Results and Discussion

4. RESULTS AND DISCUSSION

4.1- Toxicological Studies :

4.1.1- Susceptibility of sugar beet eggs and toxicity index to different insecticides :

The LC_{50}, slope (b) values and the calculated toxicity index of the nine insecticides tested against sugar beet *C. vittata* field population are recorded in Tables (1 & 2).

The data concerning toxicity of egg stage shown in Table (1) revealed in general the highly pronounced toxicity of the carbamate carbosulfan, recording T.I. = 100, whereas both of abamectin and the O.P. profenofos came next and exhibited moderate toxicity (ovicidal activity), recording T.I. of 63.86 and 61.29, respectively. Other tested insecticides revealed poor toxicity against sugar beet eggs recording T.I. of 19.26, 19.24, 16.20, 6.78 and 6.54 for azadirachtin, pyriproxyfen, lufenuron, hexaflumuron and spinosad, respectively.

El-Khouly and Omar (2002) tested the efficiency of profenofos, carbosulfan and chlorfenapyr against eggs, larvae, pupae and adults of the tortoise beetle, *C. vittata* inhabiting sugar beet fields in Kafr El-Sheikh Governorate during 1999/2000 and 2000/ 2001 sugar beet growing seasons. Data obtained revealed that when mortality rates were considered, profenofos and carbosulfan were the most efficient compounds against eggs, larvae, pupae and adults of *C. vittata*. However, chlorfenapyr demonstrates a moderate toxic effect. The side effects of the tested insecticides on the associated bio-agents, *viz*, *Coccinella undecimpunctata, Chrysoperla carnea* and *Paederus alfierii* was studied. Unfortunately, profenofos and carbosulfan demonstrate unacceptable toxic effect. Chlorfenapyr was moderately effective either in controlling the insect pest or in its side effect on the associated predators.

Table (1). Toxicity data and toxicity index ratios of nine insecticides against eggs of *Cassida vittata*.

Insecticides		**LC_{50}*** **(ppm)**	**Slope ± SE**	**T.I.**
Profenofos	72 % EC	1.24 (0.87-1.71)	1.92±0.30	61.29
Carbosulfan	25 % WP	0.76 (0.55-1.13)	1.62±0.29	100.00
Pyriproxyfen	10 % EC	3.95 (2.66-5.77)	1.57±0.10	19.24
Lufenuron	5 % EC	4.69 (3.18-6.82)	1.48±0.27	16.20
Hexaflumuron	10 % EC	11.20 (7.66-16.24)	1.37±0.26	6.78
Methoxyfenozide	24 % SC	7.55 (5.07-11.06)	1.62±0.29	10.06
Spinosad	24 % SC	11.61 (7.37-16.99)	1.53±0.27	6.54
Azadirachtin	1 % EC	3.94 (2.65-5.77)	1.71±0.30	19.28
Abamectin	1.8 % EC	1.19 (0.82-1.73)	1.77±0.29	63.86

* LC_{50} (CL 95 %)

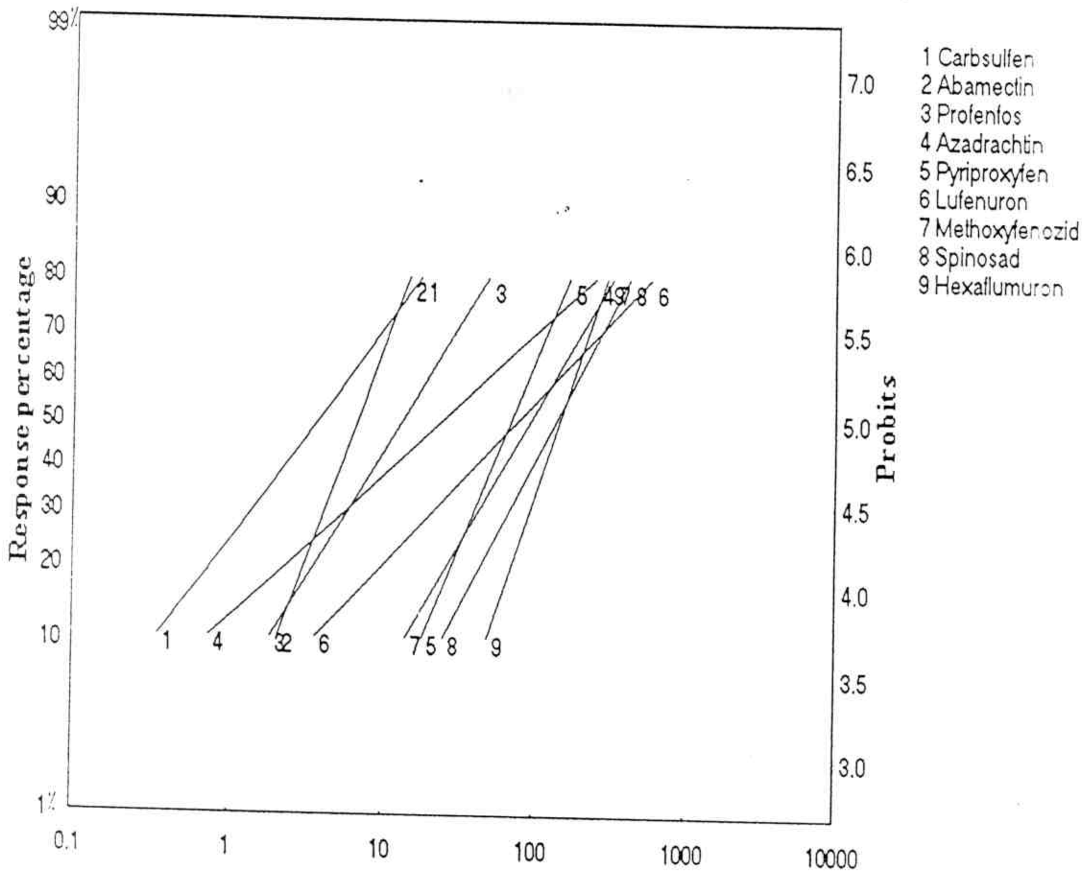

Fig. (1). Log-probit concentration lines of nine different insecticides against the eggs of *C. vittata*.

4.1.2- Susceptibility of sugar beet adults and toxicity index to different insecticides :

Data in Table (2) includes slope of mortality regression lines, the estimated LC_{50} values and calculated toxicity index.

It was obvious that carbosulfan was still the most toxic compound against *C. vittata* adult recording T.I. of 100, and abamectin and profenofos came next and exhibiting moderate toxicity index of 54.07 and 25.90, respectively. Other insecticides were mostly non-effective and the calculated T.I. were 14.06, 4.96, 4.48, 3.72, 2.54 and 2.41 for azadirachtin, pyriproxyfen, lufenuron, methoxyfenozide, spinosad and hexaflumuron, respectively.

El-Khouly (1998) found that Selecron (profenofos) caused high significant adult mortality, whereas Neemazal (azadirachtin formulation) was less potent which agree mostly with the present findings.

Table (2). Toxicity data and toxicity index ratios of nine insecticides against adults of *Cassida vittata*.

Insecticides		LC_{50}* (ppm)	Slope ± SE	T.I.
Profenofos	72 % EC	13.82 (9.18-22.73)	1.47±0.37	25.90
Carbosulfan	25 % WP	3.58 (2.16-5.25)	1.52±0.27	100.00
Pyriproxyfen	10 % EC	72.13 (34.46-307.89)	2.20±1.04	4.96
Lufenuron	5 % EC	79.75 (43.00-793.21)	0.95±0.36	4.48
Hexaflumuron	10 % EC	148.54 (117.68-233.22)	2.74±0.70	2.41
Methoxyfenozide	24 % SC	96.18 (58.13-137.86)	1.56±0.32	3.72
Spinosad	24 % SC	140.84 (100.10-491.25)	1.73±0.32	2.54
Azadirachtin	1 % EC	25.45 (3.23-55.08)	0.83±0.34	14.06
Abamectin	1.8 % EC	6.62 (5.29-9.18)	2.47±0.53	54.07

* LC_{50} (CL 95 %)

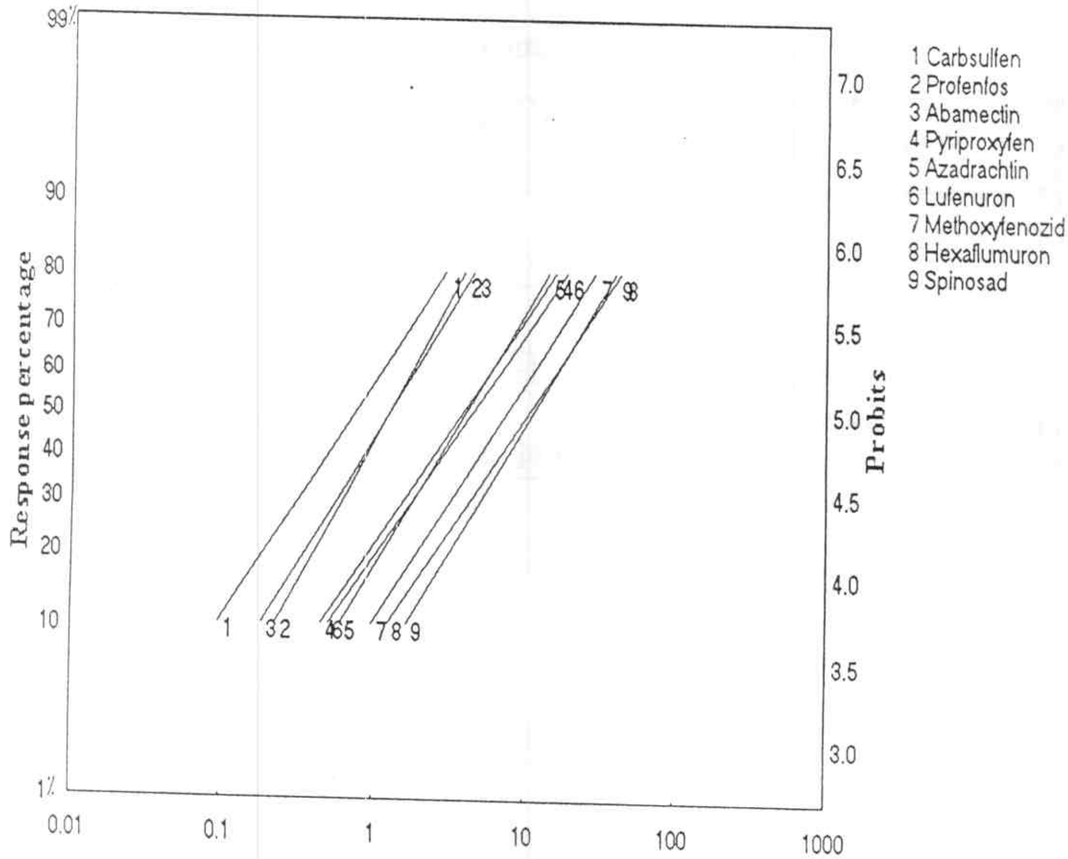

Fig. (2). Log-probit concentration lines of nine different insecticides against the adults of *C. vittata*.

4.2-Physiological Studies :

4.2.1- Initial and bioresidual toxicity of different pesticides on adult *C. vittata* :

Results in Table (3) demonstrate the percentages of initial and residual adult mortalities occurring after feeding for 2 days on sugar beet leaves treated with the tested insecticides at different time intervals following application under field conditions, among the four groups of adult *C. vittata*.

Data representing initial toxicity for the 1*st* group of adult which were exposed for 24 h feeding period on treated sugar beet leaves collected at zero day and survivors adults continued their feeding for another 24 h on treated sugar beet leaves collected at 1 day following application are presented in Table (3). The percentage of initial mortalities after 48 h feeding on treated sugar beet leaves and 72 h feeding on untreated sugar beet leaves reached 100 % for profenofos (750 and 187.5 ml/fed.) and carbosulfan (800 and 200 gm/fed.), while reached 70 and 55 % for pyriproxyfen (100 and 25 ml/fed.), 65 and 60 % for lufenuron (40 and 10 ml/fed.), 60 and 40 % for hexaflumuron (200 and 50 ml/fed.), 65 and 60 % for methoxyfenozide (350 and 87.5 ml/fed.), 70 and 65 % for spinosad (350 and 87.5 ml/fed.), 60 and 50 % for azadirachtin (300 and 75 ml/fed.) and 60 and 40 % for abamectin (40 and 10 ml/fed.).

The bioresidual toxicity of the tested insecticides on the second group of adults fed for 48 h on treated sugar beet leaves collected at 7 and 8 days following application and followed by feeding 3 days on untreated leaves are also presented in Table (3). The adult mortalities reached 100 % for carbosulfan (800 and 200 gm/fed.) and profenofos (750 ml/fed.), while reached 65 % for pyriproxyfen (100 ml/fed.), 55 % for profenofos (187.5 ml/fed.), hexaflumuron (200 ml/fed.), and spinosad (350 ml/fed.), 50 % for pyriproxyfen (25 ml./fed.), lufenuron (40 ml/fed.), methoxyfenozide (350 ml/fed.), azadirachtin (300 ml/fed.) and abamectin (40 ml/fed.), 45 % for spinosad (87.5 ml/fed.), 40 % for

Table (3). Initial and bioresidual toxicity of different insecticides against the adult *Cassida vittata* fed on treated sugar beet leaves for 48 h followed by 3 days feeding on untreated sugar beet leaves.

Insecticides	Rate ml./fed.	% Adult mortality for groups of adults fed on treated leaves collected at the indicated days					Overall mean* ± S.E.	
		Initial toxicity	Bioresidual toxicity					
		1st interval (0-1 day)	2nd interval (7-8 day)	3rd interval (14-15 day)	4th interval (21-22 day)	Mean		
Profenofos	750	100	100	90	65	85.00	88.75±16.52	a
72 % EC	187.5	100	55	40	30	41.66	56.25±30.92	cd
Carbosulfan	800	100	100	100	90	96.66	97.50±5.00	a
25 % WP	200	100	100	65	35	66.66	75.00±31.35	b
Pyriproxyfen	100	70	65	60	40	55.00	58.75±13.14	c
10 % EC	25	55	50	40	20	36.66	41.25±15.47	defg
Lufenuron	40	65	50	45	40	45.00	50.00±10.80	cde
5 % EC	10	60	40	20	10	23.33	32.50±22.17	fg
Hexaflumuron	200	60	55	45	40	46.66	50.00±9.12	cde
10 % EC	50	40	35	30	15	26.66	30.00±10.80	fg
Methoxyfenozide	350	65	50	50	45	48.33	52.50±8.66	cde
24 % SC	87.5	60	40	20	10	23.33	32.50±22.17	fg
Spinosad	350	70	55	55	50	53.33	57.50±8.66	c
24 % SC	87.5	65	45	25	15	28.33	37.50±22.17	efg
Azadirachtin	300	60	50	40	15	35.00	41.25±19.31	defg
1 % EC	75	50	40	30	10	26.66	32.50±17.07	fg
Abamectin	40	60	50	40	30	40.00	45.00±12.90	cdef
1.8 % EC	10	40	35	20	10	21.66	26.25±13.76	g
Control	-	3	1	2	3	2.00	2.25±0.95	h

* Mean followed by the same letter(s) are not significantly different according to Duncan's multiple range test.
L.S.D. at 0.05 = 13.17

lufenuron (10 ml/fed.), methoxyfenozide (87.5 ml/fed.) and azadirachtin (75 ml/fed.), 35 % for hexaflumuron (50 ml/fed.) and abamectin (10 ml/fed.).

Results of the *3rd* group of adults fed for 48 h on treated sugar beet leaves collected from the field at 14 and 15 days after application and then fed for 3 days on treated sugar beet leaves are presented in Table (3). The residual percentage mortalities reached 100 % for carbosulfan (800 gm/fed.), 90 % for profenofos (750 ml/fed.), 65 % for carbosulfan (200 gm/fed.), 60 % for pyriproxyfen (100 ml/fed.), 55 % for spinosad (350 ml/fed.), 50 % for methoxyfenozide (350 ml/fed.), 45 % for lufenuron (40 ml/fed.) and hexaflumuron (200 ml/fed.) , 40 % for profenofos (187.5 ml/fed.), pyriproxyfen (25 ml./fed.), azadirachtin (300 ml/fed.) and abamectin (40 ml/fed.), 30 % for hexaflumuron (50 ml/fed.), 30 % for hexaflumuron (50 ml/fed.) and azadirachtin (75 ml/fed.), 25 % for spinosad (87.5 ml/fed.), 20 % for lufenuron (10 ml/fed.), methoxyfenozide (87.5 ml/fed.) and abamectin (10 ml/fed.).

Following the bioresidual toxicity of tested insecticides over 21 days, the data obtained for the *4th* group of adults (Table, 3) demonstrate that the efficacy reached 90 % for carbosulfan (800 gm/ fed.), 65 % for profenofos (750 ml/fed.), 50 % for spinosad (350 ml/ fed.), 45 % for methoxyfenozide (350 ml/fed.), 40 % for pyriproxyfen (100 ml/fed.), lufenuron (40 ml/fed.), and hexaflumuron (200 ml/fed.), 35 % for carbosulfan (200 gm/fed.), 30 % for profenofos (187.5 ml/fed.) and abamectin (40 ml/fed.), 20 % for pyriproxyfen (25 ml/fed.), 15 % for hexaflumuron (50 ml/fed.), spinosad (87.5 ml/fed.) and azadirachtin (300 ml/fed.); 10 % for lufenuron (10 ml/fed.), methoxyfenozide (87.5 ml/fed.), azadirachtin (75 ml/fed.) and abamectin (10 ml/fed.).

The mean residual toxicity of *2nd*, *3rd* and *4th* groups of adults are also presented in Table (3). It demonstrated 96.66, 85.00, 66.66, 55.00, 53.33, 48.33, 46.66, 45.00, 41.66, 40.00, 36.66, 35.00, 28.33, 26.66, 26.66, 23.33, 23.33 and 21.66 % adults mortality for carbosulfan (800 gm/fed.), profenofos (750 ml/fed.), carbosulfan (200 gm/fed.), pyriproxyfen (100 ml/fed.), spinosad (350 ml/fed.), methoxyfenozide (350 ml/fed.), hexaflumuron (200 ml/fed.), lufenuron (40 ml/fed.), profenofos (187.5 ml/fed.), abamectin (40 ml/fed.), pyriproxyfen (25 ml/fed.), azadirachtin (300 ml/fed.), spinosad (87.5 ml/fed.), hexaflumuron (50 ml/fed.), azadirachtin (75 ml/fed.), lufenuron (10 ml/ fed.), methoxyfenozide (87.5 ml/fed.), abamectin (10 ml/fed.), respectively.

The overall mean adult mortality percentages were 97.50, 88.75, 75.00, 58.75, 57.50, 56.25, 52.50, 50.00, 50.00, 45.00, 41.25, 41.25, 37.50, 32.50, 32.50, 32.50 and 26.25 % for carbosulfan (800 gm/fed.), profenofos (720 ml/fed.), carbosulfan (200 gm gm/fed.), pyriproxyfen (100 ml/fed.), spinosad (350 ml/fed.), profenofos (187.5 ml/fed.), methoxyfenozide (350 ml/fed.), lufenuron (40 ml/fed.), hexaflumuron (200 ml/fed.), abamectin (40 ml/fed.), pyriproxyfen (25 ml/fed.), azadirachtin (300 ml/fed.), spinosad (87.5 ml/fed.), lufenuron (10 ml/fed.), methoxyfenozide (87.5 ml/fed.), azadirachtin (75 ml/fed.), abamectin (10 ml/fed.), respectively.

The statistical analysis of the results showed that carbosulfan was the most effective compound and has higher residual activity against the adult population of *C. vittata* at rate (800 gm/fed.) and the least toxic compound having short residuality was abamectin at the rate of (10 ml/fed.), (Table, 3).

In agreement to our results, **El-Sebae *et al* (1987)** found that organophosphorus pesticides like Selecron (profenofos) gave complete protection against *C. vittata* for a long period of 15 days after application. Also, **Saleh (1994b)** found that adults of *C. vittata* was susceptible to profenofos where the insecticide caused high initial mortality and that these results were confirmed under field application. Similarly, **Abu El-Fetouh (1995)** found that profenofos was the most toxic under field up till 21 days posttreatment against *C. vittata*. Likewise, **Ali (1996)** found that Selecron (profenofos) gave complete protection against *C. vittata* adults for 15 day after treatment.

Recently, **El-Khouly (2002)** found that profenofos was the most effective compound against *C. vittata* under field conditions in this respect.

4.2.2- Latent effect of different pesticides on certain developmental aspects in *C. vittata* biology :

4.2.2.1- Effect on accumulated adult mortality :

Under laboratory conditions, surviving adult after feeding on and exposure to residues of certain insecticides on sugar beet leaves, collected after various periods of spraying, were allowed to complete their adult stage duration. Results of overall accumulated adult mortality is given in Table (4). The tested time intervals at which treated leaves were collected are as follows :

a- Zero and 1*st* day time interval for the 1*st* group of adults.

b- 7*th* and 8*th* day time interval for the 2*nd* group of adults.

c- 14*th* and 15*th* day time interval for the 3*rd* group of adults.

d- 21*th* and 22*nd* day time interval for the 4*th* group of adults.

Data in Table (4) elucidate the overall mortality of the adult stage of *C. vittata* till pupation. The results of the 1*st* group of adults which were fed on treated sugar beet leaves collected at 0-1 days after spraying revealed that both profenofos and carbosulfan caused 100 % mortality, pyriproxyfen caused 67-76 %, lufenuron caused 66-73 %, hexaflumuron caused 49-67 %, methoxyfenozide caused 64-72 %, spinosad caused 69-75 %, azadirachtin caused 54-65 % and abamectin exhibited 44-66 % mortality. Regarding the 2*nd* group of adults, the resulted mortalities were 100-100 %, 66-100 %, 62-71 %, 46-57 %, 44-63 %, 46-61 %, 51-63 %, 49-62 % and 38-61 % for carbosulfan, profenofos, pyriproxyfen, lufenuron, hexaflumuron, methoxyfenozide, spinosad, azadirachtin and abamectin, respectively. In the 3*rd* group of adults which were fed on treated sugar beet leaves collected at 14-15 days after spraying, the accumulated adult mortalities reached 76-100 %, 47-96 %, 46-64 %, 31-54 %, 38-52 %, 27-59 %, 32-61 %, 39-52 %

Table (4). Accumulated adults mortality till pupation for groups of adults of *C. vittata* fed for 48 h on treated sugar beet leaves collected at different time intervals after applying certain insecticides under field conditions.

Insecticides	Rate ml./ fed.	Overall % adults mortality till pupation for groups of adults fed on treated leaves collected at the indicated days				Mean adult mortality* ± S.D.	
		1st interval (0-1 day)	2nd interval (7-8 day)	3rd interval (14-15 day)	4th interval (21-22 day)		
Profenofos 72 % EC	750	100	100	96	75	92.75±11.98	ab
	187.5	100	66	47	36	62.25±28.05	cd
Carbosulfan 25 % WP	800	100	100	100	94	98.50±3.00	a
	200	100	100	76	47	80.75±25.12	b
Pyriproxyfen 10 % EC	100	76	71	64	49	65.00±11.74	c
	25	67	62	46	23	49.50±19.80	def
Lufenuron 5 % EC	40	73	57	54	51	58.75±9.81	cd
	10	66	46	31	22	41.25±19.24	efg
Hexaflumuron 10 % EC	200	67	63	52	49	57.75±8.61	cd
	50	49	44	38	25	39.00±10.36	fg
Methoxyfenozide 24 % SC	350	72	61	59	54	61.50±7.59	cd
	87.5	64	46	27	17	38.50±20.82	fg
Spinosad 24 % SC	350	75	63	61	57	64.50±7.18	c
	87.5	69	51	32	23	43.75±20.48	efg
Azadirachtin 1 % EC	300	65	62	52	19	49.50±21.07	def
	75	54	49	39	14	39.00±17.79	fg
Abamectin 1.8 % EC	40	66	61	51	36	53.50±13.22	cde
	10	44	38	29	17	32.00±11.74	g
Control	-	4	3	5	6	4.25±1.29	h

* Mean followed by the same letter(s) are not significantly different according to Duncan's multiple range test.
L.S.D. at 0.05 = 12.33

and 29-51 % for carbosulfan, profenofos, pyriproxyfen, lufenuron, hexaflumuron, methoxyfenozide, spinosad, azadirachtin and abamectin, respectively. In the *4th* period of exposure, the adult fed on sugar beet leaves collected after 21-22 days from spraying showed 47-94 %, 36-75 %, 23-49 %, 22-51 %, 25-49 %, 17-54 %, 23-59 %, 14-19 %, 17-36 % mortalities for carbosulfan, profenofos, pyriproxyfen, lufenuron, hexaflumuron, methoxyfenozide, spinosad, azadirachtin, and abamectin, respectively (Table, 4). The mean percent accumulated adult mortalities were 80.75-98.50 %, 62.25-92.75 %, 49.50-65.00 %, 41.25-58.75 %, 39.00-57.75 %, 38.50-61.50 %, 43.75-64.50 %, 39.00-49.50 % and 32.00-53.50 % for carbosulfan, profenofos, pyriproxyfen, lufenuron, hexaflumuron, methoxyfenozide, spinosad, azadirachtin and abamectin, respectively.

Carbosulfan at 800 gm/fed. caused a significant increase in adult mortality (98.50 %), when compared with all other treatments, while abamectin at 10 ml/fed. demonstrated the least significant effect on adult mortality (32.00 %).

Previous studies carried out early by **Rizk and Radwan (1975)** indicated that feeding *S. littoralis 4th* instar larvae continuously for 0-5 days after application of chitin biosynthesis inhibitor, diflubenzuron (PH-6040) induced justified performance. Likewise, **Watson (1981)** found that the highest efficacy was achieved when mortality counts were assessed after 48 h exposure and feeding on IGR-treated leaves. Furthermore, **Bayoumi *et al.* (1998)** found that percentage accumulative mortality varied according to the compound, concentration, larval instar and/or strain studied.

4.2.2.2- Effect on adult longevity :

The latent effect of feeding adult of *C. vittata* on sugar beet leaves treated with insecticides are shown in Table (5) when adults longevity was concerned.

Table (5). Adult longevity of *C. vittata* for groups of adults fed on 48 h on treated sugar beet leaves collected at different time intervals after applying insecticides under field conditions.

Insecticides	Rate/ fed. (ml.)	Adult longevity (in days) resulted from groups of adult survived after feeding on treated sugar beet leaves collected at indicated days :							
		1st interval (0-1 day)		*2nd* interval (7-8 day)		*3rd* interval (14-15 day)		*4th* interval (21-22 day)	
		Duration (day)	% change	Duration (day)	% change	Duration (day)	% change	Duration (day)	% change
Profenofos	750	-	-	-	-	89.4	+19.67	80.2	+09.11
72 % EC	187.5	-	-	91.5	+21.51	85.3	+14.19	78.6	+06.93
Carbosulfan	800	-	-	-	-	-	-	87.2	+18.63
25 % WP	200	-	-	-	-	90.3	+20.88	84.6	+15.10
Pyriproxyfen	100	120.3	+59.12	117.2	+55.64	112.4	+50.46	108.2	+47.21
10 % EC	25	109.7	+45.10	103.4	+37.31	96.2	+28.78	92.7	+26.12
Lufenuron	40	116.4	+53.96	109.7	+45.68	103.3	+38.28	99.6	+35.51
5 % EC	10	110.3	+45.89	101.2	+34.39	98.6	+31.99	93.7	+27.48
Hexaflumuron	200	109.2	+44.44	104.6	+38.11	97.8	+30.92	92.1	+25.30
10 % EC	50	101.3	+33.99	97.3	+29.21	91.6	+22.62	85.5	+16.32
Methoxyfenozide	350	87.9	+16.26	83.2	+10.49	80.3	+07.49	79.6	+08.29
24 % SC	87.5	85.2	+12.69	81.6	+08.36	79.5	+06.42	78.3	+06.53
Spinosad	350	79.3	+06.61	78.4	+04.11	77.5	+03.74	78.2	+06.39
24 % SC	87.5	83.4	+04.89	76.2	+01.19	75.2	+00.66	74.3	+01.08
Azadirachtin	300	82.3	+10.31	80.9	+07.43	78.4	+04.95	75.6	+02.85
1 % EC	75	82.6	+08.86	79.2	+05.17	77.2	+03.34	74.4	+01.22
Abamectin	40	81.7	+09.25	80.3	+06.64	79.4	+06.29	77.6	+05.57
1.8 % EC	10	75.6	+08.06	79.6	+05.71	77.3	+03.48	75.2	+02.31
Control	-	75.6		75.3		74.7		73.5	

Data in Table (5) revealed remarkable increase than control in adults longevity by 15.10-18.63 % for carbosulfan, 6.93-9.11 % for profenofos, 26.12-47.21 % for pyriproxyfen, 27.48-35.51 % for lufenuron, 16.32-25.30 % for hexaflumuron, 6.42-8.29 % for methoxyfenozide, 1.08-6.39 % for spinosad, 1.22-2.85 % for azadirachtin and 2.31-5.57 % for abamectin.

Comparison between different treatments revealed that variations between treatments and control were almostly of low magnitude, and the treatments could be arranged descendingly as follow : control, spinosad, azadirachtin, abamectin, methoxyfenozide, profenofos, carbosulfan, hexaflumuron, lufenuron and pyriproxyfen, respectively.

Our results agreed with findings of **Moawad *et al.* (1996)** that pyriproxyfen at LC_{50} level in leaf dipping experimental against larval stage caused prolongation in adult stage lately. Also, are in agreement with data concerning feeding larval stage on sublethal concentrations of IGR such as diflubenzuron and triflumuron **(Attia and Ghattas, 1985)** or/and chlorfluazuron and flufenoxuron **(Hossain *et al.*, 1996)** where adult longevity was remarkably shortened.

4.2.2.3- Effect on adult weight :

The results concerning the effect of the tested insecticides on the adult weight of *C. vittata*, are presented in Table (6). A decrease in adult weight was obtained in all treatments and rates of applications. The highest decrease was demonstrated by profenofos at 750 ml/fed. (82.08 %), while the least (1.48 %) was obtained by azadirachtin at 75 ml/fed. during the 1*st* group of adults. The highest decrease in adult weight during the 2*nd* group of adult was (75.50 %) by the treatment of profenofos at 750 ml/fed., while the last one (6.37 %) was recorded by the treatment of azadirachtin at 75 ml/fed. The highest decrease in adult weight was recorded for carbosulfan (70.54 %) at 800 gm/fed. during the 3*rd* testing interval, while it was (8.05 %) for pyriproxyfen at 25 ml/fed. The highest decrease in adult weight was recorded for

Table (6). Mean adult weight (till 8 days) of *C. vittata* for groups of adults fed on 48 h on treated sugar beet leaves collected at different time intervals after applying insecticides under field conditions.

Insecticides	Rate/ fed. (ml.)	Mean weight of adults (mg.) till 8 days for groups of adults fed on treated leaves collected at indicated days :							
		1st interval (0-1 day)		*2nd* interval (7-8 day)		*3rd* interval (14-15 day)		*4th* interval (21-22 day)	
		Weight	% change	Weight	% change	Weight	% change	Weight	% change
Profenofos	750	19.13	-82.08	28.52	-75.50	78.58	-38.65	87.43	-36.23
72 % EC	187.5	32.78	-69.29	92.73	-20.36	113.77	-11.18	116.30	-15.18
Carbosulfan	800	22.15	-79.25	23.61	-75.43	37.73	-70.54	95.69	-30.21
25 % WP	200	32.47	-69.58	41.29	-64.54	97.60	-23.80	106.15	-22.58
Pyriproxyfen	100	44.06	-58.73	91.95	-71.03	97.24	-24.09	105.85	-22.80
10 % EC	25	86.59	-18.90	95.20	-18.24	117.78	-08.05	126.27	-7.91
Lufenuron	40	76.18	-28.65	89.87	-22.82	97.21	-74.11	117.54	-14.27
5 % EC	10	90.50	-15.23	95.31	-18.15	116.93	-08.71	112.62	-17.86
Hexaflumuron	200	83.25	-22.26	88.57	-23.94	97.99	-23.50	125.84	-8.22
10 % EC	50	100.61	-05.76	106.76	-08.32	117.49	-08.28	132.19	-3.59
Methoxyfenozide	350	72.53	-32.06	93.20	-19.96	100.56	-21.49	118.11	-13.86
24 % SC	87.5	85.56	-19.86	97.52	-16.25	111.84	-12.69	127.13	-7.28
Spinosad	350	71.66	-32.88	82.24	-29.37	101.38	-20.16	116.19	-15.26
24 % SC	87.5	84.10	-21.23	99.98	-14.14	112.52	-12.16	125.37	-8.56
Azadirachtin	300	91.28	-14.50	100.01	-14.11	106.35	-16.97	115.21	-15.97
1 % EC	75	105.18	-01.48	109.03	-06.37	116.45	-9.09	123.17	-10.17
Abamectin	40	55.81	-47.72	82.13	-29.47	96.12	-24.96	112.33	-18.07
1.8 % EC	10	90.73	-15.02	98.23	-15.64	116.47	-9.07	129.17	5.79
Control	-	106.77		116.45		128.10		137.12	

profenofos (36.23 %) at 750 ml/fed. during the *4th* testing interval, while it was (3.59 %) for hexaflumuron at 50 ml/fed.

4.2.2.4- Effect on adult fecundity :

Data in Table (7) elucidate the latent indirect effects on adult fecundity when the adults of *C. vittata* survived exposure and feeding on treated sugar beet leaves collected at different time intervals after application of insecticides under field conditions.

As shown in Table (7), it was obvious that all tested insecticides performed similarly and resulted in reducing insect fecundity by averages of 55.76-89.42 %, 45.36-76.09 %, 24.27-79.61 % and 1.96-71.07 % for adults resulted from groups of 1*st*, 2*nd*, 3*rd* and 4*th* testing intervals, respectively.

Comparison on the basis of mean eggs/female revealed that pyriproxyfen, lufenuron and methoxyfenozide resulted in remarkably the least number of deposited eggs/female. Considerable reduction in rate of eggs/female was recorded between other treatments including control, where means of eggs/female were lower than control treatment. The different insecticides could be arrange ascendingly in this respect as follow : abamectin, hexaflumuron, methoxyfenozide and azadirachtin, respectively.

4.2.2.5- Effect on eggs viability :

Data in Table (8) showed the latent effect of different treatments on viability of eggs deposited by adults resulted after exposure and 48 h feeding of groups of adults on insecticides-treated sugar beet leaves collected at different testing intervals. The recorded inhibition in eggs hatch reached 98.4-54.6, 90.3-51.4, 84.5-48.3 and 79.6-45.2 %. In 1*st* (0-1 day), 2*nd* (7-8 day), 3*rd* (14-15 day) and 4*th* (21-22 day) testing intervals, respectively. However, no deposited eggs was recorded by profenofos during 1*st* and 2*nd* testing intervals, by carbosulfan during the 1*st*, 2*nd* and 3*rd* intervals; as well as by pyriproxyfen, lufenuron and methoxy-fenozide during 1*st* testing interval.

Table (7). Adult fecundity of *C. vittata* for groups of adults fed on 48 h on treated sugar beet leaves collected at different time intervals after applying insecticides under field conditions.

Insecticides	Rate/ fed. (ml.)	Average no. of eggs/female resulted from group of adults survived after feeding on treated sugar bet leaves collected at the indicated days :							
		1st interval (0-1 day)		*2nd* interval (7-8 day)		*3rd* interval (14-15 day)		*4th* interval (21-22 day)	
		Eggs no.	% change	Eggs no.	% change	Eggs no.	% change	Eggs no.	% change
Profenofos	750	-	-	-	-	42	-79.61	73	-64.21
72 % EC	187.5	-	-	105	-48.78	137	-33.49	169	-17.15
Carbosulfan	800	-	-	-	-	-	-	59	-71.07
25 % WP	200	-	-	-	-	87	-57.76	102	-50.00
Pyriproxyfen	100	0	-	49	-76.09	70	-66.01	105	-48.52
10 % EC	25	35	-83.17	88	-57.07	139	-32.52	200	-01.96
Lufenuron	40	0	-	53	-74.14	82	-60.19	113	-44.60
5 % EC	10	40	-80.76	92	-55.12	142	-31.06	116	-43.13
Hexaflumuron	200	22	-89.42	55	-73.17	86	-58.25	120	-41.17
10 % EC	50	42	-79.80	97	-52.68	156	-24.27	177	-13.23
Methoxyfenozide	350	0	-	54	-73.65	84	-59.22	119	-41.66
24 % SC	87.5	41	-80.28	99	-51.70	151	-26.69	165	-19.11
Spinosad	350	60	-71.15	72	-54.87	98	-52.42	112	-45.09
24 % SC	87.5	92	-55.76	109	-46.82	124	-39.80	149	-26.96
Azadirachtin	300	50	-75.96	69	-66.34	91	-55.82	113	-44.60
1 % EC	75	88	-57.69	107	-47.80	131	-36.40	163	-20.09
Abamectin	40	55	-73.55	74	-63.90	95	-53.88	117	-42.64
1.8 % EC	10	91	-56.25	112	-45.36	136	-33.98	185	-09.31
Control	-	208		205		206		204	

Table (8). Eggs viability deposited by females of *C. vittata* resulted from groups of adults fed for 48 h on treated sugar beet leaves collected at different time intervals after applying insecticides under field conditions.

Insecticides	Rate ml./fed.	% Sterility in eggs deposited by females resulted from groups of adults survived after feeding on treated leaves collected at indicated days			
		1st interval (0-1 day)	2nd interval (7-8 day)	3rd interval (14-15 day)	4th interval (21-22 day)
Profenofos	750	-	-	73.2	68.5
72 % EC	187.5	-	72.3	69.5	65.3
Carbosulfan	800	-	-	-	69.2
25 % WP	200	-	-	64.2	61.9
Pyriproxyfen	100	-	90.3	84.5	79.6
10 % EC	25	98.4	81.0	74.6	73.7
Lufenuron	40	-	83.2	78.2	74.5
5 % EC	10	88.3	79.5	73.3	65.6
Hexaflumuron	200	85.6	73.2	69.4	62.7
10 % EC	50	81.4	70.5	65.2	59.3
Methoxyfenozide	350	-	86..2	80.4	73.6
24 % SC	87.5	84.3	82.7	77.8	71.3
Spinosad	350	81.6	78.3	73.4	68.7
24 % SC	87.5	78.4	74.5	69.3	65.3
Azadirachtin	300	61.2	57.7	53.2	50.2
1 % EC	75	55.4	51.4	49.2	47.3
Abamectin	40	60.7	53.2	50.1	48.9
1.8 % EC	10	54.6	51.4	48.3	45.2
Control	-	0.0	0.0	0.0	0.0

In previous studies, **Schmidt *et al.* (1997)** found that at concentrations of 10, 15 and 25 ppm Melia (*Azadirachta indica*) caused no adult emerged from pupae, fecundity and fertility were drastically reduced. Likewise, **Sammour and Abdalla (1989)** found that treatment of last instar larvae of *Heliothis armigera* (Hb.) with sublethal dose of teflubenzuron caused considerable reduction in fecundity and fertility of the emerged adults with sterilizing effects amounted to ca. 91 % in this respect.

Gelbic and Matolin (1984) found the juvenile hormone analogue (JHA) caused reduction in rate of eggs hatch and demonstrating that this performance could be due to numerous disorders in embryonic development. Recently, **Aldebis *et al.* (1994)** indicated that feeding on fenoxycarb (JHA)-treated leaves resulted in alteration in the development of germinal cells ending in either malformed spermatozoa or eupyrene bundles.

4.2.2.6- Effect on larval mortality :

Data in Table (9) indicate the latent effects on the larval mortality when the adults were fed for 48 h on treated leaves collected at different time intervals after insecticides application. The recorded latent larval mortality ranged between 13-21 % in 1*st* m testing interval (0-1 day), 12-20 % in 2*nd* testing interval (7-8 day), and 13-22 % in 3*rd* testing interval (14-15 day), while it reached 15-21 % in the 4*th* testing interval (21-22 day). However, the highest larval mortality percentages were recorded by pyriproxyfen treatments (21 %) in the 1*st* testing interval, by methoxyfenozide and azadirachtin treatments (20 %) in the 2*nd* interval, by carbosulfan and profenofos treatments (22 %) in the 3*rd* interval, and carbosulfan, profenofos and spinosad treatments (21 %) in the 4*th* interval.

Comparison between different treatments revealed that the highest larval mortality during all testing intervals was recorded for carbosulfan and profenofos (22 %) at the 3*rd* interval (14-15 day) and for spinosad (22 %) at the 4*th* interval (21-22 day).

Table (9). Larval mortality of *C. vittata* for groups of adults fed for 48 h on treated sugar beet leaves collected at different time intervals after applying insecticides under field conditions.

Insecticides	Rate ml./fed.	% Larval mortality resulted from groups of adults survived after feeding on treated leaves collected at the indicated days			
		1*st* interval (0-1 day)	2*nd* interval (7-8 day)	3*rd* interval (14-15 day)	4*th* interval (21-22 day)
Profenofos	750	-	-	20	21
72 % EC	187.5	-	19	22	18
Carbosulfan	800	-	-	-	21
25 % WP	200	-	-	22	19
Pyriproxyfen	100	-	15	14	19
10 % EC	25	21	18	13	16
Lufenuron	40	-	12	17	15
5 % EC	10	16	14	16	19
Hexaflumuron	200	15	13	19	20
10 % EC	50	14	16	17	19
Methoxyfenozide	350	-	20	15	18
24 % SC	87.5	17	19	21	20
Spinosad	350	18	17	15	22
24 % SC	87.5	15	19	13	18
Azadirachtin	300	17	20	15	19
1 % EC	75	14	19	20	16
Abamectin	40	13	15	14	20
1.8 % EC	10	16	17	19	15
Control	-	4	5	5	6

4.2.2.7- Effect on larval duration :

Table (10) elucidate the duration of *C. vittata* larval stage till pupation when adults were allowed to feed for 48 h on treated sugar beet leaves collected at different time intervals after applying the tested insecticides in the field and continue feeding on untreated leaves.

In the 1*st* group of adults which were fed on treated sugar beet leaves collected at (0-1 day) after spraying insecticides, the highest increase in the larval duration reached 49.23 % and 43.07 % was recorded for pyriproxyfen and lufenuron, respectively.

Regarding the 2*nd* group of adults fed on treated sugar beet leaves collected at (7-8 day) after spraying insecticides, a pronounced increase in the larval period was recorded, 33.07-43.84 % for lufenuron and 43.07-47.69 % for pyriproxyfen.

The same trend was also observed in the 3*rd* group of *C. vittata* adult. The increase in the larval period were 17.14-25.00 % for lufenuron and 22.85-30.71 % for pyriproxyfen.

A relatively lower increase in the larval duration of the 4*th* group of adults was observed, 15.00-22.85 % for profenofos and 16.42-25.71 % for carbosulfan.

However, the considerable increase recorded for pyriproxyfen and the IGR lufenuron agreed with the previous findings of **Moustafa and El-Attal (1985)** who found that the chitin inhibitor triflumuron at low concentration produced significant prolongation in *S. littoralis* larval period.

4.2.2.8- Effect on pupation and pupal malformation :

Data in Table (11) demonstrate pupation percentage and pupal abnormality resulted after feeding groups of the adult on insecticide-treated leaves collected at different time intervals after application of insecticides under field conditions.

Table (10). Larval duration for groups of adults of *C. vittata* fed on 48 h on treated sugar beet leaves collected at different time intervals after applying insecticides under field conditions.

Insecticides	Rate/ fed. (ml.)	Mean larval duration for groups of adults survived after feeding on treated leaves collected at the indicated days							
		1st interval (0-1 day)		*2nd* interval (7-8 day)		*3rd* interval (14-15 day)		*4th* interval (21-22 day)	
		Duration	% change	Duration	% change	Duration	% change	Duration	% change
Profenofos	750	-	-	-	-	15.2	+08.57	16.1	+15.00
72 % EC	187.5	-	-	14.2	+09.23	16.1	+15.00	17.2	+22.85
Carbosulfan	800	-	-	-	-	-	-	16.3	+16.42
25 % WP	200	-	-	-	-	16.4	+17.14	17.6	+25.71
Pyriproxyfen	100	0	-	19.2	+47.69	18.3	+30.71	17.9	+27.85
10 % EC	25	19.4	+49.23	18.6	+43.07	17.2	+22.85	16.2	+15.71
Lufenuron	40	0	-	18.7	+43.84	17.5	+25.00	16.1	+15.00
5 % EC	10	18.6	+43.07	17.3	+33.07	16.4	+17.14	15.7	+12.14
Hexaflumuron	200	13.3	+02.30	18.4	+41.53	17.3	+23.57	16.2	+15.71
10 % EC	50	17.2	+32.30	16.6	+27.69	15.7	+12.14	16.1	+15.00
Methoxyfenozide	350	0	-	17.9	+37.69	16.6	+18.57	16.0	+14.28
24 % SC	87.5	16.8	+29.23	16.2	+24.61	15.3	+09.28	15.9	+13.57
Spinosad	350	15.6	+20.00	15.3	+17.69	15.1	+07.85	14.8	+05.71
24 % SC	87.5	15.2	+16.92	14.9	+14.61	14.6	+04.28	14.4	+02.85
Azadirachtin	300	15.8	+21.53	15.2	+16.92	15.0	+07.14	14.8	+05.71
1 % EC	75	15.3	+17.69	14.8	+13.84	14.5	+03.57	14.3	+02.34
Abamectin	40	15.6	+20.00	15.1	+16.15	14.9	+06.42	14.6	+04.28
1.8 % EC	10	15.3	+17.69	15.2	+16.92	14.6	+04.28	14.4	+02.85
Control	-	13		13		14		14	

Table (11). Pupation and egg abnormality percentages of *C. vittata* for groups of adults fed on 48 h on treated sugar beet leaves collected at different time intervals after applying insecticides under field conditions.

Insecticides	Rate/ fed. (ml.)	% Pupation for groups of adults survived after feeding on treated sugar beet leaves collected at the indicated days							
		1st interval (0-1 day)		*2nd* interval (7-8 day)		*3rd* interval (14-15 day)		*4th* interval (21-22 day)	
		Normal	Abnormal	Normal	Abnormal	Normal	Abnormal	Normal	Abnormal
Profenofos	750	-	-	-	-	4	-	25	-
72 % EC	187.5	-	-	34	-	53	-	64	-
Carbosulfan	800	-	-	-	-	-	-	6	-
25 % WP	200	-	-	-	-	24	-	53	-
Pyriproxyfen	100	0	24	10	19	13	23	17	34
10 % EC	25	15	18	14	24	17	37	21	56
Lufenuron	40	0	27	13	30	18	28	19	30
5 % EC	10	10	24	17	37	27	42	31	47
Hexaflumuron	200	14	19	15	22	19	29	21	30
10 % EC	50	15	36	22	34	24	38	29	46
Methoxyfenozide	350	0	28	14	25	17	24	19	27
24 % SC	87.5	11	25	18	36	27	46	33	50
Spinosad	350	20	5	31	6	28	11	29	12
24 % SC	87.5	25	6	38	11	46	22	53	24
Azadirachtin	300	22	13	27	16	33	15	52	29
1 % EC	75	30	16	29	22	38	23	55	31
Abamectin	40	21	13	22	17	30	19	37	27
1.8 % EC	10	32	24	34	28	44	27	49	34
Control	-	96	-	97	-	95	-	94	-

Pupation percentages revealed that at 1*st* testing interval (0-1 day), no pupation percent was recorded in carbosulfan and profenofos treatments, where accumulated adult mortality reached 100 %. Also, it was obvious that the highest pupation percentage (56 %) in the 1*st* interval (0-1 day) was recorded in abamectin (10 ml/fed.) and that 24 % out of them were abnormal (malformed), while 32 % were healthy. The normal pupation ranged between 10 % and 38 % in the 2*nd* interval (7-8 day) and between 13 % and 53 % in 3*rd* interval (14-15 day), while it ranged between 6 % and 64 % in the 4*th* testing interval (21-22 day).

Generally, it was obvious that all insecticidal treatments resulted in remarkable reduction percentages in pupation in comparison with control. The highest reduction in pupation was recorded by carbosulfan treatments, and was followed closely with those of profenofos.

Regarding the latent on percent pupal abnormality (malformed), it was obvious that it ranged between 5 and 36 % in the 1*st* testing interval (0-1 day), between 6 and 37 % in the 2*nd* testing interval (7-8 day), and between 11 and 46 % in the 3*rd* testing interval (14-15 day), while it was between 12 and 56 % in the 4*th* testing interval (21-22 day). However, it was obvious in general that highest abnormality (malformation) percentages were mostly resulted in the low rates of pyriproxyfen (25 ml/fed.) followed by lufenuron (10 ml/fed.) and hexaflumuron and methoxyfenozide in most testing intervals, respectively.

4.2.2.9- Effect on pupal mortality :

Data in Table (12) indicate the latent effects on the pupal mortality when the adult were fed for 48 h on treated leaves collected at different time intervals after insecticides application. The recorded latent pupal mortality ranged between 3-12 % in 1*st* testing interval (0-1 day), 3-14 % in 2*nd* testing interval (7-8 day), and 5-11 % in 3*rd* testing interval (14-15 day); while it reached 4-14 % in the 4*th* testing interval (21-22 day).

Table (12). Pupal mortality of *C. vittata* resulted from groups of adults fed for 48 h on treated sugar beet leaves collected at different time intervals after applying insecticides under field conditions.

Insecticides	Rate ml./fed.	% Pupal mortality resulted from groups of adults survived after feeding on treated leaves collected at the indicated days			
		1st interval (0-1 day)	*2nd* interval (7-8 day)	*3rd* interval (14-15 day)	*4th* interval (21-22 day)
Profenofos	750	-	-	5	7
72 % EC	187.5	-	3	6	5
Carbosulfan	800	-	-	-	4
25 % WP	200	-	-	8	10
Pyriproxyfen	100	-	7	11	12
10 % EC	25	7	12	9	11
Lufenuron	40	-	5	10	13
5 % EC	10	8	9	6	12
Hexaflumuron	200	5	7	11	9
10 % EC	50	10	14	7	12
Methoxyfenozide	350	-	11	8	13
24 % SC	87.5	11	13	10	14
Spinosad	350	5	8	9	7
24 % SC	87.5	7	13	11	12
Azadirachtin	300	3	7	6	10
1 % EC	75	11	12	9	13
Abamectin	40	6	11	8	7
1.8 % EC	10	12	14	11	9
Control	-	2	1	4	3

However, the highest pupal mortality percentages were recorded by abamectin treatments (12 %) in the 1*st* testing interval, by hexaflumuron and abamectin treatments (14 %) in the 2*nd* interval, by pyriproxyfen, hexaflumuron, spinosad and abamectin treatments (11 %) in the 3*rd* interval and by lufenuron, methoxyfenozide and azadirachtin treatments (13 %) in the 4*th* interval.

Comparison between different treatments revealed that the highest pupal mortality during all testing intervals was recorded for hexaflumuron and abamectin (14 %) at the 2*nd* interval (7-8 day).

4.2.2.10- Effect on pupal duration :

Table (13) elucidate the duration of *C. vittata* pupal stage till pupation when adults were allowed to feed for 48 h on treated sugar beet leaves collected at different time intervals after applying the tested insecticides in the field and continue feeding on untreated leaves.

In the 1*st* group of adult which were fed on treated sugar beet leaves collected at (0-1 day) after spraying insecticides, an considerable decrease in the pupal duration reached 22.72 % was recorded for pyriproxyfen.

Regarding the 2*nd* group of adult fed on treated sugar beet leaves collected at (7-8 day) after spraying insecticides, a pronounced decrease (25.0 %) in the pupal period was recorded, for profenofos and pyriproxyfen.

The same trend was also observed in the 3*rd* group of *C. vittata* adults. The decrease in the pupal period were 13.23-20.58 % for pyriproxyfen and 22.05-23.52 % for profenofos.

A relatively lower decrease in the pupal duration of the 4*th* group of adults was observed, 1304-15.94 % for both profenofos and pyriproxyfen, and 11.59-18.84 % for carbosulfan.

Table (13). Pupal duration of *C. vittata* for groups of adults fed on 48 h on treated sugar beet leaves collected at different time intervals after applying insecticides under field conditions.

Insecticides	Rate/ fed. (ml.)	Mean pupal duration (in days) resulted from groups of adults survived after feeding on treated sugar beet leaves collected at the indicated days :							
		1st interval (0-1 day)		*2nd* interval (7-8 day)		*3rd* interval (14-15 day)		*4th* interval (21-22 day)	
		Duration	% change	Duration	% change	Duration	% change	Duration	% change
Profenofos 72 % EC	750	-	-	-	-	5.2	-23.52	5.8	-15.94
	187.5	-	-	5.1	-25.00	5.3	-22.05	6.0	-13.04
Carbosulfan 25 % WP	800	-	-	-	-	-	-	5.6	-18.84
	200	-	-	-	-	5.6	-17.64	6.1	-11.59
Pyriproxyfen 10 % EC	100	0	-	5.1	-25.00	5.4	-20.58	5.8	-15.94
	25	5.1	-22.72	5.8	-14.70	5.9	-13.23	6.0	-13.04
Lufenuron 5 % EC	40	0	-	5.2	-23.52	5.5	-19.11	5.7	-17.39
	10	5.7	-13.63	5.9	-13.23	5.9	-13.23	6.1	-11.59
Hexaflumuron 10 % EC	200	5.2	-21.21	5.4	-20.58	5.7	-16.17	5.8	-15.94
	50	5.8	-12.12	6.0	-11.76	6.1	-10.29	6.2	-10.14
Methoxyfenozide 24 % SC	350	0	-	5.3	-22.05	5.5	-19.11	5.9	-14.49
	87.5	5.6	-15.15	5.8	-14.70	6.0	-11.76	6.1	-11.59
Spinosad 24 % SC	350	5.2	-21.21	5.3	-22.05	5.7	-16.17	5.8	-15.94
	87.5	5.8	-12.12	6.0	-11.76	6.0	-11.76	6.3	-08.69
Azadirachtin 1 % EC	300	5.4	-18.18	5.6	-17.64	5.9	-13.23	6.0	-13.04
	75	5.6	-15.15	6.1	-10.29	6.1	-10.29	6.2	-10.14
Abamectin 1.8 % EC	40	5.3	-19.69	5.4	-20.58	5.7	-16.17	5.9	-14.49
	10	5.7	-13.63	6.3	-07.35	6.3	-07.35	6.4	-07.24
Control	-	6.6		6.8		6.8		6.9	

However, the relatively remarkable decrease in pupal duration recorded in pyriproxyfen treatment during all testing intervals came in agreement with **Moawad *et al.* (1996)** who found that pyriproxyfen at 10 ppm cause life-time of larvae being longer than control and reduced pupal duration.

4.2.3- The effect of different pesticides on the consumption, digestion and utilization of food in the adult stage of *C. vittata* :

4.2.3.1- Antifeeding activity (A.A.) :

Data in Table (14) show the deterrent effects against adults of *C. vittata* after feeding for 48 h leaves treated with recommended rate/ feddan and quarter the recommended rate. It was obvious that, azadirachtin revealed significantly the highest mean antifeedant activity (74.86-81.17) against, and another 8 insecticides; carbosulfan, spinosad, methoxyfenozide, hexaflumuron, profenofos, pyriproxyfen, lufenuron and abamectin exhibited significantly less antifeeding activity, recording (39.28-41.10), (38.82-41.18), (36.87-42.98), (36.27-44.79), (35.82-37.29), (35.31-42.32), (34.99-40.59), and (31.61-35.44) % for compounds at recommended rate and quarter recommended rate/feddan, respectively.

4.2.3.2- Food consumption (C.W.) :

On the basis of the overall mean weight of food consumed by adults of *C. vittata*, data in Table (15) indicate that the feeding ability of the adults was significantly affected by insecticidal treatments, except for pyriproxyfen at the low rate, resulting in high and significant decrease in overall mean weight of food consumed. The overall weight of consumed food reached 0.31±0.05 and 0.27±0.05 mg by pyriproxyfen (at 25 and 100 ml/200 L. water, respectively), 0.28±0.03 and 0.23±0.05 mg by abamectin (at 10 and 40 ml/200 L,

Table (14). Antifeedant activity (A.A.) for adults *Cassida vittata* after feeding for 48 h on sugar beet leaves treated with rate of feddan and quarter feddan..

Insecticides	Rate ml./fed.	*1st* interval (0-1 day)	*2nd* interval (7-8 day)	*3rd* interval (14-15 day)	*4th* interval (21-22 day)	Mean± S.D.*	
Profenofos	750	38.12	36.07	35.33	33.79	35.82±1.79	fghi
72 % EC	187.5	40.62	37.13	36.25	35.19	37.29±2.35	efgh
Carbosulfan	800	41.79	40.00	38.17	37.18	39.28±2.03	defgh
25 % WP	200	45.13	42.73	39.79	38.75	41.10±2.16	cdef
Pyriproxyfen	100	37.76	36.57	34.15	32.79	35.31±2.25	ghi
10 % EC	25	45.95	43.51	41.33	38.51	42.32±3.16	cde
Lufenuron	40	36.89	35.19	34.72	33.17	34.99±1.50	hi
5 % EC	10	43.52	41.77	39.92	37.15	40.59±2.72	vdefg
Hexaflumuron	200	39.12	37.92	35.16	32.91	36.27±2.79	fghi
10 % EC	50	47.51	45.19	44.33	42.15	44.79±2.21	c
Methoxyfenozide	350	37.19	36.02	34.18	32.72	35.02±1.97	hi
24 % SC	87.5	46.13	44.71	41.99	40.11	43.12±2.70	cd
Spinosad	350	41.12	40.00	38.19	35.99	38.82±2.24	defgh
24 % SC	87.5	44.71	42.52	40.17	37.35	41.18±3.15	cdef
Azadirachtin	300	61.15	77.77	79.54	81.00	74.86±9.23	b
1 % EC	75	71.07	82.40	85.00	86.22	81.17±6.92	a
Abamectin	40	34.20	32.19	30.97	29.11	31.61±2.13	i
1.8 % EC	10	37.92	36.11	34.52	33.21	35.44±2.03	ghi

* Mean followed by the same letter(s) are not significantly different according to Duncan's multiple range test.
L.S.D. at 0.05 = 4.63

Table.(15). Mean daily weight of consumed food (C.W.) for groups of *C. vittata* adults fed for 48 h on treated leaves collected at indicated day post-treatment, followed by 3 days feeding on untreated leaves.

Insecticides	Rate/ fed. (ml.)	Mean daily weight of consumed food (mg/adult) at the indicated testing intervals								Mean* ± S.D.	
		1st interval (0-1 day)		*2nd* interva (7-8 day)		*3rd* interval (14-15 day)		*4th* interval (21-22 day)			
		mg/ adult	% change	mg/ adult	% change	mg/ adult	% change	mg/ adult	% change		
Profenofos	750	0.23	-34.28	0.26	-23.52	0.21	-32.25	0.19	-32.14	0.22±0.03	d
72 % EC	187.5	0.32	-8.57	0.29	-14.70	0.24	-22.58	0.21	-25.00	0.26±0.04	bc
Carbosulfan	800	0.29	-17.14	0.25	-26.47	0.22	-29.03	0.18	-35.71	0.23±0.04	cd
25 % WP	200	0.31	-11.42	0.29	-14.70	0.25	-17.03	0.20	-28.57	0.26±0.04	bc
Pyriproxyfen	100	0.24	-31.42	0.36	+5.88	0.27	-12.09	0.23	-17.85	0.27±0.05	b
10 % EC	25	0.30	-14.28	0.40	+17.64	0.29	-6.54	0.27	-3.97	0.31±0.05	a
Lufenuron	40	0.28	-20.00	0.27	-20.58	0.21	-32.25	0.19	-32.14	0.23±0.04	cd
5 % EC	10	0.32	-8.57	0.33	-2.94	0.25	-19.35	0.21	-25.00	0.27±0.05	b
Hexaflumuron	200	0.27	-22.85	0.25	-26.47	0.20	-35.48	0.17	-39.28	0.22±0.04	d
10 % EC	50	0.29	-17.14	0.28	-17.64	0.26	-16.12	0.22	-21.42	0.26±0.04	bc
Methoxyfenozide	350	0.25	-28.57	0.24	-29.41	0.19	-19.35	0.16	-42.85	0.21±0.04	d
24 % SC	87.5	0.28	-20.00	0.32	-5.88	0.24	-22.58	0.21	-25.00	0.26±0.04	bc
Spinosad	350	0.24	-31.42	0.27	-20.58	0.21	-32.25	0.17	-39.28	0.22±0.04	d
24 % SC	87.5	0.29	-17.14	0.31	-8.82	0.26	-16.12	0.20	-28.57	0.26±0.04	bc
Azadirachtin	300	0.25	-28.57	0.24	-29.41	0.22	-29.03	0.19	-32.14	0.22±0.02	d
1 % EC	75	0.28	-20.00	0.32	-5.88	0.29	-6.54	0.23	-17.85	0.28±0.03	b
Abamectin	40	0.29	-17.41	0.27	-20.58	0.21	-32.25	0.18	-35.71	0.23±0.05	cd
1.8 % EC	10	0.33	-5.71	0.32	-5.88	0.27	-12.90	0.12	-25.00	0.28±0.05	b
Control	-	0.35	-	0.34	-	0.31	-	0.28	-	0.32±0.03	a
L.S.D.$_{0.05}$										0.02	

* Mean followed by the same letter(s) are not significantly different according to Duncan's (1955) multiple range test.

respectively), 0.28±0.03 and 0.22±0.02 mg by azadirachtin (at 75 and 300 ml/200 L, respectively), 0.27±0.05 and 0.23±0.04 mg by lufenuron (at 10 and 40 ml/200 L, respectively), 0.26±0.04 and 0.023±0.04 mg by carbosulfan (at 200 and 800 gm/200 L, respectively), 0.26±0.04 and 0.22±0.04 mg by hexaflumuron and spinosad (at 50, 200, 87.5 and 350 ml/200 L, respectively), 0.26±0.04 and 0.22±0.03 mg by profenofos (at 187.5 and 750 ml/200 L, respectively), and 026±0.04 and 0.21±0.04 mg by methoxyfenozide (at 87.5 and 350 ml/200 L, respectively) versus 0.32±0.03 mg for control adults. However, the reduction in overall mean consumption was in general positively correlated in most treatments with the concentration level, regardless of the tested insecticide.

Regarding the changes in mean consumed food relative to the control adults in details during different testing intervals, it was of interest to note that pyriproxyfen at 25 and 100 ml/200 L resulted in increase of +17.64 and +5.88 in mean food consumed per adult per day at the *2nd* testing interval, whereas other treatments of profenofos at 187.5 and 750 ml/200 L, carbosulfan at 200 and 800 gm/200 L, lufenuron at 10 and 40 ml/200 L, hexaflumuron at 50 and 200 ml/200 L methoxyfenozide at 87.5 and 350 ml/200 L, spinosad at 87.5 and 350 ml/200 L, azadirachtin at 75 and 300 ml/200 L and abamectin at 10 and 40 ml/200 L resulted in remarkable percent decrease of -14.70, -23.52, -14.70, -26.47, -2.94, -20.58, -17.64, -26.47, -5.88, -29.41, -8.82, -20.58, -5.88, -29.41 and -5.88, -20.58 % for the prementioned treatments, respectively. Also, it was obvious that the percent decrease in mean food consumed was gradually decline with time elapse, where the least decrease was recorded at the *4th* testing intervals (21-22 day post-treatment), where the residues of sprayed insecticides was at its least level on treated leaves. However, the maximum reduction in mean food consumed (-25.0, -42.85 %) was recorded by methoxyfenozide at 87.5 and 350 ml/200 L, whereas the least mean reduction (-3.97, -17.85 %) was recorded for pyriproxyfen at 25 and 100 ml/200 L during the *4th* testing interval (21-22 day post-treatment).

4.2.3.3- Consumption index (C.I.) :

Data indicating consumption index (C.I.) value presented in Table (16) revealed slight and insignificant decrease in overall mean C.I. for adult in all treatments and control. However, regarding the change in detailed data during different testing intervals, it was obvious that the highest reduction in C.I. values (-40.31 and -39.08 %) at the 1*st* (initial) testing interval was recorded for profenofos at 750 and 187.5 ml/200 L, respectively; while the least reduction in C.I. values (-14.08 and -18.13 %) was recorded for spinosad at rate of 87.5 and 350 ml/200 L, respectively.

The present results (Table, 16), generally show an inhibitory action of the tested compounds on the food consumption whether its determination was estimated as amount in mg (C.W.) or % (C.I.). Such an observations are in agreement with earlier reports which indicated that insect growth disruptors interfere with feeding **(Mulder and Giswijt, 1973; Ascher and Nemny, 1976; Abid *et al.*, 1978)**. Moreover, previous reports have also confirmed that diflubenzuron acts on the peritrophic membrane by affecting its chitin-protein structure, hindering its role in protecting secreting cells from any damage **(Clarke *et al.*, 1977)**.

Also, our findings agree with results recorded for several insect species such as *S. littoralis* fed on diflubenzuron-treated castor leaves **(Sundaramurthy, 1977 and Radwan *et al.*, 1986)**. *S. littoralis* fed on fenarimol or nuarimol (fungicides with anti-ecdysone activity)-treated cotton leaves **(Farag, 1991)**. Also, **Schmidt *et al.* (1997)** found that a methanol extract of *Melia azedarach* fruits reduced food consumption. Furthermore, **Salama and Ahmed (1997)** found that methanol extract, *M, azedarach* exhibited decrease in respiration quotient (OR) and destroyed epithelial cells, the peritrophic membrane and basement membrane of the midgut of the tested larvae with 100 ppm. Outside Lepidoptera, **Ismail (1995)** recorded various reductions of relative consumption rate (RCR), consumed food amounts (C.W.) and faeces after topical application of fenoxycarb (a juvenoid) onto newly moulted

Table (16). Consumption index (C.I.) for groups of *C. vittata* adults fed for 48 h on treated leaves collected at indicated day post-treatment, followed by 3 days feeding on untreated leaves.

Insecticides	Rate/ fed. (ml.)	Mean C.I. values at the indicated testing intervals								Mean* ± S.D.	
		1st interval (0-1 day)		*2nd* interva (7-8 day)		*3rd* interval (14-15 day)		*4th* interval (21-22 day)			
		C.I.	% change	C.I.	% change	C.I.	% change	C.I.	% change		
Profenofos	750	3.39	-40.31	4.05	-29.19	3.30	-7.82	3.81	-10.14	3.63±0.35	bc
72 % EC	187.5	3.46	-39.08	4.58	-19.93	3.47	-3.07	4.03	-4.95	3.88±0.53	bc
Carbosulfan	800	3.75	-33.97	3.92	-31.46	3.13	-12.56	3.29	-22.40	3.52±0.37	bc
25 % WP	200	4.45	-21.69	4.62	-19.23	3.45	-3.63	3.85	-9.19	4.09±0.54	b
Pyriproxyfen	100	4.42	-22.18	4.92	-13.98	3.31	-7.54	3.21	-24.29	3.96±0.84	bc
10 % EC	25	4.78	-15.84	4.99	-12.76	3.44	-3.91	3.42	-19.33	4.15±0.84	b
Lufenuron	40	3.98	-29.92	4.09	-28.49	2.73	-23.74	3.34	-21.22	3.53±0.63	bc
5 % EC	10	4.89	-13.90	4.92	-13.98	2.91	-18.71	3.47	-17.16	4.04±1.01	bc
Hexaflumuron	200	4.73	-16.12	4.86	-15.03	2.37	-33.79	2.82	-33.49	3.69±1.28	bc
10 % EC	50	4.58/	-19.36	4.77	-16.60	2.69	-24.86	3.83	-9.66	3.96±0.94	bc
Methoxyfenozide	350	4.37	-23.06	4.52	-20.97	2.38	-33.51	3.57	-15.80	3.71±0.97	bc
24 % SC	87.5	4.66	-17.95	4.73	-17.30	2.75	-23.18	3.22	-24.05	3.84±1.00	bc
Spinosad	350	4.65	-18.13	4.71	-17.65	2.43	-32.12	3.73	-12.02	3.88±1.06	bc
24 % SC	87.5	4.88	-14.08	4.97	-13.11	2.81	-21.50	3.67	-13.44	4.08±1.03	b
Azadirachtin	300	3.65	-35.73	3.82	-33.21	2.92	-18.43	3.28	-22.64	3.41±0.40	c
1 % EC	75	4.13	-27.28	4.32	-24.47	3.07	-14.24	3.67	-13.44	3.79±0.55	bc
Abamectin	40	4.40	-22.53	4.72	-17.48	2.84	-20.67	2.90	-31.60	3.71±0.98	bc
1.8 % EC	10	4.54	-20.07	4.87	-14.86	3.06	-14.52	3.54	-16.50	4.00±0.84	bc
Control	-	5.68	-	5.72	-	3.58	-	4.24	-	4.80±1.06	a
L.S.D.0.05										0.52	

* Mean followed by the same letter(s) are not significantly different according to Duncan's (1955) multiple range test.

last instar nymphs of *S. gregaria*. **Ghoneim (1994)**, also applied topically various doses of pyriproxyfen onto newly moulted last instar nymphs of *S. gregaria*, a dose level of 10 µg/nymph gave an inhibitory effect of this juvenoid and 100 and 150 µg/nymph gave a reverse effect on food ingestion and consumption.

4.2.3.4- Growth Rate (G.R.) :

The effect on growth rate (G.R.) after feeding adult on sugar beet leaves at specific intervals after spraying of the four tested pesticides is demonstrated in Table (17).

Data in Table (17), revealed that all tested treatments during the four testing intervals exhibited G.R. values remarkably lower than the control. The reduction percentages in G.R. values ranged between -28.66 and -0.62 % at the 1*st* (0-1 day) testing interval, -39.28 and -3.06 % at the 2*nd* (7-8 day) testing interval, -34.98 and -1.24 % at the 3*rd* (14-15 day) testing interval, while ranged between -32.25 and -2.59 % at the 4*th* (21-22 day) testing interval.

Comparison based on the overall mean during the whole experimental period revealed that G.R. values in different treatments could be arranged statistically in categories lower than control. The first lower than control (G.R. = 0.370), and the last lower than control (G.R. = 0.261), and include treatments of the other nine pesticides.

In previous study, it was rationally accepted that the larval growth had been hindered by the inhibitory action of these compounds on feeding and the metabolic abilities of *S. littoralis* larvae in this respect, **Radwan *et al.* (1986)** found that larvae of *S. littoralis* fed on diflubenzuron and triflumuron-treated leaves have shown a proportional relationship between food consumed and values of both consumption index and growth rate throughout the study course and that both treatments showed considerable decrease in growth rate. However, **Woodring *et al.* (1978)** and **Sundramurthy (1977)** indicated that the amount of growth reduction in *S. littoralis* was proportional in general

Table (17). Growth rate (G.R.) for groups of *C. vittata* adults fed for 48 h on treated leaves collected at indicated day post-treatment, followed by 3 days feeding on untreated leaves.

Insecticides	Rate/ fed. (ml.)	Mean growth rate values (G.R.) at the indicated testing intervals								Mean* ± S.D.	
		1st interval (0-1 day)		*2nd* interva (7-8 day)		*3rd* interval (14-15 day)		*4th* interval (21-22 day)			
		G.R.	% change	G.R.	% change	G.R.	% change	G.R.	% change		
Profenofos	750	0.243	-24.29	0.285	-27.29	0.373	-7.44	0.392	-7.54	0.323±0.070	cde
72 % EC	187.5	0.289	-9.96	0.380	-3.06	0.398	-1.24	0.413	-2.59	0.370±0.055	ab
Carbosulfan	800	0.265	-17.44	0.272	-30.61	0.291	-27.79	0.313	-26.17	0.285±0.021	fg
25 % WP	200	0.263	-18.06	0.238	-39.28	0.262	-34.98	0.283	-32.25	0.261±0.018	g
Pyriproxyfen	100	0.262	-18.38	0.293	-25.25	0.310	-23.07	0.319	-24.76	0.296±0.025	ef
10 % EC	25	0.278	-13.19	0.287	-26.78	0.302	-25.06	0.321	-24.29	0.297±0.018	ef
Lufenuron	40	0.290	-9.65	0.269	-31.37	0.283	-29.77	0.301	-29.00	0.285±0.013	fg
5 % EC	10	0.310	-3.42	0.316	-19.38	0.336	-16.62	0.372	-12.26	0.333±0.027	cd
Hexaflumuron	200	0.261	-18.69	0.348	-11.22	0.356	-11.66	0.369	-12.97	0.333±0.049	cd
10 % EC	50	0.307	-4.36	0.377	-3.82	0.382	-5.21	0.399	-5.89	0.366±0.040	ab
Methoxyfenozide	350	0.238	-25.85	0.308	-21.42	0.326	-19.10	0.356	-16.03	0.307±0.050	def
24 % SC	87.5	0.256	-20.24	0.328	-16.32	0.341	-15.58	0.373	-12.02	0.324±0.049	cde
Spinosad	350	0.233	-27.41	0.261	-33.41	0.297	-26.30	0.314	-25.94	0.276±0.036	fg
24 % SC	87.5	0.229	-28.66	0.285	-27.29	0.302	-25.06	0.326	-23.11	0.285±0.041	fg
Azadirachtin	300	0.256	-20.24	0.291	-25.76	0.314	-22.08	0.342	-19.33	0.300±0.036	fe
1 % EC	75	0.235	-26.79	0.276	-29.59	0.296	-26.55	0.312	-26.41	0.279±0.033	fg
Abamectin	40	0.319	-0.62	0.336	-14.28	0.363	-9.92	0.389	-8.25	0.351±0.030	bc
1.8 % EC	10	0.247	-24.61	0.293	-25.25	0.312	-22.58	0.336	-20.75	0.297±0.037	ef
Control	-	0.321	-	0.392	-	0.403	-	0.424	-	0.385±0.044	a
L.S.D.0.05										0.027	

* Mean followed by the same letter(s) are not significantly different according to Duncan's (1955) multiple range test.

to reduced food consumption. Similar results had been found by other authors after applying different IGRs against various insect species such as *Agrotis ipsilon* **(Reese and Beck, 1976a, b & c)**, *Manduca sexta* **(Dahlman, 1977)**, and *S. gregaria* **(Ghoneim, 1994)**.

However, several authors explained the depressed G.R. or depleted R.W.G. by the decreasing amounts of food consumed. The present data in Table (17)) clearly show detrimentally reduced food consumed (C.W.).

5- Approximate Digestibility (A.D.) :

Data in Table (18) reveals the approximate digestibility (A.D.) of food in adult of *C. vittata*, it was obvious that the overall mean of A.D. in control adult was 95.56±0.58 %. Feeding the adults on leaves treated with different pesticides resulted in either decrease or increase in A.D. depending on the pesticide or/and the concentration used. Feeding the adults on carbosulfan-treated leaves increased significantly the percentage of digestibility, recording 97.42 % and 97.14 % at both tested rates of 200 and 800 gm/200 L, respectively. Other treatments came next and no significant differences were noticed between them and the control. Lufenuron at rate of 10 ml/200 L recorded an approximate digestibility (95.42 %) lower than control (95.56 %).

Generally, the aforementioned data (Table, 18) revealed that the tested compounds except lufenuron induced the adult to exhibit increasing A.D. Such results confirms those obtained by **Radwan *et al.* (1986)** for *S. littoralis* due to action of diflubenzuron and triflumuron throughout the larval period from 4*th* instar to 6*th* instar. On the other hand, our data also agree partially with data of **El-Dessouki and Omar (2000)** where they found that the high concentration (37.5 ppm) of the JHM pyriproxyfen when fed as treated leaves to the 4*th* and 6*th* larval instar of *A. ipsilon* resulted in a significant reduction in A.D. % compared with control.

Table (18). Approximate digestibility (A.D.) for groups of *C. vittata* adults fed for 48 h on treated leaves collected at indicated day post-treatment, followed by 3 days feeding on untreated leaves.

Insecticides	Rate/ fed. (ml.)	Approximated digestibility (A.D. %) for adults fed for 48 h on treated leaves collected at the indicated testing intervals								Mean* ± S.D.	
		1*st* interval (0-1 day)		2*nd* interval (7-8 day)		3*rd* interval (14-15 day)		4*th* interval (21-22 day)			
		A.D. %	% change	A.D. %	% change	A.D. %	% change	A.D. %	% change		
Profenofos	750	96.25	+0.29	98.65	+3.54	97.11	+1.02	96.67	+1.88	97.17±1.04	ab
72 % EC	187.5	29.50	-3.61	96.81	+1.61	97.45	+1.38	97.07	+2.30	95.95±2.31	abc
Carbosulfan	800	96.03	+0.06	98.89	+3.79	97.44	+1.37	96.22	+1.41	97.14±1.32	ab
25 % WP	200	95.94	-0.03	99.23	+4.15	97.33	+1.25	97.18	+2.42	97.42±1.35	a
Pyriproxyfen	100	96.17	+0.02	96.30	+1.08	96.96	+0.87	96.06	+1.24	96.37±0.40	abc
10 % EC	25	93.90	-2.15	95.09	-0.18	96.88	+0.79	96.66	+1.87	95.63±1.40	bc
Lufenuron	40	95.91	-0.06	95.71	+0.46	96.84	+0.74	95.88	+1.05	96.08±0.51	abc
5 % EC	10	92.75	-3.35	95.54	+0.28	96.75	+0.65	96.67	+1.88	95.42±1.86	c
Hexaflumuron	200	96.06	+0.09	95.44	+0.17	95.63	-0.50	96.56	+1.77	95.92±0.49	abc
10 % EC	50	95.41	-0.58	94.81	+0.48	95.95	-0.17	96.92	+2.15	95.77±0.89	abc
Methoxyfenozide	350	96.47	+1.09	97.02	+1.03	95.81	-0.32	96.49	+1.69	96.44±0.49	abc
24 % SC	87.5	94.78	-1.23	96.48	+1.27	94.94	-1.22	97.07	+2.30	95.81±1.13	abc
Spinosad	350	96.48	+0.53	97.12	+1.94	95.63	-0.50	96.92	+2.15	96.53±0.66	abc
24 % SC	87.5	95.42	-0.57	95.71	+0.46	96.76	+0.65	97.44	+2.69	96.33±0.93	abc
Azadirachtin	300	96.44	+0.48	96.92	+1.73	96.00	-0.12	96.76	+1.98	96.53±0.40	abc
1 % EC	75	93.94	-2.11	96.38	+1.16	95.94	-0.18	97.18	+2.42	95.86±1.37	abc
Abamectin	40	96.83	+0.89	96.27	+1.04	96.92	+0.83	96.56	+1.77	96.64±0.29	abc
1.8 % EC	10	95.42	-0.57	95.94	+0.70	96.90	+0.81	94.44	+0.46	95.67±1.02	abc
Control	-	95.97	-	95.27	-	96.12	-	94.88	-	95.56±0.58	bc
L.S.D.0.05										1.40	bc

* Mean followed by the same letter(s) are not significantly different according to Duncan's (1955) multiple range test.

4.2.3.6- Efficiency of Conversion of Ingested food (E.C.I.) :

The ability of insect to utilize food for growth is measured by the efficiency of conversion of ingested food (E.C.I.), together with the efficiency of conversion of digested food (E.C.D.) to body substances.

Data in Table (19) demonstrate the effect of feeding adult of *C. vittata* for 48 h on insecticide treated leaves, on the efficiency of conversion of ingested food (E.C.I.) to biomass. Data show that all insecticides tested at the 1*st* testing interval (0-1 day) resulted in their increase of remarkable decrease in E.C.I. ranged between -17.98 and +47.61. In contrast, profenofos recorded highly pronounced increase of +47.61 and +27.33 % in E.C.I. values at both rates tested.

Considering the bioresidual effect of the tested insecticides on E.C.I. values, it was obvious that the decrease in E.C.I. values decline with time elapse or/and the degradation of insecticide residues on treated leaves. For instance, it declined from -17.98, -12.13, -3.06, -2.83 and -2.39 % at the 1*st* testing interval (0-1 day) to reach -29.17, -15.67, -28.32, -22.52 and -21.60 % at the 4*th* testing interval for spinosad (87.5 ml/200 L), lufenuron (40 ml/200 L), pyriproxyfen (25 ml/200 L), azadirachtin (300 ml/200 L), and hexaflumuron (200 ml/200 L), respectively. On the other hand, the considerable percent increase in E.C.I. value recorded for profenofos treatments at the 1*st* testing interval declined with time elapse and recorded remarkable percent decrease in E.C.I. values at the 4*th* testing interval.

Comparison on the basis of overall mean E.C.I. values within different testing intervals indicate that E.C.I. values in all treatments were slightly lower and were insignificant when compared with control.

4.2.3.7- Efficiency of Conversion of Digested food (E.C.D.) :

The second indicator of food utilization is efficiency of conversion of digested food (E.C.D.) which is sometimes called "Net Growth Efficiency" or "Metabolic Efficiency". It estimates the

Table (19). **Efficiency of conversion of ingested food to body tissues (E.C.I.) for groups of *C. vittata* adults fed for 48 h on treated leaves collected at indicated day post-treatment, followed by 3 days feeding on untreated leaves.**

Insecticides	Rate/ fed. (ml.)	Conversion efficiency of ingested food to body tissue (E.C.I.) at the indicated testing intervals								Mean* ± S.D.	
		1st interval (0-1 day)		*2nd* interva (7-8 day)		*3rd* interval (14-15 day)		*4th* interval (21-22 day)			
		E.C.I. %	% change	E.C.I. %	% change	E.C.I. %	% change	E.C.I. %	% change		
Profenofos	750	71.88	+27.33	70.27	+9.59	46.67	-6.54	43.59	-21.89	58.10±15.04	a
72 % EC	187.5	83.33	+47.61	61.70	-3.77	43.04	-11.83	39.02	-30.08	56.77±20.27	a
Carbosulfan	800	70.73	+25.29	69.44	+8.29	30.23	-39.46	37.84	-32.19	52.06±21.05	a
25 % WP	200	59.57	+5.52	64.10	-0.03	37.78	-24.34	46.15	-17.30	51.90±12.11	a
Pyriproxyfen	100	59.26	+4.97	66.67	+3.97	44.45	-10.99	45.45	-18.56	53.95±10.83	a
10 % EC	25	54.72	-3.06	64.91	+1.23	45.83	-8.22	40.00	-28.32	51.36±10.87	a
Lufenuron	40	49.60	-12.13	52.63	-17.91	44.74	-10.41	47.06	-15.67	48.50±3.39	a
5 % EC	10	69.57	+23.24	71.32	+11.22	55.00	+10.13	36.11	-35.29	58.00±16.32	a
Hexaflumuron	200	55.10	-2.39	65.45	+2.07	58.03	+16.19	43.75	-21.60	55.58±9.01	a
10 % EC	50	62.73	+11.12	71.31	+11.22	45.95	-7.98	43.59	-21.89	55.89±13.35	a
Methoxyfenozide	350	62.34	+10.59	73.58	+14.75	61.29	+22.72	48.65	-12.82	61.48±10.19	a
24 % SC	87.5	58.00	+2.74	66.14	+3.15	55.56	+11.25	43.90	-21.34	55.90±9.19	a
Spinosad	350	50.26	-10.96	62.22	-2.96	62.50	+25.15	48.72	-12.70	55.92±7.45	a
24 % SC	87.5	46.30	-17.98	59.18	-7.70	59.46	+19.06	39.53	-19.17	51.11±9.86	a
Azadirachtin	300	54.30	-2.83	61.21	-4.53	65.00	+10.15	43.24	-22.52	55.93±9.55	a
1 % EC	75	54.85	+8.02	64.12	0	61.90	+23.94	30.77	-44.86	52.91±15.27	a
Abamectin	40	60.98	+18.83	76.00	+18.52	46.15	-7.58	42.50	-23.84	56.40±15.31	a
1.8 % EC	10	67.08	+25.96	74.13	+15.61	38.12	-23.66	50.00	-10.41	57.33±16.33	a
Control	-	71.11	-	64.12	-	49.94	-	55.81	-	60.24±9.29	a
L.S.D.0.05										11.66	

* Mean followed by the same letter(s) are not significantly different according to Duncan's (1955) multiple range test.

percentage of assimilated food to biomass **(Slansky and Scriber, 1985)**.

Data in Table (20), indicate that the E.C.D. was moderately affected for all insecticidal treatments and within most testing intervals recording percent reduction ranged between -3.96 and +43.94 % for the 1*st* (0-1 day), -0.19 and +10.75 % for the 2*nd* (7-8 day), -1.59 and +38.66 % for the 3*rd* (14-15 day) and -10.53 and -44.69 % for the 4*th* testing interval (21-22 day).

Comparison based on overall mean E.C.D. revealed insignificant slight variations between E.C.D. values of different treatments including the control.

The ability of insects to utilize food for growth is measured by the efficiency of conversion of ingested food (E.C.I.), together with efficiency of conversion of digested food (E.C.I.) to body substances. In the present study these two criteria (E.C.I. and E.C.D.) were decreased with most of pesticides tested (pyriproxyfen, lufenuron, hexaflumuron, spinosad and azadirachtin).

Similarly, previous studies indicate that different IGRs reduced E.C.I. and E.C.D. of various insect species such as diflubenzuron and triflumuron against *S. littoralis* **(Radwan *et al.*, 1986)**, fenarimol against *S. litoralis* **(Farag, 1991)** and fenoxycarb against *S. gregaria* **(Ismail, 1995).**

El-Shazly (1993) indicated that the E.C.I. will vary with the digestibility of food (A.D.) and the proportional amount of digestible portion of the food which is converted to body substance and metabolized for energy to maintain life. Furthermore, **Waldbauer (1968)** cited that the (E.C.I.) would raise and fall with the (A.D.). This statement extends to the results obtained in this study. Though the reduced (E.C.I.) and (E.C.D.) obtained may result from diversion of energy from production of biomass to overcoming the effect of treatment.

Table (20). Efficiency of conversion of digested food to body tissues (E.C.D.) for groups of *C. vittata* adults fed for 48 h on treated leaves collected at indicated day post-treatment, followed by 3 days feeding on untreated leaves.

Insecticides	Rate/ fed. (ml.)	Conversion efficiency of digested food to body tissue (E.C.D.) at the indicated testing intervals								Mean* ± S.D.	
		1st interval (0-1 day)		*2nd* interva (7-8 day)		*3rd* interval (14-15 day)		*4th* interval (21-22 day)			
		E.C.D. %	% change	E.C.D. %	% change	E.C.D. %	% change	E.C.D. %	% change		
Profenofos	750	74.68	+24.32	71.23	+5.38	48.05	-1.59	45.09	-22.00	59.76±15.43	a
72 % EC	187.5	86.05	+43.94	63.74	-5.69	35.93	-26.41	40.20	-30.46	56.48±23.19	a
Carbosulfan	800	73.47	+23.30	70.22	+3.89	31.02	-36.47	39.33	-31.96	53.51±21.48	a
25 % WP	200	61.14	+1.78	66.13	-2.16	38.81	-20.52	47.49	-17.85	53.39±12.51	a
Pyriproxyfen	100	61.94	+3.11	69.23	+2.42	45.83	-6.14	47.31	-18.14	56.08±11.38	a
10 % EC	25	56.75	-5.52	67.12	-0.69	47.31	-3.11	41.43	-28.32	53.15±11.24	a
Lufenuron	40	52.35	-12.85	58.32	-13.71	46.20	-5.38	49.08	-15.10	51.48±5.20	a
5 % EC	10	72.56	+20.79	67.46	-0.19	56.85	+16.42	37.36	-35.37	58.55±15.57	a
Hexaflumuron	200	57.69	-3.96	67.29	-0.44	61.69	+26.33	45.31	-21.62	57.99±9.32	a
10 % EC	50	54.13	-9.88	69.85	+3.34	47.49	-2.74	44.85	-22.41	54.08±11.21	a
Methoxyfenozide	350	57.34	-4.54	76.17	-0.62	63.97	+31.00	50.42	-12.78	61.97±10.96	a
24 % SC	87.5	56.91	-5.26	57.87	-14.38	57.31	+17.36	45.23	-21.76	54.33±6.07	a
Spinosad	350	52.40	-12.76	74.86	+10.75	65.36	+33.85	50.26	-13.06	60.72±11.54	a
24 % SC	87.5	47.98	-20.12	52.36	-22.53	61.45	+25.84	40.57	-29.82	50.59±8.72	a
Azadirachtin	300	58.32	-29.13	63.83	-5.56	67.71	+38.66	44.69	-22.69	58.63±10.06	a
1 % EC	75	62.97	+4.82	59.52	-11.93	64.52	+32.13	31.97	-44.69	54.74±15.32	a
Abamectin	40	73.73	+22.74	70.64	+4.51	47.62	-2.47	44.72	-22.64	59.17±15.11	a
1.8 % EC	10	80.79	+43.49	76.03	+12.48	39.31	-19.49	51.72	-10.53	61.96±19.75	a
Control	-	60.07	-	67.59	-	48.83	-	57.81	-	58.57±7.72	a
L.S.D.0.05										13.12	

* Mean followed by the same letter(s) are not significantly different according to Duncan's (1955) multiple range test.

Several studies indicates that some IGRs action on E.C.I. and E.C.D. depended on the dose level, in addition to the nature of the chemical and insect species. In this respect, **Abo-Elghar (1993)** found that abamectin at 10 and 25 ppm caused a significant decrease in E.C.I. and E.C.D., whereas all concentrations tested of the JHM fenoxycarb and buprofezin caused increase in the E.C.I. and E.C.D. over control. Furthermore, **Abo-Elghar (1994)** found that several herbicides such as fluazifop, bentazone, ametryne, flamprop and ioxynil reduced the E.C.I. and E.C.D. below those of untreated control in *S. littoralis*.

4.3- Biochemical Studies :

In this part, we studied the toxic effects of LC_{25} of each of the profenofos, carbosulfan, pyriproxyfen, lufenuron, hexaflumuron, methoxyfenozide, spinosad, azadirachtin and abamectin on the enzymes activities in adults of *C. vittata*. The adults were exposed and fed on the tested concentration for 24 and 48 hours. The data of enzyme activity represented in this study are expressed as percentages of increase or decrease in the activity relative to control.

4.3.1- Non-specific esterases (α-E) and (β-E) :

Table (21) refers to the changes in alpha-esterase (α-E) and beta-esterase (β-E) activities from insecticides treatment. The data obtained revealed that three of the tested insecticides (lufenuron, profenofos and azadirachtin) exhibited mostly equal amount of reduction in α-E activity ranged between -44.03 and -65.70 at 24 h posttreatment.

As for β-E enzymes, it was obvious that 7 of the tested insecticides resulted in pronounced increase it enzymes activity ranged between +244.29 % and +829.6 % relative to control whereas profenofos (+244.29 %) and azadirachtin (+108.94) was mostly similar to control.

Table (22) refers to the changes in alpha-esterase (α-E) and beta-esterase (β-E) activities resulted at 48 h after insecticides treatment. The data obtained revealed that eight of the tested insecticides evoked considerable reduction % in activity ranged between -3.61 and -54.63 % whereas azadirachtin gave about the same level of the enzyme activity of control.

The same trend was obtained for β-E enzymes activity where the nine tested compounds at 48 hours after application gave variable degrees of reduction in β-E activity(-2.76 % - 70.5 %) whereas azadirachtin gave about the same level of the enzyme activity in control.

Table (21). Changes in α-E and β-E activities in adults of *Cassida vittata* with insecticides after 24 h.

Insecticides	α-E		β-E	
	Activity*	%	Activity*	%
Profenofos	33.732	55.89	43.871	102.47
Carbosulfan	120.692	200.00	161.932	378.25
Pyriproxyfen	107.165	177.58	123.304	288.02
Lufenuron	26.573	44.03	104.581	244.29
Hexaflumuron	175.143	290.23	132.624	309.79
Methoxyfenozide	475.014	787.15	355.153	829.60
Spinosad	192.318	318.69	122.950	287.19
Azadirachtin	39.653	65.70	46.638	108.94
Abamectin	174.747	289.57	113.283	264.61
Control	60.346	100.00	42.810	100.0

* α-E activity : μg α-naphthol released/adult/min.

** β-E activity : μg β-naphthol released/adult/min.

Table (22). Changes in α-E and β-E activities in adults of *Cassida vittata* with insecticides after 48 h.

Insecticides	α-E		β-E	
	Activity*	%	Activity*	%
Profenofos	43.888	14.47	52.116	25.82
Carbosulfan	13.605	4.48	31.389	15.55
Pyriproxyfen	10.972	3.61	5.584	2.76
Lufenuron	39.152	12.91	39.850	19.74
Hexaflumuron	157.469	51.93	117.537	58.24
Methoxyfenozide	87.363	28.81	142.274	70.50
Spinosad	165.668	54.63	130.322	64.45
Azadirachtin	309.764	102.16	185.464	91.91
Abamectin	102.317	33.74	135.102	66.95
Control	303.205	100.0	201.785	100.0

* α-E activity : µg α-naphthol released/adult/min.

** β-E activity : µg β-naphthol released/adult/min.

The high titer of esterases in the field strains was also found by **Harold and Ottea (1997)** in larvae of the tobacco budworm, *Heliothis virescens*. They showed high frequencies of profenofos resistance in all field-collected strains and this resistance was strongly correlated with esterase (EST) activity toward α-naphthol acetate. Also, **Harold *et al.* (1999)** found that the profenofos-resistant strain and also the field strains of the tobacco budworm, *H. virescens* characterized by higher titer in its esterase activity compared with the susceptible strain.

The reduction in non-specific esterases as was the case in the present study during the course of poisoning larvae was also observed by **Abdel-Fattah *et al.* (1986)** on *S. littoralis* larvae when treated with the LC_{15}, LC_{30} and LC_{50} with diflubenzuron. **El-Saidy *et al.* (1989)** found that there was a positive correlation between diflubenzuron metabolism inhibition and toxicity. Moreover, **El-Saidy *et al.* (1990)** studied esterase activity in larval gut homogenates of a susceptible (S) strain and an organophosphorus-multiresistant strain (MR) of the noctuid *S. littoralis*. The *in vivo* study indicated that inhibition of midgut homogenate esterases was very rapid and higher with sublethal dosages, and the recovery was only partial.

4.3.2- Changes in phosphatases activities :

Phosphatases are defined as enzymes hydrolyzing any phosphorus ester or anhydride bond, including P-O-C, P-S and others. One generalization can be made safely, all the OP-compounds can be hydrolyzed, in mammals, insects and plants by phosphatases, commonly the major metabolic route (**O'Brien, 1967**).

The close relationship of phosphatases with organophosphorus; resistance had long been conjectured, since **Van Asperen and Oppenoorth (1959)** observed unusually low esterase activity in resistant houseflies.

Results presented in Tables (23 & 24) showed the changes in acid phosphatase (AcP) and alkaline phosphatase (AlkP) activities in

Table (23). Changes in acid (AcP) and alkaline (AlkP) phosphatases activities in adults of *Cassida vittata* with insecticides after 24 h.

Insecticides	AcP*		AlkP*	
	Activity*	%	Activity*	%
Profenofos	0.630	26.21	0.561	179.23
Carbosulfan	0.817	33.99	2.661	850.15
Pyriproxyfen	10.868	452.26	0.931	297.44
Lufenuron	2.003	83.35	0.758	242.17
Hexaflumuron	2.223	92.50	0.579	184.98
Methoxyfenozide	9.945	413.85	1.381	441.21
Spinosad	3.400	141.48	0.363	115.97
Azadirachtin	0.700	29.13	0.226	72.20
Abamectin	1.430	59.50	0.312	99.68
Control	2.403	100.0	0.313	100.0

* AcP & AlkP = µg phenol released/adult/min.

Table (24). Changes in acid (AcP) and alkaline (AlkP) phosphatases activities in adults of *Cassida vittata* with insecticides after 48 h.

Insecticides	AcP*		AlkP*	
	Activity*	%	Activity*	%
Profenofos	2.514	49.63	0.391	78.35
Carbosulfan	0.111	2.10	0.621	124.44
Pyriproxyfen	0.726	13.78	0.313	62.72
Lufenuron	0.432	8.20	0.419	83.96
Hexaflumuron	1.796	34.10	0.539	108.01
Methoxyfenozide	6.122	116.25	0.598	119.83
Spinosad	8.750	166.16	0.251	50.30
Azadirachtin	20.945	397.74	0.817	163.72
Abamectin	9.351	177.57	0.316	63.32
Control	5.266	100.0	0.499	100.0

*** AcP & AlkP = μg phenol released/adult/min.**

adult of *C. vittata*. The enzymes activity was determined at 24 and 48 hours, the data obtained revealed the following :

4.3.2.1- Acid phosphatase (AcP) :

Regarding to insecticides treatment as shown in Table (23), the data obtained indicate that all the tested compounds resulted in high reduction in AcP activity except pyriproxyfen, methoxy-fenozide and spinosad.

In Table (24), the data emerged indicate that all the tested compounds resulted in high reduction in AcP activity of insects except azadirachtin, abamectin, spinosad and methoxyfenozide.

4.3.2.2- Alkaline phosphatase (AlkP) :

The effect of the nine tested compounds on AlkP activity, are shown in Table (23). The data revealed remarkable increase in AlkP activity in 7 out of 9 tested insecticides, whereas considerable decrease in enzyme activity was obtained in azadirachtin treatment after 24 h posttreatment.

In Table (24), the data obtained at 48 h posttreatment revealed remarkable decrease in AlkP activity within most insecticides versus great increase in enzyme activity of azadirachtin, carbosulfan and methoxyfenozide.

O'Brien (1967) concluded that "a minor increase in phosphatase activity, like other numerous changes in hydrolases, accompanies resistance rather than cause it". The same trend was obtained by **Saleem and Shakoori (1987)**. They showed that the sublethal concentrations of permethrin and diflubenzuron increased acid phosphatase in *6th* instar larvae of *T. castaneum*, while alkaline phosphatase were not affected by either insecticide. On the other hand, a sublethal dose (20 ppm) of bifenthrin showed higher activities of AlkP of *6th* instar larvae of *T. castaneum* resistant to malathion, while AcP was not affected. **Shakoori *et al.* (1994)** showed in laboratory studies that the adults of a malathion-resistant Pakistani (PAK) strain of *Tribolium castaneum* had more active acid phosphatase as compared with those of an organophosphorus-susceptible (FSS-II) strain.

Gao *et al.* (1996) found that field strain of *Helicoverpa armigera* had high resistance to pyrethroid, organophosphate and carbamate insecticides. They also added that the effects of sublethal concentrations (LD_5 and LC_{50}) of parathion and methomyl on the phosphatases were related to dosage and the time after treatment. The effect on alkaline phosphatase was stronger than that on acid phosphatase. The effect of sublethal concentration of Cymbush 10EC (cypermethrin) on AcP and AlkP activity in adults of *T. castaneum* was studied by **Shakoori *et al.* (1998).** They found that the treatment increased both enzymes activities.

4.3.3- Carbohydrate hydrolyzing enzymes :

Carbohydrates, proteins and lipids are very efficiently utilized by insects and most species derive the main part of their nourishment from these materials. The utilization of these nutrients depends on the digestive enzymes, amylase, trehalase, invertase, protease and lipase.

Data concerning the effect of sublethal concentration of the tested insecticides on amylase and invertase activities are represented in Tables (25 & 26).

4.3.3.1- Amylase enzyme activity :

Data in Table (25) showed in general that all tested insecticides increased amylase activity after 24 hours much greater than control except for profenofos, where it was reduced.

In Table (26) showed in general that all tested insecticides increased amylase activity after 48 hours, much lower than the control except for abamectin, azadirachtin and profenofos, where the activity was moderately increased (120.64 % - 145.71 %).

Table (25). Changes in amylase and invertase activities in adults of *Cassida vittata* with insecticides after 24 h.

Insecticides	Amylase		Invertase	
	Activity*	%	Activity*	%
Profenofos	118.802	65.69	708.058	114.80
Carbosulfan	1201.008	664.10	672.379	109.02
Pyriproxyfen	964.897	533.54	448.973	72.79
Lufenuron	974.805	539.02	633.398	102.70
Hexaflumuron	489.179	270.49	497.761	80.70
Methoxyfenozide	1888.578	1044.29	758.405	122.97
Spinosad	655.607	362.52	357.360	57.94
Azadirachtin	361.982	200.15	576.490	93.47
Abamectin	582.913	322.32	327.064	53.03
Control	180.847	100.0	616.734	100.0

* Activity = µg glucose released/adult/min.

Table (26). Changes in amylase and invertase activities in adults of *Cassida vittata* with insecticides after 48 h.

Insecticides	Amylase		Invertase	
	Activity*	%	Activity*	%
Profenofos	491.532	120.64	667.742	233.59
Carbosulfan	184.000	45.16	556.600	194.71
Pyriproxyfen	255.040	62.59	537.903	188.17
Lufenuron	206.835	50.76	459.173	160.63
Hexaflumuron	303.472	74.48	729.398	255.16
Methoxyfenozide	301.284	73.94	655.736	229.39
Spinosad	245.366	60.22	255.280	89.30
Azadirachtin	589.668	144.72	519.260	181.65
Abamectin	593.699	145.71	294.512	103.02
Control	407.429	100.0	285.857	100.0

* Activity = µg glucose released/adult/min.

4.3.3.2- Invertase enzyme activity :

Data in Table (25) showed in general that all insecticides reduced invertase activity after 24 hours much less than the control except methoxyfenozide and profenofos, where the invertase activity slightly increased (122.97-114.80).

Data in Table (26) demonstrated in general that all tested insecticides exhibited invertase activity, after 48 hours, much greater than the control except spinosad.

The increase in enzymes involved with carbohydrate metabolism was found by **Shakoori *et al.* (1998)** on adults of *T. castaneum* after treated with sublethal concentration (20 ppm) of Cymbush 10EC (cypermethrin). The data suggested the utilization of reserve carbohydrates, a finding which was supported by depleted levels of glucose (53 %) and glycogen (43 %) following insecticide exposure. **El-Saidy and Degheele (1990)** found that amylase activity was reduced, but neither invertase nor trehalase activity was affected after treatment with diflubenzuron.

The present data after 48 h posttreatment agreed with that obtained by **Abdel-Hafez *et al.* (1993c)** and **Radwan *et al.* (1985)**, who found that repeated selection of the cotton leafworm larvae with Deenate (Dimilin/Nudrin mixture) and DC-702 (Dimilin/Dursban mixture) increased the invertase activity and decreased the amylase and trehalase activity. In this concern, **Ishaaya and Ascher (1977)** concluded that carbohydrates might be affected due to the reduced levels of amylase, trehalase and invertase of the 4*th* larval instar of *T. castaneum* treated with diflubenzuron. Also, **Saleem and Shakoori (1987)** recorded a reduction in trehalase and elevated amylase activity in the 6*th* larval instar of the same insect treated also with diflubenzuron. **Naveeda *et al.* (1994)** found a high level of invertase activity in 6*th* larvae of *T. castaneum* resistant to malathion. Also, **Auda and Hedaya (1997)** found that the chitin synthesis inhibitor diflubenzuron reduced amylase activity *in vivo* and the reduction was positively correlated with DFB concentration, whereas invertase was not affected by DFB treatment.

4.3.4- Total soluble proteins :

The data in Table (27) show that all treatments were characterized by a high level of total protein after 24 hours than the control with exception of profenofos and abamectin where total protein was moderately reduced.

Table (28) demonstrate that all treatments were characterized by a low level of total protein after 48 hours than the control with exception of azadirachtin and methoxyfenozide where total protein increased remarkably.

The decrease in total protein is recorded here agree with that found by **Ahmed and Mostafa (1989)** when they studied the action of triflumuron and chlorfluazuron on the 4*th* larval instar of *S. littoralis*. They found that the haemolymph proteins and free amino acids decreased after insecticides treatment. Also, **Bakr *et al.* (1991)** reported that the total protein of larvae and pupae of *M. domesticae* treated with Dimilin and BAY SIR-8514 was less than those of the normal ones allover the larval and pupal periods. The reduction in total protein as a result of insecticides poisoning was also found by **Ahmed (2001)** on the cotton leafworm.

Likewise, **Saleem and Shakoori (1987)** studied the effects of sublethal doses of permethrin or deltamethrin on some biochemical components of 6*th*-instar larvae of the tenebrionid *T. castaneum*. Permethrin at 20 ppm led to a significant reduction in soluble proteins and free amino acids, while DNA contents were elevated significantly. Deltamethrin resulted in decreased glycogen and increased free amino acids, urea and DNA contents. Other components remained unchanged. It is concluded that deltamethrin produced more macromolecular abnormalities than did permethrin at the same dose level.

However, the inhibition of total proteins synthesis as a result of IGR's treatment may be due to the effect of these compounds on the enzyme of DNA synthesis **(Mitlin *et al.*, 1977** and **Deloach *et al.*,** Table (27). Changes in total protein activities in adults of *Cassida vittata* with insecticides after 24 h.

Insecticides	Total protein (mg/adult)	
	Activity*	%
Profenofos	6.785	82.76
Carbosulfan	11.441	139.55
Pyriproxyfen	9.908	120.85
Lufenuron	10.472	127.73
Hexaflumuron	7.961	97.10
Methoxyfenozide	16.250	198.21
Spinosad	7.986	97.41
Azadirachtin	8.335	101.67
Abamectin	7.225	88.13
Control	8.198	100.0

* Concentration : mg protein/adult.

Table (28). Changes in total protein activities in adults of *Cassida vittata* with insecticides after 48 h.

Insecticides	Total protein (mg/adult)	
	Activity*	%
Profenofos	8.378	83.33
Carbosulfan	8.892	88.44
Pyriproxyfen	5.856	57.90
Lufenuron	4.822	47.96
Hexaflumuron	10.447	103.90
Methoxyfenozide	12.510	124.42
Spinosad	9.172	91.22
Azadirachtin	14.961	148.80
Abamectin	7.810	77.68
Control	10.054	100.0

*** Concentration : mg protein/adult.**

1981). **Ferkovich** *et al.* **(1981)** supported this concept in *G. mellonella*, they found that 20-hydroxyecdysone stimulated chitin production requires the synthesis of RNA and protein. They added that there were new proteins synthesized by imaginal wing discs incubated with 20-hydroxyecdysone. The function of which is unknown but they could include cuticle structural proteins, chitin synthetase or the activator of that enzyme.

The changes in protein metabolism in the haemolymph and fat body of 5*th*-instar larvae of *B. mori* following exposure to sublethal concentrations of fenitrothion and ethion were studied by **Nath** ***et al.*** **(1997)**. The total protein content showed a depletion followed by an increase in free amino acids. The activity of proteinases in both tissues also increased at the same time. An increase in the activities of GPT and GOT paralleled the elevation of glutamate dehydrogenase activity in all the tissues studied. All changes clearly indicated a severe proteolysis and transamination of amino acids.

Shaker (2005) evaluate the relation between resistance level of *S. littoralis* to the insecticide spinosad, and some biochemical parameters, and found that the total lipids and total carbohydrates in the spinosad resistance (R), field (F) and susceptible (S) strains were higher than of laboratory (L) strain, but the total protein is lower than of laboratory strain. The invertase, amylase and aspartic aminotransferase activities in the spinosad R, F and S-strains were lower than of L-strain. The trehalase, alanine aminotransferase, α-esterase, β-esterase, alkaline phosphatase and acid phosphatase activities in spinosad R, F and S-strain were higher than of L-strain.