on various food. (kearing at temp. = 29.4°C and R.H. = 68 %) (1st generation).

Offered food	Period of /days			Longevity/days		Average no. of eggs laid/♀
	Pre-oviposition	Oviposition	Post-oviposition	♀	♂	
Potato tubers	1.5±0.17 (1-2)	6.4±0.48 (4-9)	4.6±0.37 (3-7)	12.5±0.58 (10-16)	11.1±0.67 (8-14)	107.9±7.04 (54-136)
Tomato fruits	1.9±0.18 (1-3)	5.1±0.38 (3-7)	4.0±0.4 (3-6)	11.0±0.68 (8-14)	10.0±0.52 (8-13)	70.0±8.11 (35-100)
Eggplant fruits	2.0±0.21 (1-3)	4.9±0.32 (4-7)	4.1±0.51 (2-7)	11.0±0.62 (9-15)	9.7±0.80 (6-14)	51.1±7.77 (21-91)
F value	5.45*	3.3	0.7	1.8	1.7	11.26**
L.S.D.$_{0.05}$	0.311					24.591
L.S.D.$_{0.01}$	0.427					33.698

* Significant.

** Highly significant.

Table (16) : Oviposition period , adult longevity and average number of eggs/female from *P. operculella* larvae fed on various food (Rearing at temp. = 34.3°C and R.H. = 68 %) (1st generation).

Offered food	Period of /days			Longevity/days		Average no. of eggs laid/ ♀
	Pre-oviposition	Oviposition	Post-oviposition	♀	♂	
Potato tubers	2.5±0.22 (2-3)	4.0±1.13 (1-8)	2.33±0.62 (0-4)	7.7±0.96 (4-12)	6.7±0.47 (5-9)	13.9±5.92 (0-33)
Tomato fruits	2.3±0.21 (2-3)	3.2±0.31 (2-4)	1.7 ±0.49 (0-3)	6.3±0.5 (4-9)	5.6±0.48 (4-8)	8.8±3.0 (0-21)
Eggplant fruits	2.5±0.22 (2-3)	2.3±0.33 (1-3)	1.8±0.40 (0-3)	6.8±0.63 (3-9)	5.5±0.65 (3-9)	7.7±2.45 (0-17)
F value	0.3	1.4	1.1	0.89	0.9	2.76
L.S.D.0.05						
L.S.D.0.01						

** Highly significant.

the length of the pre-oviposition period of the resulting adults, except in case of rearing at 29.4°C, where the females resulting from larvae fed on potato tubers showed, significantly, shorter period of pre-oviposition than those resulted from larvae fed on either tomato or eggplant fruits.

In this respect, Attalah et al. (1981) found that this period were 1.6, 1.9 and 2.2 days when larvae fed on potato tubers and tomato and eggplant fruits respectively at 27.1°C.

From data in Tables (13-16), it could be also stated that the pre-oviposition period, gradually, decreased with rise in temperature from 19.6 to 29.4°C. However, this period re-increased at 34.3°C again with the increase in rearing temperature. Records of Salama et al. (1972) showed that the pre-oviposition period, of adult females resulted from larvae fed on potato tubers, averaged 2.9, 1.9 and 1.9 days at 25, 30 and 35°C, respectively.

The recorded averages for the oviposition period (Tables 13-16) were 8.9 ± 1.17 (5-15), 7.3 ± 0.76 (5-13) and 6.5 ± 0.56 (4-10) days at 19.6°C; 6.9 ± 0.68 (4-10), 5.9 ± 0.41 (5-8) and 6.1 ± 0.48 (5-9) days at 24.5°C; 6.4 ± 0.48 (4-9) 5.1 ± 0.38 (3-7) and 4.9 ± 0.32 (4-7) days at 29.4°C; and 4.0 ± 1.13 (1-8), 3.2 ± 0.31(2-4) and 2.3 ± 0.33 (1-3) days at 34.3°C, for females that resulted from larvae fed on potato, tomato and egg-plant, respectively. No significant difference was found between the effects of the hosts (Tables 13-16).

As for the post-oviposition period, data in Tables (13-16) show that this period averaged 7.2 ± 0.63 (3-10), 6.2 ± 0.68 (3-9) and 5.4 ± 0.52 (3-9) days at 19.6°C; 6.0 ± 0.52 (4-9), 6.4 ± 0.54 (4-10) and 6.1 ± 0.35 (5-8) days at 24.5°C; 4.6 ± 0.37 (3-7), 4.0 ± 0.4 (3-6) and 4.1 ± 0.51 (2-7) days at 29.4°C; and 2.3 ± 0.62 (0-4), 1.7 ± 0.49 (0-3) and 1.8 ± 0.40 (0-3) days at 34.3 C; for potato, tomato and eggplant moths, respectively. Significant difference between the effects of the hosts on the post-oviposition period was absent (Tables (13-16). Attalah *et al.*

(1981) found that the oviposition periods were 8.6, 7.6 and 6.8 days of females resulting from larvae reared on potato tubers and tomato and eggplant fruits at 27.1°C.

Regarding the effect of temperature on the oviposition and post-oviposition periods, data in Tables (13-16), generally, indicate negative relationship between these periods and temperature where these periods became shorter as the rearing temperature increased. In this respect, El-Sherif (1961) recorded the periods of 7.3 and 8.3 days as oviposition periods of P. operculella females reared at 28.8 and 20.3°C, respectively. Salama et al. (1972) reported that these periods averaged 4.1, 3.1 and 1.7 days at 25, 30 and 35°C, respectively.

Egg-laying capacity :

As shown in (Table, 13), at 19.6°C, P. operculella females laid a total number of 72-110 eggs with an average of 87.7 ± 4.68 when larvae were fed on potato tubers. Rearing the larvae on tomato fruits induced adults of lower fecundity where an

insignificant effect between larval feeding on tomato and eggplant.

At 29.4°C, the females resulting from larvae fed on the different kinds of food laid 54-136 (107.9 ± 7.04), 35-100 (70.0 ± 8.11) and 21-91 (51.1 ± 7.77) eggs, respectively (Table, 15). The same trend of significancy recorded for the previous temperatures was also confirmed, statistically, at this temperature.

The lowest fecundities of P. operculella females, were recorded for insects reared at 34.3°C (Table, 16). The resultant females oviposited 13.9 ± 5.92 (0-33), 8.8 ± 3.0 (0-21) and 7.7 ± 2.45 (0-17) eggs, when larvae were fed on potato, tomato and eggplant, respectively. The calculated "F" value (2.76) was lower than the tabulated one, indicating no significant difference between the obtained means.

The mentioned results, generally indicate that the highest females fecundities were associated with larval feeding on potato tuber followed by tomato and eggplant fruits. These results agree with those recorded by Attalah et al.(1981)

reported that the means number of eggs per female were 101.0, 48.2 and 39.0 eggs when the larvae reared on potato tubers and tomato and eggplant fruits, respectively at 27.1°C.

Concerning the effect of temperature on which P. operculella individuals were reared on adults productivity, data in Tables (13-16) clearly showed that the highest oviposition rate occurred by females reared at 29.4°C, followed by those reared at 24.5°C, then those reared at 19.6°C. However, the lowest fecundities by rearing at 34.3°C where the lowest numbers of eggs (13.9, 8.8 and 7.7 eggs / female resulting from larvae fed on potato, tomato and eggplant, respectively), indicating that this temperature is, unsuitable for the insect rearing. Similar results were obtained by Kiozumi (1955) who found that the average number of eggs deposited per female were 30.7, 100 and 33.3 eggs at 10, 27 and 35°C, respectively. El-Sherif (1961) reported that the average number of eggs/female were 128.4 and 95.0 eggs at 28.8 and 20.3 C, respectively. Salama et al. (1972) found that the female fecundity were 50, 78 and 6 eggs at 25, 30 and 35°C, respectively.

Adult longevity :

The life spans of P. operculella adults were estimated, separately, for each sex for adults produced from larvae fed on the different kinds of food at each of the four mentioned thermal conditions (Tables, 13-16).

As shown in Table (13), at 19.6°C, the recorded longevities for females were 18.3 ± 0.78 (14-22), 15.9 ± 0.38 (14-18) and 14.4 ± 0.45 (12-16) days, however, those recorded for males were 15.6 ± 0.64 (11-18), 13.9 ± 0.67 (10-16) and 14.2 ± 0.65 (10-16) days when the insect larvae were fed on potato tubers and tomato and eggplant fruits, respectively. Statistical analysis indicated, highly significant, longer life-span of females resulting from larvae fed on potato tubers than those resulting from the two other feeding treatments. However, no significant difference was detected between females of tomato treatments and those of eggplant treatment. In case of males, the effect of larval food on the adult longevity was, found , insignificant (Table, 13).

When the insect was reared at 24.5°C and 68 % R.H., the female longevities ranged between 11-17 days with an average of 14.9 ± 0.66 in case of larval feeding on potato tubers, 12-18 (14.4 ± 0.72) for feeding on tomato fruits, and 11-17 (14.4± 0.56) days in case of feeding the larvae on eggplant fruits. In case of males, these longevities were 11-15 (12.8 ± 0.55), 9-14 (11.9 ± 0.59) and 9-15 (12.3 ± 0.63) days, respectively (Table, 14). No significant effect of the larval food on the adult longevity was detected in both sexes.

At 29.4°C and 68% R.H., the recorded longevities for females (Table, 15) were 12.5 ± 0.58 (10-16), 11.0 ± 0.68 (8-14), and 11.0 ± 0.62 (9-15) days for larval feeding on potato, tomato and eggplant, respectively. At the same conditions, males lived 11.1 ± 0.67 (8-14), 10.0 ± 0.52 (8-13) and 9.7 ± 0.80 (6-14) days, respectively. Statistical analysis showed , also, no significant effect of the larval food on the adult longevity of both sexes.

Rearing at higher temperature of 34.3°C resulted in adult females that lived for 7.7 ± 0.96 (4-12), 6.3 ± 0.5 (4-9) and 6.8 ± 0.63 (3-9) days, respectively. However, the recorded longevities were 6.7 ± 0.47 (5-9), 5.6 ± 0.48 (4-8) and 5.5 ± 0.65 (3-9) days, in case of males resulting from larvae fed on potato, tomato and eggplant, respectively (Table, 16). At this temperature, also, no significant effect of the larval food was detected on the adult longevity of females or males.

The previously explained results, generally, indicate that females lived longer than males. Concerning the effect of larval food on the longevity of the resultant adults, data in Tables (13-16) indicated that in spite of the longer life-spans of adults resulting from larvae fed on potato tubers, the effect was, mostly, insignificant. In this respect, Attalah et al. (1981) reported that the females and males longevity were 6.8, 5.2 and 5.8; and 5.0, 3.7 and 3.7 days from larvae fed on potato tubers and tomato and eggplant fruits.

From the mentioned tables, it could be also concluded that the adult longevity was, directly

affected by the temperature on which insects were reared. The shortest longevity was associated with rearing at 34.3°C, however, the longest adult life-span was recorded for adults reared at 19.6°C. It could be, generally, stated the presence of a negative relationship between temperature and adults longevity.

Similar results were obtained bt El-Sherif (1961), who reported that the longevity of females and males were 10.7 and 5.9, and 13.8 and 8.9 days at 28.3 and 15.4°C, respectively. Salama et al. (1972), stated that the longevity of females and males were 16.2, 17.1 and 8.7; and 14.1, 12.6 and 7.6 days at 25, 30 and 35°C, respectively.

The egg stage :

Eggs that have been deposited by females resulting from larvae fed on each of the aforementioned kinds of food at the four temperature (19.6, 24.5, 29.4 and 34.3°C) were left until hatching, where their incubation periods and percentages of hatching were estimated. Data are recorded in Table (17). At 19.6°C, eggs hatched after periods of 9.0 ± 0.13

Table (17) : Incubation period and hatchability of P. operculella-eggs induced from larvae reared at different temperatures as well as various kinds of food (1st generation).

Larval food	Incubation period for rearing at				Hatchability %			
	19.6°C	24.5°C	29.4°C	34.3°C	19.6°C	24.5°C	29.4°C	34.3°C
Potato tubers	9.0±0.13 (8-10)	6.0±0.10 (5-7)	3.6±0.10 (3-4)	2.08±0.06 (2-3)	90	94	100	64
Tomato fruits	9.2±0.15 (8-10)	6.3±0.14 (5-7)	3.8±0.09 (3-4)	2.40±0.10 (2-3)	80	80	78	52
Eggplant fruits	10.4±0.10 (10-11)	6.9±0.16 (6-8)	4.3±0.09 (4-5)	2.40±0.10 (2-3)	78	82	74	46
F value	42.4**	13.6**	17.7**	4.4*				
L.S.D.0.05	0.331	0.359	0.241	0.254				
L.S.D.0.01	0.445	0.483	0.324	0.342				

* Significant.
** Highly significant.

(8-10), 9.2 ± 0.15 (8-10), and 10.4 ± 0.1 (10-11) days, when the previous larvae were fed on potato tubers and tomato and eggplant fruits, respectively. Amongst those eggs, the percentages of hatching were 90, 80 and 78 %, respectively.

When larvae were reared at 24.5°C, the subsequent females laid eggs that hatched after 5-7 (6.0 ± 0.10), 5-7 (6.32 ± 0.14) and 6-8 (6.9 ± 0.16) days for the three treatments, respectively. The percentages of hatching were, subsequently, 94, 80 and 82 % (Table, 17).

Females reared at 29.4 C laid eggs that hatched after 3.6 ± 0.10 (3-4), 3.8± 0.09 (3-4) and 4.3 ± 0.09 (4-5) days for larval feeding on potato, tomato and eggplant, respectively. As shown in Table (17), the respective percentages of hatching were 100, 78 and 74 %.

At 34.3°C, the averages of the egg incubation period were 2.08 ± 0.06 (2-3), 2.4 +_ 0.10 (2-3) and 2.40 ± 0.10 (2-3) days for potato, tomato and eggplant feeding, respectively. The hatchability percentages amongst the oviposited eggs were 64, 52 and 46 %, respectively.

Comparing the calculated "F" values with those of the tabulated ones indicated the presence of highly significant effect of the larval food on the incubation period of the deposited eggs when individuals were reared at 19.6, 24.5 or 29.4°C. In all cases, this highly significant difference occurred between potato treatments compared with eggplant and tomato compared with eggplant. The difference between potato compared with tomato treatments was, statistically, insignificant (Tables; 13, 14 & 15). At 34.3°C, the incubation period of eggs deposited by females fed, while in the larval stage on potato tubers was, significantly, shorter than those laid by females of tomato or eggplant treatments.

It could be also concluded from Table (17) that a negative relationship existed between temperature and the length of incubation period, where the recorded means of this period (averaged from rearing on the three hosts) were 9.53 days at 19.6°C, 6.41 days at 24.5°C, 3.88 days at 29.4°C and 2.29 days at 34.3°C. Similar results were previously reported by El-Sherif (1961) as

she found the incubation periods of 5.8 and 4.1 days at 25 and 28.8°C. Salama et al. (1972), reported that this period elapsed 6.9, 5.5 and 3.9 days at 25, 30 and 35°C.

Table (17) indicates also that the percentages of hatched eggs varied according to the diet on which the previous larvae were fed. In all rearing temperatures, the highest percentages (90,94, 100 and 64 % at 19.6, 24.5, 29.4 and 34.3°C, respectively) were associated with eggs resulting from females fed, in the larval stage, on potato tubers.

On the effect of temperature on the percentage of hatching, it is clear from Table (17) that the hatchability percentages were, relatively, high when rearing occurred at 19.6, 24.5 and 29.4°C (82.67, 85.33 and 84 % on the averages, respectively). The percentages of hatching were, on the other hand, decreased by rearing insects on the higher temperature (34.3°C), where the mean percentage of eggs hatching from individuals reared on different kinds of hosts was 54 %;46 % and 64 %) (Table, 17). In similar work, Salama et al. (1972) reported the hatchability percentages

of 80, 90 and 80 % at 30, 25 and 35°C, respectively, and 75 % R.H. Briese (1980), reported that the percents of eggs hatching ranged from 100 % at 24°C to 84 % at 34°C.

The total life cycle periods :

The data concerning the life cycle of P. operculella are recorded in Table (18) and shown graphically in Fig. (4). At 19.6°C, the life cycle periods differed significantly from one host to other. The shortest one was obtained by rearing larvae on potato tubers 63.6 ± 0.65 days (58-69), followed by tomato feeding 65.9 ± 0.79 days (64-75) and the longest one was obtained by eggplant feeding 75.3 ± 0.70 days (64-75).

At 24.5°C, the mean of the periods were 48.3 ± 0.74 (44-54), 52.8 ± 0.79 (46-60) and 58.2 ± 0.80 (52-63) days when the insect larvae were fed on potato tubers and tomato and eggplant fruits, respectively. Statistical analysis indicated highly significant differences between means.

When the insects were reared at 29.4°C, the recorded means of the generation periods (Table, 18) were 35.15 ± 0.80 (28-42), 38.9 ± 0.71 (32-42) and 39.8 ± 0.73 (34-45) days for larval feeding on potato, tomato and eggplant, respectively. Statistical analysis showed, also highly significant effect of the larval food on the life cycle.

Rearing at higher temperature of 34.3°C, the obtained means of the total life cycle were 23.4 ± 0.60 (20-29), 24.0 ± 0.41 (21-28) and 24.3 ± 0.62 (20-30) days, in case of insects resulted from larvae fed on potato, tomato and eggplant, respectively. At this temperature, no significant effect of the larval food was detected on the generation periods.

Table (18) : Total life cycle of P. operculella induced from reared at different temperature and various kinds of food. (1st generation).

Larval food	Total life cycle/days			
	19.6°C	24.5°C	29.4°C	34.3°C
Potato tubers	63.6±0.65 (58-69)	48.3±0.74 (44-54)	35.15±0.80 (28-42)	23.4±0.60 (20-29)
Tomato fruits	65.9±0.79 (61-76)	52.8±0.79 (46-60)	38.9 ±0.71 (32-42)	24.0±0.41 (21-28)
Eggplant fruits	75.3±0.70 (64-75)	58.2±0.80 (52-63)	39.8 ±0.73 (34-45)	24.3±0.62 (20-30)
F value	40.7**	47.3**	10.7**	0.77
L.S.D.0.05	2.02	2.06	2.10	
L.S.D.0.01	2.70	2.75	2.80	

** Highly significant.

Second generation :

The effect of the kind of food, i.e.; potato tubers and tomato and eggplant fruits on the different immature stages of P. operculella and the adults longevity and fecundity was also, estimated for individuals from the second generation reared at the aforementioned four thermal conditions (19.6, 24.5, 29.4 and 34.3°C and 68 % R.H.). The obtained data are recorded in Tables (19-29) and Fig.(5) These data ascertained those explained for the first generation.

Table (19) : Durations of larvae, prepupae and pupae, larval mortality and adults emergence by rearing P. operculella larvae on various kinds of food (at temp.=19.6°C and R.H.=68 %) (2nd generation).

Larval food	Larval duration / days					Prepupal period/ days	Larval mortality %	Pupal period/ days	Adults emergence %
	1st instar	2nd instar	3rd instar	4th instar	Total active larval period				
Potato tubers	6.08±0.13 (5-7)	4.0±0.13 (3-5)	4.76±0.15 (4-6)	7.16±0.17 (6-9)	22.0±0.19 (20-24)	3.2±0.10 (2-4)	24.4	13.2±0.15 (12-14)	94.2
Tomato fruits	7.4 ±0.16 (6-9)	4.68±0.11 (4-6)	5.68±0.14 (5-7)	8.72±0.19 (7-10)	26.5±0.29 (24-29)	4.2±0.10 (3-5)	28.57	15.0±0.17 (13-16)	85.8
Eggplant fruits	7.8 ±0.14 (7-9)	5.12±0.18 (3-6)	6.08±0.15 (5-7)	9.0 ±0.10 (8-10)	28.0±0.32 (25-30)	4.8±0.17 (3-6)	34.0	16.12±0.15 (15-17)	87.9
F value	29.0**	15.8**	26.3**	45.55**	142**	13.6**		91.7**	
L.S.D.$_{0.05}$	0.476	0.402	0.373	0.418	0.741	0.618		0.469	
L.S.D.$_{0.01}$	0.639	0.540	0.501	0.561	0.996	0.830		0.629	

** Highly significant.

Table (20) : Durations of larvae, prepupae and pupae, larval mortality and adults emergence by rearing P. operculella larvae on various kinds of food (at temp.=24.5°C and R.H.=68 %) (2nd generation).

Larval food	Larval duration / days					Prepupal period/ days	Larval mortality %	Pupal period/ days	Adults emergence %
	1st instar	2nd instar	3rd instar	4th instar	Total active larval period				
Potato tubers	3.92±0.14 (3-5)	2.92±0.14 (2-4)	3.72±0.12 (3-5)	5.36±0.15 (4-7)	15.92±0.24 (15-19)	2.8±0.15 (2-4)	18.0	8.8 ±0.17 (8-10)	97.6
Tomato fruits	5.0 ±0.14 (4-6)	3.72±0.15 (3-5)	4.2 ±0.13 (3-5)	6.4 ±0.12 (5-7)	19.32±0.23 (18-21)	3.56±0.14 (3-5)	27.1	10.52±0.14 (10-12)	88.6
Eggplant fruits	4.88±0.13 (4-6)	3.6 ±0.14 (3-5)	4.92±0.15 (4-6)	6.88±0.15 (6-8)	20.28±0.22 (19-22)	4.0 ±0.15 (3-5)	31.25	11.32±0.16 (10-12)	90.9
F value	19.8**	11.6**	18.4**	30.2**	109.0**	17.39**		59.2**	
L.S.D.0.05	0.377	0.359	0.386	0.398	0.623	0.414		0.476	
L.S.D.0.01	0.507	0.483	0.518	0.535	0.837	0.556		0.639	

** Highly significant.

Table (21) : Larval, prepupal and pupal durations, larval mortality and adults emergence by rearing P. operculella larvae on various kinds of food (at temp.=29.4°C and R.H.=68 %) (2nd generation).

Larval food	Larval duration / days					Prepupal period/ days	Larval mortality %	Pupal period/ days	Adults emergence %
	1st instar	2nd instar	3rd instar	4th instar	Total active larval period				
Potato tubers	3.0 ±0.12 (2-4)	2.12±0.06 (2-3)	2.36±0.10 (2-3)	3.88±0.13 (3-5)	11.36±0.11 (10-12)	1.32±0.10 (1-2)	19.1	6.6±0.13 (6-7)	97.4
Tomato fruits	3.8 ±0.18 (3-5)	2.52±0.13 (2-4)	2.92±0.15 (2-4)	4.92±0.18 (4-7)	14.2 ±0.24 (12-17)	1.68±0.10 (1-2)	24.4	7.6±0.20 (6-9)	88.2
Eggplant fruits	3.48±0.16 (2-5)	2.52±0.13 (2-4)	3.6 ±0.14 (3-5)	4.8 ±0.14 (4-6)	14.4 ±0.31 (12-16)	1.36±0.10 (1-2)	39.58	8.68±0.13 (8-10)	93.2
F value	8.0**	3.5*	25.3**	13.5**	51.6**	4.9*		38.6**	
L.S.D.0.05	0.402	0.359	0.351	0.440	0.673	0.254		0.476	
L.S.D.0.01	0.540	0.483	0.471	0.592	0.904	0.342		0.638	

* Significant.

** Highly significant.

Table (22) : Larval, prepupal and pupal durations, larval mortality and adults emergence by rearing P. operculella larvae on various kinds of food (at temp.=34.3°C and R.H.=68 %) (2nd generation).

Larval food	Larval duration / days					Prepupal period/ days	Larval mortality %	Pupal period/ days	Adults emergence %
	1st instar	2nd instar	3rd instar	4th instar	Total active larval period				
Potato tubers	2.2 ±0.08 (2-3)	1.44±0.10 (1-2)	2.08±0.06 (2-3)	2.96±0.04 (2-3)	8.68±0.14 (7-10)	1.08±0.06 (1-2)	28.1	4.36±0.10 (4-5)	68.7
Tomato fruits	2.36±0.10 (2-3)	1.48±0.10 (1-2)	2.12±0.07 (2-3)	3.2 ±0.08 (3-4)	9.16±0.20 (8-11)	1.36±0.10 (1-2)	32.5	4.6 ±0.10 (4-5)	59.3
Eggplant fruits	2.48±0.10 (2-3)	1.88±0.11 (1-3)	2.2 ±0.08 (2-3)	3.28±0.09 (3-4)	9.84±0.17 (9-12)	1.32±0.10 (1-2)	51.28	5.12±0.15 (4-6)	76.4
F value	2.47	5.0*	1.1	5.8*	14.1**	3.05		9.5**	
L.S.D.0.05		0.311		0.197	0.440			0.359	
L.S.D.0.01		0.418		0.265	0.592			0.483	

* Significant.
** Highly significant.

Table (23) : Effect of larval food on the pupal weight of both sexes of P. operculella at different temperatures and 68 % R.H. (2nd generation).

Larval food	Pupal weight							
	19.6 °C		24.5 °C		29.4 °C		34.3 °C	
	♀	♂	♀	♂	♀	♂	♀	♂
Potato tubers	10.6±0.58 (10-12.6)	9.1±0.39 (9.0-10)	11.3±1.12 (9.0-13.0)	8.8±0.50 (8.0-10)	11.0±0.83 (10-13)	9.2±0.33 (8.4-10)	10.0±0.41 (9.0-11)	8.4±0.62 (7-10)
Tomato fruits	8.5±0.44 (7.5-9.3)	6.1±0.29 (5.7-7)	9.8±0.85 (8.0-12.0)	6.3±0.49 (4.9-7.3)	9.2±0.59 (7.5-10)	5.8±0.75 (4.0-7.5)	8.4±0.32 (7.5-9)	6.1±0.47 (4.8-7.0)
Eggplant fruits	7.1±0.38 (6.0-7.7)	4.4±0.23 (4-5)	7.1±0.37 (6.3-8.0)	5.0±0.08 (4.8-5.2)	6.8±0.34 (5.9-7.5)	5.2±0.48 (4.0-6.3)	6.2±0.33 (5.7-7.1)	4.5±0.20 (4.1-5.0)
F value	28.8**	94.8**	9.6**	65.2**	16.2**	14.3**	7.3**	42.6**
$L.S.D._{0.05}$	1.340	0.865	2.378	0.865	2.256	1.973	2.790	1.186
$L.S.D._{0.01}$	2.030	1.311	3.604	1.311	3.418	2.989	4.224	1.797

** Highly significant.

Table (25) : Oviposition period , adult longevity and average number of eggs/female from P. operculella larvae fed on different kinds of food. (Rearing at temp. = 24.5°C and R.H. = 68 %) (2nd generation).

Offered food	Period of /days			Longevity/days		Average no. of eggs laid/ ♀
	Pre-oviposition	Oviposition	Post-oviposition	♀	♂	
Potato tubers	1.9±0.10 (1-2)	7.2±0.66 (4-11)	6.6±0.60 (3-9)	15.7±0.54 (12-18)	14.0±0.63 (10-16)	91.1±5.43 (61-117)
Tomato fruits	2.2±0.20 (1-3)	5.6±0.45 (4-9)	6.2±0.47 (4-9)	14.0±0.58 (11-17)	11.6±0.60 (9-14)	68.0±6.66 (35-93)
Eggplant fruits	2.4±0.16 (2-3)	5.3±0.75 (2-10)	5.9±0.32 (4-7)	13.6±0.61 (12-17)	11.0±0.62 (8-14)	52.5±6.53 (29-82)
F value	2.5	3.5	0.5	5.92*	8.03**	23.58**
L.S.D.$_{0.05}$				1.36	1.67	11.893
L.S.D.$_{0.01}$				1.87	2.28	16.280

* Significant.

** Highly significant.

Table (26) : Oviposition period , adult longevity and average number of eggs/female from P. operculella larvae fed on different kinds of food. (Rearing at temp. = 29.4°C and R.H. = 68 %) (2nd generation.

Offered food	Period of /days			Longevity/days		Average no. of eggs laid/ ♀
	Pre-oviposition	Oviposition	Post-oviposition	♀	♂	
Potato tubers	1.5±0.17 (1-2)	6.2±0.73 (3-10)	4.3±0.40 (2-6)	12.0±0.70 (9-15)	10.8±0.71 (8-15)	119.1±4.45 (98-137)
Tomato fruits	2.1±0.18 (1-3)	5.4±0.45 (3-7)	3.1±0.38 (2-5)	10.6±0.52 (9-13)	9.0±0.65 (6-13)	76.5±8.20 (36-113)
Eggplant fruits	1.9±0.23 (1-3)	5.1±0.48 (3-8)	3.4±0.37 (2-5)	10.4±0.60 (8-14)	9.2±0.65 (6-13)	60.0±6.00 (35-89)
F value	3.65*	0.90	3.5	1.8	1.8	15.64**
L.S.D.0.05	0.479					22.803
L.S.D.0.01	0.656					31.237

* Significant.

** Highly significant.

Table (27) : Oviposition period , adult longevity and average number of eggs/female from *P. operculella* larvae fed on different kinds of food. (Rearing at temp. 34.3°C and R.H. 68 %) (2nd generation).

Offered food	Period of /days			Longevity/days		Average no. of eggs laid/ ♀
	Pre-oviposition	Oviposition	Post-oviposition	♀	♂	
Potato tubers	2.57±0.17 (2-3)	3.71±0.61 (2-6)	2.28±0.18 (2-3)	7.8±0.63 (4-11)	6.0±0.52 (4-8)	15.0±4.26 (0-29)
Tomato fruits	2.5 ±0.22 (2-3)	3.0 ±0.37 (2-4)	1.0 ±0.37 (0-2)	7.1±0.57 (4-10)	5.7±0.67 (3-9)	9.5±3.78 (0-21)
Eggplant fruits	2.6 ±0.25 (2-3)	2.8 ±0.20 (2-3)	1.4 ±0.25 (1-2)	6.5±0.52 (4-9)	5.3±0.40 (4-8)	6.0±3.00 (0-16)
F value	0.1	1.1	3.7	1.3	0.4	3.5
$L.S.D._{0.05}$						
$L.S.D._{0.01}$						

Table (28) : Incubation period and hatchability of P. operculella-eggs induced from larvae reared at different temperatures and on various kinds of food (2nd generation).

Larval food	Incubation period for rearing at				Hatchability %			
	19.6°C	24.5°C	29.4°C	34.3°C	19.6°C	24.5 C	29.4°C	34.3°C
Potato tubers	8.6±0.16 (8-10)	5.8±0.08 (5-6)	3.4±0.10 (3-4)	2.16±0.07 (2-3)	94	96	90	59
Tomato fruits	9.6±0.10 (9-10)	6.5±0.10 (6-7)	4.0±0.15 (3-5)	2.48±0.10 (2-3)	82	76	90	48
Eggplant fruits	10.4±0.13 (10-12)	7.2±0.16 (6-8)	4.1±0.15 (3-5)	2.52±0.10 (2-3)	74	88	80	54
F value	58.1**	40.8**	8.3**	4.9*				
L.S.D.0.05	0.337	0.321	0.359	0.254				
L.S.D.0.01	0.452	0.432	0.483	0.342				

* Significant.
** Highly significant.

Table (29) : Total life cycle of P. operculella induced from reared at different temperature and various kinds of food. (2nd generation).

Larval food	Total life cycle/days			
	19.6°C	24.5°C	29.4°C	34.3°C
Potato tubers	61.0±0.77 (54-68)	48.6±0.69 (42-54)	33.4±0.67 (30-39)	22.8±0.52 (18-27)
Tomato fruits	70.0±0.66 (62-74)	52.4±0.68 (46-57)	36.8±0.56 (32-40)	24.0±0.34 (19-28)
Eggplant fruits	73.5±0.72 (64-78)	52.7±0.95 (46-61)	38.6±0.48 (35-44)	24.4±0.46 (20-29)
F value	66.3**	14.4**	16.9**	3.38*
L.S.D.0.05	1.88	1.78	1.48	1.38
L.S.D.0.01	2.52	2.38	1.98	1.85

* Significant.

** Highly significant.

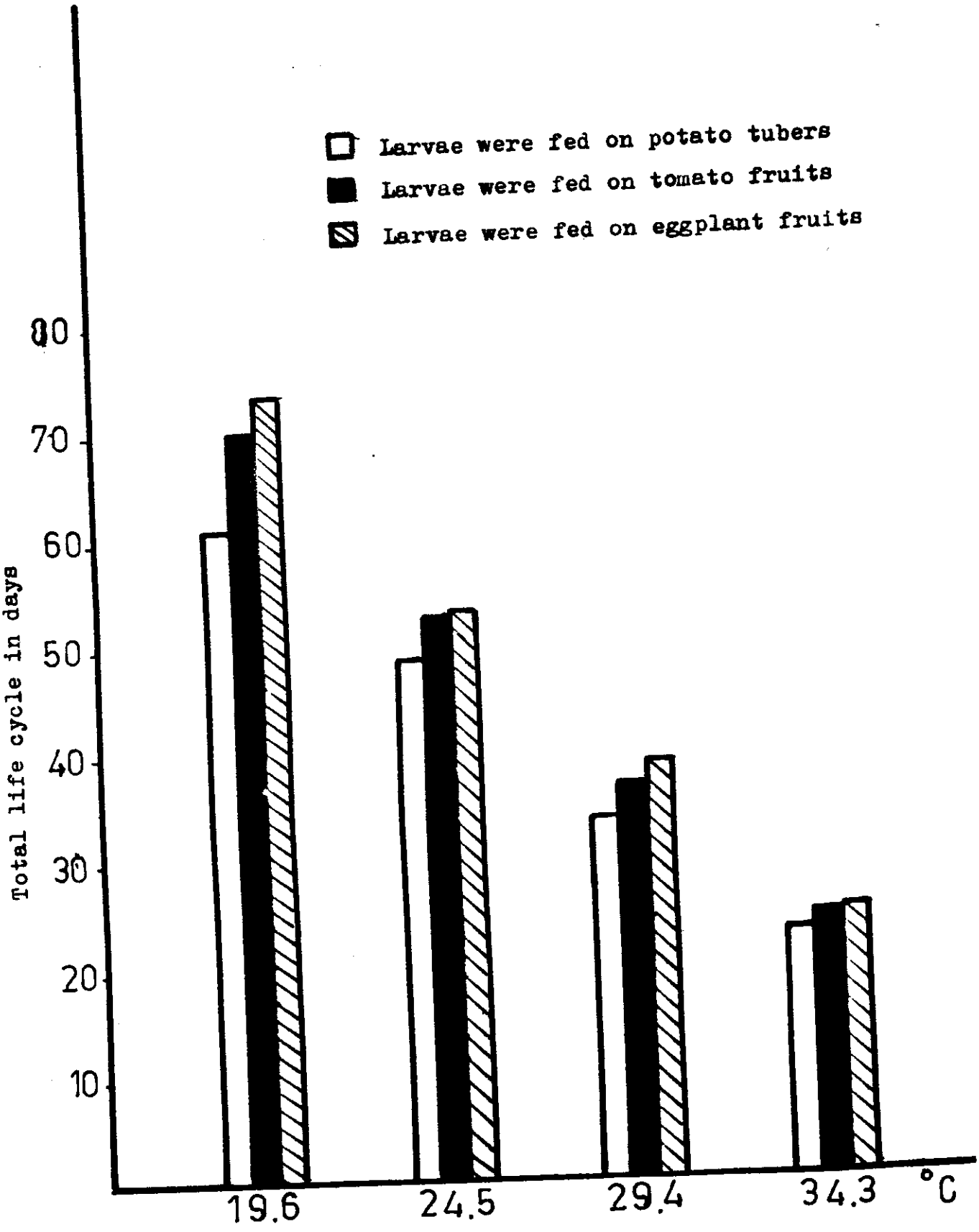

Fig. (5) : Total life cycle of P. operculella induced from reared at different temperatures and on various kinds of food (2nd generation).

Effect of different temperatures on the various insect's stages :

The previous mentioned results for both generations announced clearly that the kind of larval food has a definite effect on the durations of the different stages of P. operculella under any degree of temperature. As shown in Tables (8-18) and Tables (19-29), the data obtained on the incubation periods, larval and pupal durations and adult longevities were subjected, in each treatment to statistical analysis using "F" test and calculating the L.S.D. (0.05 and 0.01) values, Tables (30 & 31), indicated the presence of significant differences between their means in each case in the two generations.

Table (30) : Statistical analysis showing the effect of various temperatures on the different stages of P. operculella (1st generation).

Period (days)	Mean period at °C. 19.6	24.5	29.4	34.3	F value	L.S.D. 0.05	0.01
Incubation	9.5	6.4	3.9	2.3	375.0	0.57	0.86
Larvae	24.4	19.1	16.0	9.1	88.4	2.45	3.71
Pupae	15.0	10.6	7.7	4.7	174.8	1.15	1.74
Adult longevity ♀	16.2	14.6	11.5	6.9	79.2	1.59	2.40
Adult longevity ♂	14.6	12.3	10.3	5.9	506.3	0.57	0.86

Table (31) : Statistical analysis showing the effect of various temperatures on the different stages of P. operculella. (2nd generation).

Period (days)	Mean period at °C. 19.6	24.5	29.4	34.3	F value	L.S.D. 0.05	0.01
Incubation	9.5	6.5	3.9	2.4	227.6	0.72	1.09
Larvae	25.5	18.5	13.3	9.2	113.5	2.28	3.45
Pupa	14.7	10.2	7.6	4.7	180.0	1.09	1.66
Adult ♀	15.7	14.4	11.0	7.1	629.3	0.53	0.80
longevity ♂	14.0	12.2	9.7	5.7	122.5	1.13	1.71