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Assessment on Biological and Morphometric Parameters of Jatropha Leaf Webber Cum Fruit Webber, *Pempelia morosalis* (Saalm Uller) along with Associated Natural Enemies in Eastern Uttar Pradesh of India

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ABSTRACT

The present investigation was conducted in Biocontrol laboratory of the Department of Entomology and Agricultural zoology, Institute of Agricultural Sciences, BHU, Varanasi to study growth and development of *Pempelia morosalis* (Saalm Uller) on Jatropha under laboratory conditions during April 2009 to May 2010. The studies were conducted at constant temperature of 27±2°C and 75% relative humidity. All observations of biological and morphometric parameters were replicated 6 times up to successive three generations results revealed that a single female of *Pempelia morosalis* laid 41 to 60 eggs during the life span. Eggs were whitish, flat, oval to round, often in groups of 8 to 15. Eggs were hatched into larvae within 5 to 7 days. First and second instar larvae were plain, pale yellowish green colour that were changed to brown during third instar to fifth instar with dorsal longitudinal stripes. Larval development was completed in 25 to 30 days. Pupal period lasted for 7 to 8 days. The newly emerged adult was grey in colour with snout like labial palp in the head with hyaline hindwing. Male was slightly smaller than female with pointed abdominal tip. The average longevity of male and female was 5 to 6 and 7 to 8 days, respectively. Two parasitoids were found on leaf webber larvae i.e., *Bracon hebetor* (Say) and *Tachinid* sp. Both parasitoids were successfully completed their biology on 4th instar larvae of *P. morosalis*. On providing two leaf webber larvae for a pair of *B. hebetor*, a total of 36 to 49 individual parasitoids were obtained, whereas in case of *Tachinid* sp., a total of 21 to 37 individual parasitoids were obtained in research study.

Key words: Growth, development, *Pempelia morosalis*, host plant, parasitoids

INTRODUCTION

At present, India is facing energy crises due to short fall in fossil fuel production. The demand for diesel fuel is expected to grow from current level of 65 million tones to 80 million tones by 2013. *Jatropha curcas* L. a genus of Euphorbiaceae is gaining importance commercially as a biodiesel crop. This crop was earlier projected as less prone to damage perhaps due to use of this crop as live fence for protection of agricultural fields from damage by livestock. Globally more than 40 species

of insects affecting Jatropha have been reported. A global list of phytophagous insects consisting of 60 species in 21 families and four orders has been compiled in Australia, where it is considered as a weed (Manoharan *et al*., 2006). Serious damage by *Nephopteryx* larvae was observed at Pusa and Mandalay (Hampson, 1912). Manoharan *et al*. (2006) recorded more than dozen pests occurring in Jatropha. (Devi *et al*., 2008) reported that the two insect pests that are emerging as a major problem in Jatropha cultivation are the scutellarid bug *Scutellera nobilis* Fabr that causes flower fall, fruit abortion and malformation of seeds and *Pempelia morosalis* that causes webbing of inflorescence and capsule damage.

Among the various pests associated with Jatropha, *P. morosalis* is specific to Jatropha and reported to affect a few forest species like *Desmodium gangeticum*, *Flemingia* sp. and *Uraria lagopides* (Beeson, 1941) and not occurring on field crops grown in India. Considering the history of forest pests becoming the pests of field crops subsequently due to reduction of forest habitat and monoculture, *P. morosalis* may likely to become regular pests with extension of area and perennial nature of Jatropha plantations. At flowering they bore into the peduncles and fruits which show galleries made of silk and frass. The caterpillar bores into the fruits throwing out faecal matter. The greenish larvae turn pinkish at the time of pupation. It pupates on the fruits. The larvae are seen under a cover of silk, frass or excreta, which extend between flowers/fruits (Ambika *et al*, 2005). For management of the pest at present major focus falls on chemical insecticides, though a dipteran parasite and spider *Stegodyphus* sp. were reported as natural control agent in Jhansi (Shanker and Dhyani, 2006). Hence, an attempt was made to investigate biological and morphometric parameters of *P. morosalis* and associated natural enemies.

MATERIALS AND METHODS

Survey was conducted on Jatropha plantation already made at Rajiv Gandhi South Campus, Barkachha, Mirzapur, Uttar Pradesh during April 2009 to 2010. The biology of *P. morosalis* was studied in Biocontrol laboratory of Department of Entomology and Agril Zoology, Institute of Agricultural Sciences, BHU, Varanasi during both the years. Full-grown larvae collected from field were released in the insect cage having cut ends of terminal shoots of Jatropha which were immersed into 250 mL conical flask containing water to maintain the turgidity. Fresh terminal shoots were provided for feeding as and when required. On completion of larval period, pupated individuals were transferred to a petridish lined with moist cotton and kept inside the insect rearing cage (45×45×45 cm). The males with cylindrical tapering abdomen and the females with broad abdomen having tubular aperture at the end were examined to separate the sex. A pair of male and female was released into a mating cage provided with diluted honey solution in glass vials for feeding and tender Jatropha terminal shoots were provided as ovipositional substrate. Fresh terminal shoots were provided to the neonate larvae and developing caterpillars as and when required. Pupae were collected and the procedure was repeated to get desired samples. The culture maintained in the laboratory was used as a source to study the biological and morphometric parameters. The culture was maintained at 27±2°C and 75% relative humidity.

Eggs taken from the culture were kept in Petridishes (7.5 cm dia) containing moist sponge lined with filter paper. Observations were made on the date of hatching to record the incubation period of eggs. Neonate larvae were transferred by moist camel hairbrush to a fresh twig kept in flask. Larval duration and per cent pupation were recorded. Pupae were placed individually over cotton

mat in petridishes and observed for pupal period and survival. Randomly selected pupae were weighed individually using electronic balance length and girth was measured using digital vernier calliper. The adults that emerged were sexed. One pair of male and female was released into a plastic oviposition jar (30 cm dia. and 20 cm ht.) having a tender twig of Jatropha for oviposition. The cotton swabs having 10% sugar solution in glass vial was provided for adult feeding. Ten cases were studied each time and observations were recorded for preoviposition, oviposition periods and total number of eggs laid to work out preoviposition and oviposition periods. The days prior to the day of oviposition was considered as preoviposition period and the number of days required for laying eggs was considered as oviposition period. Total eggs laid per female and fertile eggs based on hatching were considered to work out fecundity and fertility, respectively.

Observations were recorded on the number of eggs laid, egg period, number of larvae hatched, larval development, larval duration, head capsule dimension, pupation, adult emergence and sexes. All observations of biological and morphometric parameters were replicated 6 times up to successive three generations. The collected data were used to compute per cent adult survival, pupation and adult emergence.

To assess the parasitic efficiency, a mated fresh female of *Bracon hebetor* and *Tachinid* sp. was released in a test tube with two numbers of fourth instar larvae. They were fed with 50 per cent honey solution as adult food. The parasitisized larvae were removed and replaced with healthy larvae daily till the parasitoid was alive. Observations were made on number of eggs laid per host larvae, number of developed grubs and maggots on the host larvae, number of pupae and adults emerged.

RESULTS AND DISCUSSION

The growth parameters on developmental periods of egg, larvae, pupae and adult (both male and female), mating, preoviposition and oviposition period, morphometrics of larvae, pupae and fecundity recorded for 2009 were shown in Table 1. Similarly growth and development parameters in 2010 were shown in Table 2. The females on emergence spent 17.36±1.26 and 18.55±1.00 h (with a range of 15.00-21.50 and 16.05-21.40 h) as premating period and spent only 16.98±0.71 and 18.47±1.47 min for mating period (16.10-20.00 and 14.20-21.50 min) during 2009 and 2010, respectively. The moth preferred to lay eggs in groups on the young terminal leaves when compared to other plant parts with the mean fecundity of 49.78±2.77 and 51.89±2.79 during both the years, respectively. The freshly laid eggs were pearl white in colour, flat, oval to round in shape and deposited along the leaf vein of the abaxial surface of leaves. Ambika *et al.* (2007) also reported that female laid whitish, flat, oval to round eggs in groups on the young terminal leaves. The incubation period of egg ranged from 5.94±0.55 days in 2009 to 6.17±0.49 days in 2010. The present findings on the duration of incubation period were in agreement with that of Ambika *et al.* (2007) that reported incubation period of 5.83 days.

Neonates were pearl white in colour. There were 5 larval instars. First and second instar larvae were plain, pale yellowish green colour that were changed to brown during third instar to fifth instar with dorsal longitudinal stripes. Total larval duration ranged between 25-29 days in 2009 to 25-30 days in 2010 with a mean duration of 26.67±0.77 and 27.11±1.04 days during both the years, respectively. Variation in the larval developmental period of *P. morosalis* from those reported by various workers might be due to the different climatic conditions, food quality and variations of

Table 1: Biology and morphometrics of *Pempelia morosalis* on Jatropha during 2009

	Generations						
Parameters	I	II	III	Range	Mean±SD	SEm±	CD at 5%
Larval period (days)	27.67	25.83	26.50	25.00-29.00	26.67±0.77	0.44	1.53
Head capsule width-10 days old instar (cm)	0.70	0.66	0.69	0.64-0.72	0.68±0.02	0.01	0.03
Head capsule width-25 days old instar (cm)	1.18	1.13	1.14	1.10-1.20	1.15±0.02	0.01	0.04
Body length-10 days old instar (mm)	9.59	9.50	9.55	9.41-9.63	9.55±0.04	0.02	0.07
Body length-25 days old instar (mm)	21.98	21.17	21.68	20.54-22.18	21.61±0.32	0.20	0.68
Larval weight (mg)-10 days old instar	12.05	11.59	11.98	11.30-12.43	11.87±0.20	0.12	0.40
Larval weight (mg)-25 days old instar	49.83	48.11	49.15	47.18-51.95	49.03±0.71	0.42	1.44
Pre-pupal period (h)	27.08	25.35	26.45	24.30-28.40	26.29±0.71	0.45	1.55
Pupation (%)	38.33	32.50	34.17	30.00-40.00	35.00±2.45	1.46	5.05
	(38.21)	(34.74)	(35.77)		(36.25)		
Length of pupa (cm)	0.88	0.82	0.84	78.00-92.00	0.85±0.03	0.01	0.05
Weight of pupa (mg)	52.87	50.15	51.77	47.52-54.16	51.60±1.10	0.71	2.45
Pupal period (days)	7.67	7.00	7.33	7.00-8.00	7.33±0.27	0.17	0.60
Adult emergence (%)	83.33	75.83	79.17	75.00-85.00	79.44±3.07	1.39	4.83
	(65.85)	(60.50)	(62.84)		(62.98)		
Total developmental period (days)	44.67	42.17	43.33	41.00-45.00	43.39±1.00	0.59	2.05
Adult Longevity-Female (days)	7.67	7.00	7.33	7.00-8.00	7.33±0.32	0.17	0.60
Adult Longevity-Male (days)	5.83	5.00	5.67	5.00-6.00	5.50±0.32	0.16	0.54
Survival (%)	86.67	80.83	82.50	75.00-90.00	83.33±2.45	1.46	5.05
	(68.58)	(63.98)	(65.24)		(65.85)		
Premating period (h)	18.67	15.65	17.76	15.00-21.50	17.36±1.26	0.74	2.56
Mating period (min)	17.83	16.14	16.98	16.10-20.00	16.98±0.71	0.40	1.39
Ovipositional period (days)	4.83	4.00	4.33	4.00-5.00	4.39±0.32	0.16	0.54
Fecundity (eggs/female)	53.50	46.83	49.00	44.00-58.00	49.78±2.77	1.66	5.75
Egg period (days)	6.67	5.33	5.83	5.00-7.00	5.94±0.55	0.25	0.86

Data in parenthesis are arcsine-transformed values

the experimental timings (Kumawat, 2007). The average width of head capsule (25 days old instar) recorded was 1.15±0.02 cm in 2009 and it varied 1.17±0.02 cm in 2010, while the body length (21.61±0.32; 21.48±0.29 mm) and body weight (49.03±0.71; 49.65±0.86 mg) was recorded during both the years, respectively. Similar, results were obtained by Ambika (2005).

The brown obtect pupa usually found inside the silken web made of dried leaves and faecal pellets. Matured larvae were in prepupal stage for 26.29±0.71 and 26.50±0.91 h (24.30-28.40 and 24.55-29.20 h) and pupated to the extent of 35.00±2.45 and 40.56±5.79% during 2009 and 2010, respectively. Pupa measured 0.85±0.03 cm length in 2009 to 0.84±0.03 cm in 2010 with the weight of 51.60±1.10 and 51.14±1.16 mg (47.52-54.16; 48.26-53.91 mg) during both the years, respectively and it spent same pupal period i.e., 7.33 (7.00-8.00) days during both the years. These observations are in close conformity with earlier report of Ambika (2005).

On an average the developmental period from egg to adult emergence ranged from 43.39±1.00 days in 2009 to 44.28±1.02 days in 2010 with a high adult emergence of 79.44±3.07 and 81.94±5.32% in both the years, respectively. Adult longevity of female was 7.33±0.32 and 7.28±0.28 days during both the years, respectively, while it ranged for male from 5.50±0.32 in

Table 2: Biology and morphometrics of *Pempelia morosalis* on Jatropha during 2010

	Generations						
Parameters	I	II	III	Range	Mean±SD	SEm±	CD at 5%
Larval period (days)	26.00	26.83	28.50	25.00-30.00	27.11±1.04	0.48	1.64
Head capsule width-10 days old instar (cm)	0.68	0.70	0.71	0.65-0.73	0.70±0.02	0.01	0.03
Head capsule width-25 days old instar (cm)	1.15	1.17	1.19	1.12-1.20	1.17±0.02	0.01	0.03
Body length-10 days old instar (mm)	9.52	9.58	9.60	9.45-9.62	9.56±0.03	0.02	0.06
Body length-25 days old instar (mm)	21.16	21.41	21.85	20.54-22.09	21.48±0.29	0.16	0.57
Larval weight (mg)-10 days old instar	11.68	11.91	12.10	11.17-12.20	11.89±0.17	0.11	0.38
Larval weight (mg)-25 days old instar	48.73	49.41	50.80	47.52-51.78	49.65±0.86	0.39	1.35
Pre-pupal period (h)	25.58	26.17	27.74	24.55-29.20	26.50±0.91	0.44	1.52
Pupation (%)	33.33	40.83	47.50	25.00-55.00	40.56±5.79	3.06	10.58
	(35.23)	(39.68)	(43.54)		(39.56)		
Length of pupa (cm)	0.81	0.83	0.87	0.79-0.89	0.84±0.03	0.01	0.03
Weight of pupa (mg)	49.88	50.85	52.68	48.26-53.91	51.14±1.16	0.53	1.84
Pupal period (days)	7.00	7.17	7.83	7.00-8.00	7.33±0.36	0.14	0.47
Adult emergence (%)	77.50	82.50	85.83	70.00-85.00	81.94±5.32	2.10	7.26
	(61.65)	(65.24)	(67.83)		(64.79)		
Total developmental period (days)	43.00	44.33	45.50	42.00-46.00	44.28±1.02	0.59	2.03
Adult Longevity-Female (days)	7.00	7.17	7.67	7.00-8.00	7.28±0.28	0.16	0.54
Adult Longevity-Male (days)	5.17	5.67	6.00	5.00-6.00	5.61±0.34	0.16	0.54
Survival (%)	73.33	79.17	82.50	65.00-85.00	78.33±3.79	2.34	8.09
	(58.86)	(62.84)	(65.24)		(62.21)		
Premating period (h)	17.30	18.61	19.75	16.05-21.40	18.55±1.00	0.50	1.74
Mating period (min)	16.53	18.98	19.92	14.20-21.50	18.47±1.47	0.57	1.96
Ovipositional period (days)	4.17	4.83	5.00	4.00-5.00	4.67±0.36	0.14	0.47
Fecundity (eggs/female)	48.50	51.83	55.33	41.00-60.00	51.89±2.79	1.45	5.02
Egg period (days)	5.67	6.00	6.83	5.00-7.00	6.17±0.49	0.30	1.04

Data in parenthesis are arcsine-transformed values

2009 to 5.61±0.34 days in 2010 exhibiting a sex ratio of 1.2:1 (male: female). The adult survival per cent varied 83.33±2.45 in 2009 to 81.89±2.57 in 2010. The adult was grey in colour with snout like labial palp in the head with hyaline hindwing. Male was slightly smaller than female with pointed abdominal tip. The total ovipositional period of female was recorded as 4.39±0.32 days in 2009 to 4.67±0.36 days in 2010. This is in accordance with the findings of Ambika (2005).

On providing two leaf webber larvae for a pair of *B. hebetor*, a total of 36 to 42 and 43 to 49 individual parasitoids were obtained in 2009 and 2010, respectively (Table 3, 4). The eggs of *B. hebetor* laid on leaf webber larvae took 2.40 and 2.60 days to hatch out in both the years, respectively. The grubs fed the internal content of caterpillar for 5-7 days and came out for pupation and spent a day as prepupa during both the years. Pupation took place in cocoon as congegration and lasted for 7.60 and 8.40 days recording a mean of 15.60 and 15.80 days from egg to adult during 2009 and 2010, respectively. Adult longevity varied 9.80 and 10.40 days for male and 13 and 14.40 days for female during both the years, respectively. These observations are in close conformity with the results obtained by Ambika (2005).

Similarly, in case of *Tachinid* sp., a total of 24 to 37 and 21 to 29 individual parasitoids were obtained in 2009 and 2010, respectively (Table 5, 6). Adults mate in 1×0.75×0.75 m cages provided 2 leaf webber larvae, where they oviposited on leaf webber larvae. The eggs hatched in 4-6 days

Table 3: Biology of *Bracon hebetor* on fourth instar larvae of *P. morosalis* during 2009

Parameters	Range	*Mean	SD	SEm±
Egg period (days)	2.00-3.00	2.40	0.49	0.22
Larval period (days)	5.00-7.00	6.00	0.63	0.28
Prepupal period (days)	1.00	1.00	-	-
Pupal period (days)	7.00-9.00	7.60	0.80	0.36
Total life cycle (days)	15.00-16.00	15.60	0.49	0.22
Adult longevity (days)				
Male (days)	9.00-10.00	9.80	0.40	0.18
Female (days)	12.00-14.00	13.00	0.89	0.40
Adult emerged (No)	36.00-42.00	38.80	2.14	0.96

*Mean of 5 observations

Table 4: Biology of *Bracon hebetor* on fourth instar larvae of *P. morosalis* during 2010

Parameters	Range	*Mean	SD	SEm±
Egg period (days)	2.00-3.00	2.60	0.49	0.22
Larval period (days)	5.00-7.00	6.20	0.98	0.44
Prepupal period (days)	1.00	1.00	-	-
Pupal period (days)	7.00-9.00	8.40	0.80	0.36
Total life cycle (days)	15.00-16.00	15.80	0.40	0.18
Adult longevity (days)				
Male (days)	10.00-11.00	10.40	0.49	0.22
Female (days)	14.00-16.00	14.80	0.75	0.33
Adult emerged (No)	43.00-49.00	45.40	2.06	0.92

*Mean of 5 observations

Table 5: Biology of *Tachinid* spp. on fourth instar larvae of *P. morosalis* during 2009

Parameters	Range	*Mean	SD	SEm±
Egg period (days)	4.00-6.00	5.00	0.63	0.28
Larval period (days)	13.00-16.00	14.40	1.02	0.46
Prepupal period (days)	1.00-2.00	1.40	0.49	0.22
Pupal period (days)	11.00-15.00	13.00	1.41	0.63
Total life cycle (days)	33.00-38.00	35.20	1.72	0.77
Adult longevity (days)				
Male (days)	11.00-13.00	12.40	0.80	0.36
Female (days)	12.00-16.00	14.20	1.47	0.66
Adult emerged (No)	24.00-37.00	29.40	4.32	1.93

*Mean of 5 observations

Table 6: Biology of *Tachinid* spp. on fourth instar larvae of *P. morosalis* during 2010

Parameters	Range	*Mean	SD	SEm±
Egg period (days)	4.00-6.00	4.80	0.75	0.33
Larval period (days)	13.00-16.00	14.80	1.17	0.52
Prepupal period (days)	1.00-2.00	1.60	0.49	0.22
Pupal period (days)	12.00-15.00	13.40	1.36	0.61
Total life cycle (days)	33.00-38.00	35.40	1.85	0.83
Adult longevity (days)				
Male (days)	12.00-14.00	12.80	0.75	0.33
Female (days)	15.00-16.00	15.20	0.40	0.18
Adult emerged (No)	21.00-29.00	26.00	2.83	1.26

*Mean of 5 observations

in both the years. The larvae development took place for 13-16 days by feeding the internal content of caterpillars but due to the eggs had been laid on mature larvae the host almost invariably completed at least the outer shell of its cocoon before being killed. Pupation was completed in cocoon itself and lasted for 11 to 15 days during both the years. Adult male longevity lasted 12.40 and 14.20 days in 2009 and 2010, respectively, whereas female were live for 12.80 and 15.20 days in both the years, respectively. The present findings on the parasitic efficiency of Tachinid sp. were in agreement with Godfray (1985) that reported mass rearing of tachinid fly *Argyrophylax basifulva* on the grater coconut spike moth, *Tirathaba* sp. (Lepidoptera: pyralidae).

Information gathered on the life cycle parameters i.e., survival, duration of life cycle, fecundity of *P. morosalis* will be helpful in construction of mathematical models for providing information on population build up of the pest. Observations on morphometrics and life cycle parameters may also prove helpful in identification of biotypes of this pest and their management.

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