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SEASONAL VARIATIONS OF MELON FLY, *Bactrocera cucurbitae* (COQUILLETT) (DIPTERA: TEPHRITIDAE) IN DIFFERENT AGRICULTURAL HABITATS OF BANGLADESH

M. Abdul Alim[1], M. Aftab Hossain[2], Mahfuza Khan[2], Shakil A. Khan[2], M. Saidul Islam[2] and M. Khalequzzaman[3]
[1]Departmen of Zoology, Jagannath University, Dhaka, Bangladesh
[2]Insect Biotechnology Division, Institute of Food and Radiation Biology, Atomic Energy Research Establishment, Savar, Ganak bari, Dhaka, Bangladesh
[3]Departmen of Zoology, Rajshahi University, Bangladesh
E-Mail: maalimzooljnu@gmail.com

ABSTRACT

Seasonal variations of melon fly, *Bactrocera cucurbitae* (Coquillett) was monitored in three different agricultural habitats of Bangladesh from January 2007 to December 2008 using cue-lure baited McPhail traps. The study areas were (i) Pubail: a cucurbit vegetables growing area where vegetables are grown at commercial scale from June to August; (ii) Goloar char: a land mass between two rivers where vegetables are grown at commercial scale from January to April; and (iii) Ganakbari: a plain land surrounded by industries and Government offices where vegetables are grown as backyard garden round the year. Abiotic factors including air temperature, relative humidity, rain-fall and biotic factors such as host-plant species were recorded during the study periods. The population of melon fly was prevalent at high level during the two-year surveillance period except in October and November. In both the years, the highest capture was recorded in April to June while the lowest was in October to November. The study showed that the seasonal rise of melon fly population coincided with the air temperature, availability and fruiting period of the host plants. The variations of the melon fly population in two consecutive years (2007 and 2008) showed almost mirror images.

Keywords: melon fly, *Bactrocera cucurbitae*, air temperature, host plants, population, vegetable growing areas.

INTRODUCTION

The melon fly, *Bactrocera cucurbitae* (Coq.) is a polyphagous fruit fly that infests as many as 125 plant species most of them belong to Cucurbitaceae and Solanaceae (Bezzi, 1913; Doharey, 1983; Dhillon *et al*., 2005). The melon flies have been reported as pests from Bangladesh, Pakistan, Nepal, China, New Guinea, the Philippines, Mariana and Hawaii Islands, and most of Southeast Asia. This species has also been reported from Egypt, Kenya and Tanzania (Weems and Heppner, 2001). In infested areas, vegetables may be completely or partially destroyed in terms of commercial values based on the levels of infestation, hence the fly species is considered a serious insect pest, and is classed as an organism subject to quarantine restrictions (Bateman, 1972; Shukla and Prasad, 1985).

In Bangladesh, fruits of melon (*Cucumis melo*), sweet gourd (*Cucurbita maxima*), snake gourd (*Trichosanthes cucumerina, Benincasa hispida*), watermelon (*Citrullus lanatus*), ivy gourd (*Coccinia grandis*), cucumber (*Cucumis sativus, Cucumis trigonus*), white-flowered gourd (*Lagenaria siceraria*), luffa (*Luffa aegyptiaca*) balsam-apple (*Momordica balsamina*), bitter gourd (*Momordica charantia*) etc. are infested by this pest species (Wadud *et al*., 2005; Khan *et al*., 2007; Saha *et al*., 2007). Losses due to this fruit fly infestation were estimated from 10 to 30% of annual agricultural produces in the country (Naqvi, 2005). Understanding the year-round population variations of any insect pest is important for successful control programme. Pheromone traps provide an easy and efficient method to monitor the abundance of fruit fly populations (Alyokhun *et al*., 2000). To monitor the fruit fly population pheromone trappings have been successfully used in different countries (Marwat and Baloch, 1986; Gillani *et al*., 2002). In nature the normal sex ratio of fruit fly is about 1:1. However, a slightly male-or-female-biased population fluctuation of melon fly has been reported during different seasons (Bhagat *et al*., 1998). But the deviation from 1:1 male-female ratio was not significant.

As a prerequisite of the test release of sterile melon fly to suppress the wild population, the current study was undertaken to understand the year-round population level of melon fly in respect to different agricultural habitats, air temperature, rainfall, relative humidity and the availability of host fruits surrounding the study areas.

MATERIALS AND METHODS

Experimental sites

The field survey of *B. cucurbitae* were carried out in three vegetable fields *viz.,* Ganakbari Savar, Dhaka ($23^0$55″N, $90^0$09″E), in Pubail, Gazipur ($23^0$55″N, $90^0$33″E) and in Goloar Char, Kishorgonj ($24^0$16″N, $90^0$40″E) in the year of 2007 and 2008. The three sites were more than 20 km apart from each other. These sites were selected because they represented the major cultivated vegetable crops grown in this region and they were commonly infested by the melon fly as well. Ganakbari, Savar is located at northwest side of Dhaka, the capital of Bangladesh. It is a high plain land with red

hilly soil. Many types of vegetables are cultivated throughout the year in this area. Pubail is located at north and south side of Dhaka and Gazipur district, respectively. It is a waved land with red fertile soil. The cucurbit vegetables are cultivated in this area at large scale mainly in the month of June to August. But all other seasons some vegetables of cucurbit group cultivated at domestic premises. Goloar Char is located southwest side of Kishorganj district. It is a land mass between two rivers which remain under water during seasonal flood. The cucurbit vegetables are cultivated in this area at large scale mainly in the month of January to April. But all other seasons some domestic cultivation has been occurred.

Fly trapping

At each experimental site four McPhail traps were set at approximately 100 m distances in the field and inspected every fortnightly. Each trap was placed on bamboo poles at a height of 1m above the ground. A parapheromone lure (cue-lure) stick was suspended inside each trap, near the center. The parapheromomne lure stick is consisted of a small cotton rope impregnated with 2 ml of cue-lure [4-(*p*-acetoxyphenyl)-2- butanone] (Safe Agriculture Bangladesh Ltd. (SABL)). A cotton ball soaked with 4% sevin-solution (contact poison of ACI. Limited, Bangladesh) was placed inside each trap as insect killer, which was replaced at 15 days intervals throughout the year. Male flies were attracted by the lures, and were quickly killed with the insecticide on the cotton ball. The flies of *B. cucurbitae* species were identified and counted in each trap at 15 days intervals. Trap capture rates were calculated based on four traps in each site.

Meteorological data

The monthly meteorological data (Table-1 and Table-2) used in the present study provided by the Center of Meteorological Department, Dhaka, Bangladesh.

Data interpretation

The trapped flies were removed from the traps and counted after every fortnight. Month-wise mean (±se) number of *B. cucurbitae* captured from each experimental site was also counted and recorded to observe the differences in population. Correlation analysis was carried out for the monthly capture rates of *B. cucurbitae* and three monthly climatic factors: mean temperature (X_1), mean relative humidity (X_2), and total rainfall (X_3) in two study years.

RESULTS

Seasonal fluctuation of fruit flies in Goloar char

The seasonal occurrence of male flies in Galoar char has been presented in Table-1 and Table-2. The results showed that the flies were available throughout the years. The fly catch rate was lower from October to March. The highest average male fly capture was observed in May (381.37±22.40 and 472.62 ±42.63) for both the years and the lowest was in November for 2007 (19.12 ±3.01) and in October for 2008 (18.37±4.37). Higher fly population (>100 fly per trap) was observed from April to August with a sharp single peak in May. The annual capture of flies in two successive years of study (2007 and 2008) from Goloar char was more or less similar.

Seasonal fluctuation of fruit flies in Pubail

The seasonal occurrence of male flies in pubail has been presented in Table-1 and Table-2. A high level (>100 per trap) of fly population was observed in Pubail with a steady peak in June for 2007 and 2008. From November to February, the fly catch rate was lower in Pubail. In October 2007, the fly capture rate was much higher (162.37±10.42) than in 2008 (27.2±2.3). Except in the month of May 2007, the fluctuation pattern of fly population in Pubail was closely identical during 2007 and 2008.

Seasonal fluctuation of fruit flies in Ganakbari

The seasonal occurrence of male flies in Ganakbari has been presented in Table-1 and Table-2. The highest average male flies capture was observed in June (278.00 ±26.65) for 2007 and for 2008 it was in April (251.62±25.73). Average lower catch rate of the flies from August to November in 2007 and July to November in 2008. Except shifting the peak population the pattern of fluctuation was closely identical during 2007 and 2008 study periods.

Table-1. Mean (±se) capture of adult male *B. cucurbitae* from tree experimental areas and average air temperature, relative humidity, and rainfall in 2007.

	Average fly captured per trap			Average Tem^{0}C	Average RH %	Total rainfall (mm)
Month	**Ganak Bari**	**Pubail**	**Goloar Char**			
Jan'07	178.75±10.79	79.62 ±3.69	71.25 ±2.13	18.0±7.3	68 ±1.54	0
Feb'07	202.00 ±11.54	86.25 ±7.86	79.37 ±4.71	21.5±5.9	68±5.23	30
Mar'07	179.37 ±17.16	161.50 ±11.64	97.25 ±5.91	25.4±5.7	54±7.65	11
Apr'07	265.75 ±32.03	292.37 ±40.97	248.75 ±41.41	28.1±4.2	69±8.76	163
May'07	209.00 ± 19.39	224.50 ±17.71	381.37 ±22.40	30.0±3.6	70±7.57	185
June'07	278.00 ±26.65	388.75 ±50.34	259.00 ±35.60	28.7±3.1	81±6.89	628
July'07	99.37 ±16.75	298.50 ±21.4	175.25 ±13.84	28.2±3.9	84±7.64	753
Aug'07	67.62 ±8.29	226.50 ±20.66	116.00 ±8.73	29.1±3.2	80±4.65	505
Sep'07	76.50 ±6.43	229.00 ±16.31	83.75 ±8.54	28.7±2.8	80±3.56	179
Oct'07	55.62 ±6.88	162.37 ±10.42	29.12 ±5.54	27.1±3.7	78±5.75	320
Nov'07	65.37 ±8.44	43.50 ±7.38	19.12 ±3.01	23.9±4.4	77±7.54	111
Dec'07	117 ±15.34	37.25 ±7.16	51.87 ±6.92	19.8±4.5	69±1.36	0

Table-2. Mean (±se) capture of adult male *B. cucurbitae* from tree experimental areas and average air temperature, relative humidity and rainfall in 2008.

	Average fly captured per trap			Average Tem^{0}C	Average RH %	Total rainfall (mm)
Month	**Ganak Bari**	**Pubail**	**Goloar Char**			
Jan'08	169.37 ±10.11	71.87 ±6.4	64.00 ±4.7	19.0± 3.2	69±6.3	23
Feb'08	180.75 ±8.76	81.12 ±5.14	71.37 ±3.49	20.3±2.3	61±5.2	56
Mar'08	155.62 ±23.91	111.25 ±22.46	77.62 ±12.87	26.6±3.5	67±6.3	45
Apr'08	251.62 ±25.73	221.37 ±32.93	341.75±61.43	29.2±4.2	64±6.8	91
May'08	180.62 ±19.16	262.00 ±12.45	472.62±42.63	29.3±3.6	70±8.6	205
June'08	150.12 ±38.83	319.37 ±47.67	236.25±19.39	28.7±3.2	80±5.3	577
July'08	63.25 ±6.63	257.50 ±15.06	126.12 ±10.9	28.3±3.2	81±8.2	563
Aug'08	64.00 ±6.43	194.50 ±6.74	99.00 ±12.82	29.2±1.2	80±3.5	205
Sep'08	63.25 ±3.76	150.62 ±9.6	71.87 ±5.89	28.5±1.8	81±4.9	345
Oct'08	35.87 ±4.38	24.50 ±5.18	18.37 ±4.37	27.2±2.3	62±5.6	0
Nov'08	69.25 ±15.43	16.12 ±2.5	20.00 ±2.77	22.6±2.5	64±4.6	0
Dec'08	123.62 ±11.57	58.62 ±3.73	42.50 ±3.8	20.3±2.4	67±6.7	0

Relationship with climatic factors

Air temperatures, rainfall, and relative humidity

The coefficient of correlation analysis between monthly capture of male flies and air temperature in Pubail shows positive correlation (R^2 values were 0.644 and 0.501 for 2007 and 2008, respectively). However, no correlation between the capture of male flies and air temperature was observed in Ganakbari and Goloar char areas for the two study years (Figure-1).

A positive correlation between fly capture and rainfall was observed in only Pubail (R^2 = 0.576, 0.671), but not in other two experimental sites (Goloar char or Ganakbari). For monthly fly capture and the role of humidity, no correlation was observed during the study periods (Figure-1).

The combined fly capture data from all the study sites were subjected to correlation regression analysis with the climatic factors and we did not find any relationships between the population fluctuation and climatic factors (Figure-1).

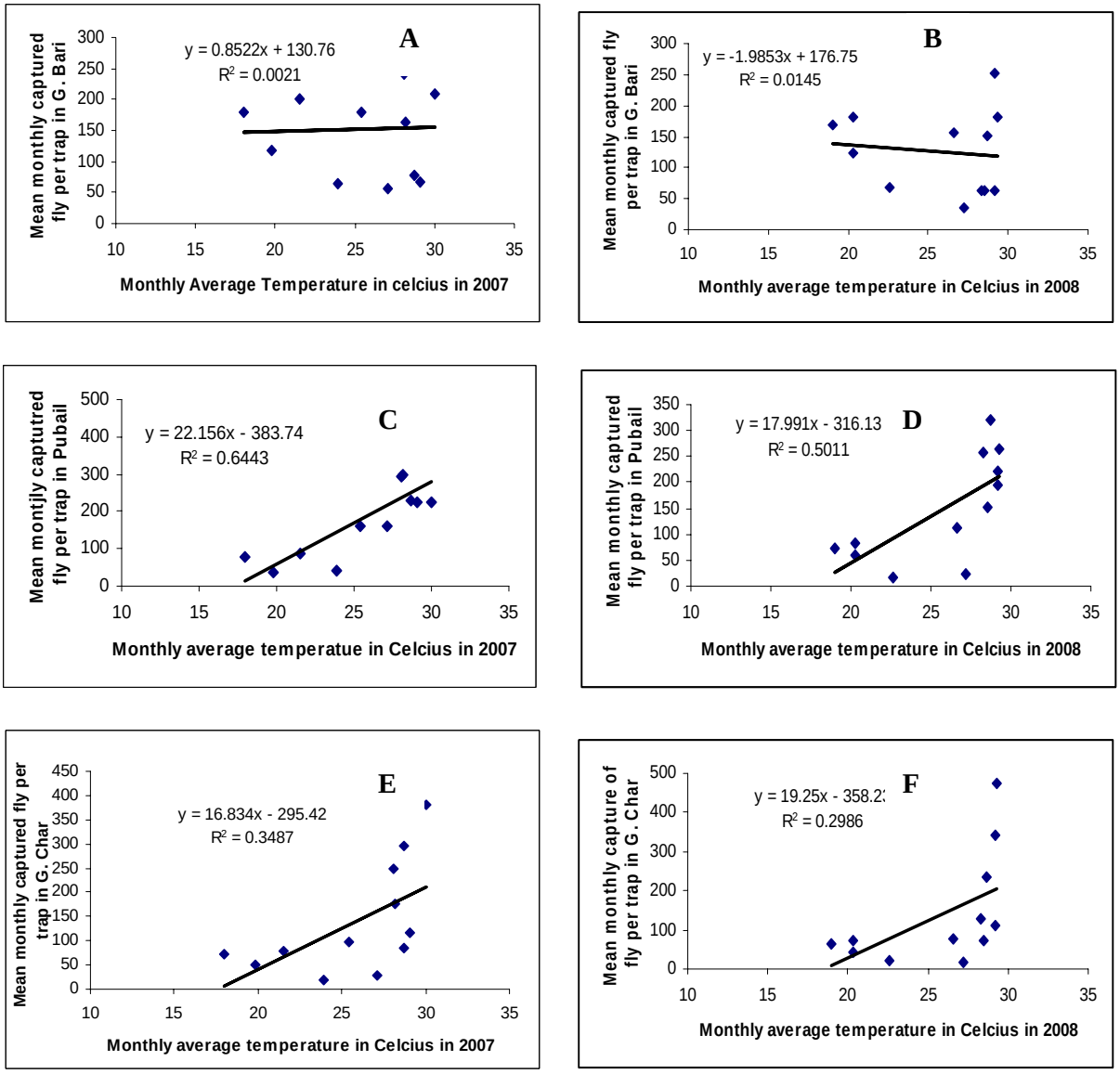

Figure-1. Linear regression analysis and correlation of mean monthly capture of *B. cucurbitae* per trap from three selected areas during 2007 and 2008.

Host plants

All the possible regular and occasional host plants of the melon fly around the selected study sites was monitored (Table-3). It was evident that some regular and occasional host plants were planted by the owner of land surrounding their living places. The principal host fruits of *B. cucrbitae* include sweet gourd, bitter gourd, cucumber, luffa; snake gourd and tomato are among the major fruit crops cultivated in three experimental sites. However, sweet gourd is most widely planted host mainly from March to June in all experimental sites.

Table-3. Principle vegetable hosts during cultivation period for *B. cucurbitae* in three experimental sites.

Month	Ganak Bari	Pubail	Goloar char
January	Tomato, bottle gourd, bean.	Tomato, bottle gourd, bean	Tomato, bottle gourd, sweet gourd, bean
February	Tomato, bottle gourd, bean,	Tomato, bottle gourd, bean, sweet gourd,	Tomato, bottle gourd, sweet gourd, bean
March	Bottle gourd, sweet gourd, bean, Luffa. bitter gourd	Tomato, bottle gourd, bean, sweet gourd,	Bottle gourd, sweet gourd, snake gourd, white gourd, bitter gourd
April	Sweet gourd, bean, Luffa, cucumber, snake gourd, white gourd, bitter gourd	Sweet gourd, bottle gourd,	Bottle gourd, sweet gourd, snake gourd, white gourd, bitter gourd
May	Sweet gourd, Luffa, cucumber, snake gourd, white gourd, bitter gourd	Sweet gourd, bottle gourd,	Bottle gourd, sweet gourd, snake gourd, white gourd, bitter gourd cucumber,
June	Sweet gourd, Luffa, cucumber, snake gourd, white gourd, bitter gourd	Sweet gourd, Luffa, snake gourd, bitter gourd	Sweet gourd, Luffa, cucumber, snake gourd, white gourd,
July	Luffa, cucumber, snake gourd, white gourd,	Sweet gourd, Luffa, cucumber, snake gourd, white gourd, bitter gourd	Sweet gourd, Luffa, cucumber, snake gourd white gourd,
August	Luffa, cucumber, snake gourd, white gourd,	Sweet gourd, Luffa, cucumber, snake gourd, white gourd,	Sweet gourd, Luffa, cucumber, white gourd,
September	Luffa, cucumber, snake gourd, white gourd,	Sweet gourd, Luffa, cucumber, snake gourd, white gourd,	----------
October	Luffa, cucumber, snake gourd, white gourd,	Bottle gourd	Bottle gourd,
November	Bottle gourd	Tomato, bottle gourd, bean.	Tomato, bottle gourd, bean.
December	Tomato, bottle gourd, bean.	Tomato, bottle gourd, bean.	Tomato, bottle gourd, bean.

DISCUSSIONS

The present study demonstrates that *B. cucurbitae* occurs throughout the year but the abundance of the fly species is higher from March to July. The patterns of population fluctuations of adult male *B. cucurbitae* in three selected areas were almost identical in 2007 and 2008 suggesting the factors influencing *B. cucurbitae* population were not changed greatly between years. The meteorological data collected from the Meteorological Office at Dhaka also reflects the fact the weather conditions in two successive years (2007 and 2008) were very similar. We observed that the population of melon fly started to increase at the beginning of summer and started to decline after summer season in Pubail and Goloar char commercial vegetable growing areas. However, the melon fly population in Ganakbari areas were found to increase at the beginning of winter remained high during the summer season and dropped in July. Our experimental result is partially similar with the findings of Makhmoor and Singh (1998) who reported that peak population (170.66 males/trap/week) of guava fruit fly, *Dacus dorsalis* was observed in July in Indian occupied Kashmir area. According to the author the population of *D. dorsalis* appeared in February, started increasing in March and reached 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 in Kunming China, *B. dorsalis* occurs only from May through November, with high abundance in July of each year. Ye (2001) stated that in China *B. dorsalis* was probably only present in the warm month of each year. Air temperature was reported as a crucial factor which influences *B. cucurbitae* and *B. dorsalis* occurrence (Vargas *et al*., 1996; Ye, 2001; Chen and Ye, 2007). In the present study sites we did not find any relationship of fly capture and the relative humidity. When correlation of air temperature and rain fall with the fly capture were analyzed independently for the study areas showed a moderately positive relationship of air temperature and the fly capture in Pubail and Goloar char area. Similarly a positive correlation between fly capture and rainfall was observed only in Pubail area, but not in other two experimental sites. The three study sites were all in plain land and located three different districts of Bangladesh. The meteorological data were same for all the study sites.

Therefore, we combined all the data of fly capture from all the study areas and subjected to correlation analysis with the climatic factors and we did not find any climatic relationships and the melon fly population fluctuation. Bangladesh is a tropical country and the air temperature remains quite high in summer but not very cold in winter. The optimal temperature for the development of *B. cucurbitae* ranged from 20°C to 28°C (Vargas *et al*., 1996, Wu *et al*., 2000). Studies on the population dynamics of *C. capitata* have shown that the main factor affecting population build up in the tropics is fruit abundance and availability, whereas in temperate areas low winter temperatures also play a major role (Vargas *et al*., 1983; Nishida *et al*., 1985; Harris *et al*., 1993; Israely *et al*., 1997; Katsoyannos *et al*., 1998; Papadopoulos, 1999). The presence of abundant backyard garden cucurbit vegetables during winter season in Ganakbari area was responsible for the presence of high level melon fly population. Ye (2001) reported that the area planted with fruit trees, the fruit production yields, and the fruiting period can all affect oriental fruit fly population size. In the field without pesticide treatments 50-70% of the cucurbit fruits were infested (Gupta and Verma, 1978; Singh *et al.*, 2000). The infested fruits in the field may serve as reservoir for continuous presence of the fly if not treated the fruits or removed or bagged the infested fruits.

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

In conclusion it may be stated that the presence of cucurbit hosts is crucial to build up the population size of melon fly in all the study sites. We also observed that warm weather influence the population build-up of melon fly in Bangladesh.

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