INTERNATIONAL JOURNAL OF PLANT PROTECTION
VOLUME 9 | ISSUE 1 | APRIL, 2016 | 313-321

● e ISSN-0976-6855 | Visit us : *www.researchjournal.co.in*

IJPP

A CASE STUDY

DOI : 10.15740/HAS/IJPP/9.1/313-321

Studies of the effects of imidacloprid and deltamethrin insecticides on the biology of *Pieris brassicae* (Linn.) on cabbage

■ HADI HUSAIN KHAN*, M. SHAFIQ ANSARI, FAZIL HASAN, SALMAN AHMAD AND MOHD. DANISH

Department of Plant Protection, Faculty of Agricultural Sciences, Aligarh Muslim University, ALIGARH (U.P.) INDIA

ARITCLE INFO

Received : 19.01.2016
Accepted : 23.03.2016

KEY WORDS :
Insecticies, *Pieris brassicae* (Linn.), Imidacloprid, Deltamethrin

***Corresponding author:**
Email: hhkhan.amu.786@gmail.com

ABSTRACT

The present investigation was conducted during *Rabi* season of 2011 to see the effect of imidacloprid and deltamethrin insecticides on the biology of *Pieris brassicae* (Linn.) on cabbage at experimental field of the Department of Plant Protection, Faculty of Agricultural Sciences, Aligarh Muslim University, Aligarh. The larvae of *Pieris brassicae* were collected from cabbage field in the month of January and February 2012. They were kept in jars measuring 25 x15 cm and provided fresh cabbage leaves as food for larvae. These jars were kept in B.O.D chamber at 24.5 ºC and 70±10 per cent relative humidity. Fresh cabbage leaves were dipped in 0.05 per cent aqueous solution of, imidacloprid and deltamethrin and dried at room temperature by keping in the experimental jars. Fifteen third instar larvae in a batch of five were allowed to feed on them for 24 hours. Survivorship and expectancy of the life was greatest in the beginning of the age and decreased gradually with the advancement of the age in the all treatment including control. The expectancy was minimum (17.18) when *P. brassicae* was treated with imidacloprid while maximum in the untreated individuals (25.83). The mortality of *P. brassicae* was significantly high in the early instars as compared to late instars in both treated and untreated individuals.

How to view point the article : Khan, Hadi Husain, Ansari, M. Shafiq, Hasan, Fazil, Ahmad, Salman and Danish, Mohd. (2016). Studies of the effects of imidacloprid and deltamethrin insecticides on the biology of *Pieris brassicae* (Linn.) on cabbage. *Internat. J. Plant Protec.*, **9**(1) : 313-321.

INTRODUCTION

The pest management strategy in India is mainly relying on chemical pesticides. Insecticide application against the larval stage of the *P. brassicae* is the primary method of control, but high tolerance to most insecticides and associated environmental problems may jeopardize their continued use (Chen and Sun, 1986; Sun *et al*., 1986; Kao *et al*., 1989 and Grisakova *et al*., 2006). Pajmon (1999) listed 38 insect pests on cole crops which includes cabbage white butterfly, *Pieris brassicae* (Linn.) (Lepidoptera: Pieridae), diamondback moth (DBM),

Plutella xylostella (L.) (Lepidoptera: Yponomeutidae); leafwebber, *Crocidolomia binotalis* Zeller (Lepidoptera: Pyralidae); Cabbage webworm, *Hellula undalis* Zeller (Lepidoptera: Pyralidae); tomato fruitworm, *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae); and aphids, *Brevicoryne brassicae* L. (Homoptera: Aphididae). Among them cabbage white butterfly, *Pieris brassicae* (Linn.) is one of the most destructive pests causing damage at all the growing stages such as seedling, vegetative and flowering stage (Khalid, 2006; Ali and Rizvi, 2007; Hasan, 2008; Rizvi *et al*., 2009, Bhandari *et al.*, 2009). It is an oligophagous pest with wide host range and is known to infest 83 species of food plants belonging to Cruciferae. The low quality of plants can perform as a defense mechanism against herbivorous pests and cause a decline in their fecundity and an increase in developmental time (Legrand and Barbosa, 2000). The control of *P. brassicae* on vegetables is usually accomplished with the use of conventional chemical insecticides (Zafar *et al.*, 2002). The damage notably affects the value of this crop because its consumption and sale happen when it is still fresh (Cartea *et al.*, 2009). Synthetic insecticides have been in use for more than 50 years and have resulted in fast, economical and effective pest control (Gossa, 2007). Insecticides application is the dominant method for controlling *Pieris brassicae* in cruciferous crops because of a low market tolerance for pest damage and the lack of reliable alternative pest control options (Lundgren and Heimpel, 2003). The present investigation was carried out to check the effects of imidacloprid and deltamethrin insecticides on the biology of *Pieris brassicae* (Linn.) on cabbage.

MATERIAL AND METHODS

Seeds of cabbage (*Brassica oleracea* var. *capitata*) were sown by adopting standard agronomic practices at experimental field of Department of Plant Protection, Faculty of Agricultural Sciences, Aligarh Muslim University, Aligarh. Larvae of *Pieris brassicae* were collected from cabbage field in the month of January and February 2012. They were kept in jars measuring 25 x15 cm and provided fresh cabbage leaves as food for larvae. These jars were kept in B.O.D chamber at 24.5 ºC and 70±10 per cent relative humidity.

Rearing of *P. brassicae* :

After emergence the adults were kept in the rearing glass jars measuring 20x10 cm. The top of the jars were covered with muslin cloth tightly fixed with the means of rubber band. The jars were maintained at a temperature of 30±1ºC and 60-70 per cent relative humidity. Fresh cabbage leaves were kept in the jar for oviposition. The stalk of the leaf was wrapped with the cotton plug containing water to maintain its freshness. A piece of the cotton wool soaked in 20 per cent sugar solution was kept in the petridish and placed in the jar for feeding. Cabbage leaves having eggs were kept in the separate jar for hatching. Cotton soaked in the sugar solution was changed daily in order to maintain hygienic environment. After hatching of the eggs, the young larvae were transferred to the jars containing fresh cabbage leaves. The faecal matter and dry leaves were removed from the jars daily and were replaced with fresh leaves. After undergoing a series of moult the larvae become mature and start spinning cocoon for pupation and occurred on the wall of the rearing jar. The adults after emerging from the pupa were transferred to another jar. After several generations of rearing in the laboratory so that the *E. vittella* may become preconditioned to study life table.

Bioassay :

Fresh cabbage leaves were dipped in 0.05 per cent aqueous solution of imidaclopridand deltamethrin, and dried at room temperature and kept in the experimental jars. Fifteen third instar larvae in a batch of five were allowed to feed on them for 24 hours. Insecticide ingested larvae were then transferred to another container and were provided with fresh leaves. Each treatment was replicated thrice. A control experiment was run parallel for each treatment in which distilled water was used. Mortality was counted on the daily basis and number dead and live larvae were counted daily and recorded. Moribund larvae (larvae lacking vitality) were regarded as dead. This experiment was conducted at 25±1ºC and 70±10 per cent relative humidity.

Study of life table under the influence of insecticides:

Surviving adults obtained from third instar that has ingeste insectiside were paired and kept in jars. Each jar was containing one pair and provided 10 per cent honey solution for feeding. 100 eggs of the same age group

were obtained and used to construct life table. It was constructed by the method of Deevey (1947) and Southwood (1978). About 5 eggs per leaves were kept with the help of wet camel hairbrush in a single glass container measuring 20 x 10 cm. After hatching the first instar larvae were given fresh cabbage leaves as food and the freshness of leaves were maintained by changing them daily till pupation. The stalk of the leaves was wrapped with the cotton plug dipped in the vial containing water to maintain freshness. During the entire period of experiment the dead larvae and pupae were counted and removed from the experimental jars. After undergoing a series of moult the larvae become mature and start spinning cocoon for pupation. The pupae were sorted out and kept in another jars for emergence of adults.

Age and stage specific life table :

Observations on the basis of alive or dead forms a cohart (100) was recorded daily. The life table was constructed by the method of Deevey (1947) and Southwood (1978). The apparent mortality, stage specific survival fraction (Sx), mortality survival ratio (MSR), indispensable mortality (IM), and K-value was determined by standard methods.

Fecundity table for females :

A pair of adult was kept in a separate jar and the eggs laid by them were counted daily. A piece of the cotton wool soaked in the 20 per cent sugar solution was kept in the petri dish and placed in the jar for feeding. Fresh leaves were kept in the jars for oviposition. Eggs were collected from the leaves daily and were kept in the separate jars for hatching. Potential fecundity (Pf), net reproductive or replacement rate (R_o), intrinsic rate of increase (r_m), finite rate of increase (λ), mean length of generation (T_c) and doubling time (DT) was determined.

RESULTS AND DISCUSSION

The findings of the present study as well as relevant discussion have been presented under the following heads:

Female fecundity and life indices:

It was revealed from the pooled observation that the insecticides have caused the adverse effect on the life of *P. brassicae*. Survivorship was greatest in the beginning of the age decreased gradually with the advancement of the age in the all treatment including control. Expectancy of the life was highest in the beginning of the age and decreased gradually with the advancement of the age (Table 1c, Table 2c and Table 3c). The expectancy was minimum (17.18) when *P. brassicae* was treated with imidacloprid while maximum in the untreated individuals (25.83) (Table 1a, 2a, 3a). The mortality of *P. brassicae* was significantly high in the early instars as compared to late instars in both treated and untreated individuals. Egg hatching was 100 per cent in both treated and untreated individuals. Insecticides had adverse effect on the fecundity of *P. brassicae*. The female of *P. brassicae* start laying eggs after 2 days of the emergence in both treated and untreated individuals. The potential fecundity (Pf) was reduced with the treatment of the insecticide in comparison to control. Least number of eggs *i.e.* 163 eggs/female/generation were recorded with imidacloprid, and highest was found in deltamethrin (192 eggs/female/generation), while it was 281 eggs/female/generation in the control. The net reproductive rate (Ro) was also reduced with the treatment of the insecticide. The Ro was minimum with imidacloprid (22.94 femals/female/generation) and maximum with control (58.62 femals/female/generation). Intrinsic rate of increase (r_m) was calculated lowest (0.0358 femals/female/day) with imidacloprid while, it was highest (0.0454 femals/female/day) in the control. The finite rate of increase (λ) of the population of *P. brassicae* was lowest (1.09 days) in both deltamethrin, and imidacloprid. The time taken by *P. brassicae* to complete its life cycle was reduced to 35.29 days with imidacloprid than in the untreated individuals (36.39days). Corrected generation time (τ) was reduced to 38.01 days with imidacloprid treated individual followed by deltamethrin (40.07 days) (Table 3b) as compared to the control (42.08 days) (Table 1b). *P. brassicae* took longer time to double its population when treated with imidacloprid (8.41 days) than untreated population (6.63 days). Hafeez *et al.* (2007) reported that insecticides resulted in significant reduction of pest and increase in marketable yield of cabbage. In present study, imidacloprid was found superior over other insecticides used. Dhawan *et al.* (2010) revealed that among novel insecticides spinosad and chlorantraniliprole proved more toxic whereas *Bt* formulations showed least toxicity. The insecticides exhibit reduction in the oviposition of *P.*

Table 1 a: Age specific life table of *P. brassicae* in untreated control

x	lx	dx	100qx	Lx	Tx	ex
0	100	0	0.00	100.00	2583.00	25.83
1	100	0	0.00	100.00	2483.00	24.83
2	100	0	0.00	100.00	2383.00	23.83
3	100	0	0.00	100.00	2283.00	22.83
4	100	0	0.00	100.00	2183.00	21.83
5	100	3	3.00	98.50	2083.00	20.83
6	97	2	2.06	96.00	1984.50	20.46
7	95	3	3.16	93.50	1888.50	19.88
8	92	4	4.35	90.00	1795.00	19.51
9	88	0	0.00	88.00	1705.00	19.38
10	88	2	2.27	87.00	1617.00	18.38
11	86	1	1.16	85.50	1530.00	17.79
12	85	0	0.00	85.00	1444.50	16.99
13	85	3	3.53	83.50	1359.50	15.99
14	82	4	4.88	80.00	1276.00	15.56
15	78	3	3.85	76.50	1196.00	15.33
16	75	5	6.67	72.50	1119.50	14.93
17	70	2	2.86	69.00	1047.00	14.96
18	68	1	1.47	67.50	978.00	14.38
19	67	2	2.99	66.00	910.50	13.59
20	65	1	1.54	64.50	844.50	12.99
21	64	5	7.81	61.50	780.00	12.19
22	59	2	3.39	58.00	718.50	12.18
23	57	2	3.51	56.00	660.50	11.59
24	55	0	0.00	55.00	604.50	10.99
25	55	4	7.27	53.00	549.50	9.99
26	51	2	3.92	50.00	496.50	9.74
27	49	2	4.08	48.00	446.50	9.11
28	47	0	0.00	47.00	398.50	8.48
29	47	2	4.26	46.00	351.50	7.48
30	45	3	6.67	43.50	305.50	6.79
31	42	4	9.52	40.00	262.00	6.24
32	38	0	0.00	38.00	222.00	5.84
33	38	0	0.00	38.00	184.00	4.84
34	38	3	7.89	36.50	146.00	3.84
35	35	6	17.14	32.00	109.50	3.13
36	29	3	10.34	27.50	77.50	2.67
37	26	3	11.54	24.50	50.00	1.92
38	23	2	8.70	18.50	25.50	1.11
39	19	2	10.53	9.50	9.50	0.50
40	17	3	17.65	8.50	8.50	0.50
41	14	5	35.71	7.00	7.00	0.50
42	9	9	100.00	4.50	4.50	0.50

brassicae. Least number of eggs *i.e.* 163 eggs/female/ generation were recorded with imidacloprid while highest in untreated individuals. Hasan and Ansari (2011) found that numbers of eggs laid by *P. brassicae* adults on treated cabbage leaves were significantly lower than those treated with water, but no significant differences were detected among the neem insecticides. They also deterred feeding by *Pieris* larvae and exhibited significant antifeedant effects. In a study, Devjani and Singh (2008) found that spraying of 0.025 per cent bioasp to first- and second instar larvae, and of 0.1 per cent bioasp to third-instar larvae induced high levels of mortality for up to 48 h after treatment. Table 1b, Table 2b and Table 2c) showed that survivorship was highest in the beginning of the age decreased gradually with the advancement of the age in the all treatment including control. Expectancy of life was lowest on imidacloprid treatment.

Stage specific:

Results showed that all the eggs of *P. brassicae* were hatched with treated and untreated individuals. Highest mortality of first instar was recorded with the treatment of imidacloprid (25%) (Table 2b) , as compared to control (12%) as shown in Table 1b. Lowest number of adults *i.e.* 17 were survived with imidacloprid while 38 adults (Table 2b) were recorded with the control. K-

Table 1 b: Stage specific life table of *P. brassicae* in untreated control

Stages x	No. surviving at beginning of stage lx	No. dying at stage dx	Apparent mortality 100qx	Survival Fraction Sx	Mortality/ Survival ratio MSR	Indispensable mortality IM	log lx	k-Values
Egg	100	0	0.000	1.0000	0.0000	0.000	2.0000	0.0000
I instar	100	12	12.000	0.8800	0.1364	3.818	2.0000	0.0555
II instar	88	2	2.273	0.9773	0.0233	0.651	1.9445	0.0100
III instar	86	8	9.302	0.9070	0.1026	2.872	1.9345	0.0424
IV instar	78	11	14.103	0.8590	0.1642	4.597	1.8921	0.0660
V instar	67	10	14.925	0.8209	0.1818	5.091	1.8261	0.0857
Pre-pupa	57	2	3.509	0.6667	0.0526	1.474	1.7559	0.1761
Pupa	55	17	30.909	0.6909	0.4474	12.526	1.7404	0.1606
Adult	38	0	-	-	-		1.5798	-
							K=	0.5963

Table 1 c: Age specific fecundity table of *P. brassicae* in untreated control

Pivotal age (Day) X	Age specific female survivorship lx	Fecundity mx	lx.mx	lxmx.x
0.5-30.5	Immature stage			
31.5-32.5	Preoviposional period			
33.5	0.38	17.00	6.460	216.410
34.5	0.38	28.00	10.640	367.080
35.5	0.35	45.00	15.750	559.125
36.5	0.29	75.00	21.750	793.875
37.5	0.26	53.00	13.780	516.750
38.5	0.23	32.00	7.360	283.360
39.5	0.19	19.00	3.610	142.595
40.5	0.17	12.00	2.040	82.620
41.5	0.14	0.00	0.000	0.000
42.5	0.07	0.00	0.000	0.000
	Total=	281.00	81.390	2961.815

Table 2 a: Age specific life table of *P. brassicae* derived from 3rd instar ingested 0.05 per cent imidacloprid impregnated cabbage leaf

x	lx	dx	100qx	Lx	Tx	ex
0	100	0	0.00	100.00	1718.00	17.18
1	100	0	0.00	100.00	1618.00	16.18
2	100	0	0.00	100.00	1518.00	15.18
3	100	0	0.00	100.00	1418.00	14.18
4	100	0	0.00	100.00	1318.00	13.18
5	100	0	0.00	100.00	1218.00	12.18
6	100	12	12.00	94.00	1118.00	11.18
7	88	0	0.00	88.00	1024.00	11.64
8	88	13	14.77	81.50	936.00	10.64
9	75	7	9.33	71.50	854.50	11.39
10	68	11	16.18	62.50	783.00	11.51
11	57	5	8.77	54.50	720.50	12.64
12	52	6	11.54	49.00	666.00	12.81
13	46	2	4.35	45.00	617.00	13.41
14	44	2	4.55	43.00	572.00	13.00
15	42	0	0.00	42.00	529.00	12.60
16	42	2	4.76	41.00	487.00	11.60
17	40	4	10.00	38.00	446.00	11.15
18	36	5	13.89	33.50	408.00	11.33
19	31	2	6.45	30.00	374.50	12.08
20	29	4	13.79	27.00	344.50	11.88
21	25	0	0.00	25.00	317.50	12.70
22	25	0	0.00	25.00	292.50	11.70
23	25	3	12.00	23.50	267.50	10.70
24	22	0	0.00	22.00	244.00	11.09
25	22	0	0.00	22.00	222.00	10.09
26	22	0	0.00	22.00	200.00	9.09
27	22	0	0.00	22.00	178.00	8.09
28	22	3	13.64	20.50	156.00	7.09
29	19	0	0.00	19.00	135.50	7.13
30	19	2	10.53	18.00	116.50	6.13
31	17	0	0.00	17.00	98.50	5.79
32	17	0	0.00	17.00	81.50	4.79
33	17	0	0.00	17.00	64.50	3.79
34	17	2	11.76	16.00	47.50	2.79
35	15	4	26.67	13.00	31.50	2.10
36	11	3	27.27	9.50	18.50	1.68
37	8	3	37.50	6.50	9.00	1.13
38	5	5	100.00	2.50	2.50	0.50

Table 2 b: Stage specific life table of *Pieris brassicae* derived from 3rd instar ingested 0.05 per cent imidacloprid impregnated cabbage leaf

Stages x	No. surviving at beginning of stage lx	No. dying at stage dx	Apparent mortality 100qx	Survival fraction Sx	Mortality/ Survival ratio MSR	Indispensable mortality IM	log lx	k-values
Egg	100	0	0.000	1.0000	0.0000	0.000	2.0000	0.0000
I instar	100	25	25.000	0.7500	0.3333	9.333	2.0000	0.1249
II instar	75	18	24.000	0.7600	0.3158	8.842	1.8751	0.1192
III instar	57	15	26.316	0.7368	0.3571	10.000	1.7559	0.1326
IV instar	42	11	26.190	0.7381	0.3548	9.935	1.6232	0.1319
V instar	31	6	19.355	0.7097	0.2727	7.636	1.4914	0.1489
Pre-pupa	25	3	12.000	0.6800	0.1765	4.941	1.3979	0.1675
Pupa	22	5	22.727	0.7727	0.2941	8.235	1.3424	0.1120
Adult	17	0	-	-	-		1.2304	-
							K=	0.9370

Table 2 c: Age specific fecundity table of *P. brassicae* derived from 3rd instar ingested 0.05 per cent imidacloprid impregnated cabbage leaf

Pivotal age (Day) x	Age specific female survivorship lx	Fecundity mx	lx.mx	lxmx.x
0.5-30.0		Immature stage		
31.5-32.5		Preoviposional period		
33.5	0.17	14.00	2.380	79.730
34.5	0.17	39.00	6.630	228.735
35.5	0.15	57.00	8.550	303.525
36.5	0.11	38.00	4.180	152.570
37.5	0.08	15.00	1.200	45.000
38.5	0.05	0.00	0.000	0.000
	Total=	163.00	22.940	809.560

Table 3 a : Age specific life table of *P. brassicae* derived from 3rd instar ingested 0.05 per cent deltamethrin impregnated cabbage leaf

x	lx	dx	100qx	Lx	Tx	ex
0	100	0	0.00	100.00	1766.00	17.66
1	100	0	0.00	100.00	1666.00	16.66
2	100	0	0.00	100.00	1566.00	15.66
3	100	0	0.00	100.00	1466.00	14.66
4	100	0	0.00	100.00	1366.00	13.66
5	100	7	7.00	96.50	1266.00	12.66
6	93	4	4.30	91.00	1169.50	12.58
7	89	11	12.36	83.50	1078.50	12.12
8	78	6	7.69	75.00	995.00	12.76
9	72	11	15.28	66.50	920.00	12.78
10	61	4	6.56	59.00	853.50	13.99
11	57	2	3.51	56.00	794.50	13.94
12	55	6	10.91	52.00	738.50	13.43
13	49	2	4.08	48.00	686.50	14.01
14	47	4	8.51	45.00	638.50	13.59
15	43	4	9.30	41.00	593.50	13.80
16	39	0	0.00	39.00	552.50	14.17
17	39	1	2.56	38.50	513.50	13.17
18	38	3	7.89	36.50	475.00	12.50
19	35	4	11.43	33.00	438.50	12.53

Table 3 contd...

Contd....Table 3

20	31	2	6.45	30.00	405.50	13.08
21	29	1	3.45	28.50	375.50	12.95
22	28	0	0.00	28.00	347.00	12.39
23	28	3	10.71	26.50	319.00	11.39
24	25	0	0.00	25.00	292.50	11.70
25	25	0	0.00	25.00	267.50	10.70
26	25	0	0.00	25.00	242.50	9.70
27	25	0	0.00	25.00	217.50	8.70
28	25	0	0.00	25.00	192.50	7.70
29	25	0	0.00	25.00	167.50	6.70
30	25	6	24.00	22.00	142.50	5.70
31	19	0	0.00	19.00	120.50	6.34
32	19	0	0.00	19.00	101.50	5.34
33	19	0	0.00	19.00	82.50	4.34
34	19	4	21.05	17.00	63.50	3.34
35	15	0	0.00	15.00	46.50	3.10
36	15	0	0.00	15.00	31.50	2.10
37	15	4	26.67	13.00	16.50	1.10
38	11	4	36.36	5.50	8.00	0.73
39	7	3	42.86	3.50	3.50	0.50
40	5	5	100.00	2.50	2.50	0.50

Table 3 b : Stage specific life table of *P. brassicae* derived from 3rd instar ingested 0.05 per cent deltamethrin impregnated cabbage leaf

Stages x	No. surviving at beginning of stage lx	No. dying at stage dx	Apparent mortality 100qx	Survival fraction Sx	Mortality/ Survival ratio MSR	Indispensable mortality IM	log lx	k-values
Egg	100	0	0.000	1.0000	0.0000	0.000	2.0000	0.0000
I instar	100	28	28.000	0.7200	0.3889	10.889	2.0000	0.1427
II instar	72	15	20.833	0.7917	0.2632	7.368	1.8573	0.1015
III instar	57	14	24.561	0.7544	0.3256	9.116	1.7559	0.1224
IV instar	43	8	18.605	0.8140	0.2286	6.400	1.6335	0.0894
V instar	35	7	20.000	0.7143	0.2800	7.840	1.5441	0.1461
Pre-pupa	28	3	10.714	0.6786	0.1579	4.421	1.4472	0.1684
Pupa	25	6	24.000	0.7600	0.3158	8.842	1.3979	0.1192
Adult	19	0	-	-	-		1.2788	-
							K=	0.8897

Table 3 c : Age specific fecundity table of *P. brassicae* derived from 3rd instar ingested 0.05 per cent deltamethrin impregnated cabbage leaf

Pivotal age (Day) x	Age specific female survivorship lx	Fecundity mx	lx.mx	lxmx.x
0.5-31.0		Immature stage		
32.5-33.5		Preoviposional period		
34.5	0.19	15.00	2.850	98.325
35.5	0.15	32.00	4.800	170.400
36.5	0.15	59.00	8.850	323.025
37.5	0.15	47.00	7.050	264.375
38.5	0.11	28.00	3.080	118.580
39.5	0.07	11.00	0.770	30.415
40.5	0.05	0.00	0.000	0.000
	Total=	192.00	27.400	1005.120

values significantly varied at different stages of *P.brassicae* with different insecticides. Highest survival fraction (Sx) was 1.00 was recorded at egg stage with all the treatments including control. Mortality Survival Ratio (MSR) was recorded as zero at the egg stage with all the insecticides including control (Table 1b, Table 2b and Table 3b). Lowest indispensable mortality was found 0.00 (Table 1b) with egg stage in all the treatments including control. The peak of k-value was found on pre-pupal stage followed by first instar stage. It showed that pre-pupal stage was the most succeptible stage on all treatment the untreated control.

REFERENCES

Bhandari, K., Sood, P., Mehta, P.K., Choudhary, A. and Prabhakar, C.S. (2009) Effect of botanical extracts on the biological activity of granulosis virus against *Pieris brassicae*. *Phytoparasitica*, **37** (4) : 317-322

Devjani, P. and Singh, T.K. (2008). Management of cabbage large butterfly, *Pieris brassicae* (Linn.) in cauliflower ecosystem. (Insect and Environment VIII) Volume **1** : 175-180.

Grisakova, M., Metspalu, L. , Jogar, K. , Hiiesaar, K., Kuusik, A. and Poldma, P. (2006). Effects of biopesticide Neem EC on the Large White Butterfly, *Pieris brassicae* L. (Lepidoptera, Pieridae). *Agron Res*., **4** : 181-186.

Hafeez, Ahmad, Uma, Shankar, Monobrullah, M. Sunil Singh, Abrol, D.P. and Kaul, V. (2007) Seasonal incidence and management of cabbage butterfly *Pieris brassicae* (Linn.) in Jammu. *Enviro & Ecol*., **25**(2) : 429-434.

Hasan, F. (2008). Studies on the bionomics of *Pieris brassicae* (Linn.). M.Sc. Thesis, Department of Plant Protection, Aligarh Muslim University, Aligarh (U.P.) India.

Hasan, F. and Ansari, M.S. (2011). Toxic effects of neem-based insecticides on *Pieris brassicae* (Linn.). *Crop Protec.*, **30** (4) : 502-507

Kao, C.H., Hung, C.F. and Sun, C.N. (1989). Parathion and methyl parathion resistance in diamondback moth (Lepidoptera : Plutellidae) larvae. *J. Econ. Entomol.*, **82** : 1299-1300.

Khalid, S. (2006). Ecological studies of *Pieris brassicae* (Lepidoptera:pieridae) on different hosts. M.Sc. Thesis, department of plant proyection faulty of agricultural sciences, Aligarh Muslim University, Aligarh, U.P. (INDIA).

Legrand, A. and Barbosa, P. (2000). Pea aphid (Hom.: Aphididae) fecundity, rate of increase, and within plant distribution unaffected by plant morphology. *Environ. Entomol.*, **29** : 987–993.

Pajmon, A. (1999). Pest of cabbage. *Sodobna Kemetijstvo*. **32** : 537-540.

Sun, C.N., Wu, T.K., Chen, J.S. and Lee, W.T. (1986). Insecticide resistance in diamondback moth. In Talekar, N. S., and Griggs, T. D. (ed.) Diamondback Moth Management: Proc first international workshop, AVRDC, Shanhua, Taiwan, 359-371pp.