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Developmental Response of Cabbage Butterfly, *Pieris brassicae* L. (Lepidoptera: Pieridae) on Different Cole Crops Under Laboratory and Field Condition

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Abstract: An attempt was made to find out the developmental response of cabbage butterfly, *Pieris brassicae* on different cole crops under Laboratory and field condition. The overall development of *P. brassicae* was recorded significantly higher on yellow sarson (40.70±2.38 and 37.87±1.93 days) as compared to lower on cabbage (34.15±1.80 and 33.12±1.95 days), under laboratory and field condition, respectively ($p \leq 0.05$). All the developmental stages (egg, larval instars, prepupal and pupal) of *P. brassicae* was registered their maximum development period on yellow sarson followed by gobhi sarson, cauliflower and cabbage under both conditions. However, the maximum development period of adult was recorded on cabbage and minimum on yellow sarson in both situations. The cabbage butterfly tuned their highest generation mortality on yellow sarson (0.3565 and 0.3645) in contrast to lowest on cabbage (0.2555 and 0.2486) in both laboratory and field conditions, respectively. The number of adults was recorded maximum in laboratory than the field condition on all the cole crops. It is possible due to the presence of natural enemies (predators and parasitoids), abiotic factors (temperature, relative humidity and rainfall) and some unknown factors in the field condition.

Key words: Cabbage butterfly, cole crop, cabbage, cauliflower, gobhi sarson, yellow sarson

INTRODUCTION

Cole crops is a general term used to describe several vegetables belonging to the Cruciferae or mustard family, including broccoli, brussels sprouts, cabbage, cauliflower and kohlrabi. All cole crops are cultivated in winter season and prefer 60-70°F temperatures for their optimal growth and can withstand light frosts without injury. The cole crops are extensively grown in tropical and subtropical regions of the world. The cabbage (*Brassica oleracea* var. capitata) and cauliflower (*Brassica oleracea* var. botrytis) originated in Mediterranean era and introduced in India during the Mughal period (Das, 1992; Khalid, 2006). Both these crops are rich in minerals like iron, magnesium, phosphorous etc. Besides cabbage and cauliflower, rapeseed-mustard also has a commercial importance in India. It is most important oilseed crop next to groundnut in the country. Among rapeseed-mustard, yellow sarson is considered to be the oldest mustard originated from India (Singh, 1958, 1983; Khalid, 2006).

It has been estimated that insect pest alone causes more than 40% of yield loss on different vegetable crops annually. Pajmon (1999) listed about 38 insect pests on the cole crops. Among them cabbage butterfly, *Pieris brassicae* is one of the most destructive pests causing damage at all the growing stages such as seedling, vegetative and flowering stage (Sachan and Gangwar, 1980; Lal and Ram, 2004; Younas *et al*., 2004; Khalid, 2006). In India, it passes winter in the plains and migrates to hilly regions during summer (Gupta, 1984). It breeds on rapeseed-mustard in the month of September and remain active till the April. The young caterpillars feed gregariously on leaves, resulting defoliation in plants (Younas *et al*., 2004; Khalid, 2006). On cabbage and cauliflower, the caterpillar sometime bores into the heads and become most destructive. The strategies for controlling this insect pest on vegetable crops in general need a detailed study on habits, habitats, distribution and mode of damage on various crops. Therefore, developmental response of cabbage butterfly on different cole crops was aimed under laboratory and field condition.

MATERIALS AND METHODS

Different cole crops viz., cabbage (*Brassica oleracea* var. capitata), cauliflower (*Brassica oleracea* var. botrytis), gobhi sarson (*Brassica napus*) and yellow sarson (*Brassica rapa* var. yellow sarson) were raised in the winter season of year 2005-2006 at experimental field of the Department of Plant Protection, Faculty of Agriculture Sciences, Aligarh Muslim University, Aligarh, India. These all crops were sown in plot size 3×4 m during the last week of October and each replicated thrice in Randomized Block Design (RBD). All these crops were

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monitored regularly so as to assess the attack of cabbage butterfly, *Pieris brassicae*. The egg laying commenced on cabbage and cauliflower in the first week of November, while on rapeseed-mustard (gobhi sarson and yellow sarson) in the last week of November. Eggs were found in clusters on the lower sides of the leaves of few plants. They were collected from respective crop fields and brought them in laboratory and placed in BOD incubator calibrated at 25±1°C coupled with 65±5% relative humidity and the photoperiod of 12 h L:12 h D. After calculating percent of hatching from eggs, one hundred newly hatched larvae were collected and reared in plastic vials (10×12 cm) along with selective food in the form of leaves. This procedure was followed for rearing *P. brassicae* on respective food. When the caterpillars reached in to third larval instar, were reared individually till the formation of adult in plastic vials sized 6×10 cm and their subsequent death was also noticed till the culmination of generation. Whereas, in field condition, the eggs were found on lower leaf of the plants and they were wrapped randomly through the nylon mesh on the leaf of respective host plant. After hatching, larvae were fed on desired host plants inside nylon mesh. On adult emergence, to obtain the potential fecundity of female, the males and females were collected and caged in different sized nylon mesh cage on respective host plants. The cage was specially designed with respect to crop height, for cabbage and cauliflower the cage height was 2 feet, for yellow sarson, it was 3 feet and for gobhi sarson, the cage was 6 feet in height. The meteorological data also recorded for field study.

The data collected for the development of *P. brassicae* were subjected to analysis of variance (ANOVA) or the Critical Difference (CD) was calculated by using formula:

$$CD = \sqrt{2 \times EMSS/r} \times t$$

Where:
EMSS = Error mean sum of squares,
r = No. of replications and
t = Tabulated value at p = 0.05 level of significance.

The mean values were compared using Duncan's Multiple Range Test (DMRT).

The data on survival and mortality of *P. brassicae* were computed and dealt here under. The developmental stage is defined as the age of insect at which insect being survived and also denoted by x. Where, l_x represents the number of individuals surviving at the beginning of each age interval out of 100. The Apparent Mortality (100 q_x) gives the information on percentage of individuals entering to next stage and was calculated by using the formula:

$$\text{Apparent Mortality } (100\ q_x) = d_x/l_x \times 100$$

k-value is the key factor, which is primarily responsible for increase or decrease in number of butterflies from one generation to another and was computed as the difference between the successive values for log l_x and the total generation mortality was calculated by adding the k-values of different development stages of the cabbage butterfly, which is designated/indicated as K (Varley and Gradwell, 1960; Southwood, 1978).

$$K = k_0 + k_1 + k_2 \ldots\ldots\ldots k_n$$

Where, k_o, k_1, k_2, ……k_n are the k-values at egg, first instar, second instar, third instar, fourth instar, fifth instar, pre-pupal and pupal stages.

RESULTS AND DISCUSSION

It was inferred from Table 1 that the overall development of *P. brassicae* was recorded significantly higher on yellow sarson (40.70±2.38 and 37.87±1.93 days) and lower on cabbage (34.15±1.80 and 33.12±1.95 days) under laboratory and field conditions, respectively ($p \leq 0.05$). Similarly, the total immature development was also tuned high value on yellow sarson (36.55±2.24 and 33.45±1.76 days) as compared to low on cabbage (29.05±1.66 and 27.5±1.78 days) in both situations, respectively. While, adult development was recorded maximum on cabbage (5.10±0.14 and 5.62±0.17 days) in contrast to minimum on yellow sarson (4.15±0.14 and 4.42±0.17 days) under laboratory and field conditions, respectively (Table 1). Similar study also made by Bhatia *et al.* (1995), Thakur *et al.* (1998) and

Table 1: Developmental response of cabbage butterfly, *Pieris brassicae* on different host plants under laboratory and field condition

Stages	Cabbage	Cauliflower	Gobhi sarson	Yellow mustard	CD ($p \leq 0.05$)
Under laboratory condition					
Immature	29.05±1.66a	32.25±1.64b	33.50±1.96c	36.55±2.24d	0.64
Adult	5.10±0.14c	4.45±0.14b	4.35±0.15ab	4.15±0.14a	0.27
Overall	34.15±1.80a	36.70±1.78b	37.85±2.11c	40.70±2.38d	0.91
Under field condition					
Immature	27.50±1.78a	30.40±1.30b	31.55±1.54c	33.45±1.76d	0.79
Adult	5.62±0.17c	4.65±0.16b	4.57±0.15ab	4.42±0.17a	0.22
Overall	33.12±1.95a	35.05±1.46b	36.12±1.69b	37.87±1.93c	1.10

Same alphabets showed non-significance whereas the different alphabets denoted significance between the host plants, CD = Critical Difference

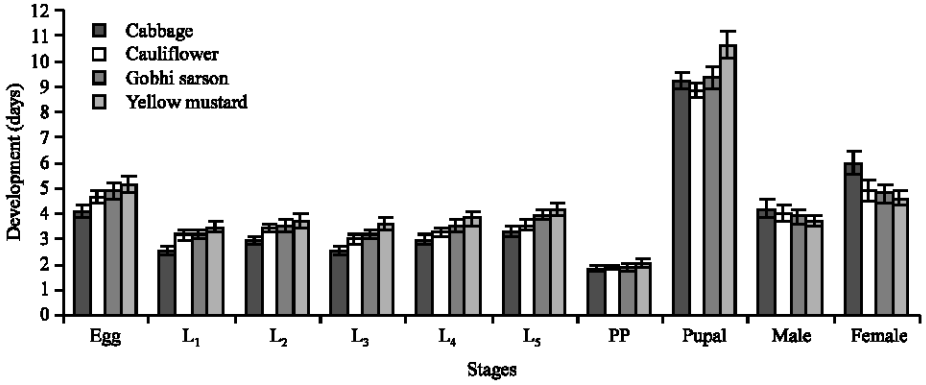

Fig. 1: Development of cabbage butterfly, *P. brassicae* on different host plants under laboratory condition (L_1 = First larval instar, L_2 = Second larval instar, L_3 = Third larval instar, L_4 = Fourth larval instar, L_5 = Fifth larval instar and PP = Prepupal stage)

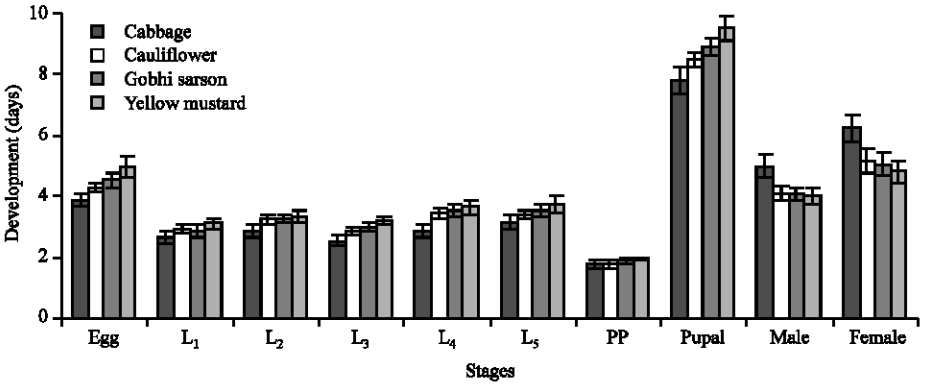

Fig. 2: Development of cabbage butterfly, *P. brassicae* on different host plants under field condition (L_1 = First larval instar, L_2 = Second larval instar, L_3 = Third larval instar, L_4 = Fourth larval instar, L_5 = Fifth larval instar and PP = Prepupal stage)

Metspalu *et al.* (2003). They recorded shortest development of *P. brassicae* on cabbage than the other cole crops.

The Fig. 1 and 2 exhibited that the development of different stages of *P. brassicae* viz., egg, larval instars (1st to 5th), prepupal and pupal were registered their maximum period on yellow sarson followed by gobhi sarson, cauliflower and cabbage under both laboratory and natural condition. Nevertheless, the maximum period of adult (male and female) development was witnessed on cabbage as compared to other cole crops under both conditions (Fig. 1 and 2). These findings are in complete agreement with the findings of David and Gardiner (1962), Mitchell (1977), Chew (1980), Eltez (1999), Ramdhane and Ihsan (1999) and Gupta (2002). They calculated maximum egg hatching, minimum incubation period and shortest larval development of *P. brassicae* on cabbage as compare to other cole crops. However, Metspalu *et al.* (2003) opined that the gobhi sarson (*Brassica napus*) also preferred food of *P. brassicae*.

A remarkable difference was however recorded on mortality parameters of cabbage butterfly on different host plants under laboratory as well as field condition. Among developmental stages the highest percent mortality was recorded at pupal stages (14.89 and 21.74%) on yellow sarson and lowest at prepupal stage (3.39 and 3.51%) on cabbage under laboratory and field condition, respectively (Table 2 and 3). Likewise, the cabbage butterfly tuned their highest generation mortality on yellow sarson (0.3565 and 0.3645) in contrast to lowest on cabbage (0.2555 and 0.2486) in both situations, respectively. It was also inferred from Table 2 and 3 that the emerged adults were also recorded maximum on cabbage (52 and 48 individuals) followed by cauliflower

Table 2: Survival, mortality and k-values of cabbage butterfly, *P. brassicae* on different host plants under laboratory condition

	l_x				$100q_x$				log l_x				k-values			
x	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Egg	100.00	100.00	100.00	100.00	11.00	12.00	13.00	14.00	2.00	2.00	2.00	2.00	0.0506	0.0555	0.0605	0.0655
Larva 1	89.00	88.00	87.00	86.00	13.48	14.77	11.49	12.79	1.95	1.94	1.94	1.93	0.0629	0.0694	0.0530	0.0594
Larva 2	77.00	75.00	77.00	75.00	9.09	10.67	12.99	12.00	1.89	1.88	1.89	1.88	0.0414	0.0490	0.0604	0.0555
Larva 3	70.00	67.00	67.00	66.00	5.71	7.46	8.96	7.58	1.85	1.83	1.83	1.82	0.0256	0.0337	0.0407	0.0342
Larva 4	66.00	62.00	61.00	61.00	4.55	4.84	9.84	9.84	1.82	1.79	1.79	1.79	0.0202	0.0215	0.0450	0.0450
Larva 5	63.00	59.00	55.00	55.00	6.35	8.47	7.27	9.09	1.80	1.77	1.74	1.74	0.0285	0.0385	0.0328	0.0414
Pre-pupa	59.00	54.00	51.00	50.00	3.39	3.70	3.92	6.00	1.77	1.73	1.71	1.70	0.0150	0.0164	0.0174	0.0269
Pupa	57.00	52.00	49.00	47.00	8.77	11.54	12.24	14.89	1.76	1.72	1.69	1.67	0.0399	0.0532	0.0567	0.0700
Adult	52.00	46.00	43.00	40.00	100.00	100.00	100.00	100.00	1.72	1.66	1.63	1.60	0.0000	0.0000	0.0000	0.0000
													K = 0.2555	K = 0.2988	K = 0.3337	K = 0.3565

A = Cabbage, B = Cauliflower, C = Gobhi sarson and D = Yellow sarson, x = Developmental stages, l_x = Individuals surviving at the beginning of each age interval, $100q_x$ = Percent mortality, log l_x = log value of surviving individuals, k = Factor responsible for increase or decrease in number from one generation to another and K = Total generation mortality

Table 3: Survival, mortality and k-values of cabbage butterfly, *P. brassicae* on different host plants under natural condition

	l_x				$100q_x$				log l_x				k-values			
x	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Egg	100.00	100.00	100.00	100.00	11.00	12.00	12.00	13.00	2.00	2.00	2.00	2.00	0.0506	0.0555	0.0555	0.0605
Larva 1	89.00	88.00	88.00	87.00	7.87	7.95	7.95	8.05	1.95	1.94	1.94	1.94	0.0356	0.0360	0.0360	0.0364
Larva 2	82.00	81.00	81.00	80.00	6.10	4.94	7.41	6.25	1.91	1.91	1.91	1.90	0.0273	0.0220	0.0334	0.0280
Larva 3	77.00	77.00	75.00	75.00	5.19	3.90	5.33	8.00	1.89	1.89	1.88	1.88	0.0232	0.0173	0.0238	0.0362
Larva 4	73.00	74.00	71.00	69.00	8.22	12.16	12.68	13.04	1.86	1.87	1.85	1.84	0.0372	0.0563	0.0589	0.0607
Larva 5	67.00	65.00	62.00	60.00	14.93	15.38	16.13	16.67	1.83	1.81	1.79	1.78	0.0702	0.0726	0.0764	0.0792
Pre-pupa	57.00	55.00	52.00	50.00	3.51	7.27	7.69	8.00	1.76	1.74	1.72	1.70	0.0155	0.0328	0.0348	0.0362
Pupa	55.00	51.00	48.00	46.00	12.73	17.65	16.67	21.74	1.74	1.71	1.68	1.66	0.0591	0.0843	0.0792	0.1065
Adult	48.00	42.00	40.00	36.00	100.00	100.00	100.00	100.00	1.68	1.62	1.60	1.56	0.0000	0.0000	0.0000	0.0000
													K = 0.2486	K = 0.3042	K = 0.3216	K = 0.3645

A = Cabbage, B = Cauliflower, C = Gobhi sarson and D = Yellow sarson, x = Developmental stages, l_x = Individuals surviving at the beginning of each age interval, $100q_x$ = Percent mortality, log l_x = log value of surviving individuals, k = Factor responsible for increase or decrease in number from one generation to another and K = Total generation mortality

(46 and 42 individuals), gobhi sarson (43 and 40 individuals) and yellow sarson (40 and 36 individuals) under laboratory and field conditions, respectively. Similar observations also made by Hashmi *et al.* (1985), Rai *et al.* (1985) and Thakur and Deka (1997) on different cole crops in laboratory as well as field conditions. This study further strength by Sharma *et al.* (1999) they reported the number of emerged adults was highest in laboratory in comparison to field condition.

A comparative study revealed that *P. brassicae* took shorter period for their development in field condition as compared to laboratory with regard to all cole crops. Where, number of adults was recorded maximum in laboratory than the field condition on all cole crops. It is possible due to the presence of natural enemies (predators and parasitoids), abiotic factors (temperature, relative humidity and rainfall) and some unknown factors in the field condition. Therefore, it can be concluded from the present study that cabbage butterfly, *Pieris brassicae* exhibited their speedy development on cabbage with highest yield of adults in both laboratory and field conditions and the yellow sarson is the least preferred food.

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