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Bionomics of chiku moth, *Nephopteryx eugraphella* Ragonot (Lepidoptera : Pyralidae) on sapota

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ABSTRACT

Studies on bionomics of chiku moth, *Nephopteryx eugraphella* Ragonot (*Lepidoptera*: Pyralidae) were carried out at Department of Entomology, B. A. College of Agriculture, Anand Agricultural University, Anand during July to September, 2015. The female laid eggs along the midrib on under surface of tender leaves scattered or in batches. The freshly laid eggs were flat, oval in shape having one end broad and other slightly narrow and yellowish white in colour. The average length and breadth of eggs were 0.96 ± 0.02 and 0.46 ± 0.02 mm, respectively. The average incubation period was 3.60 ± 0.49 days. The average hatching percentage was 84.83 ± 6.33. The larva was passed through six instars. The length of first, second, third, fourth, fifth and sixth instar larva was 2.72 ± 0.22, 4.84 ± 0.25, 7.65 ± 0.26, 11.70 ± 0.36, 15.61 ± 0.28 and 20.71 ± 0.52 mm, whereas breadth was 0.47 ± 0.04, 0.80 ± 0.13, 1.46 ± 0.05, 1.73 ± 0.07, 2.09 ± 0.14 and 2.37 ± 0.11 mm, respectively. The width of the head capsule of respective instars was 0.38 ± 0.01, 0.52 ± 0.03, 0.79 ± 0.03, 1.08 ± 0.10, 1.42 ± 0.04 and 1.71 ± 0.04 mm, respectively. The duration of first, second, third, fourth, fifth and sixth instar larva was 3.40 ± 0.78, 5.10 ± 0.84, 4.44 ± 0.64, 3.28 ± 0.46, 3.46 ± 0.50 and 2.80 ± 0.61 days, respectively. The total larval period was 22.48 ± 1.35 days. Fully developed larva suspended feeding, looked sluggish, wrinkled and gradually contract in length and turned into pre-pupal stage. The length and breadth of pre-pupa were 17.33 ± 0.40 and 2.18 + 0.04 mm, respectively. The duration of pre-pupal stage was 1.72 ± 0.45 days. The larvae pupated between webbed leaves. The pupa was light green in colour. The length and breadth of pupal stage were 10.69 ± 0.44 and 2.78 ± 0.15 mm, respectively. The length and breadth of male moth were 17.13 ± 0.75 and 18.81 ± 1.59 mm, respectively. The length and breadth of female moth were 20.25 ± 1.03 and 23.20 ± 1.07 mm, respectively. The pre-oviposition, oviposition and post oviposition periods were 1.57 ± 0.49, 4.05 ± 0.92 and 1.14 ± 0.69 days, respectively. The fecundity of the female was 95.90 ± 14.40 eggs. The sex ratio (male : female) was 1: 1.24 ± 0.36. The total life span for male and female was 34.24 ± 2.20 and 44.18 ± 4.20 days, respectively.

Key word: Bionomics, chiku moth, *Nephopteryx eugraphella*

Sapota [*Manilkara achras* (Mill.) Farsberg, syn. *Achras zapota* Linn.] is an important tropical fruit tree, which is largely grown for commercial purpose in Gujarat, Maharashtra, Karnataka, Tamil Nadu, Kerala, Uttar Pradesh, Haryana, Punjab and West Bengal (Cheema *et al.*, 1954 and Vevai, 1971). In India, the area under sapota is increasing year after year. It was cultivated in 1.77 lakh ha area with a total production of 17.44 lakh tonnes and productivity is 9.90 tonnes/ha (Anonymous, 2014a). In Gujarat, it was grown under 28,800 hectares area with a production of 2.97 lakh tonnes and productivity is 10.4 tonnes/ha (Anonymous, 2014b).

About 25 insect pests attack sapota tree (Butani, 1975). Among these, chiku moth, *Nephopteryx eugraphella* is the more destructive pest of sapota in India. This pest is active throughout the year under Central Gujarat conditions. The newly hatched larvae of *N. eugraphella* infested young terminal, fresh leaves, buds and fruits of sapota. First instar larvae scrapped and fed on green tissues of leaves, whereas later

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instars larvae webbed the few terminal leaves of the shoots and feed on it by remaining inside the web. The pest also attacked on flower, buds and tender fruits which resulted in to premature shedding. The infested plant easily recognized from a distance by presence of numerous webbed brown terminal shoots and dried up clusters of leaves. Considering the economic importance of the pest, its biology and nature of damage were studied along with description of different stages of the pest.

MATERIALS AND METHODS

The biology of *N. eugraphella* on sapota was carried out at Department of Entomology, B. A. College of Agriculture, Anand Agricultural University, Anand during July to September, 2015. The research was carried out at the temperature of 27.71 to 33.40 with an average of 29.71 ± 1.75 °C and relative humidity of 60.14 to 93.84 with an average of 81.11 ± 10.20 per cent in laboratory condition.

Maintenance of culture

Initially, *N. eugraphella* larvae were collected from the unsprayed sapota field and brought to the laboratory. The field collected larvae were kept in plastic container (10 cm diameter and 12 cm height). The container was covered with clean white muslin cloth with the help of rubber bands to prevent the larvae from escaping. Fresh sapota leaves were provided daily to the larvae as a food. After pupation of larvae, pupae were collected in Petri dish which was put in the acrylic rearing cage for emergence of adult. The cage was placed in sun light during morning hours to provide natural condition to the adult. The tender sapota terminal shoots with leaves were wrapped with cotton lint soaked in water at cut end to keep the leaves and fruits fresh and turgid for longer periods. The bouquet of tender shoot prepared as above and held erect in a vial (Diameter: 1.5 cm, Height: 6 cm) was placed inside the cage for egg laying. A swabs of absorbent cotton dipped in 5 per cent honey solution were kept inside the cage as food for adult. The freshly laid eggs were used for details study of bionomics. The measurement of length and breadth was recorded with help of Stereo Zoom microscope and Magnus-Pro software.

RESULTS AND DISCUSSION

Biology of N. eugraphella on sapota

Egg

The female moth of *N. eugraphella* preferred tender leaves and corolla of buds to deposit eggs during night hours only. The eggs were laid scattered as well as in batches along the midrib on under surface of tender leave. Some times, the eggs were laid on the corolla of chiku buds. The freshly laid eggs were flat, oval in shape having one end broad and other slightly narrow and yellowish white in colour. A mobile yellowish embryo could be easily seen under microscope in fertile eggs prior to hatching. At the time of hatching, the colour of the eggs changed to reddish brown. The unfertilized eggs were oval in shape and they were white in colour. The description of the present investigation on eggs are in conformity with the findings of Gupta and Gangarde (1955), Butani (1975), Sran and Sandhu (1989), Patel *et al.* (1988), Patange *et al.* (1996), Patel (1996), Hajare *et al.* (2008) and Shukla and Patel (2011).

The length of eggs ranged from 0.94 to 1.01 mm with an average of 0.96 ± 0.02 mm while breadth varied from 0.43 to 0.53 mm with an average of 0.46 ± 0.02 mm. The data on eggs are in agreement with the report of Patel *et al.* (1988), Patange *et al.* (1996), Patel (1996) and Hajare *et al.* (2008). The incubation period varied from 3 to 4 days with an average of 3.60 + 0.49 days. Results of the present investigation on incubation period of *N. eugraphella* are in close agreement with Gupta and Gangarde (1955), Sran and Sandhu (1989), Patel *et al.* (1987), Patange *et al.* (1996), Patel (1996) and Hajare *et al.* (2008).

In laboratory, the hatching percentage ranged from 66.67 to 95.24 with an average of 84.83 ± 6.33. The present observations on hatching percentage are in accordance with the report of Sran and Sandhu (1989), Patel (1996) and Hajare *et al.* (2008). However, higher hatching percentage (100%) noticed by Gupta and Gangarde (1955) and Patel *et al.* (1988).

Larva

The larvae were found to pass through six instars on sapota leaves in the laboratory. The first instar larva was very active and pale yellowish in colour. The head is brownish and fairly broad. When the larva was viewed under the microscope, the mouth parts were seen fairly prominent with distinct pinkish mandibles. The epicranial suture of head was well seen. The abdomen carries 5 pairs of prolegs on 3rd, 4th, 5th, 6th and 10th abdominal segments. The whole body of larva carries hairs on dorsal side and a set of 3 dorso - lateral pinkish strips on either sides. The length and breadth of the larva ranged from 2.42 to 3.06 mm (Av. 2.72 ± 0.22 mm) and 0.40 to 0.58 mm (Av. 0.47± 0.04 mm), respectively. While, the width of the head capsule ranged from 0.36 to 0.42 mm (Av. 0.38 ± 0.01 mm). The duration of first larval instar was found to

Table 1 Duration of different life stages of *N. eugraphella*

Sr. No.	Life stages	Period (days)		
		Minimum	Maximum	Mean ± SD
1	Egg	3	4	3.60 ± 0.49
	Hatching (%)	66.67	95.24	84.83 ± 6.33
2	Larva			
	I instar	2	4	3.40 ± 0.78
	II instar	4	7	5.10 ± 0.84
	III instar	3	6	4.44 ± 0.64
	IV instar	3	4	3.28 ± 0.46
	V instar	3	4	3.46 ± 0.50
	VI instar	2	4	2.80 ± 0.61
	Total	19	25	22.48 ±1.35
3	Pre-pupa	1	2	1.72 ± 0.45
4	Pupa	7	9	7.28 ± 0.83
5	Adult period			
	Pre-oviposition	1	2	1.57 ± 0.49
	Oviposition	3	5	4.05 ± 0.92
	Post-oviposition	0	2	1.14 ± 0.69
	Longevity			
	Male	5	7	5.84 ± 0.98
	Female	6	8	6.76 ± 0.85
	Fecundity	65	126	95.90 ± 14.40
	Sex ratio	1:0.33	1:1.83	1: 1.24 ± 0.36
6	Total life span: Egg to adult death			
	Male	31	38	34.24 ± 2.20
	Female	35	51	44.18 ± 4.20

Note: SD: Standard Deviation

vary from 2 to 4 days with an average of 3.40 ± 0.78 days. Similar observations were reported by Gupta and Gangarde (1955), Sran and Sandhu (1989), Patel *et al.* (1988), Patange *et al.* (1996), Patel (1996) and Hajare *et al.* (2008).

Second instar larva resembled the first instar in colour and general body form. The second instar larva was comparatively more greenish with light brown longitudinal strips on the body. The thorax carried three pairs of true legs and abdomen carries five pairs of prolegs with faint brown colour head. Similar observations were reported by Gupta and Gangarde (1955), Patel *et al.* (1988), Patange *et al.* (1996), Patel (1996) and Hajare *et al.* (2008). The length, breadth and head capsule width of second instar larva ranged from 4.25 to 5.27 mm (Av. 4.84 + 0.25 mm), 0.60 to 1.24 mm (Av. 0.80 ± 0.13 mm) and 0.48 to 0.56 (Av. 0.52 ± 0.03 mm), respectively. The data on length and width of second instar larva are tally with the finding of Gupta and Gangarde (1955), Patel *et al.* (1988), Patel (1996) and Hajare *et al.* (2008). The duration of second instar larvae varied from 4 to 7 days with an average of 5.10 ± 0.84 days. The duration of second instar larva is closely tally with the report of Patange *et al.* (1996), Patel (1996) and Hajare *et al.* (2008). Patel *et al.* (1988) reported a shorter period (4.27 days) of second instar larva of *N. eugraphella*. However, this contrast might be due to the effect of food and different environmental conditions.

The third instar larva was deep greenish to brownish in colour with black dotted longitudinal strips on either sides and having hairs on body. The mandibles assumed a black colour. The first thoracic segment was brown in colour. Other morphological characteristics were similar to second instar larva. Similar observations were reported by Gupta and Gangarde (1955), Patel *et al.* (1988), Patange *et al.* (1996), Patel (1996) and Hajare *et al.* (2008). The length of third instar larvae was found to vary from 7.11 to 7.95 mm (Av. 7.65 + 0.26 mm), the width from 1.31 to 1.55 mm (Av. 1.46 ± 0.05 mm) and width of head capsule from 0.76 to 0.86 mm (Av. 0.79 ± 0.03 mm). According to Gupta and Gangarde (1955), the length was 7 to 8 mm. While data on width was 1.0 to

Table 2 Measurements of different life stages of *N. eugraphella*

Sr. No.	Life stages	Particulars	Measurement (mm)		
			Minimum	Maximum	Mean ± SD
1	Egg	Length	0.94	1.01	0.96 ± 0.02
		Breadth	0.43	0.53	0.46 ± 0.02
2	Larva I instar	Length	2.42	3.06	2.72 ± 0.22
		Breadth	0.40	0.58	0.47 ± 0.04
		Head capsule width	0.36	0.42	0.38 ± 0.01
	II instar	Length	4.25	5.27	4.84 ± 0.25
		Breadth	0.60	1.24	0.80 ± 0.13
		Head capsule width	0.48	0.56	0.52 ± 0.03
	III instar	Length	7.11	7.95	7.65 ± 0.26
		Breadth	1.31	1.55	1.46 ± 0.05
		Head capsule width	0.76	0.86	0.79 ± 0.03
	IV instar	Length	10.92	12.38	11.70 ± 0.36
		Breadth	1.52	1.86	1.73 ± 0.07
		Head capsule width	0.96	1.36	1.08 ± 0.10
	V instar	Length	15.18	16.10	15.61 ± 0.28
		Breadth	1.81	2.35	2.09 ± 0.14
		Head capsule width	1.37	1.46	1.42 ± 0.04
	VI instar	Length	19.54	21.56	20.71 ± 0.52
		Breadth	2.13	2.54	2.37 ± 0.11
		Head capsule width	1.62	1.82	1.71 ± 0.04
3	Pre-pupa	Length	16.46	18.15	17.33 ± 0.40
		Breadth	2.08	2.27	2.18 ± 0.04
4	Pupa Male	Length	10.00	11.60	10.69 ± 0.44
		Breadth	2.45	3.13	2.78 ± 0.15
	Female	Length	10.52	12.25	11.48 ± 0.39
		Breadth	2.51	3.14	2.83 ± 0.14
5	Adult Male	Length	15.98	18.22	17.13 ± 0.75
		Breadth (wing expanded)	15.11	21.20	18.81 ± 1.59
	Female	Length	18.69	21.74	20.25 ± 1.03
		Breadth (wing expanded)	21.64	24.86	23.20 ± 1.07

Note: SD - Standard Deviation

1.5 mm as reported by Gupta and Gangarde (1955), Patel *et al.* (1988), Gajare (1993), Patange *et al.* (1996) and Hajare *et al.* (2008). Thus, present findings are in confirmly with the results of earlier workers. The duration of third instar larvae varied from 3 to 6 days (Av. 4.44 ± 0.64 days). The larval period of third instar observed in present study was similar to the report of Patel *et al.* (1988), Patel (1996) and Hajare *et al.* (2008).

The fourth instar larva was differed from third instar larva by having the first thoracic segment with a dark brown plate and one pair of black spiracles, second thoracic segment bears two black dorso-lateral spots. The ventral side of larva was greenish in colour and the longitudinal stripes became distinctly visible due to dark brown to blackish colour. The head was lined spotted dark brown. Similar observations were reported by Gupta and Gangarde (1955), Gajare (1993), Patange *et al.* (1996) and Hajare *et al.* (2008). The length and breadth of fourth instar larva were varying from 10.92 to 12.38 mm (Av. 11.70 ± 0.36 mm) and 1.52 to 1.86 mm (Av. 1.73 ± 0.07 mm), respectively, whereas the width of head capsule was varying from 0.96 to 1.36 mm (Av. 1.08 ± 0.10 mm). The present findings on length and breadth of fourth instar are almost in conformity with the reports of Gupta and Gangarde (1955), Gajare (1993) and Patange *et al.* (1996). The width of head capsule are closely tally with result of Patel *et al.* (1988), Gajare (1993), Patel (1996) and Hajare *et al.* (2008). The duration of fourth instar larva varied from 3 to 4 days (Av. 3.28± 0.46 days). The duration of fourth instar recorded during present study are in accordance with the report of Patel *et al.* (1988), Gajare (1993), Patange *et al.*(1996) and Hajare *et al.* (2008).

The fifth instar larva became slightly pinkish in colour with ventral side light green. Larva became stouter and tapering posteriorly. At this stage, the larva was very active and move very rapidly on shoots. The larva having a pair of dark black spot on second thoracic segment. The head becomes green with black brown marks on it. The head and mouth parts were became more prominent. Similar observations were recorded by Gupta and Gangarde (1955), Gajare (1993), Patange *et al.* (1996) and Hajare *et al.* (2008). The length of the larva was found to vary from 15.18 to 16.10 mm (Av. 15.61 ± 0.28 mm). The breadth ranged from 1.81 to 2.35 mm (Av. 2.09± 0.14 mm). The head capsule width ranged from 1.37 to 1.46 mm (Av. 1.42 ± 0.04 mm). Gupta and Gangarde (1955), Gajare (1993), Patange *et al.* (1996) and Hajare *et al.* (2008) had also reported similar length and breadth of fifth instar larva. The width of the head capsule is closely tally with the report of Gajare (1993) and Hajare *et al.* (2008). The duration of the fifth instar larva varied from 3 to 4 days with an average of 3.46 ± 0.50 days. The data on duration are closely tally with Gajare (1993), Patange *et al.* (1996) and Hajare *et al.* (2008).

The sixth instar larva was deep pink in colour. The longitudinal strips became dark black with ventral side to green colour. The prominent hairs were present on dorso lateral side of the body. The full grown larva was very active, moving rapidly on shoots to find out suitable place for pupation. The head was pink brown in colour with black marks on it. Similar observations were recorded by Gupta arid Gangarde (1955), Patel *et al.* (1988), Gajare (1993), Patange *et al.* (1996), Patel (1996) and Hajare *et al.* (2008). The length of the sixth instar larva was found to vary from 19.54 to 21.56 mm (Av. 20.71 ± 0.52 mm). The breadth ranged from 2.13 to 2.54 mm (Av. 2.37 ± 0.11 mm). The head capsule width ranged from 1.62 to 1.82 mm (Av. 1.71± 0.04 mm). Gupta and Gangarde (1955), Gajare (1993), Patange *et al.* (1996) and Hajare *et al.* (2008) had also reported similar length and breadth of sixth instar larva. While Sran and Sandhu (1989), Patel *et al.* (1988) reported more length and breadth of sixth instar larva. This contrast might be due to the effect of food and different environmental conditions. The duration of the sixth instar larvae ranged from 2 to 4 days with an average of 2.80 ± 0.61 days. The data on duration of sixth instar larva are closely tally with Gajare (1993), Patange *et al.* (1996) and Hajare *et al.* (2008).

The total larval period of *N. eugraphella* was ranged from 19 to 25 with an average 22.48 ± 1.35 days. The data on larval period was in close agreement with the finding of Gupta and Gangarde (1955), Gajare (1993), Patange *et al.* (1996) and Hajare *et al.* (2008).

Nature of damage

It was observed under field condition that the larvae of *N. eugraphella* were infesting young terminal, fresh leaves, buds and fruits of sapota. First instar tiny larvae moved about on the leaf surface for some time and then scrapped and fed on green tissues and produced a parchment. After 3 to 4 days, the larvae started to web a few top tender leaves. As the larvae grown, some more leaves were attached to the web so that the web of leaves became larger; the larvae remained inside the webbed leaves and fed voraciously on chlorophyll of leaves leaving behind a papery layer with fine network of veins. Young larvae also attacked the flowers and flower-buds and bore into basal portion

of the buds, which wither and then move on the next bud. The injured flowers and flower-buds dried up and did not bear any fruits. In case of fruits, the larvae fed on small portion and then rejected the fruits. It was also observed the larvae in case, bored into the fruits and consumed the fruit flesh. Infested trees could be easily recognized from a distance by presence of numerous webbed brown terminal shoots and dried up clusters of leaves. The present observations on nature of damage caused by *N. eugraphella* on sapota are in accordance with report of Gupta and Gangarde (1955), Sandhu *et al.* (1974), Butani (1975), Patel *et al.* (1988), Sran and Sandhu (1989), Jhala *et al.* (1993), Patel *et al.* (1993), Patange *et al.* (1996), Patel (1996), Hajare *et al.* (2008) and Shukla and Patel (2011).

Pre-pupa

In the laboratory, it was observed that the fully grown larva was active and move on twig to find suitable place for spinning cocoon of silk and excreta in between two webbed leaves. The larva suspendedits feeding and gradually contracts in length. The colour changes from dark pink to creamy white. The length of pre - pupa ranged from 16.46 to 18.15 mm with an average of 17.33 ± 0.40 mm, while breadth was ranged from 2.08 to 2.27 with an average of 2.18 ± 0.04 mm. Similar observations were reported by Gupta and Gangarde (1955), Sran and Sandhu (1989), Patel *et al.* (1988), Gajare (1993), Patange *et al.* (1996) and Hajare *et al.* (2008). The pre - pupal period was lasted for 1 to 2 days with an average of 1.72 ± 0.45 days. The data on pre - pupal period were in accordance with Gupta and Gangarde (1955), Gajare (1993), Patel (1996), Sran and Sandhu (1989), Patel *et al.* (1988), Gajare (1993), Patange *et al.* (1996) and Hajare *et al.* (2008).

Pupa

In the laboratory, the pupation took place in between two webbed leaves forming cocoon with silk and excreta. The pupa was soft bodied and light green in colour. Gradually, it became hard and changed to reddish brown colour with prominent black eye like spots. The pupae became dark brown prior to emergence of adults. The pupae were long, cylindrical and tapering towards the posterior end. When the pupal period about to over, the adult development was completed and the legs and the wings were clearly visible through the pupal skin under microscope. The pupa which had to develop in to male moth had a slit representing the genital opening in the posterior part of ninth abdominal segment, while in case of female, it was on the eight abdominal segments. The anal apture in both sexes was located on the tenth abdominal segment. Similar observations on colour and shape of pupa were reported by Gupta and Gangarde (1955), Sran and Sandhu (1989), Patel *et al.*, (1988), Gajare (1993), Patange *et al.*, (1996) and Patel *et al.*, (1996).

The length of male pupa ranged from 10.00 to 11.60 mm with an average of 10.69 ± 0.44 mm, while breadth was ranged from 2.45 to 3.13 mm with an average of 2.78 ± 0.15 mm. The length of female pupae was varied from 10.52 to 12.25 mm with an average of 11.48 ± 0.39 mm and breadth varies from 2.51 to 3.14 mm with an average of 2.83 ± 0.14 mm. The data on length and breadth are in close conformity with the report of Gupta and Gangarde (1955), Patange *et al.*, (1996), Sran and Sandhu (1989), Patel *et al.*, (1988), Gajare (1993) and Hajare *et al.*, (2008).

The pupal period was ranged from 7 to 9 days with an average of 7.28 ± 0.83 days. The data on pupal period are tally with the pupal period mentioned by Patel *et al.*, (1988), Gajare (1993), Patange *et al.*, (1996) and Patel (1996).

Adult

The adult of chiku moth was greyish in colour with compound black eyes and setaceous antennae. Forewings were greyish with four black transverse wavy lines. Hind wings were membranous white. Both the wings were fringed at outer margins. A brownish line was present near the outer margins of the wings. The female was slightly bigger than male and with a yellowish brown brush like projection at the tip of abdomen while male having slender abdomen. The observations on morphology and colour of the adults are in accordance with the findings of Gupta and Gangarde (1955), Sran and Sandhu (1989), Patel *et al.*, (1988), Gajare (1993), Patange *et al.*, (1996), Patel (1996) and Hajare *et al.*, (2008).

The length of male adult ranged from 15.98 to 18.22 mm with an average of 17.13± 0.75 mm while breadth was ranged from 15.11 to 21.20 mm with an average of 18.81 ± 1.59 mm. In case of female, the length varied from 18.69 to 21.74 mm (Av. 20.25 ± 1.03 mm) and breadth varied from 21.64 to 24.86 mm (Av. 23.20 ± 1.07 mm).

Gajare (1993) measured the length with wing expanse was about 19 to 20 mm in male and 23 to 25 mm in female. The length of female moth was 10.27 to 11.17 mm and that of male moth was 9.10 to 10.18 mm with the wing expanse of 23.14 to 24.22 mm and 18.18 to 19.91 mm, respectively (Patange *et al.*, 1996).

As per the report of Patel (1996), the length of male and female were 9.24 ± 0.26 mm and 8.14 ± 0.31 mm and width with expanse of wings were 17.90 ± 0.40 mm and 16.34 ± 0.66 mm, respectively. The length of female moth was 17.00 ± 0.81 mm and that of male moth was 20.20 ± 1.03 mm with the breadth of 18.84 ± 1.50 mm and 23.40 ± 1.10 mm, respectively (Hajare *et al.*, 2008). Thus, these reports are more or less similar to present findings.

Pre-oviposition periods

The pre-oviposition period was 1 to 2 days with an average of 1.57± 0.49 days. The pre-oviposition period was vary from a few hours to 2 days (Gupta and Gangarde, 1955); 1.00 to 4 days with average of 1.79 days (Patel *et al.*, 1988); 1.00 to 2.33 days with an average of 1.56 days (Patange *et al.*, 1996); 1.75 ± 0.43 days (Patel, 1996), 1.00 to 2.00 days with an average of 1.40 ± 0.50 days (Hajare *et al.*, 2008). The duration of pre-oviposition period reported by above workers are more or less in agreement with the present findings.

Oviposition periods

The oviposition period varied from 3 to 5 days with an average of 4.05 ± 0.92 days. The oviposition period found in present study is tally with the report of Gupta and Gangarde (1955), Sran and Sandhu (1989), Patel *et al.*, (1988) and Hajare *et al.*, (2008).

Post oviposition periods

The post-oviposition period varied from 0 to 2 days with an average of 1.14 + 0.69 days. The present observation on post-oviposition period is in accordance with the finding of Gupta and Gangarde (1955), Patel (1996) and Hajare *et al.*, (2008), as they reported with range of 0 to 2 with an average 1.15 ± 0.66 days.

Fecundity

The fecundity was varied from 65 to 126 eggs with an average of 95.90 ± 14.40 eggs. Variation in data on fecundity of *N. eugraphella i.e.*, 123 to 214 eggs (Sran and Sandhu, 1989), 4 to 175 eggs (Patel *et al.*, 1988), 118 to 244 eggs with an average of 181 eggs (Patange *et al.*, 1996), an average 32.63 ± 11.66 eggs (Patel, 1996) and an average 97.13 ± 15.14 eggs (Hajare *et al.*, 2008) had been reported by various workers.

The variation in the egg laying capacity of *N. eugraphella* reported by above mentioned workers might be due to the effect of host plants fed to larvae, food given to the adults in the laboratory and other environmental factors.

Longevity

The longevity of mated female ranged from 5 to 7 days (Av. 5.84 ± 0.98 days), while that of male ranged from 6 to 8 days (Av. 6.76 ± 0.85 days).

Thus, the male moth had comparatively shorter life span than female moth. Adult longevity was reported as 3 to 23 days (Gupta and Gangarde, 1955), 8 to 17 days (Sran and Sandhu, 1989). Patel *et al.*, (1988) reported an average longevity of male and female moths was 3.06 and 3.31 days, respectively, while Patange *et al.*, (1996) reported that the longevity of chiku moth varied from 9 to 11 days with an average of 9.76 days. The variation in longevity might be due to difference in weather condition and food provided to the immature stage of this pest.

Sex ratio

In laboratory conditions, male: female ratio was 1:1.24 ± 0.36. Thus, female had preponderance over male in laboratory conditions. The preponderance of females over males of *N. eugraphella* had been reported by Patel *et al.*, (1988), Patel (1996) and Hajare *et al.*, (2008).

Total life period

The total life cycle was found vary from 31 to 38 days (Av. 34.24 ± 2.20 days) in case of male and 35 to 51 days (Av. 44.18 ± 4.20 days) in case of female.

The period of total life cycle was shorter in case of male as compared to female. Similarly, total life cycle of *N. eugraphella* was 26 to 38 days in summer, whereas longer period of total life cycle 45 to 49 days in winter was reported by Gupta and Gangarde (1955), 35 to 39 days (Gajare, 1993), 26 to 92 days (Butani *et al.*, 2002). According to Hajare *et al.*, (2008), the total life cycle of chiku moth was found varied from 36 to 45 days (Av. 39.60 ± 3.21 days) in case of male and 37 to 46 days (40.68 ± 3.10 days) in case of female.

The variation in total life cycle of *N. eugraphella* reported by above mentioned workers might be due to different ecological conditions and nutritional qualities of different cultivar of sapota.

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