J. Sher-e-Bangla Agric. Univ., 7(1): 15-21, January 2014 ISSN 1997-6038

ASSESMENT OF SEASONAL ABUNDANCE OF ORIENTAL FRUIT FLY, *BACTROCERA DORSALIS* (HENDEL) AND DEVELOPMENT OF ARTIFICIAL LARVAL DIET FOR ITS MASS REARING

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ABSTRACT

Seasonal variations of oriental fruit fly, *Bactrocera dorsalis* (Hendel) were monitored in different agricultural field of Ganakbari, Savar, Dhaka during January 2012 to December 2012 and artifitial larval diet was prepared in the laboratory of Insect Biotechnology Division (IBD), Institute of Food and Radiation Biology (IFRB), Atomic Energy Research Establishment (AERE), Savar, Dhaka for possible field application of Sterile Insect Technique (SIT). Air temperature, relative humidity and rainfall were recorded during the study period. High level of oriental fruit fly population was found throughout the year except February and mean monthly capture was the highest in May. In case of efficiency of artifitial larval diet the highest hatching percentage and the lowest larval duration was observed from the 4.87-4.89 pH of the diet. But based on the highest number of pupa, flier percentage, adult emergence percentage and lowest pupal duration diet having 5.22-5.26 pH was found to be economical and suitable for mass rearing of *B. dorsalis*.
Keywords: *Bactrocera dorsalis*, artifitial larval diet, sterile insect technique (SIT), pH.

INTRODUCTION

The oriental fruit fly, *Bactrocera dorsalis* (Hendel) is a very destructive pest of fruit in areas where it occurs (White and Elson-Harris, 1994). It is established in many areas in Bangladesh. The oriental fruit fly has been recorded from more than 150 kinds of fruit and vegetables including apricot, banana, mango, guava, papaya, avocado, citrus, fig, coffee, peach, pea, pineapple, and tomato (Koyama, 1989). Fruit flies constitute one of the largest and most diversified groups of insects and consist of over 4000 species, of which nearly 700 belong to the Dacine fruit flies (Fletcher, 1987). Nearly 250 species are of economic importance and are distributed widely in temperate, sub-tropical, and tropical regions of the world (Christenson and Foote, 1960). Eighty seven species of Tephritidae in India of which the genus, *Bactrocera* caused heavy damage to fruits and vegetables in Asia (Nagappan *et al.,* 1971). This fruit fly is a very important group of pests for many countries due to their potential to cause damage in fruits, vegetables and to their potential to restrict access to international markets for plant products that can host fruit flies. Losses due to this fruit fly infestation were estimated from 10 to 30% of annual agricultural produces in our country (Naqvi, 2005). Understanding the year round population variations of any insect pest is important for successful control program. Pheromone traps provide an easy and efficient method to monitor the abundance of fruit fly populations (Alyokhun *et al.*, 2000).
The classical approach of using of pesticides cannot be relied upon because of environmental and health hazards to both applicator and consumers. The sterile insect technique (SIT) has proved to be a well-established method of controlling several key pests of agricultural importance (Snow, 1988; Vargas, 1989). SIT involves the suppression of insect population through the release of sterile insects rendered infertile by gamma radiation. It includes rearing millions of insects in the laboratory using artificial diet making sterile by exposure to gamma radiation and then releasing them into target areas. As a prerequisite of the test release of sterile oriental fruit fly to suppress the wild population, the current study was undertaken to understand the year round population level of oriental fruit fly in

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respect to different agricultural habitats, air temperature, rainfall, relative humidity and availability of host fruits surrounding the study area. It is also essential to develop cost effective artificial larval diet for continuous supply of huge amounts of larvae/pupae in short period of time to success the SIT program

MATERIALS AND METHODS

The present study was conducted to establish the Sterile Insect Technique (SIT) method of controlling *B. dorsalis* (Hendel) in the laboratory and experimental field of Insect Biotechnology Division (IBD), Institute of Food and Radiation Biology (IFRB), Atomic Energy Research Establishment (AERE), Ganakbari, Savar, Dhaka.

Assessment of seasonal variations: The field survey of *B. dorsalis* was carried out in a vegetable field of Ganakbari, Savar, Dhaka ($23^0 59''$N, $90^0 16''$E) during January 2012 to December 2012. Ganakbari, Savar located at the Northwest side of Dhaka, the capital of Bangladesh. It is a high plain land with red hilly soil. Eight McPhail traps were set at approximately 100 m distances in the field and inspected every fortnightly. Each trap was placed on bamboo poles or on tree branch at a height of 1m above the ground. A parapheromone lure (methyl eugenol) stick was suspended inside each trap, near the center. The parapheromone lure stick consisted of a small cotton rope impregnated with 2 ml of lure [4 allyl-1, 2-dimethoxybenzene-carboxylate] marketed by Safe Agriculture Bangladesh Ltd. A cotton ball soaked with 100 ml Carbaryl (Sevin 85SP) solution (Insecticide, Bayer Bangladesh) was placed inside each trap as insect killer, which was replaced at 15 days intervals throughout the experimental period. Male flies were attracted by the lures, and were quickly killed with the insecticide on the cotton ball. The flies of *B. dorsalis* species were identified and counted in each trap at 15 days intervals. Trap capture rates were calculated based on four traps in each site. The monthly meteorological data used in the present study was provided by the Center of Meteorological Department, Dhaka, Bangladesh.

Adult rearing: About 5,000 adult oriental fruit fly, *B. dorsalis* were maintained in steel framed cages ($76 \times 66 \times 76$ cm) covered with wired net. The front side of the cage had one hole covered with nylon mesh net to insert food, water and egging receptacles. The flies were supplied with protein based artificial diets *viz*., (i) baking yeast: sugar: water at 1:3: 4 ratio, and (ii) casein: yeast extract: sugar at 1:1:2 ratio. Water was supplied in a conical flask socked with cotton ball. The temperature and the relative humidity (RH) of the rearing room were maintained at 27 ± 2^0C and $75 \pm 5\%$, by using air conditioner (Model No. Movincool Classic Plus 26, USA).

Egg collection: Eggs were collected with yellow plastic cylinder (10.5×20.5 cm) perforated with about 400 oviposition holes. Crushed paste of banana was placed within inside wall of the receptacle in order to stimulate oviposition. The egging receptacle was enclosed with a wet sponge to prevent desiccation of eggs. The egg laying devices were kept in the cage for 4 to 5 hours. It was then washed with distilled water and sieved with a very fine screen and then measured volumetrically.

Diet preparation: The artificial diet was composed of Wheat bran75g, Rice bran 50g, Soya bran 100g, Sweet potato 250g, Ascorbic acid, 5g, Sugar 50g, Sodium benzoate 4g and water 464ml, 463ml, 462ml and 466 ml for four different compositions were measured and mixed in a blender thoroughly. Four different compositions were prepared using different amounts (2, 3, 4 and 0 ml) of HCl. After mixing one liter diet was poured on stainless steel tray (6" wide×12" length).

P^H test: P^H level of four different diet compositions were tested using a pH meter made by Bangladesh Atomic Energy Commission.

Egg seedling: One liter diet was poured on each tray. About 800-900 eggs (0.5 ml eggs with water) were placed on a moist tissue paper placed on the diet. The eggs were found to hatch within 30 to 36 hours.

Pupa collection: The trays were kept on saw dust in big bowls covered with clothes. After six days of seedling, the sawdust was sieved and pupae were collected. The pupae were kept on the large Petri dishes in small rearing cages for adult emergence.

Temperature and humidity: The temperature and the relative humidity of the larval rearing room were maintained 28± 2^{0}C and 70±10%, respectively.

Flight ability test: Two days before estimated adult emergence 100 pupae were placed in a petri dish (90 mm diameter) kept in a fruit fly rearing cage and a 10 cm PVC tube coated with talcum powder kept on the petri dish and the flies were allowed to emerge freely. Flight ability (flies escaping from the PVC tube) was determined based on the number of unemerged pupae and residual flies remaining in the petri dish. Then, the percentage of flying flies was calculated for each replicate. Three replications of 100 pupae from each group were performed.

Statistical analyses: The recorded data were compiled and tabulated for statistical analysis. Analysis of variance was done with the help of computer package MSTAT-C program. The treatment means were separated by Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Seasonal variations of oriental fruit flies and relation with climatic factors: The fortnightly captures of oriental fruit fly males were averaged on monthly basis in study area (Table 1). The prevalence of oriental fruit fly was found to be abundant in the study sites in Ganakbari area, Savar, Dhaka.

Table 1. Number of adult male oriental fruit fly, *B. dorsalis* captured per Mcphail trap in 2012 at GanakBari area and monthly average temperature, relative humidity and total rainfall

Month	No. of adult male captured (Mean ± SE)	Average Temperature ^{0}C (Mean ± SE)	Average RH % (Mean ± SE)	Total rainfall (mm)
January	59±17.33 fg	18.0 ±2.2	69.0 ± 6.3	23
February	30.5±8.60 h	21.3 ± 3.3	68.0 ± 5.2	28
March	47.88±19.29 g	27.6 ± 2.5	67.0 ± 6.3	79
April	59.5±15.09 fg	30.2 ± 3.2	71.0 ± 6.8	105
May	314.8±12.15 a	31.3 ± 3.6	70.0 ± 8.6	205
June	226.9±22.90 b	30.7 ±3.2	80.0 ± 5.3	806
July	89.38±8.58 e	27.3 ± 2.2	82.0 ± 8.2	1295
August	197.5±6.59 c	28.2 ± 3.2	81.0 ± 3.5	1191
September	161.1±7.79 d	29.5 ±2.8	82.0 ± 4.9	809
October	66.38±23.45 f	26.2 ± 3.3	78.0 ± 5.6	170
November	205.5±8.79 c	21.6 ± 3.5	64.0 ± 4.6	35
December	34.13±12.201h	20.3 ± 3.4	64.0 ± 6.7	12
LSD(0.05)	13.41	--	--	--
CV (%)	10.83	--	--	--

Means having the same letter in each column do not differ significantly at $p<0.05$ by DMRT.

The capture rate was increased during May-June, August-September and November and the highest capture was obtained in the month of May. The average number of adults captured per trap ranged from highest 314.8±12.15 (May) to lowest 30.5±8.6 (February) at Ganakbari in 2012. In the area *B. dorsalis* infestations happened all year round but peak population levels appeared during May to September ecept July. Numbers of the monthly capture were significantly related to the peak population of fruit flies during May to September when captures were peaked (Fig. 1). In addition, a significant correlation was found between capture rates and incidence of fruit fly during May-June when the monthly highest captures were recorded. This suggested that the peak population levels mainly depended on the host fruiting availability. Result of this experiment was partially similar with the findings of Makhmoor and Singh (1998) who reported that peak population (170.66 males/ trap/ week) of oriental fruit fly was observed in June at Kasmir area in India. According to the author the population of *B. dorsalis* appeared in February, started increasing in March and reached at peak in July at both guava (80.66 males/trap/week) and nectarine (168.66 males/ trap/ week) orchard in Islamabad. Ye and Liu (2005) also demonstrated that *B. dorsalis* occurred only from May to November with high abundance in July of each year at Kunming, China. Monthly average air temperatures, rainfall and relative humidity are shown in the Table1. A moderate positive correlations were found between monthly capture rates and the monthly average air temperatures (R^2=0.2726, Fig 1a) and total rainfall (R^2=0.113, Fig 1b). Air temperature was reported as a circular factor which influences *B. dorsalis* occurrence (Vargas *et al.,* 1996; Chen and Ye, 2007). But no significant correlation was found between monthly captured rates and relative humidity (R^2=0.065, Fig 1c) in all the areas.

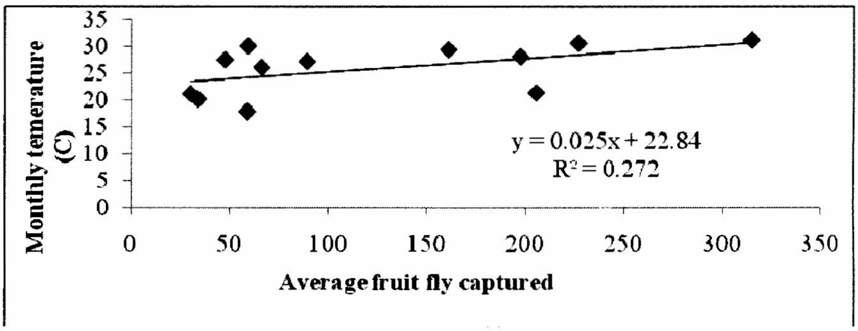

Fig. (a)

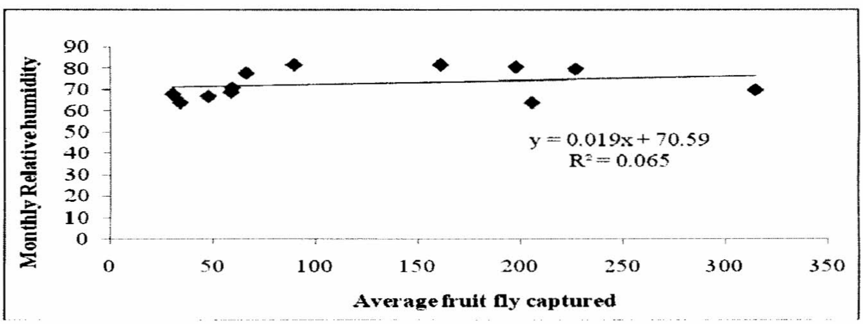

Fig. (b)

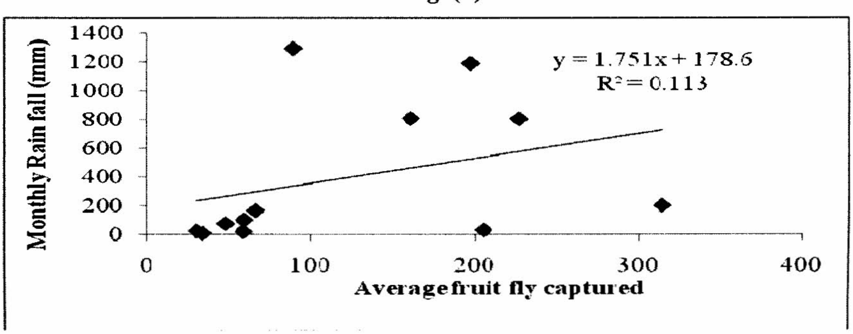

Fig. (c)

Fig. 1. Regression line and correlation between average air temperature (a), total rainfall (b) and average relative humidity (c) with average oriental fruit fly captured during 2012.

Host plants relationship: All the possible regular and occasional host plants of the oriental fly around the selected study site were monitored. It was evident that some regular and occasional host plants were planted by the owner of land surrounding their living places. Among the major fruits crops cultivated in the experimental sites, the principal agricultural hosts of *B. dorsalis* were banana, mango, guava, papaya, citrus, cucumber and tomato. Table 2 shows the approximate number of host points of the agricultural habitats where male oriental fruit flies were trapped. The lowest number of host points (60) was found in December and gradually increased, reached in peak (180) during April to June then declined. The result supported the findings of Ye (2001) who reported that oriental fruit fly population was affected with the area of fruit trees, the fruit yield and the fruiting period. In the field without pesticide treatments 50-70% of the cucurbit fruits were infested (Singh *et al*., 2000). The infested fruits in the field may serve as reservoir for continuous presence of the fly if not treated or removed or bagged the infested fruits.

Table 2. Approximate host points of the agricultural habitats where male oriental fruit flies were trapped during 2012

Month	Host points
January	90
February	90
March	150
April	180
May	180
June	180
July	120
August	120
September	120
October	120
November	90
December	60

It is necessary to point out that, hence the cue lure used in the present study only attracts adult male *B. dorsalis*, the fly population studied in the present research was for the male population. Because 1:1 sex ratio for *B. dorsalis* adults the entire population could be estimated based on the size of male adult populations (He *et al.*, 2002).

Development of new larval diet: Larval diet of four different compositions was tested for rearing of oriental fruit fly, *B. dorsalis*. Sweet potato paste was used as the main ingredients in all four compositions of diet supplemented with wheat, rice and soya bran in different ratios. Artificial diet for rearing of *B. dorsalis* was prepared with locally available low cost ingredients. Expensive ingredients like yeast extract, casein hydrolysate, brewer's yeast were not used in the current larval diet. The pH of the larval diet had significant effect on hatching percentage, larval and pupal duration, flier percentage and adult emergence. At pH 4.87-4.89, the highest hatching percentage (83.91%) was observed and the lowest hatching percentage (71.21%) was observed at 6.34-6.36 pH. The highest larval duration was observed at 6.34-6.36 pH and the lowest at both 5.22-5.26 and 4.87-4.89 pH. The highest number of pupae was found at 5.22-5.26 pH and the lowest at 6.34-6.36 pH. Pupal duration was highest at 6.34-6.36 pH and lowest at 5.22-5.26 pH. In case of flier percentage and adult emergence percentage the best performance was observed at 5.22-5.26 pH (Table 3). The result indicates that the diet having 5.22-5.26 pH was found to be economical and suitable for mass rearing. Chan *et al.* (1998) reported that pH at >5.5 was essential to reduce the microbial activity in the diet. Because of the variation of biotic and abiotic factors some time the result do not supports the findings.

The result revealed that warm weather influence the population build-up of oriental fruit fly in Bangladesh. It can be also stated that although the highest hatching percentage was observed from the 4.87-4.89 pH of larval diet 5.22-5.26 pH was found to be economical and suitable for mass rearing of *Bactrocera dorsalis* based on highest number of pupa production, lowest larval and pupal duration, flier percentage and adult emergence percentage

Table 3. Effect of pH on the cost effective artificial diet for oriental fruit fly *B. dorsalis* (Hendel) larvae

pH	Amount of HCl	Hatching percentage	Larval duration	No. of pupae	Pupal duration	Flier %	Adult emergence %
6.34-6.36	0 ml	71.21d	12.00 ±1.00 a	562.7±28.44 b	10.67±0.58 a	79.67 b	79.77 b
5.47-5.50	2.0 ml	77.20 c	11.00 ±1.00 a	852.3±15.53 a	9.667±0.58 b	85.00 ab	80.59 b
5.22-5.26	3.0 ml	81.26 b	8.67 ± 0.58 b	919.3±11.01 a	8.333±0.58 c	90.33 a	86.68 a
4.87-4.89	4.0 ml	83.91 a	8.67 ± 0.58 b	791.7±11.01 a	8.667±0.58c	82.33 ab	81.86 b
LSD(0.05)		1.09	1.2	201.60	0.58	8.45	2.39
CV (%)		0.7	5.96	12.91	3.09	5.02	1.45

Means having the same letter in each column do not differ significantly at $p<0.05$ by DMRT.

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