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Short Communication

SEASONAL ABUNDANCE AND INFESTATION OF FRUIT FLY ON CUCUMBER

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ABSTRACT

Population dynamics and infestation of fruit fly, *Bactrocera cucurbitae* Coquillett (Diptera: Tephritidae) was monitored on cucumber, *Cucumis sativus* using methyl eugenol trap during summer and autumn in 2017 at Gazipur, Bangladesh. Relationship between the abundance of fruit fly and meteorological factors was also studied. The fruit fly showed significantly higher abundance in summer compared to autumn. The larval population per fruit was found higher in summer (24.9 fruit^{-1}) than that in autumn (1.5 fruit^{-1}). The daily mean temperature had significant positive, light intensity had insignificant positive, relative humidity had insignificant negative and rainfall had insignificant negative correlation with fruit fly abundance. The temperature, light intensity, relative humidity and rainfall individually contributed to fruit fly abundance of 14.1 %, 24.0 %, 0.8 % and 1.8 %, respectively. The combined effect of the weather parameters on fruit fly abundance was 40.7 % and the equations were insignificant. The fruit fly showed significantly lower level of infestation in methyl eugenol treated plots as compared to controls in both summer and autumn.

Keywords: *Bactrocera cucurbitae, Cucumis sativus,* Methyl eugenol, Population dynamics, Weather factors

INTRODUCTION

The cucumber, *Cucumis sativus,* is a widely cultivated plant in the gourd family Cucurbitaceae which is one of the monoecious annual crops cultivated by man for over 3,000 years (Enujeke, 2013). It is the fourth most important vegetable after tomato, cabbage and onion in Asia and the second most important vegetable after tomato in Western Europe (Azad et al., 2013). The cucurbits are major groups of vegetable in Bangladesh which occupied 66.0 % of the land under vegetable production and contribute 11.0 % of total vegetable production (IPM CRSP, 2004).

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In 2014-2015 cropping year, 63.9 thousand MT cucumber was produced in Bangladesh (BBS, 2015).

The fruit fly, *Bactrocera cucurbitae* Coquillett (Diptera: Tephritidae) is the most destructive insect pest of cucurbits in Bangladesh and also in tropical and subtropical regions. The extent of yield loss caused by the fruit fly to cucurbitaceous vegetables ranged from 30 to 100 %, depending upon cucurbit species and the season (Nath and Bhusan, 2006). Fruit flies reduce yield as well as the quality of fruit (IPM CRSP 2004).

The activity of the fruit flies depends mostly on the prevailing climatic conditions and the host species. Amin et al. (2011) reared fruit fly *B. cucurbitae* on five cucurbitaceous vegetables and observed that the sweet gourd was the most favorable host. Fruit fly caused up to 24.0 % of yield loss to cucurbits in Pakistan whenever the crops were cultivated without management practices (Stonehouse et al., 1998).

Fruit flies are considered as the main obstacle for economic production of cucumber in Bangladesh. Management of this pest is very difficult using chemical insecticides due to their larval internal feeding behavior. The purpose of the present study was to monitor fruit fly population in cucumber field during summer and autumn, to know the effect of methyl eugenol trap on fruit infestation of cucumber, and to determine the effect of meteorological factors such as temperature, light intensity, relative humidity and rainfall on the population dynamics of fruit fly.

MATERIALS AND METHODS

Study area

The study was conducted in the field of the Department of Entomology, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur, Bangladesh from March to May 2017, and from June to August 2017. The area is located at 25°25′ North latitude and 89°5′ East longitude, and has a sub-tropical climate.

Experimental design and cultivation of cucumber

The cucumber plants were cultivated in six plots following completely randomized design with plot size of 4.0 × 4.0 m. The spacing between two plots was 1.0 m. The plots were separated by cultivation of maize as a fence. Fertilizers were applied according to the fertilizer recommendation guide (BARC, 2012) (N 70 kg ha^{-1}, P 22 kg ha^{-1}, K 100 kg ha^{-1}). The subsequent two sowing were done in each plot on March 03, 2017 for the summer and June 02, 2017 for the autumn. All the plots contained three rows and each row had 5 pits which were 60 cm apart from each other. After emergence of seedlings the plants were supported by bamboo scaffold to facilitate creeping. Intercultural operations were done whenever necessary.

Observation of fruit fly abundance and fruit infestation

Abundance of adult fruit fly was monitored using methyl eugenol trap (Ispahani Biotech, Gazipur, Bangladesh) during the fruiting stage of the cucumber plants. The traps were set in three plots according to the method of Khan and Naveed (2017). Only one trap was set in each plot to catch male flies. Remaining three plots were kept free from traps and these plots were considered as control treatments. Monitoring was done from 7th to 23rd April for summer and from 7th to 23rd July for autumn cultivation. The traps were checked on every fourth day interval and the number of males caught in each trap was counted. At every inspection, the number of fruits per plot and number of infested fruits per plot were counted and percent fruit infestation was calculated. The infested fruits were brought to the Entomology Laboratory of BSMRAU to know the population of larvae inside the fruit. Number of larvae per fruit was recorded from the infested fruits of every inspection and five fruits were investigated for each season.

Collection of weather data

Light intensity was measured with a digital light meter (Model 401025, Extech Instruments Corporation, USA) throughout the fruiting period. Data were collected on every fourth day interval between 10.00-11.00 h of the day-time at the canopy area of the plants. Data on mean daily temperature, relative humidity and rainfall were collected from the weather station of BSMRAU which is located at the close proximity of the experimental site.

Data analysis

One-way analysis of variance (ANOVA) followed by Tukey's Posthoc was used for analyzing infestation levels. Comparisons were made between summer and autumn with the number of the abundance of fruit fly and number of larvae per fruit using a Student's t-test (paired sample). Linear regression and step-wise multiple regression analysis of different climatic parameters to fruit fly abundance were calculated. All the analyses were performed by using IBM SPSS 19.0.

RESULTS AND DISCUSSION

The fruit fly population in summer and autumn varied from 21-34 and 10-19/ trap/ 4-days, respectively (Table 1). In summer, the highest number of fruit fly catch was recorded on 11th April and the lowest number on 7th April. In autumn, the fruit fly showed the highest abundance on 15th July and lowest on 11th July. The mean abundance of the fruit fly in summer and autumn were 26.0±2.5 and 14.2±1.7/trap/4-days, respectively and the results differed significantly (Figure 1; $t_4 = 3.5$, $P < 0.05$). The mean larval population in the infested fruit of summer and autumn were 24.9 ± 7.5 and 1.5 ± 0.5/fruit, respectively and the results differed significantly (Figure 2; $t_4 = 11.1$, $P < 0.05$).

Table 1. Abundance of the fruit fly on cucumber and meteorological data during April to July (summer and autumn) 2017 at Gazipur, Bangladesh

Observation date	Mean adult fly population	Mean temperature (°C)	Light intensity (lux)	Relative humidity (%)	Rainfall (mm)
07 April	21	28.0	446	77	0.0
11 April	34	31.5	473	79	0.0
15 April	23	29.5	345	78	0.0
19 April	30	30.0	320	85	3.3
23 April	22	28.0	280	86	16.9
07 July	12	28.0	242	92	8.4
11 July	10	28.5	210	92	45.5
15 July	19	31.3	345	85	3.3
08 July	17	31.0	354	85	2.9
23 July	13	30.5	232	78	16.9

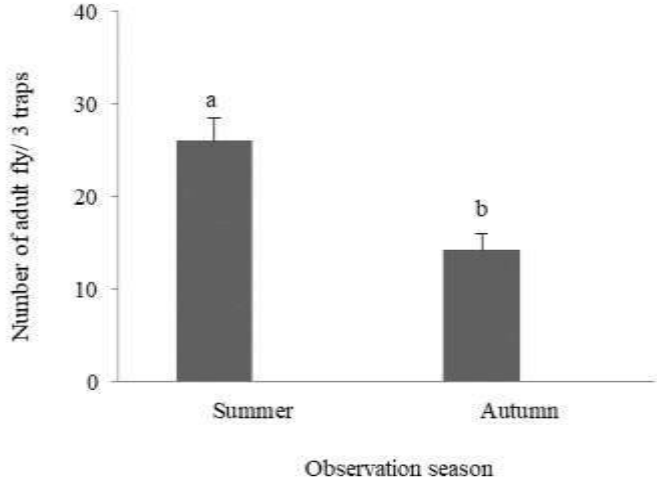

Figure 1. Abundance of fruit fly in the cucumber field during April to July (summer and autumn) 2017 at Gazipur, Bangladesh. Data expressed as mean ± SE. Bars with no common letter(s) are significantly different by Student's paired t-test at $P < 0.05$.

The incidence of fruit fly was associated with reproductive stage of the plants. Variations in weather conditions and time of the season also have affected population dynamics of the flies. The peak in the fruit fly population coincided with tender fruits. The presence of fruiting duration and age of fruit can have significant effects on the fruit fly abundance (Ye, 2001). High temperature, long period of sunshine, and plantation activity influenced the *B. cucurbitae* abundance (Lee et al., 1992). Seasonal variations of the weather factors play a vital role in multiplication, growth, development and distribution of insects, and influence on their population

dynamics (Dhaliwal and Arora, 2001). Weather parameters have significant effect on the population dynamics of fruit fly and temperature and rainfall are reported as the most important factors (Khan et al., 2003).

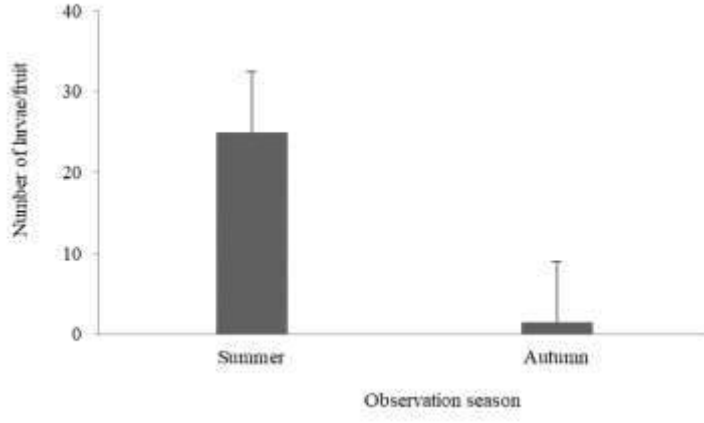

Figure 2. Number of fruit fly larvae found in infested fruit of cucumber during April to July (summer and autumn) 2017 at Gazipur, Bangladesh. Data expressed as mean ± SE number fruit $^{-1}$ Bars with no common letter (s) are significantly different by Student's paired t-test at $P < 0.05$.

The daily mean temperature had significant positive correlation ($y = -39.85 + 2.023x$, $r = 0.375$, $F_{1, 8} = 1.3$, $P < 0.001$), light intensity had insignificant positive correlation ($y = -0.9416 + 0.0648x$, $r = 0.747$, $F_{1, 8} = 4.4$, $p= 0.058$), relative humidity had insignificant negative correlation ($y = 75.89- 0.6665x$, $r = 0.4893$, $F_{1, 8} = 2.5$, $p= 0.15$) and rainfall had insignificant negative correlation ($y = 23.32 - 0.332x$, $r= 0.61$, $F_{1, 8} = 1.6$, $p= 0.301$) with fruit fly abundance (Figure 3).

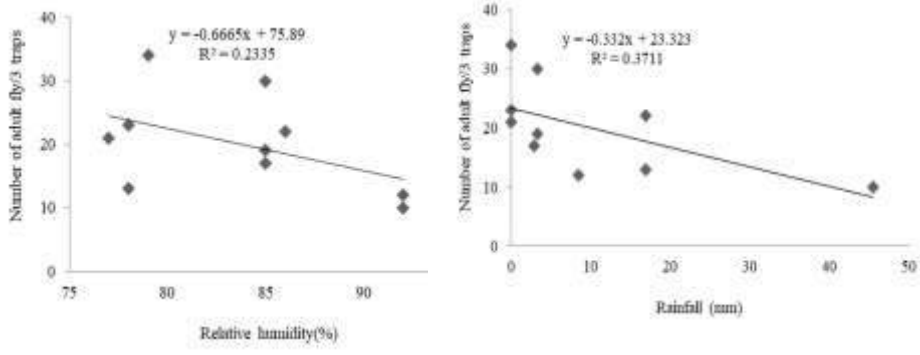

Figure 3. Relationship between climatic parameters and adult fruit fly abundance in cucumber plantation during April to July (summer and autumn) 2017 at Gazipur, Bangladesh.

Table 2 showed that temperature individually exerted 14.1 % population abundance of fruit fly and its effect was significant. The temperature in combination with light intensity revealed 38.1 % abundance, which was statistically insignificant. The individual effect of light intensity demonstrated 24.0 % abundance. The combined effect of temperature, light intensity and relative humidity (RH) depicted 38.9 % abundance and the result was statistically insignificant. The individual effect of RH was 0.8 %. The individual contribution of rainfall on fruit fly abundance was 1.8 %. The multiple linear regression analysis showed that all the weather parameters together contributed 40.7 % abundance of fruit fly and equation was insignificant.

Table 2. Multiple regression models along with coefficients of determination (R^2) regarding impact of weather parameters on the seasonal abundance of fruit fly on cucumber from April to July (summer and autumn) 2017 at Gazipur, Bangladesh

Regression equation	R^2	% Role of Individual factor	F statistic	
$Y = -39.852+2.023X_1$	0.141	14.1	$F_{1, 8} = 1.3$	$P < 0.001$
$Y = 83.324 -2.278X_1 +0.026X_2$	0.381	24.0	$F_{2, 7} = 4.40$	$P = 0.06$
$Y = -18.88 +0.672X_1 +0.061X_2 -0.007x_3$	0.389	0.8	$F_{3, 6} = 2.5$	$P = 0.16$
$Y = -16.175+ 0.597X_1 + 0.054X_2 +.022X_3 7-0.074X_4$	0.407	1.8	$F_{4, 5}= 1.62$	$P = 0.30$

Y, insect population/trap/observation; X_1, temperature (^oC); X_2, light intensity (lux); X_3, relative humidity (%); X_4, rainfall (mm)

Khan and Naveed (2017) observed weak positive correlation between fruit fly population and temperature and no correlation with sunshine hours and relative humidity. Win et al. (2014) reported a positive correlation of minimum temperature with fruit fly abundance. Similarly, positive correlation of the fruit fly with temperature was reported by Kannan and Venugopala (2006). Gillani et al. (2002) investigated the abundance of guava fruit fly *Dacus dorsalis* and reported that the pest appeared in the field in April and reached to the maximum population in August, and coincided with the guava fruiting season.

Fruit infestation level varied from 16.7 ± 4.2 to 67.2 ± 4.3% (Figure 4) and the results differed significantly ($F_{3, 16} = 42.32$, $p < 0.05$).

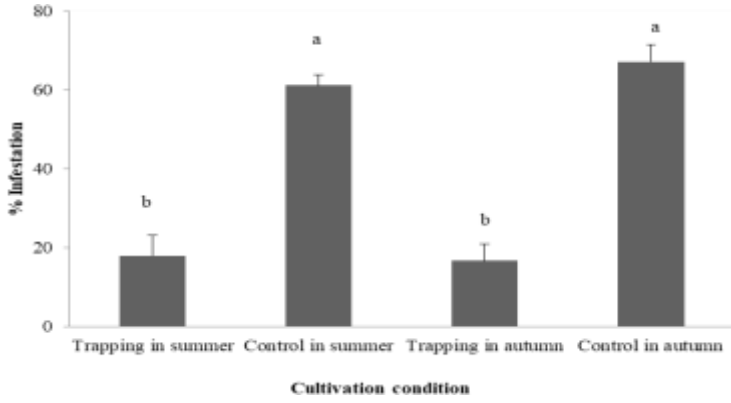

Figure 4. Effect of methyl eugenol trap on fruit infestation of cucumber by fruit fly during April to July (summer and autumn) 2017 at Gazipur, Bangladesh. Data expressed as % mean ± SE. Bars with common letter(s) are not significantly different by Tukey post hoc statistic at $p < 0.05$.

The highest and lowest levels of infestation were observed in summer when the cucumbers were cultivated under control and trapping condition, respectively. The fruit fly *B. cucurbitae* caused 21.0 to 71.5 % infestation on different cucurbitaceous crops in Bangladesh (Amin et al., 2011). Atwal and Dhaliwal (2005) reported that fruit fly caused 30 to 100 % damage on cucurbits in India (Gupta and Verma, 1992; Dhillon et al., 2005). Infestation levels of fruit fly depend on the environmental conditions and susceptibility of crop species. Chen and Ye (2006) reported that the temperature reflects infestation patterns of *B. dorsalis.*

CONCLUSION

Based on the findings of the current study, it is evident that fruit fly population in the cucumber field is strongly influenced by temperature, which could be an indication for selection of proper time for cultivation. Besides, methyl eugenol trapping could be a tactics for management of this pest as it exerted significantly lower level of infestation.

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