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Shreedhar Chatter
Department of Agril. Entomology, University of Agricultural Sciences, Dharwad, Karnataka, India

Roopa S Patil
Department of Agril. Entomology, University of Agricultural Sciences, Dharwad, Karnataka, India

Basappa H
Department of Agril. Entomology, University of Agricultural Sciences, Dharwad, Karnataka, India

Akkamahadevi Agasimani
Department of Agril. Entomology, University of Agricultural Sciences, Dharwad, Karnataka, India

Corresponding Author:
Shreedhar Chatter
Department of Agril. Entomology, University of Agricultural Sciences, Dharwad, Karnataka, India

The comparative seasonal biology studies of banana leaf roller, *Erionota torus* evans under laboratory conditions

Shreedhar Chatter, Roopa S Patil, Basappa H and Akkamahadevi Agasimani

Abstract
The results of comparative seasonal biology studies of Banana leaf roller, *Erionota torus* Evans revealed, female skipper laid eggs in cluster on under side of the banana leaves. During rainy season, the incubation, total larval and pupal period ranged from 7-9 days, 26-33 days and 10-12 days, respectively. The total life cycle (egg to adult) varied between 52-67 days for male and 55-70 days for female. However, slight variation was observed during winter season with 7-10 days, 27-36 days and 11-13 days, respectively for incubation, larval and pupal period. The total life cycle (egg to adult) ranged from 55-72 days for male and 58-75 days for female.

Keywords: Banana leaf roller, *Erionota torus* evans and biology

Introduction
Banana (*Musa* spp.) is an important fruit crop belongs to genus *Musa* and family Musaceae. The world's largest producers of bananas in 2016 were India and China, which together accounted for 28 per cent of total production [1]. There are many insect pests on bananas and the most important folivorous one is the banana leaf roller. Although the banana leaf roller (*Erionota torus* Evans) is often considered as a minor pest in its native Southeast Asia, it is a serious pest when its natural enemies are absent especially outside its native area [7]. Though the damage resulting from the larva is usually below economic damaging levels but during the severe infestation 100 per cent defoliation have been reported in some farms [5].

The leaf roller is also called as banana skipper, red palm eye, rounded palm-redeye, giant banana skipper, Sikkim palm dart, Sikkim palm-redeye. The *E. torus* was initially described by Evans in 1941 and early occurrence of this pest has been reported from South-East Asian countries like South China, Burma, Malaya, Vietnam, Papua New Guinea, Thailand, Sri Lanka and North Eastern states of India. In India, it has been reported from North Eastern states like Sikkim, Calcutta, Assam [2], Manipur [9], Madhya Pradesh [12] and South Indian states like North Kerala, Coimbatore, Southern parts of Karnataka and from Andaman and Nicobar Islands [13]. In Karnataka the pest outbreak was reported during the year 2012-14 from Coastal parts of Uttar Kannada [3], Dakshina Kannada and Udupi and then spread to Malnad regions [10] and also from Bangalore [4]. *Musa paradisiaca* cv. Puttabale (AB group) is most popular indigenous cultivar in Malnad and Coastal regions of Karnataka. The current changing climate scenario would have helped the pest to extend its range towards South confirming the geographical expansion. In 2014 and 2015, due to its outbreak, the banana leaf roller created havoc in coastal and malnad regions of Karnataka. There is very little information about species and biology of banana leaf roller. Hence, the present studies were undertaken to know the comparative seasonal biology.

Materials and Methods
The comparative seasonal biology studies were done twice, rainy and winter season 2017-18 under laboratory conditions at ICAR–Krishi Vigyan Kendra, Sirsi, Uttara Kannada, Karnataka. During the research period the mean temperature ranged from 24 to 27.5 ℃ and relative humidity from 80.5 to 94 per cent in rainy season i.e. July – September 2017 and 19 to 25 ℃and relative humidity ranged from 64.5 to 80 per cent in winter season i.e. November 2017 – January 2018.

Maintenance of pure culture

The pure culture was initiated by collecting the sufficient number of larvae and pupae from the infested field in and around Sirsi area. The collected larvae and pupae were kept in an insect rearing cage till the adult emergence, which served as a source of initiating the pure culture under laboratory condition. Among the emerged adults, ten pairs of male and female adults were released in a greenhouse condition, provided with five banana plants [six months old, local banana variety- Ney Poovan (AB group)] for egg laying. Banana inflorescence was kept nearer to banana plants which act as a source of nectar for the adult male and female butterflies.

Pure culture was started with fresh eggs laid by the female butterfly on banana leaves. The collected eggs were kept in a petri plate. After hatching, the first and second instar larvae were reared individually on fresh banana leaf which served as food. Third, fourth and fifth instar larvae were reared in a plastic tub on rolled fresh banana leaves which were changed daily. Adults male and female longevity were recorded by releasing them in a rearing cage and 10 per cent honey solution was provided as food.

The morphological characters like length of each instar larva, width and length of head capsule for different larval stages and length and breadth for adults were recorded. The pre-pupal, pupal and time of adult emergence were recorded. The observations on pre-ovipositional, ovipositional, post-ovipositional, fecundity for females and adult male and female longevity were also recorded.

Results and Discussion

The female butterfly laid eggs in cluster on the underside of the banana leaves mostly at the edge of the leaf. The eggs are dorsoventrally flat and are creamish or yellowish in colour (Fig. 1) but later turned to pinkish in colour (Fig. 2). One or two days before hatching, eggs turned white colour with prominently visible black head capsule of developing larva (Fig. 3). The eggs were laid in the groups ranged from 14 to 28. The fecundity of female banana leaf roller was ranged from 16 to 28 eggs with 26.20±3.68 of mean during rainy season and 19 to 32 with the mean of 29.40±3.20 during winter season. Similar type of studies conducted to study the biology of banana leaf roller observed that, majority of females laid eggs in groups ranged from 11 to 30 [10]. Also it observed that, other species *E. thrax* can lay eggs up to 60 and even more depending on the quality of the food [8].

There were 27 to 33 clearly visible longitudinal ridges on chorion with the mean of 29.27±2.30 ridges.

Rainy season (July to September 2017)

The studies on biology of banana leaf roller carried out during rainy season revealed that, incubation period ranged from 7 to 9 days with mean of 7.80±0.63 days. The larvae in initial stages were yellow or pale green coloured but in later stages there was development of white waxy coating on their body (Fig. 4 – Fig. 8). Larvae passed through five distinct instars over a period of 26 to 33 days with the mean of 29.90±2.18. The total larval period of *E. torus* was not much varied from *E. thrax* which is about 25 – 30 days [6] and 20 - 29 days [5]. The pre-pupal stage (Fig. 9) lasts for 3 to 4 days with 3.50±0.53 days of mean and the pupal stage ranged from 10 to 12 days with the mean of 11.10±0.99 days. The pupa is characterized by creamish in colour with prominently visible red coloured eye (Fig. 10) and it turned to brown colour with prominent three yellow colour spots visible on its wing pad on day before emergence of adult (Fig. 11). The female pupa can be distinguished from male pupa by the presence of slit on 8th and 9th segment of ventral side of the abdomen (Fig. 12 and Fig. 13). The pupal period was in conformity with the findings of previous studies conducted on biology [11]. The adult longevity of male and female was 6 to 9 days and 9 to 12 days with mean of 7.50±0.97 and 10.90±1.20, respectively. The total lifecycle was ranged from 52 to 67 days for male with the mean of 61.40±3.86 days and 55 to 70 days with the mean of 63.10 ±4.07days for female leaf roller.

Winter season (November 2017 to January 2018)

There was slight variation in the biology of banana leaf roller reared during winter season i.e. November 2017 to January 2018. The incubation period ranged from 7 – 10 days with the mean of 8.10±0.74. The total larval period lasted for 27 to 36 days with the mean of 32.70±1.50. The pupal period was ranged from 11 to 13 days with the mean of 12.50±0.71 days. The adult longevity of male and female was 6 to 9 days and 9 to 12 days with mean of 7.50±0.97 and 10.90±1.20, respectively. The total life cycle lasted for 55 to 72 days for male with the mean of 65.80±5.80 days and 58 to 75 days with the mean of 68.70±6.67 days for female. These difference may be due to the minimum temperature, morning and evening relative humidity may prolong the life cycle of the insect [10]. The data for both rainy and winter season recorded are presented in Table 1.

The observations recorded on average wingspan of adult banana leaf roller are presented in Table 2. The adult leaf rollers are characterized by brown coloured wings with three yellow spots on each forewing (Fig. 14 and Fig. 15). The wing length was ranged from 7.00 to 7.60 cm with the mean of 7.29 cm and breadth ranged from 2.50 to 3.00 cm with the mean of 2.76 cm for adult male. While, female wing length was about 7.00 to 7.80 cm of range with mean of 7.38 cm and breadth ranged from 2.70 to 3.10 cm with 2.89 cm of mean. These results are in line with the findings of previous studies [10, 14]. Also observations recorded on length and width of head capsule of different larval instar of leaf roller are presented in Table 3. The length of head capsule of larva was 1.29, 1.63, 2.25, 3.20 and 4.65 mm, as well as width of head capsule of larva was 1.12, 1.39, 2.15, 2.53 and 3.42 mm, respectively for first, second, third, fourth and fifth instar larvae, respectively. The data of lengths and breadths of head capsule of different larval instars were presented in table 4.

Table 1: Duration of different stages of banana leaf roller *Erionota torus*

Sl. No.	Life Stages	July-September		November-January	
		Range (days)	*Mean (days)	Range (days)	*Mean(days)
1.	Incubation period	7-9	7.80±0.63	7-10	8.10±0.74
2.	Larval period I Instar	3-4	3.70±0.67	3-5	4.20±0.79
	II Instar	2-4	3.20±0.42	3-4	3.60±0.52
	III Instar	9-11	9.80±0.79	9-11	10.20±0.79
	IV Instar	5-6	5.50±0.53	5-7	6.30±0.67
	V Instar	7-8	7.50±0.53	7-9	8.40±0.70

	Total	26-33	29.90±2.18	27-36	32.70±1.50
3.	Pre-pupal period	3-4	3.50±.0.53	3-4	3.80±0.42
4.	Pupal period	10-12	11.10±0.99	11-13	12.50±0.71
5.	Pre-ovipositional period	2-3	2.50±0.53	2-3	2.60±0.52
6.	Ovipositional period	1-2	1.50±0.53	1-2	1.80±0.42
7.	Post-ovipositional period	6-7	6.50±0.53	7-8	7.20±0.42
8.	Fecundity/female	16-28	26.20±3.68	19-32	29.40±3.20
9.	Male adult longevity	6-9	7.50±0.97	7-9	8.70±0.67
10.	Female adult longevity	9-12	10.90±1.20	10-12	11.60±0.92
11.	Total life cycle Male (egg to adult) Female	52-67 55-70	61.40±3.86 63.10±4.07	55-72 58-75	65.80±5.80 68.70±6.67

(*Mean of ten observations)

Table 2: Length and breadth of adult *Erionota torus* reared on banana leaves under laboratory condition

Details	**Length (cm)**		**Breadth (cm)**	
	Range	***Mean ± SD**	**Range**	***Mean ± SD**
Male	7.00 – 7.60	7.29 ± 0.20	2.50 – 3.00	2.76 ± 0.13
Female	7.00 – 7.80	7.38 ± 0.30	2.70 – 3.10	2.89 ± 0.17

(*Mean of five observations)

Table 3: Length of larva and pupa of banana leaf roller, *Erionota torus*

Stage of Insect	**Length (cm)**	
	Range	***Mean ± SD**
I Instar	0.30-0.60	0.43 ± 0.10
II Instar	0.90-1.30	1.05 ± 0.14
III Instar	2.30-2.40	2.41 ± 0.09
IV Instar	3.10-3.50	3.28 ± 0.10
V Instar	4.90-5.10	4.93 ± 0.11
Pupa	4.30-4.70	4.54 ± 0.17

(*Mean of five observations)

Table 4: Head capsule length and width of different instars of *Erionota torus*

Stage of Insect	**Head capsule (mm)**			
	Length	***Mean ± SD**	**Width**	***Mean ± SD**
I Instar	1.19-1.32	1.27 ±0.04	1.03-1.16	1.12 ±0.03
II Instar	1.58-1.69	1.63 ±0.04	1.35-1.44	1.39 ±0.04
III Instar	2.18-2.40	2.25 ±0.06	1.82-2.40	2.15 ±0.19
IV Instar	3.10-3.22	3.20 ±0.05	2.28-2.85	2.53 ±0.15
V Instar	4.51-4.71	4.65 ±0.12	3.28-3.63	3.42 ±0.12

(*Mean of five observations)

Fig 1: Freshly laid eggs

Fig 2: Eggs turned into pink colour

Fig 3: Eggs one day before

Fig 4: Newly hatched larva feeding on egg

Fig 5: II instar larva

Fig 6: III Instar

Fig 7: IV Instar

Fig 8: V Instar

Fig 9: Pre-pupa

Fig 10: Pupa

Fig 11: Pupa one day before

Fig 12: Male pupa

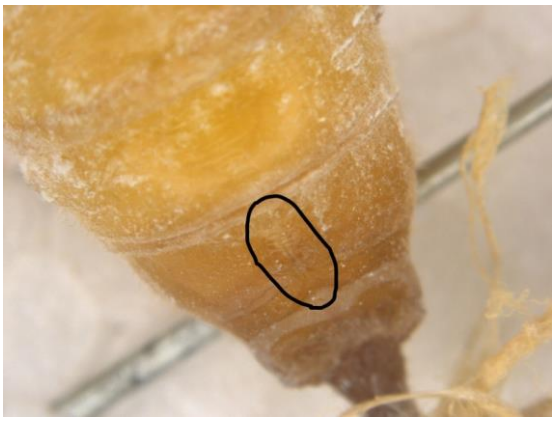

Fig 13: Female pupa

Fig 14: Adult Male

Fig 15: Adult Female

Conclusion

The comparative seasonal biology studies of banana leaf roller revealed that, the total life cycle period was slightly long during winter compared to rainy season which may be due to variation in temperature and relative humidity.

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