



**“BIO- MORPHOMETRICS OF PAPILIO  
DEMOLEUS (LINN.), A SIRIOUS PEST ON CITRUS PLANTS  
IN DISTRICT SHAMLI OF WESTERN U. P. (INDIA).”**

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**ABSTRACT:**

Papilio demoleus (Linn.) is a serious pest of lemon plants and some other host plants and worldwide distributed. It caused a great loss to citrus. Severe infestation of this pest almost 85% defoliation of citrus plants and retard the growth as well as decreased the yield of fruits caused great economic loss. The developmental stages, caterpillars are the voracious foliage feeder. For the biological and morphometric studies, the insect were reared in laboratory. The biological and morphometrical data were collected and statistically analyzed. The female butterfly mostly, laid their eggs singly but sometimes 4 to 6 eggs in groups on fresh leaves as well as on tender part of shoots. Majority of eggs found on the under surfaces of leaves. The average size of eggs was measured as  $1.08 \pm 0.13$  mm in diameter with an average incubation period of  $3.29 \pm 0.38$  days at optimum temperature and humidity. The five instars were recorded in caterpillar stages. The morphometric variations of different developmental stages of Papilio demoleus, L. have been recorded the lemon was the most preferred host plant. Average larval period of Ist, IInd, IIIrd, IVth and Vth instars were observes as  $2.27 \pm 6.03$ ,  $2.37 \pm 0.01$ ,  $2.51 \pm 0.25$ ,  $3.09 \pm 0.08$  and  $3.3 \pm 0.12$  days, respectively. Pupal period was 7 to 9 days. The life span of adult fly  $4.68 \pm 0.72$  and female fly was  $5.98 \pm 1.38$  days. Average life cycle of insect completed within 24.02 days at the level of optimum temperature. The biology and development are mainly depends on the climatic conditions of that particular area, location and plant species on which it is feeding.

**AIM AND SCOPE:** Due to the seriousness of this pest the study of biology and morphometrics of Papilio demoleus, L. provides an opportunity to examine closely its different developmental stages and their survival, weak link in different stages, its behavior and other parameters to evolve an effective management strategy against this pest.

**KEY WORDS:** Citrus, Papilio, Incubation period, larval period, caterpillars, mating, oviposition, longevity.

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## **INTRODUCTION:**

Citrus is worldwide distributed plant, having third position amongst fruit category. Only banana and mango fruits are ahead the citrus production. It contributes in the economy of nation in agro-food and pharmaceutical industries (Addi et al. 2022). It belongs to the family Rutaceae (Shakour, et al. 2020) and includes several number of wild and cultivated species plants native to sub tropical and tropical regions of the world. Andhra, Punjab, Maharashtra, Uttar Pradesh, Bihar, Orissa, Assam and Gujarat are the most citrus producing states of India. About 8607.70 thousands metric tons per annum citrus production was recorded in India, (Indian Hort. Data Base, 2016). More than 120 million tons per annum citrus production was recorded in the world (Karn et al., 2021). Citrus fruits globally used in regular diets as lemon juices, pickle and ornamental products (Hans-Jaochime, 2021). It is great source of vitamin C (Singh, R. 1969) and has a medicinal use in various diseases (Tocmo, et al. 2020) like inflammations, cardio vascular disorders (Maugeri, et al. 2019), cancer treatments (Xingmiao, et al. 2021) and also used as health promoting and anti oxidant agent (Otoni et al. 2017). It is being traditionally cultivated in home gardens and modern plantation. (Saljoqui, et al. 2006).

More than 150 species of insect pests infested the citrus species and caused great loss of economy Atwal, A. S. (1964). More than 30% yield loss per annum in Indian Territory reported by Reshama, et al. (1988). Amongst various pests lemon butterfly, *Papilio demoleus* is a serious pest which caused a remarkable loss to citrus industry in India and abroad Khan, M. M. H. et al. (2021). The larvae of *Papilio* are voracious feeder of citrus nurseries which feeds on young foliages of host plants and retarded the growth and development of citrus plants (Mangrio, et al 2020). Severe infestation of citrus caterpillar results the entire tree is defoliated by voraciously feed on leaf lamina and leaving behind on mid rib (Sharifi & Zaria, 1970). Due to the importance of citrus several workers had been done lots of work on this pest so far. There for the present work was done in the area of district Shamli of Western U.P. for further investigation in this field.

## **MATERIAL AND METHODS:**

The fully fed fifth instar larvae were collected from citrus orchard and reared them in various glass jars in laboratory conditions at suitable temperature (28°C-35°C) provided by incubators Ashoken, A. R. (1997). The fresh leaves of citrus were provided as food. The 5<sup>th</sup> instar larvae reached in to the pupal stage. Then pupae were transferred in the rearing cages of wood & wire (size- 3x3x3 feet) for the emergence of adults. The potted citrus plants were kept inside the cages. After the emergence of adults females laid the eggs on the plants leaves. Almost same laid eggs were collected and shifted into petridishes and reared. During the rearing the fresh citrus leaves were provided as food material. Various larval stages were found then separate and collected for Bio-Morphometric measurements. The ocular micrometer was used to measure the various developing stages of the insect. To observe the fecundity, mating, oviposition, sex ratio and longevity of adults, the five pairs of freshly emerged adults (male & female) were kept in separate wooden cages and data were collected for analysis. The data like size, shape, color,

incubation, larval, pre-pupal, pupal periods and adult duration etc. were carefully recorded and statistically analyzed and placed in table.

## **RESULT AND DISCUSSION:**

During the course of study observed and statistically analyzed consolidated data were placed in the table. The biological and morphometrical findings were discussed in the following stages.

**EGG STAGE:-** The fertilized female butterfly laid eggs singly on the lower surface of fresh leaves and tender shoots also. About 84% eggs were found on under surface, 12% upper surface of leaves and 04% eggs were also reported on the tender shoot of citrus plants. The eggs are attached by means of a sticky substance which harden and glues them firmly in position. A single female laid about 76- 83 eggs in an average.

The eggs are almost spherical, basal surface slightly flat, pale yellow or creamy white when freshly laid. Average size of egg was  $1.08 \pm 0.02$  mm in diameter. The average incubation period was observed as  $03.29 \pm 0.38$  days at the level of moderate temperature ( $24^{\circ}\text{C}$ - $36^{\circ}\text{C}$ ). The incubation period is inversely proportion to the temperature, as the temperature become decreased the incubation would be increased but as the temperature increased the larval period became decreased. At the extremely high temperature (above  $45^{\circ}\text{C}$ ) the eggs became died and at extremely low temperature (below  $4^{\circ}\text{C}$ ) the eggs became freeze. Mangrio, et al. (2022) was also found similar findings during their studies on the biology and measurement on lemon butterfly.

**CATERPILLAR STAGE:-** Newly hatched (Neonate) larvae is cylindrical, spiny and light brown in color but turn in dark brown after few hours after hatching. Dorsally a V- shaped mark on the body looks like bird's excreta. Neonate larvae were observed as  $2.45 \pm 0.24$  mm long and  $1.03 \pm 0.14$  mm in width. Fully grown 1<sup>st</sup> instar larvae were measured as  $3.85 \pm 0.81$  mm long and  $0.03 \pm 0.14$  mm width. The data revealed that larval period of 1<sup>st</sup> instar stage was  $2.07 \pm 0.03$  days. The findings were in agreement with the work of Riaz, S. et al. (2020).

Second, Third and Fourth instar larvae were morphologically similar except in size. These were spiny, blackish in color, a creamy white lateral strip found on each side of thoracic region. A prominent blackish white creamy V shaped mark on the abdominal segments resemble to the Bird's excreta. The osmetorium, a defensive organ is brownish which released a specific chemical odor in any attack of enemies. It was Burger, B. V. et al (1978) also studies on chemical nature of defensive organ, osmetaria. Morphometrically, 2<sup>nd</sup> instar caterpillars were  $6.43 \pm 0.93$  mm long &  $1.77 \pm 0.10$  mm width, 3<sup>rd</sup> larvae were  $11.06 \pm 1.32$  mm long &  $2.78 \pm 0.34$  mm width and 4<sup>th</sup> stage larvae were measured as  $20.78 \pm 0.34$  mm long &  $5.57 \pm 0.28$  mm width. The average larval periods of 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> instar larvae were reported as  $2.37 \pm 0.01$  days,  $2.51 \pm 0.21$  day and  $3.09 \pm 0.08$  days, respectively.

The Fifth instar caterpillar or last stage larvae was quite different in body color. They became yellow green and smooth dorsally. The ventral side of body is milky white with a strip

throughout length of body. A brown band, arise obliquely from lateral side of the 4<sup>th</sup> abdominal segment up to the dorsal of the 5<sup>th</sup> abdominal segment. The osmeteria is reddish and colorful. Full grown 5<sup>th</sup> instar larvae change from yellow green to deep green .it was  $39.35\text{mm}\pm 1.43\text{mm}$  in length and  $8.36\pm 0.59\text{mm}$  in width. The larval duration reported as  $03.39\pm 0.71$  days. The observations of this study were resembles to the study of Islam, M. S. et al. (2017) & Jahnvi, M. et al. (2018).

**PUPAL STAGE:-** Just before reaching into the pupal stage ,the 5<sup>th</sup> instar larvae stopped feeding and become inactive and void the semi liquid excreta from their body. After selecting a suitable site it spins a silky thread around the body, which support the prepupae and pupae and withdraw its claspers from the shriveled skin which falls and with a twist engaged the cremasters in the silicon pads. Then prepupae enter in to the pupal stage. The pre pupae lasted for 16 to 18 hrs. in summer and 38hrs in winter.

Morphologically pupae were obtact, necked, upward head, smooth and body surface slightly pitted all over pupae. Three colored viz. green, dry straw or brown and dark grey with black markings pupae were observed in the ratio of 61.80%, 30.20% and 08.18%, respectively. The pupae were measured as  $32.50\pm 0.64\text{mm}$  long and  $9.25\pm 0.22\text{mm}$  in width with an average  $7.82\pm 0.52$  days of pupal period. It is also inversely proportional to temperature. At extreme low temperature the pupae reached into the hibernation. As the temperature increased the pupae comes out from hibernation and ready to emergence. The recorded data were near to the findings of Riaz, S. et al. (2020), Mangrio, et al. (2022) who conduct a detailed study on various aspect of the biology of citrus butterfly.

**ADULT STAGE:-** Fully developed butterfly emerged dorsally from pupal case and got 1 to 3 hrs for first fly. Adult male and female of citrus butterfly is large sized, tailless and beautiful having creamy and black spots on wings. The body was clothed with tufts of black and creamy yellow hairs, wings were also covered with black and creamy yellow scales, palpi also having same texture as those of tufts. Head and thorax black with creamy yellow streak on each side. Abdomen and legs are tusks black. Both fore and hind wings have row of creamy yellow sub-marginal spots and a small marginal lumiles. For wings at the base with little creamy yellow dots united in the form of transverse line. Hind wings black at base and bricks red oval patches on its formal angle and the blue black circular spots near its apical margins. Abdomen is creamy yellow at under side with lateral longitudinal black lines. Antennae club shaped. The average size of male adult was  $27.03\pm 2.07\text{mm}$  long and  $06.23\pm 0.95\text{mm}$  width while female adult was  $29.07\pm 3.5\text{mm}$  long and  $6.98\pm 1.00$  mm width. The maximum wing expansion is  $91.31\pm 7.51\text{mm}$ . Atwal A.S. (1964) reported similar results during his course of study.

The female butterfly lived longer than the male. The longevity of male adult was  $3.68\pm 1.72$  day and  $6.08\pm 1.38$  days of female. The sex ratio of male and female were reported as 46 : 54. The mentioned findings matched with the findings of Singh & Gangwar (1989)

**SEXUAL BEHAVIOUR: -** A few hours of emergence the butterflies were found on business. The male and female were seen indulging some short of courtship. Male is found to be

aggressive and the female vary passive before mating. After some time of the sexual play the pair sited quietly. The male all initiatives and sits by the side of female (already sitting) both facing in the same direction, and made intimate convection by bending its abdomen. After this the male at once turned its body to the opposite direction for mating. The average copulation period was  $89.95 \pm 25.42$  minutes recorded in laboratory conditions. This was in agreement with the data of Tadke and Kandalkar (1988).

The fertilized female usually starts eggs laying on the next day after copulation but occasionally the eggs may be laid on the same day. The pre oviposition period observed as  $18.25 \pm 5.40$  hrs. The oviposition of an egg is involved within a few seconds. After a few minute of flight, the female repeats the operation of egg laying taking 2 or 3 minutes, often a much longer time elapses between depositions of two eggs. The female usually placed one egg on the leaves, but very often two to five and occasionally more eggs may be found on a single leaf. The oviposition period was the shortest during summer with  $2.24 \pm .071$  days and longest during winter with  $5.08 \pm 1.99$  days. The average numbers of eggs laid per female were recorded as  $88.79 \pm 20.01$ .

Normally female die a few hours after laying their last quota of eggs but the post oviposition period of female was  $5.96 \pm 4.02$  hours. Islam, M. S. (2017) conducted a detailed study on the biology and the morphometrics of lemon butterfly and found similar results.

**CONCLSIONS:** - The laboratory work on the biology and morphometrics of citrus butterfly, papilio demoleus was an evident that the butterfly usually laid the eggs singly, occasionally in groups of 2 to 5 eggs. The total average eggs laid per female was 90 to 110. The incubation period as well as larval periods directly affected by temperature, therefore, variability was found. The average incubation at optimum temperature was  $3.29 \pm 0.38$  days. The five instars were recorded during larval development with average total larval period  $13.35 \pm 0.08$  days. Average pre pupal period during summer was 16 hours and during winter 38 days. The pupal period in summer was recorded as  $8.22 \pm 0.47$  days and during winter it may prolonged to  $122.56 \pm 17.19$  days, which indicate the hibernation.

The morphometrics measurements of the eggs, larvae, pupae and adults were indicated that shape, size, and color etc. were remarkable variable during the different developmental stages of the cycle. Morphometric observations were very close to the Madan suri, A. et al. (1979) who made a detailed work of chetotaxy of insects. The revealed morphometrical data of Islam, M. S. (2017); Riaz, S. et al. (2020) & Mangrio, et al. (2022) were much closed to the recent study on lemon butterfly during the course of this work. The study was proven that the geo-climatic conditions may affect the bio - morphological properties of an insect of that particular region.

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**Table:- Morphometrical measurements of P. demoleus (LINN.) :**

PARAMETER	EGG	CATERPILLAR STAGES (INSTARS)						PREPUPAE	PUPA
		Neonate	1 <sup>ST</sup>	2 <sup>ND</sup>	3 <sup>RD</sup>	4 <sup>TH</sup>	5 <sup>TH</sup>		
LENGTH (mm)	1.08+0.13 diameter	2.45+0.24	3.85+0.81	6.43+0.93	11.06+1.32	20.78+0.34	39.35+1.43	35.21+0.10	32.5
WIDTH (mm)		0.89+0.01	1.03+0.14	1.77+0.10	2.78+0.34	5.50.28	8.36+0.59	8.16+0.42	9.25
COLOR	Creamy white	Light brown	Dark brown	Blackish brown	Blackish brown	Blackish brown	Yellow green	Yellow green	Green 61.80 Brown 30.20 Grey 08.18
DURATION days	3.20+0.38	0.67+0.03	2.07+0.03	2.37+0.01	2.50+0.21	3.09+0.08	3.39+0.07	0.89+0.11	7.82
COPULATION PERIOD (min)	-	-	-	-	-	-	-	-	
PRE-OVIPOSITION PERIOD (hrs)	-	-	-	-	-	-	-	-	
OVIPOSITION PERIOD (days)	-	-	-	-	-	-	-	-	
POST OVIPOSITION PERIOD (days)	-	-	-	-	-	-	-	-	
NO.OF EGGS LAID	-	-	-	-	-	-	-	-	
SEX RATIO	-	-	-	-	-	-	-	-	
LONGIVITY OF ADULT (days)	-	-	-	-	-	-	-	-	