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Studies on biology and morphometrics of fruit borer, *Etiella* sp. (Lepidoptera: Pyralidae) on mango under laboratory conditions

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Abstract

A study was carried out on the biological parameters of *Etiella* sp in the laboratory of Food Quality Testing Laboratory Fruit Research Station, Gandevi, Navsari Agricultural University during 2008 to 2009. The eggs were found to be laying singly or in batches near the peduncle of fruit. The freshly laid eggs were oval in shape and pale yellowish or dirty white in colour which changed to dark yellowish prior to hatching. Average length and breadth of egg was 0.63 ± 0.03 mm and 0.39 ± 0.03 mm, respectively. The incubation period of eggs ranged from 3 to 5 days with 74.16 ± 7.28 per cent of hatchability. The larvae passed through five instars. The average duration of first, second, third, fourth and fifth instar was 1.45 ± 0.51 , 2.45 ± 0.51 , 3.40 ± 0.50 , 5.40 ± 0.50 and 3.50 ± 0.51 days, respectively. The total larval period completed in 16.20 ± 1.40 days. The Pupation took place in earthen cocoon in soil and the pupal period was of 9.85 ± 0.81 days. The female and male adults measured on an average 13.20 ± 0.73 mm and 10.24 ± 0.73 mm in length and 2.86 ± 0.14 mm and 2.50 ± 0.12 mm in breadth, respectively. The pre oviposition, oviposition and post oviposition periods were of 2.40 ± 0.50 , 2.25 ± 0.97 and 1.80 ± 0.70 days, respectively. The average fecundity of female recorded as 24.55 ± 8.75 eggs. The longevity of male and female was 4.45 ± 1.10 days and 6.14 ± 1.14 days, respectively. The total life cycle occupied 22 to 31 days (Av. 26.62 ± 2.57 days) by male and 25 to 33 days (Av. 28.90 ± 2.11 days) by female.

Keywords: Biology, morphometrics, laboratory, mango

Introduction

Mango, *Mangifera indica* Linnaeus, is grown almost all around the world and occupies a unique place amongst the rest of the fruit crops grown in India. The total area under mango cultivation in Gujarat is 96031 hectares with 0.77 million tones production and 8.04 tonnes/ha productivity. In south Gujarat, total area under mango cultivation is about 50512 hectares with annual production of about 0.48 million tonnes and with productivity of 9.50 tonnes/ha (Anonymous, 2007) [2]. The Valsad district rank first in area (21840 hectares) and production (0.20 million tonnes) among all the districts of Gujarat. Next to Valsad, Junagadh district produced mango in area of 15930 hectares with 0.11 million tonnes production. In mango, about 492 species of insects and 17 species of nematodes have been reported from all over the world. Of these, 188 species have been reported from India (Tandon and Verghese, 1985) [10] and only a handful are of major importance namely hopper (*Amritodus atkinsoni* Leth), mealy bug (*Drosicha mangiferae* Green), fruit flies (*Bactocera dorsalis* Hendel; *B. correctus* Bezzi; *B. zonata* Bezzi) and stone weevil *Sternochetus mangiferae* Fabricius. However, with the changing atmosphere some of the minor pest also found to attain pest status. Pest complex in mango is a major constraint for production and quality and some of them are of quarantine significance which can hamper export trade. Fruit borer is one among them which is taken seriously as industry threat in Australia. In India, *Noorda albizonalis* Hampson is reported as a major pest on grafted varieties viz., Baiganpalli, Latsundari and Totapuri (Sengupta and Behura, 1955) [8] in Orissa. Moreover, *Deanolis* (= *Noorda* = *Autocharis*) *albizonalis* Hampson though was a minor pest has assumed serious status in Andhra Pradesh and Karnataka (Zaheruddin and Sujatha, 1993) [11]. This pest was also identified as major pest of mango in Orissa by Sengupta and Behura (1955) [8]. However, these species of fruit borer are not observed so far in Gujarat. Apart from above species of fruit borer, recently, *Etiella* sp.

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(Lepidoptera: pyralidae) commonly known as “lima-bean pod borer” identified as mango fruit borer in south Gujarat. The damage posed by *Etiella* sp. as fruit borer in term of quality can interrupt local and global market and hence need attention. Although, *Etiella* sp. known as lima-bean pod borer and mango is observed as new host for the first time, a concerned literature is lacking. Moreover, considering the nature of damage and spread of this pest it was felt necessary to have a detailed study on “Biology of mango fruit borer, *Etiella* sp.” during present investigation.

Materials and Methods

The biology was studied in the laboratory of Food Quality Testing Laboratory Fruit Research Station, Gandevi, Navsari Agricultural University during 2008 and 2009. The initial culture was obtained by collecting larvae from mango plantation at Horticultural Farm, Navsari; Fruit Research Station, Gandevi and Agricultural Experimentation Station, Paria of Navsari Agricultural University and further reared in the laboratory. The field collected larvae were kept individually in plastic bottle (10 cm diameter × 8 cm height). A medium sized fruits having soft kernel were provided to the larvae as a food until pupation. This food was changed once after a week period. After completion of third instar, a fine soil was layered in the plastic bottle for pupation. Pupae were removed carefully from the soil and kept separately in plastic vials (4.0 cm diameter × 7 cm height) until the emergence of adults. Newly emerged male and female adults (3:1) were released into glass jars (20.0 cm height × 16.0 cm diameter) and fresh leaves or fruits of mango were provided to the moths inside the glass jars for resting and egg laying. A cotton swab dipped in five per cent sugar solution was liberated in rearing jar as a food to the moths. The open end of glass jars was covered with fine muslin cloth, secured in a position with the help of the rubber band. The leaves or fruits were replaced with fresh one every third day and the egg laid on the leaves or fruits were removed from the jar and observed for further studies.

Egg: Size of the eggs was measured under microscope using stage and ocular micrometer. To study the incubation period, counted numbers of freshly laid eggs were observed daily till hatching. Incubation period was calculated from the date of egg laying to the date of hatching. Hatching percentage was calculated from the data on number of eggs hatched out from total number of eggs kept for hatching.

Larva: With a view to determine the number and duration of different larval instars and total larval period, the newly emerged larvae were transferred individually with the help of fine camel hair brush on a piece of unripe mango in the petridish and after three days to plastic bottle (10.0 cm diameter × 8.0 cm height) containing a medium sized or fruits of mango as a food. Plastic bottle were cleaned thoroughly and fresh food was provided to the larvae after a week period which served as food to the larvae until pupation. In order to determine the number of larval instars individual larva was observed daily. Moulting was confined by the presence of casted off head capsule and exuviae. Observations for the colour and size of the larvae were recorded in each instar. Length and breadth of larvae were measured initially ocular and stage micrometers and that of later instar with millimeter scale. The total larval period was calculated from the date of egg hatching to the date of formation of pre-pupa.

Pre-pupa: Pre pupal stage was considered when larvae stopped feeding and became inactive. A period between inactivation to the formation of pupa was considered as a pre pupal period. The length of pre-pupa was measured using millimeter scale while, breadth was measured under microscope.

Pupa: The pupae were studied for their shape, size, colour and pupal period. The length and breadth was also measured. Pupal period was calculated from the date of formation of pupa and date of emergence of adult from the pupa.

Adult: Adults emerged from the pupae in the laboratory were critically observed under magnifying lense for their shape, size and colour. The length and breadth with their wing expanded were measured directly with the help of standard scale.

Sex ratio: To study the sex ratio, laboratory reared pupae and adults were observed for the sex differentiation and the ratio was calculated by separating the male and female based on difference in morphological characters.

Pre-oviposition, oviposition and post-oviposition periods: Pre-oviposition period was calculated from the date of emergence of female to the date of initiation of egg laying. Oviposition period was calculated from the date of egg laying starts to the date of egg laying stops. Post-oviposition period was calculated from the date of egg laying stops to the date of death of female.

Fecundity: To determine the fecundity, the number of eggs laid by single female were collected daily in the morning and counted till the death of the female.

Longevity: Longevity of male and female was calculated separately from the date of emergence to the date of death of adult.

Total life period: The period from egg laid to the death of adult was considered as the total life period.

Results and Discussion

Studies on biology and morphometrics is aimed to generate information on various life stages and behavior so that effective planning for management can be executed. Incidence of *Etiella* sp. as mango fruit borer is observed for the first time in Gujarat. It is obvious that the relevant literature is not available. Keeping this in mind, attempts were made to study the biology of the pest.

Site and pattern of egg laying: The female found to lay eggs singly or in batches of 2-4 found to lay near the peduncle of fruit though the number was much fewer. The eggs were also found on the surface of glass jar. While Sahoo and Jha (2009)^[7] reported that eggs of mango fruit borer *N. albizonalis* laid in mass near the fruit apex. Zehrudin and Sujatha (2002)^[12] observed that the stalk of inflorescence and fruit are most preferred site for oviposition of *D. albizonalis*.

Colour, Shape and Size: The eggs were pale yellowish or dirty white in colour which changed to dark yellowish prior to hatching Sahoo and Jha (2009)^[7] reported that eggs of *N. albizonalis* was milky white in colour and Zehrudin and Sujatha (2002)^[12] reported that eggs of *D. albizonalis* were

cream colour. Eggs were oval in shape. The length of eggs varied from 0.60 to 0.70 mm, with an average of 0.63 ± 0.03 mm and breadth varied from 0.34 to 0.44 mm, with an average of 0.39 ± 0.03 mm which coincides with the finding of Jaglan *et al.* (1995)^[4].

Incubation period: The incubation period varied from 3 to 5 days with an average of 3.75 ± 0.79 (Table-1). This period was recorded as 4 to 7 days (Singh and Dhooria, 1971)^[9], 5 days (Bindra and Singh, 1969)^[3] for *E. zinckenella*. Thus, the present finding on incubation period is more or less similar with those reported for *E. zinckenella* by earlier workers.

Hatching percentage: The hatching per cent of eggs varied from 63.16 to 83.78 with an average of 74.16 ± 7.28 (Table-1). It was reported as 60 per cent (Stone, 1965) and 92.8 per cent (Singh and Dhooria, 1971)^[9].

Number of larval instars: Larva was observed to pass through five larval instars. Similar number of larval instar of *E. zinckenella* was reported by Jaglan *et al.* (1995)^[4].

First instar larva: The larva was light brown to black in colour with light brown head. There were few hairs all over the body. The larva found sluggish which became active after some times. The length of larva ranged from 0.86 to 0.92 to mm with an average of 0.89 ± 0.02 mm and width varied from 0.16 to 0.18 mm with an average of 0.17 ± 0.01 mm, thus confirming the findings of Jaglan *et al.* (1995)^[4]. The duration of larvae varied from 1 to 2 days with an average of 1.45 ± 0.51 days (Table-1 &2).

Second instar larva: The larva was brown to black in colour with light brown head and scattered hairs on all over the body. The length of larva varied from 2.90 to 3.42 mm with an average of 3.15 ± 0.17 mm while, breadth of larva varied from 0.50 to 0.72 mm with an average of 0.62 ± 0.07 . The duration of larva varied from 2 to 3 days with an average of 2.45 ± 0.51 days (Table-1&2) which coincides with the findings of Jaglan *et al.* (1995)^[4].

Third instar larva: The larva was dark brown to black in colour with brownish head and scattered hairs all over the body. The segmentation is clearly visible. The length of larva varied from 5.40 to 7.10 mm with an average of 6.22 ± 0.61 mm while, the breadth varied from 1.30 to 1.64 mm with an average of 1.47 ± 0.10 mm. The duration of larvae varied from 3 to 4 days with an average of 3.40 ± 0.50 days (Table-1&2). Similar findings have been noticed by Jaglan *et al.* (1995)^[4].

Fourth instar larva: It had the same pattern of marking and body colour as third instar larva. The larva measured varied from 10.00 to 13.40 mm with an average of 12.03 ± 1.01 mm in length and that of width varied from 1.72 to 2.00 mm with an average of 1.88 ± 0.08 mm. The duration of larva varied from 5 to 6 days with an average of 5.40 ± 0.50 days (Table-1&2), thus confirming the findings of Jaglan *et al.* (1995)^[4].

Fifth instar larva: The larva was dark brown to black in colour with metallic dark brownish head, segmentation is clearly visible and scattered hairs all over the body. Body is stout and a long hair on either side of each segment on dorso-lateral region was distinctly visible with naked eyes. Larva was very active and have tendency to move backward on

slight touch and cannibalism also seen. The body length of larva varied from 18.00 to 24.50 mm with an average of 21.70 ± 2.13 mm while, the breadth of body varied from 2.50 to 3.00 mm with an average of 2.81 ± 0.16 mm which coincides with the findings of Jaglan *et al.* (1995)^[4]. The duration of larva varied from 3 to 4 days with an average of 3.50 ± 0.51 days (Table-1&2).

Total larva period: The total larval period varied from 14 to 19 days with on average of 16.20 ± 1.40 days. Peiu (1967)^[6] observed that the caterpillar stage was completed in 15-27 days on pea (Table-1).

Pre Pupa: The full grown larva become sluggish, the body contracted and colour changed to greenish black. The length of pre-pupa varied from 8.40 to 11.20 mm with an average of 9.49 ± 0.90 mm while, the breadth varied from 2.22 to 2.62 mm with an average of 2.43 ± 0.10 mm. The duration of pre-pupa ranged from 2 to 3 days with an average of 2.45 ± 0.51 days (Table-1&2). This period in *E. zinckenella* ranged from 2 to 4 days on lentil (Singh and Dhooria, 1971)^[9].

Pupa: The pupa was yellowish in colour and later on changed to light brown and dark brown in colour before the emergence of moth. The pupa was object type. The length of pupa ranged from 7.50 to 9.50 mm with an average of 8.53 ± 0.71 mm while, the breadth varied from 2.50 to 3.00 mm with an average of 2.74 ± 0.16 mm. Similar observations were also made by Jaglan *et al.* (1995)^[4]. The duration of pupal stage varied from 9 to 11 days with an average of 9.85 ± 0.81 days (Table-1&2). It was 10 days in *E. zinckenella* on pigeon pea (Bindra and Singh, 1969)^[3].

Adult: The moth was medium in size with forewing and hind wing are of metallic grey in colour. In case of female, the fore wings remain overlapped to each other while resting. Hind wing are fringed with hairs. In case of male wings are silvery grey in colour. Antennae are of setaceous type and light grey in colour. Male moths are smaller in size than female. Moreover, adult of male moth had a brush like tuff of hairs on the lateral side of the last abdominal segment. This was absent in case of female. The abdomen of female was relatively bigger in size as compared to male. The length of male varied from 9.00 to 11.00 mm with an average of 10.21 ± 0.73 mm, while, with wing expanded it was varied from 17.00 to 19.00 mm with an average of 18.18 ± 0.63 mm. In case of female, the length varied from 12.00 to 14.00 mm with an average of 13.20 ± 0.73 mm, while with wing expanded varied from 19.00 to 24.00 mm with an average of 21.90 ± 1.61 mm (Table-1&2). Thus, the female moth was slightly bigger in size than that of male moth which coincides with the findings of Jaglan *et al.* (1995)^[4]. Singh and Dhooria (1971)^[9] also reported that female moth measuring 20.08 mm in wing expanse and 11.4 mm in length. The present findings on size of moths are in concurrence with those of earlier findings.

Sex ratio: The sex ratio of male to female was 1: 0.91 (Table-1), thus female outnumbered the male during present investigation. However, according to Papova (1957)^[5] the male and female of *E. zinckenella* were equally distributed. While, according to Abul Nasar and Awadalia (1957)^[1], the male exceeded the female.

Pre-oviposition period: The period of *Etiella* sp. varied from 2 to 3 days with an average of 2.40 ± 0.50 days (Table-1).

According to Bindra and Singh (1969)^[3] the pre oviposition period of *E. zinckenella* was 1 to 4 days.

Oviposition period: The oviposition period was found to be varying from 1 to 4 days with an average of 2.25 ± 0.97 days (Table-1) during present studies.

Post oviposition period: The post oviposition period was found to be varied from 1 to 3 days with an average of 1.80 ± 0.70 days (Table-1) during present studies.

Fecundity: The total number of egg laid by an individual female varied from 10 to 38 eggs with an average of 24.55 ± 8.75 (Table-1). According to Abul Nasar and Awadalia (1957)^[1] the egg laying capacity of *E. zinckenella* was 44 to 178 eggs.

Longevity: The longevity of adult female varied from 5 to 8 days with an average of 6.40 ± 1.10 days (Table-1). While, longevity of male varied from 3 to 6 days with an average of 4.45 ± 1.10 days. Thus, the male lived shorter than the females. The present findings tally with those of Singh and Dhooria (1971)^[9].

Total life cycle: The total life cycle from egg to the death of adult in female ranged from 25 to 33 days with an average of 28.90 ± 2.11 days. While, it was 22 to 31 days with an average of 26.62 ± 2.57 days in male (Table-1). The total life cycle was completed in 22 to 24 days on pigeon pea. (Bindra and Singh, 1969)^[3]. However it was 35.8 days on pea and 43.7days on lentil according to Singh and Dhooria (1971)^[9].

Table 1: Details of life cycle of *Etiella* sp.on mango

Sr. No.	Particulars	Period (days)		
		Minimum	Maximum	Average \pm SD
1.	Incubation period	3	5	3.75 ± 0.79
2.	Hatching percentage	63.16	83.78	74.16 ± 7.28
3.	Larval period			
	1 st instar	1	2	1.45 ± 0.51
	2 nd instar	2	3	2.45 ± 0.51
	3 rd instar	3	4	3.40 ± 0.50
	4 th instar	5	6	5.40 ± 0.50
	5 th instar	3	4	3.50 ± 0.51
	Total	14	19	16.20 ± 1.40
4.	Pre-pupal period	2	3	2.45 ± 0.51
5.	Pupal period	9	11	9.85 ± 0.81
6.	Adult period			
	Pre-oviposition	2	3	2.40 ± 0.50
	Oviposition	1	4	2.25 ± 0.97
	Post-oviposition	1	3	1.80 ± 0.70
	Longevity:			
	Female	5	8	6.40 ± 1.14
	Male	3	6	4.45 ± 1.10
7.	Total life cycle:			
	Female	25	33	28.90 ± 2.11
	Male	22	31	26.62 ± 2.57
8.	Egg laying capacity (number)	10	38	24.55 ± 8.75
		Male	Female	M:F
9.	Sex ratio	26	23	1: 0.91

Table 2: Morphometrics of different development stages of *Etiella* sp. fed on mango

Sr. No.	Number observed	Developmental stage	Average length (mm)	Range	Average breadth (mm)	Range
1.	20	Egg	0.63 ± 0.03	0.60-0.70	0.39 ± 0.03	0.34-0.44
Larva						
2.	20	1 st instar	0.89 ± 0.02	0.86-0.92	0.17 ± 0.01	0.16-0.18
	20	2 nd instar	3.15 ± 0.17	2.90-3.42	0.62 ± 0.07	0.50-0.72
	20	3 rd instar	6.22 ± 0.61	5.40-7.10	1.47 ± 0.10	1.30-1.64
	20	4 th instar	12.03 ± 1.01	10.00-13.40	1.88 ± 0.08	1.72-2.00
	20	5 th instar	21.70 ± 2.13	18.00-24.50	2.81 ± 0.16	2.50-3.00
Pupa						
3.	20	Pre- pupae	9.49 ± 0.90	8.40-11.20	2.43 ± 0.10	2.22-2.62
	20	Pupae	8.53 ± 0.71	7.50-9.50	2.74 ± 0.16	2.50-3.00
Adult						
4.	20	Female	13.20 ± 0.73	12.00-14.00	2.86 ± 0.14	2.70-3.20
	20	Male	10.21 ± 0.73	9.00-11.00	2.52 ± 0.12	3.30-2.70

Conclusion

The female laid eggs singly or in batches on peduncle of the fruit. The freshly laid eggs were pale yellowish in colour, which changed to yellowish brown prior to hatching. Eggs were oval in shape. The average length and breadth of egg was 0.63 ± 0.03 mm and 0.39 ± 0.03 mm respectively. The

incubation period of eggs ranged from 3 to 5 days with 74.16 ± 7.28 per cent of hatchability. The newly hatched larva was light brown to black in colour with light brown head. There were few hairs all over the body. The second instar larva was brown to black in colour with light brown head. There were scattered hairs on all over the body. Third instar larva was

dark brown to black in colour with brownish head. The segmentation is clearly visible. The fourth instar larva had the same pattern of marking and body colour as third instar larva. The fifth instar larva was dark brown to black in colour with metallic dark brownish head. Body is stout and a long hair on either side of each segment on dorso-lateral region. Larva is very active and have tendency to move backward on slight touch. The average length of first, second, third, fourth and fifth instar larva was 0.89 ± 0.02 , 3.15 ± 0.17 mm, 6.22 ± 0.61 mm, 12.03 ± 1.01 mm and 21.70 ± 2.13 mm, while average breadth of body was 0.17 ± 0.01 mm, 0.62 ± 0.07 mm, 1.47 ± 0.10 mm, 1.88 ± 0.08 mm and 2.81 ± 0.16 mm, respectively. The average duration of first, second, third, fourth and fifth instar larva was 1.45 ± 0.51 , 2.45 ± 0.51 , 3.40 ± 0.50 , 5.40 ± 0.50 and 3.50 ± 0.51 days, respectively. Total larval period completed in 16.20 ± 1.40 days. The average pre-pupal period was 2.45 ± 0.51 days. The freshly formed pupa was yellowish and later on changed to light brown and then dark brown in colour before emergence of moth. The average length and breadth of pupa was 8.53 ± 0.71 mm and 2.54 ± 0.15 mm respectively, while the pupal period recorded was 9.85 ± 0.81 days during the investigation. The adults were small in size with forewing and hind wings are of metallic grey in colour. In case of female, the forewings remain overlapped to each other while resting. Hind wings are fringed with hairs. The wings are silvery grey in colour in male. Male moths are smaller in size than female. It was noticed during the morphological studies that, a tuft of silken hairs were present at the tip of the abdomen of the male which were absent in case of female. The average length and breadth of female moth measured was 13.20 ± 0.73 mm and 2.86 ± 0.14 mm while that of male; it was 10.21 ± 0.73 mm and 2.52 ± 0.12 mm, respectively. The above data revealed that, the male moth were smaller than female moth. The sex ratio of male: female was found to be 1:0.91. The average pre-oviposition, oviposition and post oviposition period were recorded were as 2.40 ± 0.50 , 2.25 ± 0.97 and 1.80 ± 0.70 days, respectively. The average fecundity of the female recorded as 24.55 ± 8.75 eggs. The average longevity of male was 4.45 ± 1.10 days and 6.40 ± 1.14 days of female. The total life cycle of male of *Etiella* sp. was completed in 22 to 31 days with an average of 26.62 ± 2.57 days and 25 to 33 days with on average of 28.90 ± 2.11 days in case of female.

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