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ASSESSMENT OF BIOLOGY AND MORPHOMETRIC CHARACTERISTICS OF DIFFERENT STAGES OF LEAFHOPPER, *AMRASCA BIGUTTULA BIGUTTULA (ISHIDA)* ON OKRA

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ABSTRACT
Okra is an economically important vegetable crop grown in tropical and sub-tropical parts of the world. Among many destructive pests of okra, leafhoppers are undoubtedly more severe. Studies on biology and morphometric characteristics of *Amrasca biguttula biguttula* (Ishida) were conducted under laboratory conditions during 2011-12 at University of Agricultural Sciences, College of Agriculture, Raichur. The incubation period lasts for 6.55 ± 0.40 days. The duration of first, second, third, fourth and fifth nymphal instars were 6.55, 1.67, 1.27, 1.33, 1.67 and 2.10 days, respectively. The total nymphal period was 8.04 ± 0.51 days. The male and female had longevity of 16 and 18 days respectively, with a total fecundity of 17.53 ± 0.52 per female. The life cycle ranged from 15 to 18 days.

INTRODUCTION

India is a leading vegetable producing country in the world and grows maximum vegetables (over 60 in number) in one or the other parts of the country. Okra (*Abelmoschus esculentus* L. Moench) also known as lady's finger, is grown over an area of 4.52 lakh ha with a production of 48.03 lakh tonnes in India, whereas in Karnataka it is cultivated over an area of 8,600 ha with a production of 75.1 thousand tones. Orissa has the largest area of 84,450 ha, followed by Bihar (78,000 ha). Bihar ranks first in production (819.00 million tonnes) followed by Orissa (654.7 million tonnes) (Anon., 2011). Okra is especially valued for its tender and delicious fruits which contain dietary fiber, carbohydrates (29 %), protein (22 %), vitamin A, B, C and minerals. It is good for people suffering from renal colic, leucorrhoea, chronic dysentery and general weakness (Singh and Singh, 2000). It is one of the most nutritious vegetable, which contain minerals like iodine, magnesium, potassium (Aykroud, 1963). Okra seeds contain 18 to 20 per cent of crude protein (Berry *et al.*, 1988).

Besides various reasons for low productivity, heavy damage inflicted by insect pests is a key limiting factor. About 72 species of insects have been recorded on okra (Srinivasa Rao and Rajendran, 2003) of which, most destructive insect pests reported are leafhopper, *A. biguttula biguttula* (Ishida), aphid, *Aphis gossypii* (Glover), whiteflies, *Bemisia tabaci* (Gennadius), fruit borer, *Helicoverpa armigera* (Hubn.), spotted bollworm, *Earias vittella* (Fabricius) and *Earias insulana* (Boisd.) (Kale *et al.*, 2005; Kumar and Pathania, 2006 and Chakraborty *et al.*, 2014). Among the sucking pests, *A. biguttula biguttula* (Ishida) is the major constraints in achieving the potential yield (Atwal and Singh, 1990; Shah and Jhala, 2001). The female leafhoppers inserted the eggs singly into the plant tissue mainly on midrib and other veins. The egg was slightly hooked towards the anterior end and the other end being broadly pointed. Before hatching, a pair of brownish red eyes appeared near the anterior end of the egg. After hatching, both nymphs and adults suck the sap from under the surface of the leaf causing speckling, crinkling and distortion of leaves which shows reddening all along the margins. Such type of symptom is called "Hopper burn" which leads to drying of leaves affecting the growth and reduction in fruit number and final loss in yield. Failure to control the leafhoppers in the initial stages was reported to cause a yield loss to the tune of 54.04 per cent (Chaudhary and Dadeech, 1989). The jassids attack, at times, is so serious that the entire crop may lose (Jotwani and Sarup, 1996). Though, leafhopper was thought to be a seedling pest, its activity is expanded throughout the cropping period resulting in higher yield loss. Therefore, for the sound management, it is essential to know the weak links in the bio-ecology, life history and development of the insect *Viz.*, feeding habits, behavior and duration of different developmental stages. Literature pertaining to biology and morphometry of *A. biguttula biguttula* is meager. Hence, the present investigations were undertaken to give the emphasis on biological study.

MATERIALS AND METHODS

The biology of the predominant species of okra leafhopper, *Amarasca biguttula biguttula* (Ishida) was studied from December to February 2011-12 at University of Agricultural Sciences, College of Agriculture, Raichur (16º15' N latitude and 77º20' E longitude) on okra variety *Arka Anamika* under the laboratory conditions at 25-30ºC and 60-70% RH.

Pure culture maintenance

The field collected final instar nymphs of *A. biguttula biguttula* were released in potted okra plants covered with cages (2.28 m Height, 1.8 m length and 1.8 m breadth). The final instar nymphs were identified based upon the extent of wing pads developed and were maintained in rearing cages till they reach adult stage and these adults were collected and used for the biological studies. The male and female sexes were identified based on the genitalia and abdominal characters (male had blunt abdomen while the female had pointed abdomen) (Thirumalaraju, 1984). Later, a pair of newly emerged male and female leafhoppers was released into a microcage (7 × 5 cm) to record the nymphal duration, length and breadth. For reproductive biology the newly emerged adult male and females were collected and released into the microcages which were fixed to the okra leaf in such a way that the leaf was inserted into it from one side and the other side of it was covered with the muslin cloth.

Preovipositional period

To study the pre-ovipositional periods (including pre-mating and mating periods), a pair of freshly emerged adult leafhoppers of both sexes from pure culture was released into the micro cage containing single okra leaf with 15 replications. Microcage was opened daily and the leaves were observed under microscope for oviposition and this was continued till the first egg was laid and duration was recorded.

Nymphal instars and adult longevity

The freshly hatched nymphs were transferred into the plastic containers with okra leaf and the leaf stalk dipped in a small vial containing water. The number of instars and days required for each instars were recorded based on the moulted skin. The duration of the adult leafhoppers from emergence till their death was recorded by enclosing them in the microcage, fixed to single okra for recording adult longevity with food, whereas the adult longevity without food also recorded by simply releasing the plastic containers (6 x 4 cm) without okra leaf. The turgidity of the leaf was maintained by dipping the leaf stalk in a small vial containing water.

Morphometric measurements

Observations were made on all the morphological stages *Viz.,* egg, nymphal and adult stages. The measurements (mm) on the length and breadth of these stages were taken using a Leica microscope using the software.

Morphometric measurements (egg, nymphal and adult stages) and biological parameters (incubation period, nymphal period, pre-ovipositional, ovipositional, post-ovipositional period, fecundity and adult longevity) were recorded (Thirumalaraju, 1984; Hanumanthappa, 2003; Shivanna *et al.,* 2009 and Shreevani *et al.,* 2013).

RESULTS AND DISCUSSION

Biology of leafhopper, *A. biguttula biguttula* on okra

The female leafhoppers inserted the eggs singly into the plant tissue mainly on midrib and other veins. The color of the egg was pale whitish and was translucent. The egg was slightly hooked towards the anterior end and the other end being broadly pointed. Before hatching, a pair of brownish red eyes appeared shining through the chorion near the anterior end of the egg. In the present study, egg length varied from 0.50 to 0.63 mm with an average of 0.61 ± 0.03 mm and egg width ranged from 0.19 to 0.23 mm with an average of 0.21 ± 0.02 mm. The incubation period varied from 6 to 7 days with an average of 6.55 ± 0.40 days (Table 1 and 2), the present results are in close proximity with findings of Hanumantappa (2003) and Shivanna *et al.* (2009).

Nymphal instars and total nymphal periods

During the development period, the nymph moulted four times and the insect had five nymphal instars. The details of each instar have been presented here under (Table 2). The newly hatched first instar nymph was transparent and yellowish in colour; second instar nymph had white eyes and dark reddish colour underneath with rudimentary wing pads along the posterior side of meso and metathorax; third instar nymph was yellowish green in colour with small wing pads; fourth instar nymph was yellowish green in colour with increase in size of wing pads; fully developed fifth instar nymph was greenish yellow in colour and eyes were prominent and whitish in colour with enlarged wing pads reaching up to 9th abdominal segment having black dot on each near the base; duration of 1st, 2nd, 3rd, 4th and 5th instars were 6.55, 1.67, 1.27, 1.33, 1.67 and 2.1 days respectively (Table 2). The

Table 1: Morphometry of different stages of leafhopper, *A. biguttula biguttula*

Life stages*	Length (mm) Range	Mean ± SD	Breadth (mm) Range	Mean ± SD
Egg	0.50 - 0.63	0.61 ± 0.03	0.19 – 0.23	0.21 ± 0.03
I Instar	0.63 - 0.74	0.67 ± 0.03	0.18 – 0.24	0.22 ± 0.04
II Instar	1.00 - 1.10	1.07 ± 0.02	0.30 – 0.38	0.36 ± 0.03
III Instar	1.26 - 1.40	1.30 ± 0.07	0.50 – 0.56	0.54 ± 0.21
IV Instar	1.50 – 1.68	1.62 ± 0.08	0.61 – 0.66	0.63 ± 0.03
V Instar	2.05 - 2.10	2.06 ± 0.06	0.69 – 0.76	0.72 ± 0.04
Adult				
Male	2.36 - 2.55	2.48 ± 0.05	0.65 – 0.76	0.73 ± 0.03
Female	2.66 - 2.80	2.76 ± 0.04	0.70 – 0.78	0.75 ± 0.02

* Mean of 10 observations (n = 10)

Table 2: Biological parameters of *A. biguttula biguttula* on Okra under laboratory conditions

Stage of development*	Range (days)	Mean ± SD
Egg stage (Days)	6.00 - 7.00	6.55 ± 0.40
Nymph stage		
I instar (Days)	1.00 - 2.00	1.67 ± 0.36
II instar (Days)	1.00 – 2.00	1.27 ± 0.26
III instar (Days)	1.00 – 2.00	1.33 ± 0.24
IV instar (Days)	1.00 - 2.00	1.67 ± 0.36
V instar (Days)	2.00 – 2.50	2.10 ± 0.27
Total nymphal period (Days)	6.00 - 10.50	8.04 ± 0.51

* Mean of 15 observations (n = 15)

Table 3: Adult longevity and fecundity of *A. biguttula biguttula* on Okra under laboratory conditions

Insect Stage *	Range (days)	Mean ± SD
Premating period (Days)	2.00 – 3.00	2.50 ± 0.48
Mating period (minutes)	4.00 - 5.00	4.56 ± 0.34
Pre-ovipositional period (Days)	3.00 - 3.50	3.28 ± 0.32
Ovipositional period (Days)	6.50 - 8.00	6.65 ± 0.26
Fecundity (number)	17.00 - 18.00	17.53 ± 0.52
Post-ovipositional period (Days)	3.50 - 4.00	3.73 ± 0.26
Total period (days)	15 – 18.50	16.16 ± 0.48
Longevity		
Male (with food) (Days)	14.00 - 17.00	16.13 ± 1.53
Male (without food) (hours)	15.00 - 18.00	16.20 ± 1.52
Female (with food) (Days)	16.00 - 21.00	18.20 ± 1.63
Female (without food) (hours)	17.00 - 22.00	19.33 ± 1.66
Total life cycle (Days)	22.00 – 31.50	29.50 ± 1.96

* Mean of 15 observations (n = 15)

average length and breadth of 1st, 2nd, 3rd, 4th and 5th instars were 0.67 ± 0.03 mm and 0.22 ± 0.04 mm; 1.07 ± 0.02 mm and 0.36 ± 0.03; 1.30 ± 0.07 mm and 0.54 ± 0.21; 1.62 ± 0.08 mm and 0.63 ± 0.03; and 2.06 ± 0.06 mm and 0.72 ± 0.04 mm, respectively (Table 1). The present findings of nymphal characters are in close conformity with the findings of Kiran Kumar and Bhat (2003), Hanumantappa (2003) and Shreevani (2013). However, the present finding represents a slight variation in size and duration with the findings of Shivanna *et al.* (2009) which might be due to change in hosts on which biology was carried out. The total nymphal period of leafhopper ranged from 6.00 to 10.50 days with an average of 8.04 ± 0.51 days (Table 2).

Reproductive biology of *A. biguttula biguttula*

Adults were green in color and have prominent black spots on both sides of the median line in the vertex of the head and another on the apical area of the wing. Female were sexed based on the genitalia on the pointed abdomen and the size was slightly bigger than male. The longevity of female leafhoppers, with food ranged from 16 to 21 days with an average of 18.20 ± 1.63 days, whereas, longevity without food ranged from 17 to 22 hours with an average of 19.33 ± 1.66 hours. The average length and breadth of female leafhopper was 2.76 ± 0.04 mm and 0.75 ± 0.02 mm, respectively (Table 1 and 3). These findings are in confirmation with the earlier findings of Hanumanthappa (2003), Shivanna *et al.* (2009) and Shreevani (2013). Male was sexed based on the presence of blunt and roundish abdominal tip with prominent aedeagus. The longevity of male leafhoppers, with food varied from 14 to 17 days with an average of 16.13 ± 1.53 days and longevity without food recorded 15.00 to 17.00 hours with an average of 16.20 ± 1.52 hours. The average length and breadth of male leafhopper was 2.48 ± 0.05 mm and 0.73 ± 0.03 mm, respectively, which were in close association with the reports of Hanumanthappa (2003), Shivanna *et al.* (2009) and Shreevani (2013).

Mating was observed during the early hours from 7.00 to 8.00 am and during late evening hours from 5.30 to 7.00 pm. The mating period ranged from 4 to 5 minutes with an average of 4.56 ± 0.34 minutes. The mated female did not lay the eggs immediately after mating, pre-ovipositional period ranged from 3 to 3.50 days with an average of 3.28 ± 0.32 days (Table 3). The ovipositional period ranged from 6.50 to 8.00 days with an average of 6.65 ± 0.26 days. The post-ovipositional period ranged from 3.50 to 4.00 days with an average of 3.73 ± 0.26 days (Table 3) which was in line with the findings of Shivanna *et al.* (2009) who recorded the post ovipositional period as 3.10, 3.90 and 3.80 days respectively. The adult females preferred to lay the eggs singly by inserting into the midrib and veins. Fecundity of each female ranged from 17 to 18 eggs with an average of 17.53 ± 0.52 eggs (Table 3). These findings are in close agreement with the findings of Sharma and Sharma (1997) who recorded the fecundity of leafhopper as 17.20 and 17.50 eggs, respectively. A total life span of leafhopper on okra lasted for 22 to 31 days with an average of 29.50 ± 1.96 days (Table 3). The results of total life cycle are in close agreement with the results of Shivanna *et al.* (2009) who reported that the duration of entire lifespan was 19 to 35 days with a mean of 27.63 days.

Precise knowledge of the biology and ecology of insect pests serves as a prerequisite for integrated pest management. Thus, the present study provides insight into knowledge on morphology, biology and development of *A. Biguttula biguttula* and in turn, which helps to provide weak links in particular growth stages that facilitate in the better pest management.

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