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Effects of dimethoate and neemarin insecticides on the biology of *Pieris brassicae* (Linn.) on cabbage

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ABSTRACT

An attempts has been made to study the effects of insecticides *i.e.* 0.05 per cent aqueous solution of dimethoate and Neemarin, on the biology of *Pieris brassicae* (Linn.) at 25±1°C and 70±10 per cent relative humidity through life table methods. 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 number of eggs was found less in deltamethrin (192 eggs/female/generation) as compared to neemarin (207 eggs/female/generation), and dimethoate (214 eggs/female/generation) while it was found 281 eggs/female/generation in the control. The net reproductive rate (Ro) was also reduced with the treatment of the insecticide. K-values of *P. brassicae* was lowest on Neemarin treatment. The peak of k-value was found on Pre-pupal stage followed by Ist instar stage. It showed that Pre-pupal stage was the most susceptible stage on all treatments and non treated control .

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INTRODUCTION

Cabbage (*Brassica oleracea* var. *capitata* L.) is one of the most important winter vegetable in India. The major cabbage growing states are Orissa, west Bengal, Bihar, Karnataka, Maharashtra, Gujarat, Punjab, Himanchal Pradesh, Uttar Pradesh and Haryana. It is considerable quantities are exported to several subtropical countries. Cabbage is growing in an area of about is 2.073 million hectares spread over more than 90 countries of the worlds. 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 and 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. It has a Palearctic distribution from North Africa across Europe and Asia to the Himalayan Mountains (Raqib, 2004 and Jainulabdeen and Prasad, 2004). Cabbage butterfly is present throughout the year although major period of its

activity is during mid February to October, which coincided with the main growing season of these vegetables. From November to mid February incidence is of minor in nature. This indicated that extreme cold conditions are not favorable for its multiplication. The young caterpillars feed gregariously on leaves and cover the whole inflorescence, resulting defoliation in the plants (Younas *et al*., 2004; Jainulabdeen and Prasad, 2004 and Hasan, 2008). On cabbage and cauliflower, the caterpillar sometime bores into the heads and become most destructive and causes serious damage economically (Ali and Rizvi, 2007; Hasan, 2008; Rizvi *et al*., 2009; Sharma and Gupta, 2009). The present study was conducted to check the effects of Dimethoate and Neemarin 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, A.M.U., Aligarh. Larvae of *Pieris brassicae* were collected from cabbage field in the month of January and February 2012.

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 Dimethoate and Neemarin, 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 20x10 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),

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

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 found from the pooled observation that the insecticides have caused the adverse effect on the life of *P. brassicae*. Expectancy of the life was highest in the beginning of the age and decreased gradually with the advancement of the age. 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. The number of eggs

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 dimethoate impregnated cabbage leaf

x	lx	dx	100qx	Lx	Tx	ex
0	100	0	0.00	100.00	2187.00	21.87
1	100	0	0.00	100.00	2087.00	20.87
2	100	0	0.00	100.00	1987.00	19.87
3	100	0	0.00	100.00	1887.00	18.87
4	100	0	0.00	100.00	1787.00	17.87
5	100	0	0.00	100.00	1687.00	16.87
6	100	7	7.00	96.50	1587.00	15.87
7	93	8	8.60	89.00	1490.50	16.03
8	85	7	8.24	81.50	1401.50	16.49
9	78	4	5.13	76.00	1320.00	16.92
10	74	3	4.05	72.50	1244.00	16.81
11	71	3	4.23	69.50	1171.50	16.50
12	68	0	0.00	68.00	1102.00	16.21
13	68	7	10.29	64.50	1034.00	15.21
14	61	4	6.56	59.00	969.50	15.89
15	57	2	3.51	56.00	910.50	15.97
16	55	4	7.27	53.00	854.50	15.54
17	51	2	3.92	50.00	801.50	15.72
18	49	2	4.08	48.00	751.50	15.34
19	47	1	2.13	46.50	703.50	14.97
20	46	2	4.35	45.00	657.00	14.28
21	44	2	4.55	43.00	612.00	13.91
22	42	0	0.00	42.00	569.00	13.55
23	42	3	7.14	40.50	527.00	12.55
24	39	0	0.00	39.00	486.50	12.47
25	39	0	0.00	39.00	447.50	11.47
26	39	0	0.00	39.00	408.50	10.47
27	39	1	2.56	38.50	369.50	9.47
28	38	0	0.00	38.00	331.00	8.71
29	38	1	2.63	37.50	293.00	7.71
30	37	6	16.22	34.00	255.50	6.91
31	31	0	0.00	31.00	221.50	7.15
32	31	0	0.00	31.00	190.50	6.15
33	31	0	0.00	31.00	159.50	5.15
34	31	1	3.23	30.50	128.50	4.15
35	30	1	3.33	29.50	98.00	3.27
36	29	3	10.34	27.50	68.50	2.36
37	26	5	19.23	23.50	41.00	1.58
38	21	3	14.29	14.00	17.50	0.83
39	18	5	27.78	9.00	9.00	0.50
40	13	4	30.77	6.50	6.50	0.50
41	7	7	100.00	3.50	3.50	0.50

was found more (neemarin 207 eggs/female/generation) as compared to 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 finite rate of increase (λ) of the population of *P. brassicae* was highest (1.11) with neemarin and control. The time taken by *P. brassicae* to complete its life cycle was reduced to. Corrected generation time (τ) was more from neemarin dimethoate (40.02 days) to (40.07 days) as compared to control (42.08 days). Hafeez *et al.,* 2007 revealed that insecticides resulted in significant reduction of pest and increase in marketable yield of cabbage. The insecticides exhibit reduction in the oviposition of *P. brassicae*. Hasan and Ansari (2011) found that numbers of eggs oviposited 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 *et al.*, 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. However, for later stages, only the higher concentrations of Bioasp resulted in substantial mortality. In present study, Neemarin was found significantly superior in reducing the fecundity and increasing the larval mortality over control. Similar results were given by Luik and Viidalepp (2001) when third instar of *P. brassicae* was treated with neemazal. They found that Neem Azal-T/S exhibited a strong antifeedant activity against the third-instar larvae of *P. brassicae*. Such effect was found to be concentration-dependent and increased with

Table 2 b : Stage specific life table of *P. brassicae* derived from 3rd instar ingested 0.05 per cent dimethoate 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	22	22.000	0.7800	0.2821	7.897	2.0000	0.1079
II instar	78	7	8.974	0.9103	0.0986	2.761	1.8921	0.0408
III instar	71	14	19.718	0.8028	0.2456	6.877	1.8513	0.0954
IV instar	57	10	17.544	0.8246	0.2128	5.957	1.7559	0.0838
V instar	47	5	10.638	0.8298	0.1282	3.590	1.6721	0.0810
Pre-pupa	42	3	7.143	0.7381	0.0968	2.710	1.6232	0.1319
Pupa	39	8	20.513	0.7949	0.2581	7.226	1.5911	0.0997
Adult	31	0	-	-	-		1.4914	-
							K=	0.6405

Table 2 c: Age specific fecundity table of *P. brassicae* derived from 3rd instar ingested 0.05 per cent dimethoate 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	0.31	14.00	4.340	145.390
34.5	0.31	25.00	7.750	267.375
35.5	0.3	38.00	11.400	404.700
36.5	0.29	57.00	16.530	603.345
37.5	0.26	42.00	10.920	409.500
38.5	0.21	28.00	5.880	226.380
39.5	0.18	10.00	1.800	71.100
40.5	0.13	0.00	0.000	0.000
41.5	0.07	0.00	0.000	0.000
	Total	214.00	58.620	2127.790

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

x	lx	dx	100qx	Lx	Tx	ex
0	100	0	0.00	100.00	2162.00	21.62
1	100	0	0.00	100.00	2062.00	20.62
2	100	0	0.00	100.00	1962.00	19.62
3	100	0	0.00	100.00	1862.00	18.62
4	100	0	0.00	100.00	1762.00	17.62
5	100	0	0.00	100.00	1662.00	16.62
6	100	9	9.00	95.50	1562.00	15.62
7	91	5	5.49	88.50	1466.50	16.12
8	86	11	12.79	80.50	1378.00	16.02
9	75	3	4.00	73.50	1297.50	17.30
10	72	3	4.17	70.50	1224.00	17.00
11	69	4	5.80	67.00	1153.50	16.72
12	65	0	0.00	65.00	1086.50	16.72
13	65	6	9.23	62.00	1021.50	15.72
14	59	2	3.39	58.00	959.50	16.26
15	57	2	3.51	56.00	901.50	15.82
16	55	4	7.27	53.00	845.50	15.37
17	51	2	3.92	50.00	792.50	15.54
18	49	2	4.08	48.00	742.50	15.15
19	47	1	2.13	46.50	694.50	14.78
20	46	1	2.17	45.50	648.00	14.09
21	45	2	4.44	44.00	602.50	13.39
22	43	0	0.00	43.00	558.50	12.99
23	43	3	6.98	41.50	515.50	11.99
24	40	0	0.00	40.00	474.00	11.85
25	40	3	7.50	38.50	434.00	10.85
26	37	0	0.00	37.00	395.50	10.69
27	37	0	0.00	37.00	358.50	9.69
28	37	0	0.00	37.00	321.50	8.69
29	37	0	0.00	37.00	284.50	7.69
30	37	6	16.22	34.00	247.50	6.69
31	31	0	0.00	31.00	213.50	6.89
32	31	0	0.00	31.00	182.50	5.89
33	31	0	0.00	31.00	151.50	4.89
34	31	0	0.00	31.00	120.50	3.89
35	31	2	6.45	30.00	89.50	2.89
36	29	3	10.34	27.50	59.50	2.05
37	26	7	26.92	22.50	32.00	1.23
38	19	4	21.05	9.50	9.50	0.50
39	15	9	60.00	7.50	7.50	0.50
40	7	7	100.00	3.50	3.50	0.50

Table 3b: Stage specific life table of *Pieris brassicae* derived from 3rd instar ingested 0.05 per cent neemarin 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	6	8.000	0.9200	0.0870	2.435	1.8751	0.0362
III instar	69	12	17.391	0.8261	0.2105	5.895	1.8388	0.0830
IV instar	57	10	17.544	0.8246	0.2128	5.957	1.7559	0.0838
V instar	47	4	8.511	0.8511	0.1000	2.800	1.6721	0.0700
Pre-pupa	43	3	6.977	0.7209	0.0968	2.710	1.6335	0.1421
Pupa	40	9	22.500	0.7750	0.2903	8.129	1.6021	0.1107
Adult	31	0	-	-	-		1.4914	-
							K=	0.6507

Table 3c: Age specific fecundity table of *Pieris brassicae* derived from 3rd instar ingested 0.05 per cent neemarin 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	0.31	13.00	4.030	135.005
34.5	0.31	29.00	8.990	310.155
35.5	0.31	42.00	13.020	462.210
36.5	0.29	57.00	16.530	603.345
37.5	0.26	32.00	8.320	312.000
38.5	0.19	22.00	4.180	160.930
39.5	0.15	12.00	1.800	71.100
40.5	0.07	0.00	0.000	0.000
	Total	207.00	56.870	2054.745

increasing concentration of NeemAzal-T/S. Treatment with 0.1 per cent NeemAzal-T/S resulted in 100 per cent larval mortality during 4 days following treatment.

Stage specific:

Results showed that all the eggs of *P. brassicae* were hatched with treated and untreated individuals. The mortality of first instar was recorded with the treatment of neemarin (25%), dimethoate (22%) as compared to control (12%). K- 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 (Table 1b, Table 2b and Table 3b. Mortality Survival Ratio (MSR) was recorded as zero at the egg stage with all the insecticides including control. Highest indispensable mortality 17.111 was recorded on pupal stage with the treatment of mythomyl and lowest 0.00 with egg stage in all the treatments including control.

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