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

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ABSTRACT: *Nephopteryx eugraphella* Ragonot (Lepidoptera : Pyralidae), commonly known as chiku moth, is a serious pest of sapota. Its bionomics was studied during April 2008 to March 2010 at Fruit Research Station, Navsari Agricultural University, Gandevi, Gujarat, India. Pre-mating and mating periods of the pest, on an average, were 1.26 ± 0.45 and 0.44 ± 0.10 days, respectively. The pre-oviposition, oviposition and post-oviposition period averaged 3.1 ± 0.73, 3.0 ± 0.47 and 0.95 ± 0.37 days, respectively. The longevity of male and female was 5.43 ± 0.63 and 7.83 ± 0.44 days, respectively. The female laid an average of 72.0 ± 24.15 eggs in her life span. The eggs were laid necked either singly or in groups on the leaves, leaf-petioles and branches. The eggs hatched within 4.25±0.58 days and the viability of eggs averaged 94.0 ± 6.99 per cent. The larval stage was completed in 15.76 ± 0.84 days. Pre-pupal and pupal stages and total life cycle of the insect lasted for 1.13 ± 0.44, 6.93 ± 1.16 and 44.46 ± 2.82 days, respectively. The larvae fed on leaves, flower buds, flowers and fruits. Extent of leaf area infested varied from 4.55 to 16.15 per cent. Damage to flowers/buds varied from 1.0 to 6.6 per cent. The pest was active throughout the year with the peak in May-June on flower/bud and in the month of February on leaves.

Keywords: Bionomics, chiku moth, *Nephopteryx eugraphella*

INTRODUCTION

Sapota (*Manilkara achras* (Mill.) Fosberg) is one of the important tropical fruit crops of India. Sapota trees are ravaged by several species of insect and mite pests throughout the year (Sandhu *et al.*, 1974 ; Bhutani, 1979). Among different insect pests of sapota, *Nephopteryx eugraphella* Ragonot, commonly called chiku moth, is a regular and serious pest of sapota throughout India (Sandhu *et al*., 1974). It was first recorded on sapota 1919 at Pusa (Fletcher,1920). This pest is active throughout the year under South Gujarat conditions. The larvae scrape to skeletonize the tender leaves in the terminals that are usually joined together by silken threads. They remain hiding in between the leaves and under lose web of excreta. Infested trees will have a number of dried up leaf clusters, conspicuous from a distance. Later the larvae devour buds, flowers and also bore into the fruits thus reducing the yield considerably. Considering the economic importance of the pest, its biology, nature of damage and effect of abiotic factors on the incidence were studied along with description of different stages of the pest.

MATERIALS AND METHODS

Studies on the biology of *N. eugraphella* were conducted during 2008-10 at Fruit Research Station of Navsari Agricultural University, Gandevi, Gujarat, India. The field collected larvae were transferred on to the tender leaves of sapota (cv *Kalipatti*) placed in glass jars (15 x 10cm) covered with the piece of muslin cloth. The food was changed daily till pupation. The pupae were transferred into glass jars containing 2cm moist sand at the bottom covered with a piece of blotting paper. Five pairs of the adults were released in glass jars line with tissue papers and provided with terminal shoots of sapota for oviposition. Ten per cent sugar solution was provided as food for the moths. The eggs thus obtained were kept in Petri-dishes (7.5 x 1.25cm) for studying the incubation period and viability. Newly emerged larvae were reared singly in glass vials (7.5 x 2.5cm) on tender leaves and food was changed daily till pupation. The adult that emerged were sexed and pairs were made and release in glass jars (15 x 10cm) containing fresh terminals and cotton swabs were changed daily. Moths were observed to study pre-mating and mating period. Observations on pre-oviposition, oviposition and post-oviposition periods and fecundity of the female moths were recorded daily. Description of different stages of the insect was made by examining the details of the specimens and measurements of different stages were also taken.

Nature of damage was studied by closely observating in the field the way of feeding of the insect. Five trees of sapota (cv. *Kalipatti*) were selected at random to study the extent of damage. Assessment of leaf injury was made on the basis of per cent leaf area infested which was obtained by ploting hundred randomly selected leaves on square graph paper. To study the extent of infestation of flowers/buds and fruits, hundred flowers/buds and twenty fruits per tree were examined at random for the presence of insect damage.

Table1. Biology of *Nephopteryx eugraphella* Ragonot on sapota

Stage	Life period in days	
	Range	**Mean**
Incubation period	3.0-5.0	4.25 ± 0.58
Viability (%)	80-100	94.0 ± 6.99
I instar larvae	2.0-4.0	3.0 ± 0.56
II instar larvae	4.0-5.0	4.46 ± 0.51
III instar larvae	2.5-4.0	3.06 ± 0.31
IV instar larvae	4.5-5.5	5.2 ± 0.31
Total larval period	14.0-17.5	15.76 ± 0.84
Pre-pupal period	0.5-2.0	1.13 ± 0.44
Pupal period	5.0-9.0	6.93 ± 1.16
Pre-mating period	1.0-2.0	1.26 ± 0.45
Mating period	0.3-0.6	0.44 ± 0.10
Pre-oviposition period	2.0-4.0	3.1 ± 0.73
Oviposition period	2.0-4.0	3.0 ± 0.47
Post-oviposition period	0.5-1.5	0.95 ± 0.37
Adult longevity (Male)	4.0-6.5	5.43 ± 0.63
Adult longevity (Female)	7.0-8.5	7.83 ± 0.44
Sex ratio	1:1.30	—
Fecundity (No of eggs/female)	27.0-102.0	72.0 ± 24.15
Total life cycle (egg to egg stage)	40.0-50.0	44.46 ± 2.82

Table 2. Morphometrics of *Nephopteryx eugraphella* Ragonot on sapota

Stage parameter	Morphometric measurements (mm)	
	Range	**Mean**
Egg length	0.93-0.99	0.97 ± 0.15
Egg breadth	0.45-0.50	0.46 ± 0.01
Length of I instar larvae	1.32-1.36	1.34 ± 0.01
Length of II instar larvae	4.68-4.72	4.69 ± 0.01
Length of III instar larvae	13.10-13.15	13.12 ± 0.01
Length of IV instar larvae	19.34-19.37	19.35 ± 0.1
Length of full grown larvae	22.0-26.0	23.8 ± 1.42
Pupal length	9.0-11.0	10.07 ± 0.73
Pupal breadth	2.6-2.8	2.72 ± 0.07
Adult length at resting	11.19-11.21	11.22 ± 0.01
Adult length with wing expand	19.7-20.5	21.03 ± 0.21

To study the effect of abiotic factors on the incidence of chiku moth, ten medium sized trees of sapota were randomly selected from the orchard of Fruit Research Station of Navsari Agricultural University, and marked with white paint for recording the observations. For this, five twigs from each tree were selected and observed fortnightly for the incidence of chiku moth. Total number of buds as well as buds damaged by chiku moth was counted from each twig. Similarly, the total number of new leaves as well as leaves damaged by the pest was also observed and per cent infestation was worked out accordingly. No insecticide treatments were given in the field selected for present studies. The data thus obtained were correlated with various abiotic factors *viz.*, maximum, minimum and mean temperature as well as mean relative humidity and simple correlation (r) has been worked out.

RESULTS AND DISCUSSION

Biology of *N. eugraphella*

The pre-mating and mating period were 0.5 to 2.0 (1.13 ± 0.44) days and 0.3 to 0.6 (0.4 ± 0.10) days, respectively, while the pre-oviposition, oviposition and post-oviposition period were found 2.0 to 4.0 (3.1 ±0.73), 2.0 to 4.0 (3.0 ± 0.47) and 0.5-1.5 (0.95 ±0.37) days, respectively. These results are in agreement with that of Cherian and Ananthanarayanan (1942). The incubation period was 3.0 to 5.0 (4.25 ± 0.58) days and a single female laid 27.0 to 102.0 (72 ± 24.15) eggs in her life span and on an average 94.0 ± 6.99 per cent egg hatchability was recorded under the laboratory conditions. Cherian and Ananthanarayanan (1942) also reported the incubation period of 3-5 days in case of *N. eugraphella*. The larvae passed through four instars. The first instar larval period observed was 2.0 to 4.0 (3.0 ± 0.56) days. The second, third and fourth instar larvae were very active and hide in the webbings. Average larval period for second, third and fourth instars was 4.46 ± 0.51, 3.06 ± 0.31 and 5.20 ±0.31 days, respectively whereas the total larval period completed within 14.0 to 17.5 days with an average of 15.76 ± 0.84 days. The pre-pupal period varied from 0.5 to 2.0 (1.13 ± 0.44) days, whereas pupal period ranged from 5.0 to 9.0 days with an average of 6.93 ± 1.16 days. It is in agreement with that reported by Cherian and Ananthanarayanan (1942). The male moth lived for 5.0 to 6.5 days with an average of 5.43 ± 0.62 days while female moths for 7.0 to 8.5 days with an average 7.83 ± 0.44 days. The sex ratio was found to be 1:1.30. Under the present studies the total life cycle of chiku moth was completed in 40.0 to 50.0 (44.46 ± 2.82) days which is in close agreement with the earlier report of Saran and Sandhu (1987).

Egg: Freshly laid eggs were soft, pale yellow but semitransparent and fertile eggs turned pink within 24 hrs. Eggs were oval, 0.97 ± 0.15mm in length and 0.468 ± 0.01mm in breadth. Eggs are laid usually in small batches of 4 to 30 along the mid rib of the underside of leaf or tender branches.

Larva: Newly hatched larvae measured 1.35 ± 0.01mm in length. Initially it was pink but become yellow within 24 hrs and letter on become greenish. Head was pale yellow. On the body there was one longitudinal median and a set of three dorso-lateral purple strips on its either side. Prolegs were present on 3rd to 6th and 10th abdominal segments. Dorsal surface of body was covered with microhairs. The colour of the remaining three instars and fully grown larva was pinkish brown with conspicuous longitudinal dorso-lateral lines. The body length of second, third and fourth instar larvae measured on an average 4.69 ± 0.01, 13.12 ± 0.01 and 19.35 ± 0.01mm, respectively while the full grown larvae on an average measured 23.8 ± 1.42mm in length. Head and first thoracic segment were yellowish brown with black lines and spots. Dorsal side of body was pink in colour while ventral side was green. First and third pair of strips were pink in colour blended with black spots on each segment while second pair was purple in colour. There was a pair of dorso-lateral prominent black spots on the second thoracic and eight abdominal segment. Longitudinal stripes and hairs on the body were quite conspicuous. These observations are in general agreement with the description given by earlier workers (Cherian and Ananthanarayanan, 1942; Saran and Sandhu, 1987).

Pupa: Pupation takes place in soil preparing an earthen cell with an exit hole for the emergence of adult. The newly formed pupae were light green in colour, which turned light to reddish brown within 24 hrs and become dark brown prior to the emergence of adult. It was broad anteriorly and tapering posteriorly. Compound eyes were prominent. The average length and breadth of pupa was 10.02 ± 0.73mm and 2.72 ± 0.07mm. The size of the male pupae was comparatively bigger than female pupae.

Adult: The moth measured 20.03 ± 0.21mm in wing expanse and 11.2 ± 0.01mm in resting position. Body was grayish in colour with compound black eyes with setaceous antennae. Fore wings were grayish with four black transverse wavy lines. Hind wings were membranous white. Both the wings were fringed at the outer margins. A brownish line was present near the outer margins of the wings. In case of female, tip of abdomen was yellow or black with slit like genital aperture, whereas in male the tip of slender abdomen was

grayish and pointed. Saran and Sandhu (1987) reported females to be bigger than males while under the present studies no such difference was recorded, but they also describe that the female had yellow brush of hairs on tip of abdomen which was also recorded in the present studies.

Nature of damage

The larvae damaged the leaves, flower buds, flowers and fruits. In case of leaves, the larvae fed inside the leaf folds, made by joining the leaves with silken threads and excretal pellets were entrapped in the webs. Young larvae damaged the leaves by scrapping while grown up larvae damaged both by scraping and biting the leaves. As a result of continuous feeding, severely damaged leaves dried up and get detached at the base of pedicel. Young larvae also attacked the flowers and flower-buds and fed on the internal organs. The injured flowers and flower-buds dried up and did not bear any fruit. In case of fruit, the larvae fed on a small portion and then rejected the fruit. It was also observed that larvae, in case, bored into the fruits and consumed the fruit flesh. Under the present study it was found that in laboratory conditions on an average a single larvae damage 13.6 buds during the total larval period. Patel *et al.* (1988) observed that under laboratory conditions a single larvae consumes on an average 11.34 chiku buds during its larval period.

Extent of damage

Extent of leaf area damaged by chiku moth larvae varied from 11.55 to 16.15 per cent round the year. Maximum leaf area damage were recorded in the month of July to September i.e., 17.5 per cent (Table 3). The damage to the flowers/buds varied from 1.0 to 6.6 per cent during the study period. The maximum flowers/buds damage was recorded in the month of May in 2008-09 with 4.25 per cent damage whereas it was 6.6 per cent in the month of July 2009-10. Injury to the fruits varied from 1.0 to 2.1 per cent. The severity of attack however lasted for about a month *viz.*, July (Table 4).

Table 3- Extent of damage by chiku moth on different stages.

Months	Per cent leaf area damaged		
	Maximum	Minimum	Mean
January-March	15.2	10.2	13.6
April-June	16.6	11.3	14.5
July-September	17.5	14.3	15.3
October-December	15.3	10.4	13.9
Mean	16.15	11.55	14.32

Table 4. Percentage of flowers/buds and fruits attacked by chiku moth larvae.

Date of observation	Flowers/buds	Fruits
04.01.2008	2.53	1.0
04.03.2008	2.75	1.0
04.05.2008	4.25	1.0
04.07.2008	3.73	2.10
04.09.2008	2.50	2.0
04.11.2008	4.00	1.0
04.01.2009	1.50	1.0
04.03.2009	1.0	—
04.05.2009	3.54	—
04.07.2009	6.6	2.1
04.09.2009	3.3	—
04.11.2009	6.0	1.0
04.01.2010	5.8	1.0

Population dynamics of *Nephopteryx eugraphella* Ragonot on sapota:

The data on population dynamics of *N. eugraphella* are presented . The pest activity on the buds was recorded throughout the year. During 2008-09, the pest damage on buds was maximum in first fortnights of May and June (4.54%) and it was fluctuated round the year, whereas during 2009-10 the maximum per cent bud damage was recorded in first fortnight of July (10.00%). During the year 2009-10 the pest was recorded throughout the year with 1.0 to 10.0 per cent bud infestation. This pest also damaged the newly emerged leaves. During year 2008-09 the leaves damaged ranges from 2.91 to 9.52 per cent with maximum per cent leaves damaged during the first fortnight of February. Similar trends were also observed during 2009-10 the per cent leaves damaged by chiku moth were ranged between 0.90 to 8.30. The maximum per cent damaged leaves were recorded in the first fortnight of Feburary (8.30%). Various correlation coefficient are also worked out with chiku moth damage and weather parameters. During the year 2008-09, the per cent bud damaged should be significantly positive with minimum temperature (r = 0.521) and mean temperature (r = 0.670), whereas it showed non-significant correlation with maximum temperature (r = 0.295) and mean relative humidity (r = -0.511), whereas non-significant correlations were also recorded during 2009-10 except with maximum temperature (r = -0.611). In both the years of the study the per cent leaf damaged by the chiku moth showd a non-significant correlation values (Table 6). The present study revealed that the activities of chiku moth were prevalent throughout the year. The present findings

Table 6. Correlation of chiku moth with weather factors

Weather parameters	Per cent bud damaged		Per cent leaf damaged	
	2008-09	2009-10	2008-09	2009-10
Maximum Temperature (°C)	0.295 NS	-0.611**	-0.130 NS	0.134 NS
Minimum Temperature (°C)	0.521**	0.00 NS	-0.399 NS	-0.161 NS
Mean Temperature (°C)	0.670**	-0.289 NS	-0.200 NS	-0.086 NS
Mean RH (%)	-0.511 NS	0.220 NS	0.264 NS	-0.127 NS

NS-Non-Significant, ** Significant at 5%

corroborated with the earlier work done at the Gandevi (Anonymous, 2009) who also reported that chiku moth, *N. eugraphella* was active throughout the year in South Gujarat conditions on sapota crop. This is due to continuous monoculturing of sapota and availability of flower buds and favourable climatic conditions round the year.

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