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IMPACT OF ABIOTIC FACTORS ON THE BIOLOGY OF THE CABBAGE BUTTERFLY, *PIERIS BRASSICAE*, IN VALLEY AREAS OF MANIPUR

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Abstract: The cabbage butterfly, *Pieris brassicae* (Lepidoptera: Pieridae), is a significant pest of cruciferous crops, including cabbage, causing substantial yield losses globally. This research article aims to investigate the influence of prevailing agro-climatic conditions in valley areas of Manipur on the biology of *Pieris brassicae*. Given Manipur's diverse abiotic factors and the importance of cabbage cultivation, understanding this interaction is crucial for developing effective and sustainable pest management strategies. The study synthesizes existing knowledge on *P. brassicae* biology and its environmental drivers, focusing on how temperature, humidity, rainfall, and host plant availability in the specific context might modulate its life cycle, development, and incidence.

IndexTerms **- Biology, abiotic factors, cabbage, temperature, humidity.**

I. INTRODUCTION

Manipur , which is located in the extreme north-eastern boarder of India, with its unique topography and climatic conditions (tropical monsoon type in central plain and cool temperate in the hills) has a rich diversity of flora and fauna and is suitable for almost all types of vegetables, both summer and winter crops. Among the winter vegetables, the *Brassica* crops are the most important among which cabbage is more popular than the others. In Manipur cabbage, *Brassica oleracea* var *capitata* Linn. is widely cultivated and occupy an important status in the agricultural economy of the state. In the State it is grown over an area of about 1000 ha. with an average yield of 10,000 tones per ha. annually (Anonymous, 2010-11). In the plains depending upon the time of maturity cabbage is cultivated as early (September to November), mid (November to January) and late (January to May) crops. Cabbage being a winter vegetable, its productivity reaches maximum during winter season. However, this vegetable is attacked and damaged by a large group of insect pests which not only hampers the yield of the crop but also reduces the market value. In Manipur 24 insect species belonging to 5 orders and 12 families are known to attack this vegetable. Among these, *Pieris brassicae* Linn (Lepidoptera: Pieridae) is the most serious one. *P. brassicae* is an oligophagous insect and has been reported as the most noxious pest of cruciferous crops throughout the world (Bonnemaison, 1965; Karnavar, 1983). This pest has been reported to cause 20-100% damage to important cruciferous crops including cauliflower in different parts of the country (Rataul, 1959; Sachan& Gangwar, 1980,1990). A good amount of work on the life and seasonal history, nature and extent of damage of this pest associated with cole crops has been done by several workers (Fletcher, 1914; Rataul, 1976; Sachan & Srivastava 1972). Meanwhile, biological parameters of *P. brassicae* on different cole crops has also been assessed by several workers (Khanna, 1977, Ali & Rizvi, 2007; Hasan & Anzari, 2010) both in laboratory & field condition. In addition to the above studies different aspects on control measures for this noxious pest have been taken up by various workers in India and abroad (Laing & Levins, 1982; Ram & Pathak, 1992; Azad Thakur, 1994, Zafar *et al.*, 2002; Sato & Ohsaki, 2004; Anurag Sharma & Gupta, 2009; Sahak *et al*., (2010) Aramideh *et al*., (2010),.)). In Manipur, some workers like Ram & Pathak (1992), Devjani (1999), Devi (2010), Devjani & Singh, 2006 have worked on some aspects of this pest on certain cruciferous crops. Its cultivation is frequently threatened by various insect pests, among which the cabbage butterfly, *Pieris brassicae*, stands out as a formidable challenge. The larvae of *P. brassicae* are voracious feeders, leading to significant defoliation and economic losses for farmers. This study seeks to explore the biology of insect influenced by environmental factors, particularly agro-climatic conditions. Variations in temperature, relative humidity, and rainfall can profoundly impact developmental rates, survival and fecundity of insect pests in the context of valley areas of Manipur.

II. MATERIAL AND METHODS

The experiment was conducted to study the impact of abiotic factors on the biology of the *Pieris brassicae*. Three replications and a completely randomized design were used to set up the experiment. To prepare them for pupation and adult emergence, *Pieris brassicae* larvae were gathered from the cabbage field and raised on cabbage leaves in glass petriplates (21 cm dia.) in the laboratory of Khongnangthaba University, Manipur. Observation on biology of *Pieris brassicae* started as soon as their emergence was noticed. After emerging, the moths were placed in rearing cages with cabbage plants in the 4-5 leaf stage that had

been grown in disposable plastic cups for oviposition. For hatching, the plants with *P. brassicae* egg masses were maintained in petriplates over damp filter paper. Ten neonate larvae were individually moved to pieces of cabbage leaf that were kept in a petriplate over moist filter paper for feeding after hatching. Fresh leaves were given to the larvae every day until they pupated. Based on the eggs, observations were made during the incubation period. The duration of the pupa and larval instars was noted. Every observation was predicated on ten individuals. Meteorological parameters (temperature, rainfall and humidity) were collected from meteorological office of Indian Council of Agricultural Research (ICAR), Lamphelpat, Manipur and correlated with the biology of cabbage butterfly *(Pieris brassicae*) through Microsoft Excel.]

III. BIOLOGY OF PIERIS BRASSICAE

Pieris brassicae, commonly known as the cabbage butterfly or large white butterfly, is a pest that damages cabbage and other brassicae crops. *P. brassicae* undergoes a complete metamorphosis, comprising four distinct life stages: egg, larva (five instars), pupa, and adult.

Fig.1: *Pieries brassicae*

Eggs: Typically laid in clusters on the underside of host plant leaves. They are flask-shaped and change color from light yellow to grey or orange before hatching. Incubation periods generally range from 4-7 days.

Fig. 2: Egg

Fig. 3: Larvae

Fig. 4: Pupa

Fig. 5: Adult

Larvae: The damaging stage. Larvae are greenish with yellow lines and numerous hair-topped tubercles. They feed voraciously on cabbage leaves, often stripping shoots and even entire plants in later instars. The larval period can vary, but generally lasts around 14-20 days, depending on environmental conditions and host plant quality.

Pupa: After the final larval instar, the larva pupates, typically on walls, fencing, or under leaves, attaching itself by a silken girdle. Pupae can be pale green (non-diapausing) or greyish-white (diapausing). The pupal duration is usually 7- 10 days.

Adult: The adult butterflies are creamy white with smoky markings on their forewings. Females typically have two black spots on each forewing, while males have one. Adults are non-damaging but responsible for reproduction and dispersal. Adult longevity ranges from 7-12 days. The total developmental period from egg to adult can range from 32-44 days.

Table. 1: Biology of *P.brassicae*

Life Stage	Description	Duration (Approx.)
Egg	Yellow, flask-shaped, laid in clusters on the underside of host plant leaves.	3-6 days
Larva (Caterpillar)	Undergoes four molts, resulting in five instars. - 1st Instar: Light yellow with a distinct shiny black head. Scrapes leaf surface. - Later Instars (2nd-5th): Body color changes to greenish, then dark greenish. Covered with numerous hairs. Full-grown larva: Pale yellow, becomes greenish, measures 40-50 mm.	15-40 days (average 19-24 days on cabbage)
Pupa (Chrysalis)	Full-grown larvae stop feeding and find a suitable place (e.g., on stems, undersides of leaves, nearby structures like walls or fences) to pupate. Whitish to greyish with numerous spots. Anchored by the tip of the abdomen and a silken thread around the thorax.	7-28 days (average 10-12 days on cabbage)

Adult (Butterfly)	Emerges from the pupa. Pale white wings with black patches on the apical angle of the forewings. Females have two conspicuous black circular dots on the dorsal side of each forewing. Males are smaller and have black spots on the underside of each forewing.	3-12 days (females 9 days; males 8.15 days)

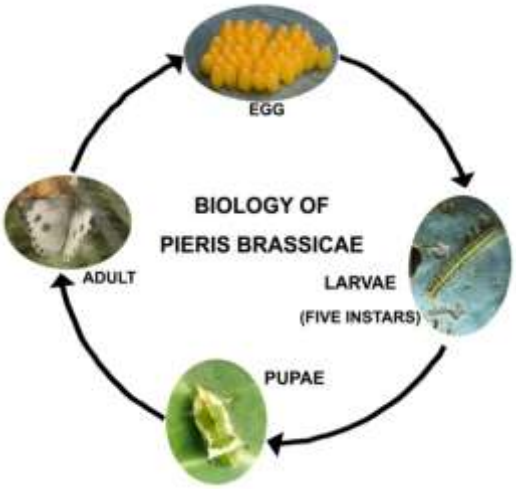

Fig.6: Biology of *P. brassicae*

IV. AGRO-CLIMATIC CONDITIONS OF MANIPUR

Manipur, falls under the Eastern Himalayan agro-climatic zone, characterized by a tropical monsoon type climate. Valley areas of Manipur experiences a sub-tropical plain zone climate. Key climatic parameters include:

***Temperature**:* Varies significantly across seasons. While specific data for Manipur is needed, Manipur valley generally experiences a range from sub-zero in winter to 36°C in warmer months. Optimal temperatures are crucial for insect development.

***Relative Humidity**:* High humidity is characteristic, especially during the monsoon season (May to September). Relative humidity can range from 40.5% (February) to 100% (August). High humidity can favor certain pest by reducing desiccation stress.

***Rainfall**:* Valley areas of Manipur receives substantial rainfall, particularly during the monsoon. Unusual rainfall patterns have been linked to increased pest problems, including those on cabbage. Cabbage is a major crop in Manipur Valley, providing a continuous food source for *P. brassicae* during its growing seasons. The practice of year-round vegetable cultivation in Manipur ensures host plant availability across different periods.

V. RESULT

Temperature is arguably the most critical environmental factor influencing insect development; the seasonal temperature fluctuations will directly impact the *P. brassicae* biology. During warmer periods, rapid growth can be expected, while cooler periods might see reduced activity and prolonged life cycles.

Table 2. Effect of Temperature on the biology of *P. brassicae*

Temperature (°C)	Egg Incubation(Days)	Larval Duration (Days)	Pupal Duration (Days)	Adult Longevity (Days)	Fecundity (Eggs/Female)
15±1.9	10–12	25–28	18–20	10–12	150–200
20±2.3	6–7	18–20	12–14	8–10	250–300
25±1.4	4–5	14–15	9–10	6–8	400–450
30± 4.1	3–4	11–12	7–8	4–5	500–550
35±0.5	2–3	9–10	6–7	2–3	300–350
>35	Development slows or stops; high mortality observed				

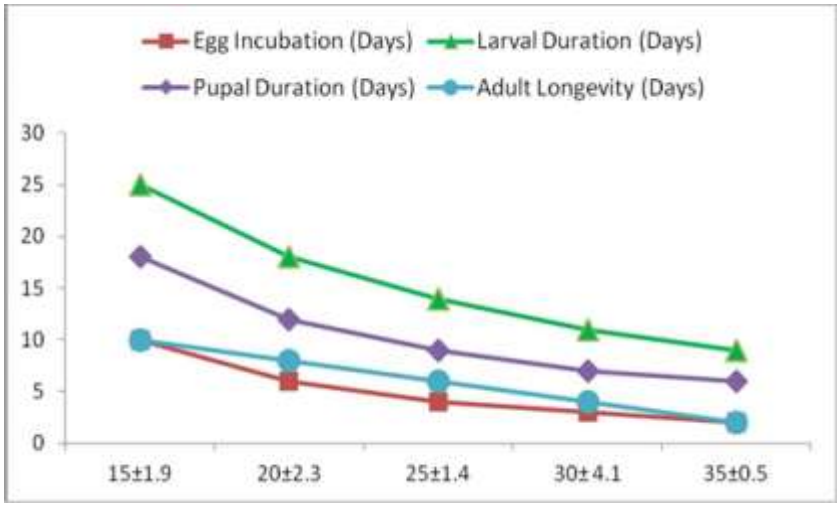

Fig 7. Graph showing impact of temperature on egg incubation, larval, pupal duration and adult longivity

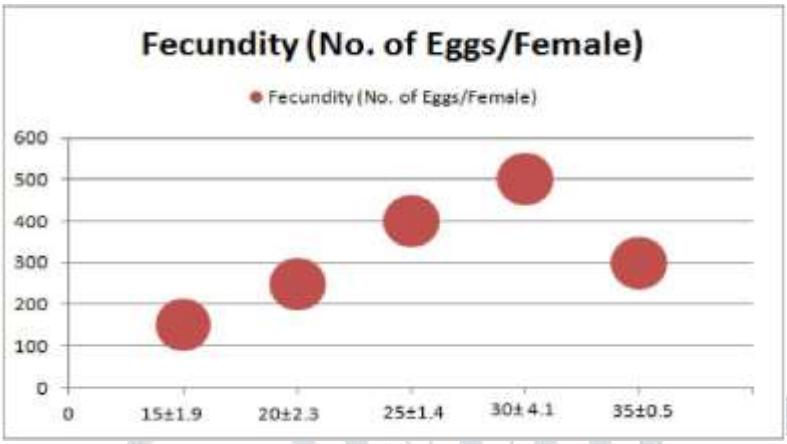

Fig 8. Graph showing impact of temperature on fecundity of *P.brassicae*

Humidity plays a significant role in insect physiology and behavior.

Table 3. Effect of Relative Humidity on the biology of *P.brassicae*

Relative Humidity (%)	Egg Hatching (%)	Larval Duration (days)	Pupal duration (days)	Adult Longevity (days)	Fecundity (eggs/female)
40±5%	30	17	11	4	120
50±10%	45	15	10	5	150
60-70%	65	13	9	6	200
70-80%	85	11	8	7	260
80-85%	**95**	**9**	**7**	**8**	**300**
90%	90	10	7.5	7	280
100%	70	11	8	6	220

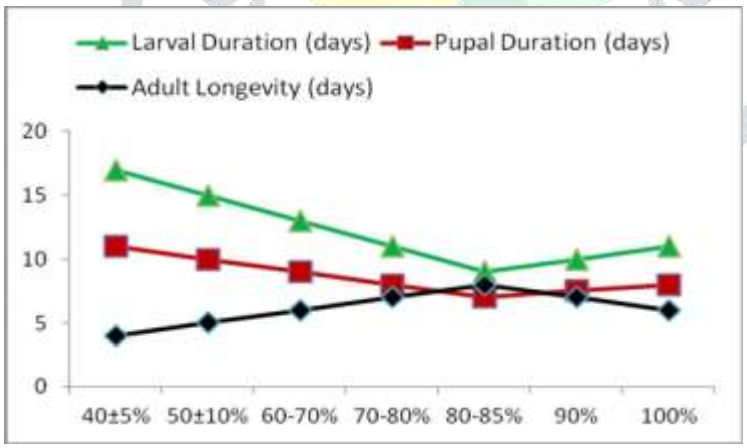

Fig.9. Graph showing impact of Relative humidity on Larval, pupal and longevity of *P.brassicae*

Fig.10. Graph showing impact of Relative humidity on fecundity and egg hatching percentage of *P.brassicae*

Here is a tabular representation of the effect of rainfall on the biology of *Pieris brassicae*

Table 4. Effect of Rainfall on the biology of *P.brassicae*

Rainfall Level	Egg Viability (%)	Larval Survival (%)	Pupal Development	Adult Activity	Fecundity (Eggs/Female)
No Rainfall / Dry	60–70	50–60	Normal	High	300–350
Moderate Rainfall	80–95	75–90	Optimal	High	450–550
Heavy Rainfall	60–70	40–60	Delayed or disrupted	Low	250–300

VI. DISCUSSION

Optimum temperatures (within an optimal range of approximately 25-30°C) generally lead to a faster completion of the *Pieris brassicae* life cycle (egg to adult), meaning more generations per year. This can result in increased pest pressure on crops (shows in Fig.8). Ali and Rizvi (2007) investigated the developmental response of the cabbage butterfly, *Pieris brassicae*, on different crops under both laboratory and field conditions and found that the duration of the total life cycle (from egg to adult) approximately 24.57 days in the laboratory and 27.67 days in the field. The study showed that the larval and pupal periods were significantly shorter on cauliflower and cabbage compared to other tested crops like sarson and knol-khol. Colder temperatures (15-20ºC) longer developmental time, lower egg production and pupae may enter a dormant stage (diapause) to survive the winter. This limits the number of generations in colder periods. The survival rate is excessively high temperatures (>35ºC) can lead to increased mortality rates for all life stages (Table 2.). Egg-laying capacity (fecundity) is also temperature-dependent, often peaking at moderate temperatures within the optimum range (shows in Fig.9). High relative humidity (70-100%) can be beneficial for *P. brassicae* by reducing water loss from the insect's body, thus enhancing survival, especially for early instars that are more susceptible to desiccation and Optimal RH for development and reproduction is around 80-85% (Fig.10). Egg hatching, fecundity, and adult longevity are best at this range.

S. C. Khanna's (1977) studied the biological parameters of *Pieris brassicae* on different cole crops and recorded 100% egg hatching and low larval mortality on cabbage. However, the life expectancy and survival of the insects generally decreased with age on all the cole crops. The study also noted that the time required to complete one generation (from egg to adult) was approximately 40 days on cabbage, cauliflower, and broccoli.

Hasan and Ansari (2010) investigated the effect of different cole crops on the biological parameters of the large white butterfly, *Pieris brassicae* and reported a reproduction rate of 24.89 on cabbage The study also observed a low larval mortality rate and 100% egg hatching on cabbage.

Moderate levels are often conducive to adult activity, including mating and oviposition. At low (<50%) and very high (>90%),(shows in Fig.11) survival and reproduction decline. Manipur's humid climate, particularly during the monsoon, is likely to support robust *P. brassicae* growth provided other factors are favorable. Moderate rainfall ensures availability of lush host plants (like cabbage/mustard), favoring egg laying and larval development. Heavy rain can wash away eggs and small larvae, soak pupae leading to fungal infections or death and reduce adult activity due to wing wetting and low temperatures on the other hand light rain provides humidity and plant growth without drowning (Table 4.)

VII. CONCLUSION

The agro-climatic conditions in valley areas of Manipur, exert a profound influence on the biology dynamics of *Pieris brassicae*. The sub-tropical plain zone climate, characterized by warm temperatures and high humidity, particularly during the monsoon, appears to be highly conducive to the proliferation of this pest. In Manipur the seasonal temperature fluctuations will directly impact the *P. brassicae* growth. During warmer periods, rapid growth build-up can be expected, while cooler periods might see reduced activity and prolonged life cycles. The monsoon season in Manipur, while bringing much-needed water for agriculture, may also present challenges in terms of *P. brassicae* management due to its potential impact on pest dynamics. Understanding these intricate relationships is paramount for developing effective and sustainable pest management strategies. Integrating a deeper understanding of agro-climatic influences with targeted research and adaptive management practices, it is possible to mitigate the impact of *Pieris brassicae* on cabbage cultivation and enhance agricultural sustainability in valley areas of Manipur.

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