

Response of Different Temperatures on Biology of Cabbage Butterfly, *Pieris brassicae* (L.), Lepidoptera: Pieridae on Broccoli Leaves in Laboratory

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ABSTRACT

Effect of different temperatures namely, 15, 20, 25±1 (Room temperature), 30 and 35°C at 75 per cent relative humidity were evaluated on biology of cabbage butterfly, *Pieris brassicae* (L.) at department of entomology, Veer Chand Singh Garhwali Uttarakhand University of Horticulture and Forestry, Uttarakhand, India 246123. Observations on fecundity, size, hatching period (day), Length of Larva (mm), total larval duration, Pre pupal period (days), Pupal period (days), Post pupal period (days), Post pupal period, length of adult (mm), wing span, Sex ratio, Life span of male and female (days) and Mortality were recorded. Among different temperature, 30°C was found highly favourable for growth and development of Cabbage butterfly on broccoli leaves.

Key words: Cabbage butterfly, Temperature, Biology, Life span.

INTRODUCTION

Broccoli (*Brassica oleracea* L. var. *italica*) is an important cole crop which belongs to the family Brassicaceae. It is cultivated extensively in tropical and temperate regions of the world including India¹³. Broccoli consists of 141 kJ of energy, Carbohydrates 6.64 g, Fat 0.37 g, Protein 2.28g; it consists of many essential Vitamins such as beta-carotene, Thiamine, Riboflavin, C, E and K. It is rich in dietary fibre; contain phyto-nutrients like Carotene-alfa, Carotene-beta and Lutein-zeaxanthin, electrolytes like sodium and

potassium. In ancient times, it was used against ailment like gout, diarrhoea, stomach and celiac troubles. Broccoli shares Cancer fighting properties, it protects against bowel cancer due to the presence of indole-3-carbinol. It has immune boosting properties with other cruciferous vegetables such as cauliflowers and cabbage. It also helps in cholesterol reduction and in reducing allergic reaction and inflammation. It is also a powerful antioxidant¹². A large number of insect-pests are associated with this crop.

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These are the cabbage butterfly, *Pieris brassicae* Linnaeus; diamondback moth, *Plutella xylostella* Linnaeus; cabbage semi-looper, *Thysanoplusia orichalcea* Fabricius and *Autographa nigrisigna* Walker; the tobacco caterpillar, *Spodoptera litura* Fabricius; leaf webber, *Crocodylomia binotalis* Zeller; the cabbage borer, *Hellula undalis* Fabricius and flea beetles, *Phyllotreta cruciferae* Goeze; *P. chotanica* Duviv, *P. birmanica* Harold., *P. oncera* Maulik and *P. sdownesi* Baly². The cabbage butterfly (*Pieris brassicae*) belongs to the order Lepidoptera and family Pieridae. The species has a natural range across Europe, North Africa, and Asia²². It was accidentally introduced to Quebec, Canada around 1860 and spread rapidly throughout North America¹¹. In India it is distributed in the Himalayas from Chitral to Bhutan, while in the plains it has been recorded from Andhra Pradesh, Bihar, Gujrat, Haryana, Madhya Pradesh, Orissa, Punjab, Rajasthan, Uttar Pradesh and West Bengal¹⁹. The damage is caused by the larva which in the initial stage feed gregariously and cause damage by scrapping the leaf surface but later on feed individually by making hole on leaves. In Germany, almost complete failure of cole crops was attributed to the noxious role played by this pest⁷. The temperature limits for oviposition is between 16 to 35°C and 24.4°C for maturation of eggs. The young larvae are pale yellow and become greenish yellow later on. The head is black and the dorsum is marked with black spot. Short hairs are distributed throughout the body. Adults are pale white, with a black patch on the apical angle of each four wings and a black spot is found on the costal margin of each hind wing. They feed gregariously during their early instars and disperse as they approach maturity and cause serious economic losses¹⁶. At pre-heading stage, the caterpillars may gormandise the whole plant but at head formation stage, they damage by feeding on head and also by contaminating it with faeces. Whereas, after head formation the caterpillars feed mainly on inflorescence reducing the seed yield. The insect overwinters in the pupal stage.

Estimates show that a single female of this species might be the progenitor in a few generations of millions⁸. Moiseeva¹⁵ recorded that a single larva of *P. brassicae* consumed 74-80 cm² of cole crops leaves, 85 to 87 % of which was consumed by the fifth instar. The cabbage butterfly is the major constraints in commercial cultivation of this crop in hill and plain areas of Uttarakhand^{14,26}. Keeping in view for eco-friendly and effective management of cabbage butterfly we studied Response of different temperatures on biology of cabbage butterfly, *Pieris brassicae* (L.), Lepidoptera: Pieridae on broccoli leaves in laboratory.

MATERIAL AND METHODS

The experiment was conducted at Department of Entomology, College of Horticulture, VCSG Uttarakhand University of Horticulture and Forestry, Bharsar, Pauri Garhwal, Uttarakhand. The experimental site was located at an altitude of 1900 m above mean sea level lying between latitude 30.056⁰ North and longitude 78.99⁰ East. It falls under the mid- hill zone of Uttarakhand (IMD, 2015). Light yellow eggs and larvae of cabbage butterfly were collected from the Vegetable Research and Demonstration Block. Leaf containing eggs were plucked from plant and kept into poly bag and brought to laboratory. The glassware and instruments used for cabbage butterfly rearing were washed properly with teepol and kept into oven at 100⁰C. A camel hair brush and forceps was used to transfer the larvae. The 2 per cent ethyl alcohol was used to disinfect the camel hair brush and to avoid spreading infections. Sanca make BOD incubator was sterilized by spraying formalin 2%. Whatman paper was wetted with sterile distilled water and kept at bottom of each petriplates. Then the eggs along with leaf were transferred in these petriplates. The petriplates were kept in the BOD incubator facilitated with light source at different temperatures and humidity as per present studies. After hatching of larva from the egg, the newly hatched first instar larvae were transferred to separate petriplates, 6

larvae in each of the four petriplate with leaves of broccoli. The petriplates were cleaned of excrement and food residue every day. The fifth instar larvae were transferred into separate cages. Cages were lined with fresh Kraft paper, and the floor and sides of the cages were vacuumed to reduce the buildup of wing scales. After emergence, adults were provided with 10% glucose solution as food. The known amount of male and female adult cabbage butterfly (1:1) was released in cage. The fresh plant of broccoli was kept in cage to induce egg laying. There were 5 treatments of different temperature levels each having 4 replication. The design followed during this experiment was Complete Randomized Design. The details of treatment were given in table 1. The observations on fecundity, size, shape and colour, hatching period (day), length of larva (mm), total larval period, Pre pupal period (days), Pupal period (days), Length of pupa (mm), weight of pupa (mg), post pupal period (days), length of adult (mm), Length of fore wings (mm), Length of hind wings (mm), Sex ratio, Life span of male and female (days) and Mortality (days) were recorded.

RESULT AND DISCUSSION

The results of present investigation were discussed under following heads.

1. Response of different temperature on eggs of *P. brassicae*.

The eggs of the cabbage butterfly were initially pale yellow colour in colour and turned darker yellow within twenty four hours after oviposition. Before hatching, they became black in colour, and the shell was more transparent. The shape of the egg resembled a bullet with ridged (Plate-I). The data presented in Table 2 revealed that all the treatments were found statistically significant with each other in respect to number of eggs produced by per female. The maximum number of eggs (60.00) was recorded at 30°C followed by 25°C (53.00), 20°C (45.00), 35°C (41.00) and 15°C (33.00). Treatment T4 (30°C) was found statistically significant with all the remaining treatments. The present result was confirmatory with Chandel *et al.*^{6,27} who

reported 17–55 eggs per female, Thakur *et al.* (1998) 49.66 eggs per female at favourable temperature. The maximum egg 1.90 mm was recorded at temperature 30°C followed by 1.65 mm at 25°C, 1.50 mm at 20°C, 1.20 mm at 15°C mm and 1.05 mm at temperature 35°C. The increase in size of egg might be due to the favourable temperature. The result shows strong conformity with the results reported by Shankar *et al.*^{1, 23}, where they had reported that the length of egg of cabbage butterfly range between 1.05mm -1.81mm at 30°C. The minimum hatching period (5.25 days) was recorded at temperature 30°C and it was significant with all other treatments except the treatment T5 (35 °C). The hatching period of egg showed maximum number of days required to hatch into larva (10.25 days) was recorded with T1 (15°C). Similar finding were observed by Ryan *et al.*, 2015, they said 25-30°C speed up hatching period. This result was also close conformity with Atwal and Dhaliwal² where they observed that number of days required to hatch into larva varies from 7 -11 days.

2. Response of different temperatures on larva of *P. brassicae*.

The larva was green, velvety in appearance, and bear five pairs of pro legs. Small hairs were distributed all over their body. All the larval stages except the first instar bear a narrow yellow line running along the centre of the back; this stripe was sometimes incomplete on the early instars. A broken yellow line, or series of yellow spots, also occurred on each side (Plate-II). The data from table 3 showed that, different temperatures affected the larval growth of *P. brassicae*. Similar finding was also reported by Sadozai and Khan²¹. The maximum length 5.50, 9.00, 17.75, 26.50 and 38.75 mm of 1st, 2nd, 3rd, 4th and 5th instar larvae, respectively were recorded at temperature 30°C. The result are in strong conformation with Bhubaneshwari *et al.*³, they reported that the length of 1st, 2nd, 3rd, 4th and 5th instar larvae were 4.4 ± 1.2, 12.3 ± 0.38, 15.9 ± 1.07, 27.6 ± 2.47, 39.74 ± 1.98mm. Similar, result were obtained by Shevale²⁵ and Thapa²⁸ who observed the

average length of the first and fifth instar larva of cabbage butterfly was 3.05 mm and 34.03mm, respectively. The maximum length of head of larva was observed (4.00mm) in 30⁰C followed by 3.85 (25⁰C), 3.30 (20⁰C), 2.75 (15⁰C) and 2.50 (35⁰C). These finding was also reported by Web and Shelton, (1988) who observed that the length of head of 5th instar larva of cabbage butterfly varies between 1.98mm-3.68 mm. The maximum length of thorax and abdomen of 5th instar larva were in 6.00 and 28.75 mm, in treatment T4 (30⁰C). This result was also conformed by Mustajaeva *et al.*¹⁷, The longest larval duration was observed (19 days) in T1, 15⁰C due to unfavourable temperature and the smallest larval period was observed (12 days) in T5, 35⁰C. Above finding were conformity with the result reported by Bist *et al.*⁴, they concluded that the total larval period varied from 12-24 days, at temperature of 14.8⁰C and 27.5⁰C.

3. Response of different temperatures on pupa of *P. brassicae*.

The pupa of the cabbage butterfly was usually pale yellow, grey and speckled brown. A sharply angled, keel- like projection was evident dorsally on the thorax and dorsolateral on each side of the abdomen. At pupation, the chrysalis was anchored by the tip of the abdomen to the silk pad and a strand of silk was loosely spun around the thorax (Plate-III). The minimum pre pupal duration 2.25 days was recorded at 30⁰C followed by 3.00, 3.75, 4.50 and 5.25 days at treatment 35⁰C, 25⁰C, 20⁰C and 15⁰C, respectively (Table 4). Hemchandra and Singh¹⁰, reported pre pupal period of *P. brassicae* varied from 2-4 days. The minimum duration of pupal period 9.00 days was observed in treatment 30⁰C. It was followed by 25⁰C (11.50 days), 35⁰C (12.00 days), 20⁰C (15.00 days) and 15⁰C (16.25 days). The shortest post pupal period 4.50 days was recorded in treatment T4 followed by T5 (6.00 days), T3 (7.00 Days), T2 (8.50 Days) and T1 (9.00 Days). Treatment T4 was found significantly with all treatments except T5. Chahil and Kular⁵, also reported that the pupal period varied from 8.55-18.45 days. Maximum

Pupal length (28.00 mm) was recorded in Treatment T4 (30⁰C) followed by T3 (27.00 mm), T2 (26.00 mm), T4 (25.00 mm) and T5 (24.00 mm). Treatment T4 was significantly differed with all treatments except T3. Treatments T2, T3 and T1, T5 were at par with each other. The largest pupa 28.00mm was recorded at temperature 30⁰C. Shankar *et al.*^{1, 23} also reported that the length of pupa varied from 22-27 mm. Treatment T4 (30⁰C) showed maximum pupal weight (485.250 mg) followed by T3 (438.00 mg), T2 (417.50 mg) T4 (391.00 mm) and T5 (380.25 mm). Treatment T4 was significant with all other treatments. Above finding were in close conformity with the result reported by Sadozai and Khan.²¹, they reported that the highest weight of pupa of *P. brassicae* is 440 mg and the lowest pupal weight was 332 mg at temperature of 30⁰C.

4. Response of different temperatures on adult of *P. brassicae*.

The adult of the cabbage butterfly were white with black at the tips of the forewings. The front wings were also marked with black dots; two in the central area of each forewing in the female, and one in case of males. When viewed from below, the wings generally were yellowish, and the black spots usually showed faintly through the wings. The hind wing of each sex also bears a black spot on the anterior edge. The body of the butterfly was covered with dense hair, which was coloured white in females, but darker in males (Plate- IV). Data from Table 5 showed that different temperature had variable effect on length of the adult cabbage butterfly, length of fore wing, length of hind wing, Sex ratio, Life span of male, and female and per cent mortality. The maximum length (25.750 mm) of adult cabbage butterfly was recorded at 30⁰C followed by 24.50 mm (25⁰C), 23.75 mm in (20⁰C), 22.50 mm (15⁰C) and 21.25 mm in (35⁰C). Treatment T5 were found significant with all other treatments. Shankar *et al.*^{1, 23}, reported that the highest length of adult of *P. brassicae* is 26 mm and the lowest length was 21 mm. The maximum length of fore wings was observed 34.75 mm in T4 (30⁰C) followed

by 34.00 mm in T3 (25⁰C), 33.75 mm in T2 (20⁰C), 32.50 mm in T1 (15⁰C) and 31.50 mm in T5 (35⁰C). Treatment T5 was found significantly differed with all other treatment except T1. The longest hind wings 36.00 mm was found in T4 (30⁰C) and the smallest hind wing 32.75 mm was found in treatment T5. This finding was also confirmed by Ahmad *et al.*^{1, 23}. The maximum longevity of male butterfly 48.00 days was recorded in T4 (30⁰C) which was statistically significant with all other treatment except T3. Minimum life span was recorded in treatment T5 (39.00 days). Hemchandra and Singh¹⁰ and Palanisamy and Kailayarasan¹⁸, reported that the total life span of male of cabbage butterfly recorded was varied between 39-48 days. The life span of female butterfly was found maximum 80.00 days in T4 (30⁰C) followed by 77.75 days in T3 (25⁰C), 76.00 days in T2 (20⁰C), 72.50 days in T1 (15⁰C) and 69.75 days in T5

(35⁰C). Hemchandra and Singh¹⁰ and Palanisamy and Kailayarasan¹⁸, that the total life span of female of cabbage butterfly recorded was varied between 41-49 days at minimum temperature between 15⁰C-30⁰C. The minimum mortality of cabbage butterfly was recorded in 8.25 per cent in T 4 (30⁰C) and maximum 11.00 per cent at 15⁰C. Sadozai and Khan²¹ reported that mortality of *P. brassicae* was ranged between 6.60 to 86.66 per cent. The sex ratio of male and female of cabbage butterfly 1.47:1, 1.37:1, 1.35:1, 1.30:1 and 1.25:1 were recorded in treatment T4 (30⁰C), T3 (25⁰C), T2 (20⁰C), T1 (15⁰C) and T5 (35⁰C), respectively. Shankar *et al.*^{1, 23} and Thapa²⁸ reported a 1.22:1 (Female: Male) ratio which may be due to different host and prevailing environmental conditions. Hasan and Ansari⁹ also reported that the sex ratio of cabbage butterfly was 1.5:1, female: male.

Table 1: Details of treatments

Sr. No.	Treatments	Treatment details
1	T1	15 ⁰ C at 75% Relative Humidity
2	T2	20 ⁰ C at 75% Relative Humidity
3	T3	Room temperature 25±1 ⁰ C at 75% Relative Humidity
4	T4	30 ⁰ C at 75% Relative Humidity
5	T5	35 ⁰ C at 75% Relative Humidity

Table 2: Effect of different temperatures on fecundity, size and hatching period of *P. brassicae*.

Treatments	No. of eggs/female	Size of eggs (mm)	Hatching period (days)
T1 - 15 ⁰ C	33.00	1.20	10.25
T2 - 20 ⁰ C	45.00	1.50	7.50
T3 - 25±1 ⁰ C	53.00	1.65	7.00
T4 - 30 ⁰ C	60.00	1.90	5.25
T5 - 35 ⁰ C	41.00	1.05	6.00
CD _(0.05)	2.29	0.17	1.14

Table 3: Effect of different temperatures on larval growth of *P. brassicae*

Treatments	Length of larva in the indicated instar (mm)					Length of 5th Instar larva(mm)			Larval period (days)
	I	II	III	IV	V	Head	Thorax	Abdomen	
T1 - 15 ^o C	4.50	7.25	15.50	22.75	33.75	2.75	4.00	27.00	19.00
T2 - 20 ^o C	4.75	7.50	16.25	24.50	35.05	3.30	4.50	27.25	16.00
T3 - 25±1 ^o C	5.25	8.25	17.00	25.25	36.50	3.85	5.00	27.65	14.00
T4 - 30 ^o C	5.50	9.00	17.75	26.50	38.75	4.00	6.00	28.75	12.00
T5 - 35 ^o C	2.75	7.00	14.25	20.50	30.50	2.50	3.50	24.50	13.00
CD _(0.05)	1.48	1.81	2.19	2.09	1.90	1.18	1.36	1.05	2.15

Table 4: Effect of different temperatures on pupal growth of *P. brassicae*

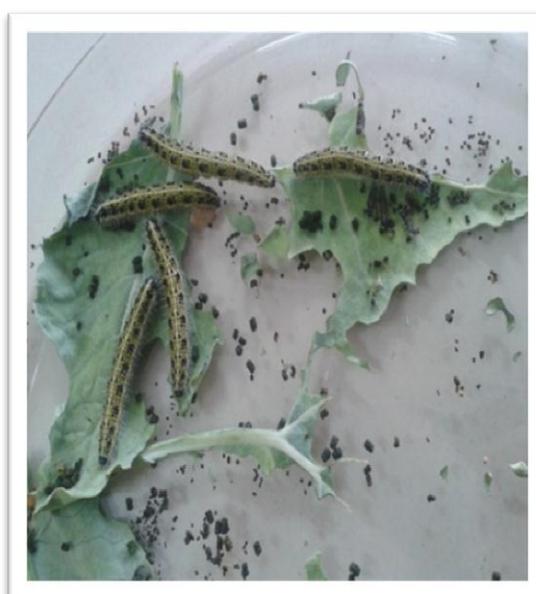
Treatments	Pre pupal Period (days)	Pupal period (days)	Post pupal period (days)	Length of pupa (mm)
T1- 15 ^o C	5.25	16.25	9.00	25.00
T2 -20 ^o C	4.50	15.00	8.50	26.00
T3 -25±1 ^o C	3.75	11.50	7.00	27.00
T4 -30 ^o C	2.25	9.00	4.50	28.00
T5 -35 ^o C	3.00	12.00	6.00	24.00
CD _(0.05)	1.31	1.45	1.57	1.70

Table 5: Effect of different temperatures on growth of adult *P. brassicae*

Treatments	Length of adult (mm)	Length of fore wing (mm)	Length of hind wing (mm)	Longevity of Male (days)	Longevity of Female (days)	% Mortality	Sex ratio (F:M)
T1- 15 ^o C	22.50	32.50	33.00	42.00	72.50	11.00	1.30:1
T2 -20 ^o C	23.75	33.75	33.75	44.00	76.00	10.50	1.35:1
T3 -25 ^o C	24.50	34.00	34.25	46.00	77.75	9.25	1.37:1
T4 -30 ^o C	25.75	34.75	36.00	48.00	80.00	8.25	1.47:1
T5 -35 ^o C	21.25	31.50	32.75	39.00	69.75	11.00	1.25:1
CD _(0.05)	0.95	1.78	2.09	2.23	2.45	1.49	



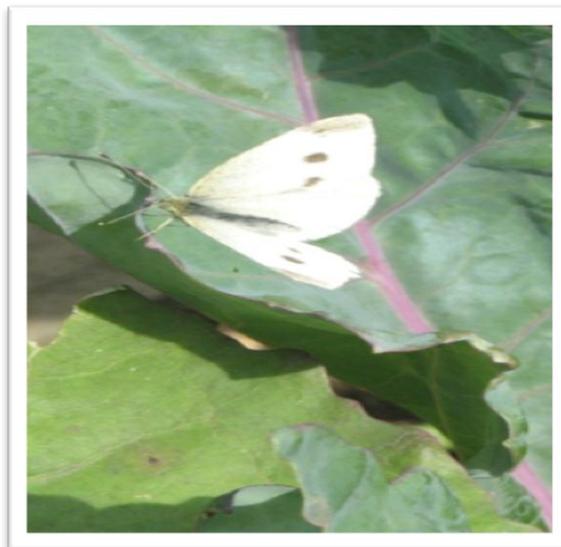
Plates I: Eggs of cabbage butterfly



Plates II: Larvae of cabbage butterfly



Plates III: Pupa of cabbage butterfly



Plates IV: Adult of cabbage butterfly

CONCLUSION

Among different temperature viz. 15⁰ C, 20⁰ C, 30⁰ C and 35⁰ C, the 30°C was found most effective temperature for size of eggs, length and weight of larva, length and weight of pupa, length of adult, length of fore wings, length of hind wings and life span of both male and female butterfly.

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