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SEASONAL ABUNDANCE OF THE FRUIT FLY IN A MANGO BASED AGROFORESTRY

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ABSTRACT

The study was conducted with a view to understanding the seasonal abundance of fruit fly in a mango based agroforestry of Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh during February to September 2017. Two species of fruit fly namely *Bactrocera dorsalis* and *B. tryoni* were found in the mango based agroforestry. Abundance of the fruit fly species were significantly higher in February to May (dry season) compared to June to September (rainy season). The daily mean temperature, relative humidity and rainfall had significant negative and light intensity had significant positive correlation with fruit fly abundance. Individually temperature, light intensity, relative humidity and rainfall contributed 29, 42.4, 2.8 and 12.5% abundance, respectively. The combined effect of the weather parameters on fruit fly abundance was 86.7% and the equations were significant.

Keywords: Seasonal abundance**,** fruit fly, *Mangifera indica,* population dynamics, weather parameters.

INTRODUCTION

Mango *Mangifera indica* L. is one of the most popular fruit in the tropical and subtropical countries like Bangladesh, India, Pakistan, South China and Malaysia (Joshi and Kumar 2012). Mango fruit is highly nutritive having attractive appearance and very popular to growers and consumers (Matin *et al*. 2008, Rathore *et al.* 2013). In the tropical and subtropical regions, mango trees have been introduced in the agroforestry system as upper storied crop because of its sparse foliage, which permits adequate light penetration for under storied intercrops (Musvoto and Campbell 1995).

Insect infestation is one of the major constraints of mango production in Bangladesh and other tropical and subtropical countries. The fruit flies are known

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to be the most notorious insect pest of mango. In Asia, two species of fruit flies viz., *Bactrocera dorsalis* and *Bactrocera tryoni* are predominant in mango. The female flies lay eggs under the skin of the fruits and cause direct losses (Isabirye *et al.* 2015). The eggs hatch into larvae that feed on the decaying flesh of the fruit. Infested fruit rot quickly and become inedible or drop to the ground. Besides the direct damage to fruit, indirect losses are associated with quarantine restrictions, because infestation and sometimes the mere presence of the flies in a particular country could restrict the trade and export of fruit to markets abroad (Bissdorf and Weber 2005).

Seasonal abundance is a common phenomenon among insects. Insect abundance can change over time for a variety of reasons including macroclimatic and microclimatic changes, variation in the availability of host and natural enemies. Seasonal variations of the weather factors play an important role in multiplication, growth, development and distribution of insects, and influence on their population dynamics (Dhaliwal and Arora 2001).

Seasonal changes in mango fruit fly populations have been studied in many countries (Mwatawala *et al.* 2006, Vayssieres *et al.* 2014). Information on seasonal population dynamics of any insect pest is a prerequisite for forecasting and development of its integrated management program. But there is limited information on the seasonal abundance of fruit fly in Bangladesh, especially when the mango has been cultivated as an agroforestry crop. Therefore, the objectives of the study were to identify the fruit fly species which are abundant in the mango based agroforestry in Bangladesh, their seasonal abundance and relationship between their abundance and weather factors.

MATERIALS AND METHODS

Study site: The study was conducted in the Agroforestry field of Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur, Bangladesh during February to September 2017. The study site is located in the middle of Bangladesh (25°25′ North latitude and 89°5′ East longitude). The site is surrounded by sal *Shorea robusta* forest. The area of the agroforestry is 1000 m^2 having 11 years old, 7 m apart, and 3-4 m height mango trees (variety Amrapali), guava (variety IPSA peyara 3) and lichi (variety bombai) orchard, some ornamental plants and jackfruit trees.

Climatic conditions: The study area has a subtropical climate characterized by a well-defined dry season (February to May), rainy season (June to September) and short winter (December and January). Annual mean maximum and minimum temperatures, relative humidity and rainfall are 36.0 and 12.7 ^{o}C, 65.8% and 237.6 cm, respectively.

Installation of fruit fly trap and collection of insect: To assess the seasonal changes of fruit fly abundance, sampling protocol was targeted on free-living male insects. Methyl Eugenol trap was used to capture male fruit flies. The trap was made from transparent plastic bottles of approximately 1 liter capacity. Two holes were cut, one in the lid and the other exactly the opposite to facilitate the entry of fruit flies. The holes were fitted with a PVC (Polymerizing Vinyl Chloride) pipe of about 1.5 cm diameter with a length of 8 cm. The lure was suspended exactly in the center. Ten traps were suspended from the branches of the fruit trees randomly about 1m above the soil surface. Five traps were hung in the mango based agroforestry area and each trap represented a replication. Every seven days interval the captured male fruit flies in each trap was counted and the traps were replaced by new traps.

Identification of fruit fly species: The collected male fruit flies were brought from the experiment field to the Entomology Laboratory of BSMRAU. The insects were killed by storing in a freezer for a few hours, mounted on points, dried and identified. Male *B. dorsalis* possessed two horizontal black stripes and a longitudinal median stripe extending from the base of the third segment to the apex of the abdomen, and the markings formed a T-shaped pattern, whereas *B. tryoni* lack of median dark stripe on the abdominal tergites and T-shaped marking.

Collection of weather data: Light intensity was measured with a digital light meter (Model 401025, Extech Instruments Corporation, USA). Data were collected fortnightly interval between 10.00 and 11.00 am at the canopy area of the trees. Mean daily temperature, relative humidity and rainfall data were collected from the weather station of BSMRAU.

Statistical analysis: One way analysis of variance (ANOVA) followed by Tukey posthoc statistics was employed for analyzing abundance of the species. Correlation coefficients were calculated for total abundance with meteorological parameters. All the analyses were performed using IBM SPSS 21.0 (IBM SPSS statistics 21, Georgia, USA).

RESULTS AND DISCUSSION

The present study showed that the mean abundance of the fruit fly in the mango based agroforestry during the study (February to September) ranged from 3.3±1.3 to 39.6±3.9 per trap per week (Fig. 1) and the results differed significantly ($F_{3, 28}$ = 25.3, $p< 0.001$). In dry season (February to May), the abundances of *B. dorsalis* and

B. tryoni were 39.6±3.9 and 28.6±4.9 per trap per week, respectively. In wet season (June to September), their abundances were 7.5±2.3 and 3.3±1.3 per trap per week, respectively (Fig. 1).

The variations of the meteorological conditions, blooming flowers and availability of the tender fruits during the study affect the population dynamics of the pest. In the present study, the abundance of both the species of fruit fly were significantly higher during dry season because of the availability of host plants, blooming and fruiting season of mango, and may be the lower abundance of the natural enemies. Ye and Liu (2005) reported that *B. dorsalis* infestations occurred seasonally, mostly appeared when temperature was sufficiently high, from late spring to mid-autumn in Yunan, China. Bangladesh is a subtropical country and the air temperature remains quite high in summer but not very cold in winter. 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 (Katsoyannos *et al*. 1998).

Weather factors, particularly temperature and rainfall are the main parameters influencing the distribution of the fly. Chen and Ye (2006) reported that the

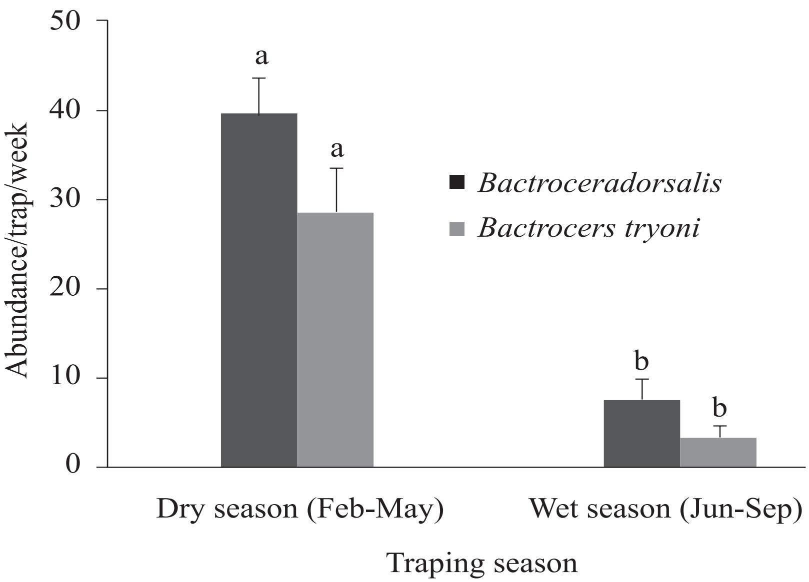

Fig. 1. Abundance of fruit fly species in a mango based agroforestry in Bangladesh during dry (February to May) and wet (June to September) seasons. Data expressed as mean ± SE. Bars with common letter(s) are not significantly different by Tukey HSD posthoc statistic at $p \leq 0.05$

temperature affected infestation patterns of *B. dorsalis.* In the present study, the daily mean temperature had significant negative correlation (Fig. 2. y = 178.779 – 5.545x, r = 0.845, $F_{1, 14}$ = 34.950, p<0.001), light intensity had significant positive correlation (Fig. 3. y =-33.547 + 0.161x, r = 0.384, $F_{1, 14}$ = 10.360, p=0.006), relative humidity had significant negative (Fig. 4. y =255.454- 2.682x, r = 0.534, $F_{1, 14}$ = 5.591, p = 0.033) and rainfall had significant negative correlation (Fig. 5. y = 47.943 -7.248x, r = 0.531, $F_{1, 14}$ = 5.497, p=0.034) with fruit fly abundance.

It was reported that infestation of *B. dorsalis* reflected with local temperature (Liu and Yeh 2006, Chen and Ye 2007). *B. dorsalis* completes more than five generations per year in most tropical regions, and as many as 10 generations per year in particular tropical areas, but less than four generations per year in most subtropical regions (Shi and Ye 2004, Shi *et al*. 2005). The temperature range permitting development and reproduction of *B. dorsalis* is 15-34°C, and the optimum temperature range for development is 18-30°C (Wu *et al*. 2000). The threshold temperature ranges for eggs, larvae and pupae are 11-12°C, 9-11°C and 9-11°C, respectively (Wu *et al*. 2000). When the temperature is >34°C or <15°C, a large number of adults and larvae die (Wu *et al*. 2000). The present study showed that the temperature had significant negative correlation with fruit fly population during the study. Because

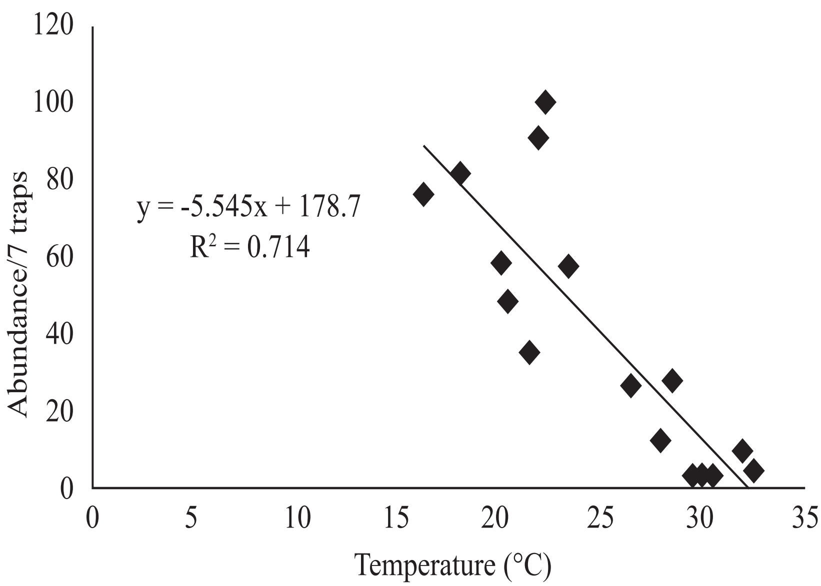

Fig. 2. Relationship between temperature and fruit fly abundance in a mango based agroforsetry in Bangladesh during February to September 2017

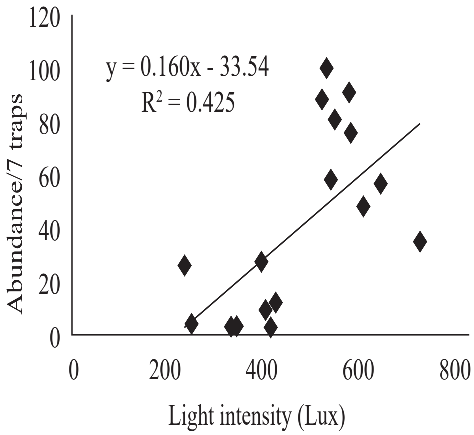

Fig. 3. Relationship between light intensity and fruit fly abundance in a mango based agroforestry in Bangladesh during February to September 2017

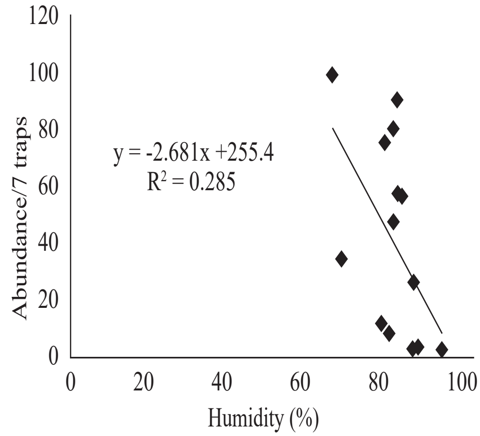

Fig. 4. Relationship between relative humidity and fruit fly abundance in a mango based agroforestry in Bangladesh during February to September 2017

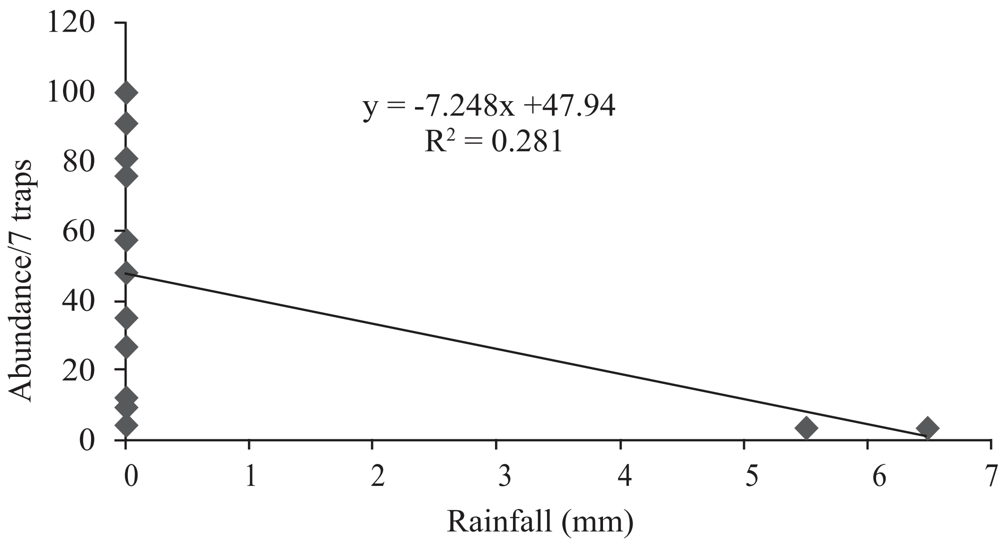

Fig. 5. Relationship between rainfall and fruit fly abundance in a mango based agroforestry in Bangladesh during February to September 2017

the temperature becomes very high (>30°C) in Bangladesh from April and prevails until September.

Relative humidity is closely related to precipitation and rainfall frequency, which influence soil moisture and affects pupation and eclosion of *B. dorsalis* (Duyck *et al.* 2006). Alyokhin *et al.* (2001) reported that >30% soil moisture create problem for adult emergence of *B. dorsalis*. In Bangladesh, there are clear dry (February to May) and wet (June to September) seasons. During the wet season, high temperature prevails and there is high relative humidity and heavy rainfall, while saturated soil moisture affects the growth and reproduction of fruit fly.

Table 1 showed that temperature individually contributed 29.0 % population abundance of fruit fly and its effect was significant. The temperature with combination of light intensity revealed 71.4% abundance, which was statistically significant. The individual effect of light intensity demonstrated 42.4% abundance. The combination effect of temperature, light intensity and relative humidity depicted 74.2% abundance and the result was statistically significant. The individual effect of humidity was 2.8%. The individual contribution of rainfall on fruit fly abundance was 12.5%. The multiple linear regression analysis showed that all the weather parameters jointly contributed 86.7% abundance of fruit fly and equations were significant. A study by Namni *et al.* (2017) showed multiple linear regressions equation based on weather parameters and insect population on mango. They reported that the weather parameters contributed 59.2% role on the population build up of insect.

Table 1. Multiple regression models along with coefficients of determination (R^2) regarding the impact of weather parameters on the seasonal abundance of fruit fly in mango based agroforestry

Regression equation	R^2	100 R^2	%Role of individual factor	F statistic	
$Y = 178.779 - 5.55\ X_1$ (X_1 = Temperature)	0.29	29	29	$F_{1,14} = 10.4$	$P < 0.001$
$Y = 178.182 - 5.53\ X_1 - 0.001X_2$ (X_2 = Light intensity)	0.714	71.4	42.4	$F_{2,13} = 16.2$	$P < 0.001$
$Y = 281.4 - 5.56X_1 - 0.034X_2 + 1.081X_3$ (X_3 = Relative humidity)	0.742	74.2	2.8	$F_{3,12} = 11.5$	$P < 0.01$
$Y = 248.557 - 5.2X_1 - 0.026X_2 - 0.803X_3 - 1.65X_4$ (X_4 = Rainfall)	0.867	86.7	12.5	$F_{4,11} = 8.3$	$P < 0.01$

The present study was carried out in a small area and the population dynamics was studied with weather parameters during the dry and wet season, when the mango trees had flower and fruit bearing stage. So, further investigations are necessary to study the abundance throughout the year, to clarify infestation level and host plant of the pest prior to develop an integrated management program.

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