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Effect of Seasonal Variations on Jackfruit Trunk Borer (*Batocera rufomaculata* De Geer) Infestation

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Abstract: The study of seasonal influence on incidence of trunk borer infestation was undertaken during 2010 at Kapasia upazila under district of Gazipur, Bangladesh. The borer was found in orchard from June to September with a peak emergence in mid July. The larval population of Jackfruit trunk borer is the destructive pest stage, which evokes concern in jackfruit growing areas of Bangladesh. The highest percentage of infestation was in July (7.33%) followed by June and August (6.00%). The cumulative infestation over the year in the study area was 35.33% in October. The lowest infestation was observed in February (0.67%) whereas no activity was found during November to January. The incidence of infestation of trunk borer was influenced by temperature, rainfall and relative humidity due to seasonal variations and their contribution of the regression (R^2) were 63, 65 and 31%, respectively. Five independent weather factors in stepwise regression equation pooled responsible for 67.4% of the total variance. Stepwise regression showed that maximum temperature was the most important to influence 35.3% and the influence was lowest (2.1%) in case of average rainfall.

Key words: Seasonal variation, infestation, jackfruit trunk borer, *Batocera rufomaculata*

INTRODUCTION

The climate in Bangladesh is suitable for the cultivation of jackfruit trees. But there have been several problems associated with the production of jackfruit in agroforestry system faced by farmers. Insect pests is one of the main constrain for jackfruit tree cultivation. Among various insect pests, jackfruit trunk borer caused severe damage to the jackfruit production (Hasan *et al.*, 2008; Alam, 1974; Rasel, 2004). The adult insects of *Batocera rufomaculata* is quite active during October to January (winter season) and disappear during rainy days (Kulkarni, 2010). Being a univoltine insect with polyphagous nature, jackfruit trunk borer is likely to differ in its seasonal distribution spatially even within a host plant and temporally within the growing season of a particular host plant. Again, the weather pattern varies across continents and, therefore, the seasonal distribution of the insect is likely to vary regionally as well (Kulkarni, 2010). Altaf Hussain *et al.* (2007) reported that adult population of *Apriona germari* emerged in subtropical region (Jammu province), from June to September with a peak emergence in mid July while in temperate region (Kashmir province) peak emergence occurred in mid August. The difference in peak emergence of trunk borer in two regions seems to be due to the climatic factors viz., temperature, relative humidity and rain fall. Temperature is one of the most important environmental factors that influence the rate of development of a particular insect pest. The relationship between temperature and the rate of development of poikilotherms is an important aspect of ecological studies and basic to the development of a pest management program. As a poikilotherm animal, the development rate of insects depends on the environmental temperature to which they are exposed (Andrewartha and Birch, 1954; Kitching, 1977) and hence, the development threshold and the thermal constant may be useful indicators of an insect's abundance and distribution (Messenger, 1959). The relationship between temperature and the developmental rate can be described using linear or non-linear techniques (Campbell *et al.*, 1974; Wagner *et al.*, 1984). It is usually plotted as a development rate (i.e., inverse of development time) against a series of constant temperatures. The rate increases with temperature to a maximum and then decreases as the upper lethal temperature is approached. This relationship is curvilinear at extreme temperatures,

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but at moderate temperatures it is approximately linear (Campbell *et al.,* 1974). Degree day models based on simple linear regression of development rate and temperature is used widely for predicting and forecasting insect development within the range of temperatures typically encountered in the field (Campbell *et al.,* 1974). However, there is no survey record available or no study regarding the actual pattern of incidence of the trunk borer infestation on jackfruit plant in different seasons with varying weather conditions particularly on the same host plant in Bangladesh context. Knowledge of insect population dynamics is essential for developing sustainable crop protection strategies and for safeguarding the health of agricultural environments. It is also required for interpreting and forecasting of the pest to weather patterns that varying on a daily basis, seasonally, or as a long-term consequence of global climate change. Therefore, the present study was undertaken with the following objectives:

- To know the year round infestation pattern of trunk borer on jackfruit trees
- To know the climatic factors regulating the seasonal distribution of the pest

MATERIALS AND METHODS

The seasonal influence on the incidence of trunk borer in farmers' orchard was studied in terms of trunk infestation in jackfruit trees throughout the year 2010. For this purpose, three orchards were selected at Kapasia upazila under Gazipur district of Bangladesh. From those orchards a total of randomly selected 150 healthy jackfruit trees were studied. Observations were made on the jackfruit trees at 15 days interval on 2.5 m height trunk from ground. Observation was made to detect the presence of infestation of the trees in different months of the year. The symptoms observed to detect the presence of infestation are given bellow:

- Presence of yellowish brown chewed saw dust beneath the tree ground
- Number of hole per tree trunk
- Symptoms of secreting fresh red cell sap (red watery and sticky substance)
- Oozing hole per tree trunk
- Fresh frass/excreta present or its accumulation on surroundings of the entry of hole
- To find eggs of the trunk borer damaged plant parts were observed. The adults were difficult to find in day time because of its nocturnal habits. Besides observing the above symptoms, the hole and tunnels were cut-open and the alive larvae inside the tunnel were collected for rearing and those dead were preserved in the laboratory for further study

Percent incidence of infestation of different months was calculated as bellow:

$$\text{Incidence of infestation (\%)} = \frac{\text{Number of attacked trees of the month}}{\text{Total number of trees}} \times 100$$

These observations were used to assess the pest occurrence and population fluctuations round the year. Weather parameter such as temperature, rainfall and relative humidity were recorded from the adjoining meteorological station of the department of agricultural extension at kapasia. All the collected data were coded, tabulated, checked and analyzed by using descriptive statistical methods including the computer-based statistical package SPSS13 version suitable for survey data analysis (Rashid *et al.*, 2003) Microsoft Excel and Mstat-C was also utilized.

RESULTS AND DISCUSSION

The results of the present study regarding the effect of seasonal variations on the incidence of trunk borer have been discussed with interpretations and furnished under the following sub-headings:

Seasonal incidence of infestation: Monthly incidence of infestation observed in the farmers' orchard at Kapasia, Gazipur in the year 2010 and has been showed in Table 1. The highest percentage of infestation was in the July (7.33%) followed by June and August (6.00%). The lowest infestation was observed in February whereas no activity was found during November to January (Table 1). In the study area, infestation was found over a period of nine months. Initially symptoms of infestation were observed in February, which gradually increased up to August.

Table 1: Jackfruit trunk borer infestation on jackfruit trees caused in farmer's orchard in Kapasia, Gazipur during January to December 2010

Observation period	Month wise infestation (%)	Cumulative infestation (%)	Relative activity in different month
January	0.00	0.00	- -
February	0.67	0.67	+
March	2.00	2.67	+
April	3.33	6.00	+
May	5.33	11.33	++
June	6.00	17.33	+++
July	7.33	24.67	++++
August	6.00	30.67	++++
September	2.67	33.33	++
October	2.00	35.33	+
November	0.00	35.33	- -
December	0.00	35.33	- -

++++: Very high: +++: High: ++: Moderate: + Low, - - Nil

Intensity of infestation was high in May to September and it reached peak in July to August. The cumulative infestation was observed in the study area was 35.33% in October (Table 1). The seasonal distribution of jackfruit trunk borers, determined by the percent of infestation by the grubs, during 2010 is presented in Fig. 1 and cumulative increase of infestation is shown in Fig. 2. The trunk infestation started at very low in mid January to February (Fig. 1), which then gradually increased and reached a peak on July. Subsequently, the infestation started to decline from mid September with a short peak in mid August and then gradually declined to nil in mid November to mid January due to low temperature and low rainfall.

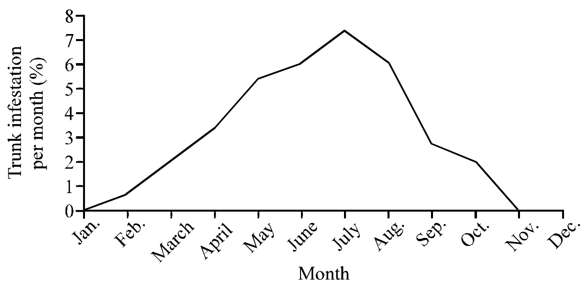

Fig. 1: Seasonal fluctuation of trunk infestation caused by trunk borer during 2010 in farmer's orchard

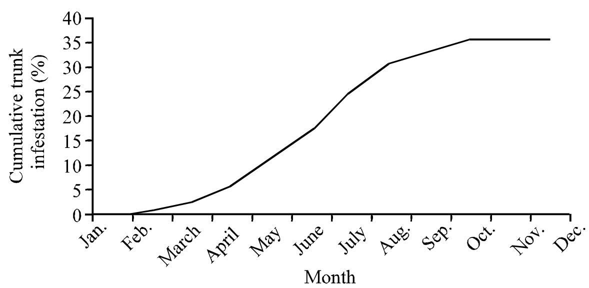

Fig. 2: Cumulative trunk infestation of jack fruit tree by trunk borer during 2010 in farmer's orchard

According to Xiao (1992) the development of insects in any life stage can be sub-divided into starting period, peak period and ending period when 16, 50 and 84% of the population reaches this stage, respectively. Huang *et al.* (1997) found the peak activity of the larvae to appear mainly in May to August. Figure 2 shows cumulative increase in infestation in February (0.67%), which then gradually increased up to mid October (35.33%) and then stayed steadily.

Effect of weather factors: The monthly weather data on maximum, minimum and average temperature, total rainfall and average relative humidity (%) at Kapasia, Gazipur during January to December 2010 have been showed in Fig. 3. The incidence of infestation of trunk borer was influenced by temperature, rainfall and relative humidity due to seasonal variations. The trunk infestation gradually increased and reached a peak in July when temperature and rainfall were high (Fig. 4, 5). Then it gradually decreased and became nil in November to mid January when temperature and rainfall dropped drastically. Being a subtropical country, Bangladesh has a mild climatic condition. In winter season temperature often goes very low and rainfall seldom occurs that might be the reason of low infestation.

For termination of diapause and acceleration of the pupation, the longicorn beetle needs the low temperature for a certain period (Galford, 1974; Shimane and Kawakami, 1991). The grub ceased to feed at various grub stages at low temperature (Yoon and Mah, 1999). Result of the present study also indicate that no infestation occurs in mid November to mid January in the studied

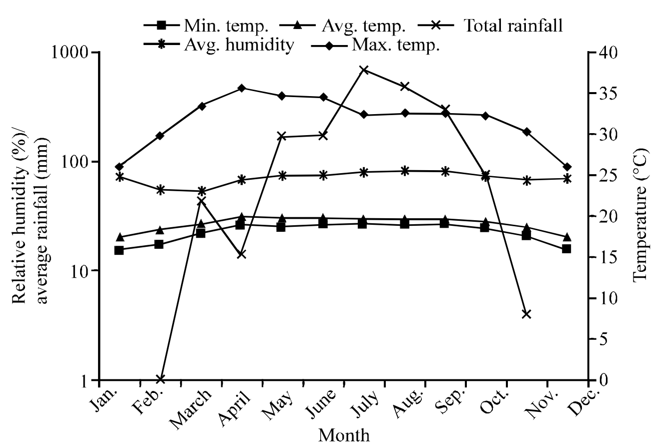

Fig. 3: Weather parameters on different months of observation during Jan-Dec 2010 at Kapasia, Gazipur

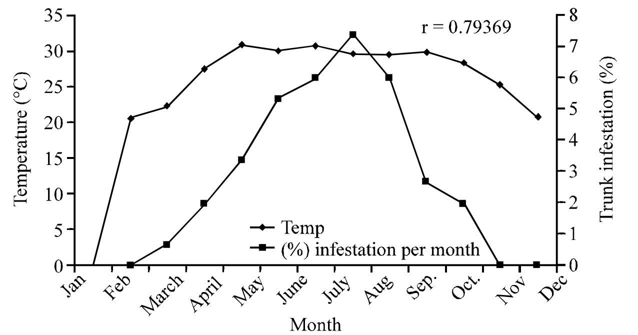

Fig. 4: Effect of temperature on trunk infestation in different months of the year 2010

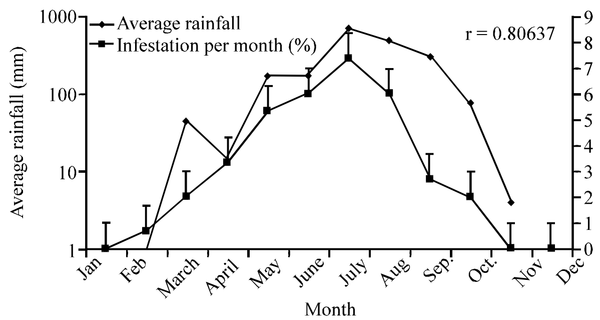

Fig. 5: Effect of rainfall on trunk borer infestation in different months of the year 2010

Table 2: Simple correlation coefficient between different weather factors and trunk borer infestation

	Trunk borer infestation			
Weather parameters	Correlation coefficient (r)	(±)SE	Student's t-value	Probability
Temperature (°C)				
Minimum	0.838**	0.100	4.861	0.001
Maximum	0.688*	0.193	2.995	0.012
Average	0.799**	0.134	4.204	0.001
Average rainfall (mm)	0.807**	0.002	4.316	0.001
Average relative humidity (%)	0.554^{NS}	0.075	2.103	0.059

*Indicates significant at p<0.05, **Indicates significant at p<0.01, ^{ns}not significant

locality, meaning that the insect in response to extreme climatic conditions, which severely affect the growth, development and survival of insects (Pedigo, 2002) and goes to inactive stage.

Relationship between infestation and weather factors: The results demonstrate an apparent impact of climatic conditions especially temperature, rainfall and relative humidity on jackfruit trunk borer infestation. Simple correlation have been worked out (Table 2) between trunk borer infestation and maximum temperature, minimum temperature and average temperature and average rain fall and relative humidity (%). Trunk infestation was significantly and positively correlated with maximum temperature ($p<0.05$, $r = 0.688$), minimum

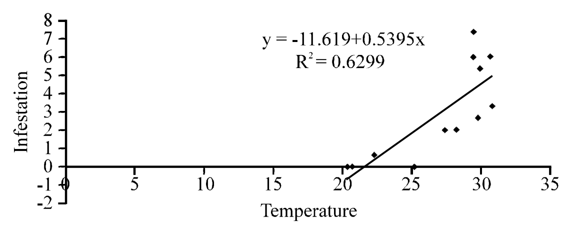

Fig. 6: Relationship between temperature and trunk infestation

temperature ($p<0.01$, $r = 0.838$) and average temperature ($p<0.01$, $r = 0.799$) in different seasons of study period which indicated a relationship with increase in temperature and rainfall in summer season when there were progressive increase in trunk borer infestation. A linear regression was fitted between in infestation and temperature (Fig. 6). The regression equation $Y = a+bx$, where Y = Trunk infestation (%), a = -11.619, b = 0.5395 and X = Temperature was obtained. The contribution of the regression ($R^2 = 0.6299$) was 63%.

Average rainfall (Fig. 5) was found nil from January to mid February and November to December. The trunk borer infestation started in mid January to October and in November to December there were no infestation found in orchard (Fig. 5). Trunk infestation was significantly ($p<0.01$) and positively correlated with average rain fall ($r = 0.807$), which indicated that the increase of rainfall was favorable to increase trunk borer infestation (Table 2).

A linear regression was fitted between trunk infestation and rainfall (Fig. 7). The regression equation Y = a+bx, where Y = Trunk infestation (%), a = 1.3862, b = 0.0097, X = rain fall was obtained. The contribution of the regression (R^2 = 0.6502) was 65%.

High relative humidity was observed in July to September 2010 at Kapasia, Gazipur during study period (Fig. 8). Relationship (r = 0.554) between trunk borer infestation and relative humidity was positive but non significant (Table 2). High relative humidity and high temperature (30°C) were found to be more favorable for multiplication of any pest (Atwal and Verma, 1972). A linear regression was fitted between infestation and humidity (Fig. 9). The regression equation Y = 0.1579 X-8.1511, where Y = Trunk infestation (%), intercept = -8.1511, slope = 0.1579, X = relative humidity (%) was obtained. The contribution of the regression (R^2 = 0.3066) was 31%.

It can, therefore, be inferred that the pest become most active at worm climate and rain fall. High temperature and average weekly rainfall as prevailed during June-August was favorable for the activity of trunk borer leading into higher infestation rate and thus the peak period of activity of the borer was in July-August.

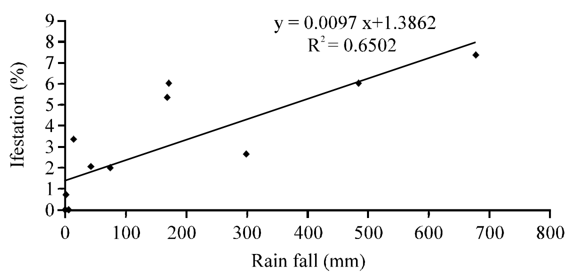

Fig. 7: Relationship between rainfall and trunk borer infestation

Contribution of weather parameter to trunk borer infestation: The regression equation fitted to the data taking trunk borer infestation and meteorological factors having significant positive relation (Table 3). In order to find out the contribution of weather parameter to trunk borer infestation in different seasons of the year, stepwise multiple regressions was computed on the basis of correlation results (Table 4). The stepwise regression analysis indicated that the five variables entered in the model and their contribution in trunk borer infestation is presented in Table 4. It may be assumed that whatever contribution was there, it was due to five variables included in the stepwise regression model. The

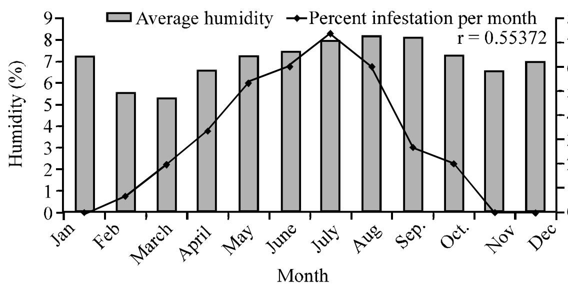

Fig. 8: Effect of humidity on trunk borer infestation in different months of the year 2010

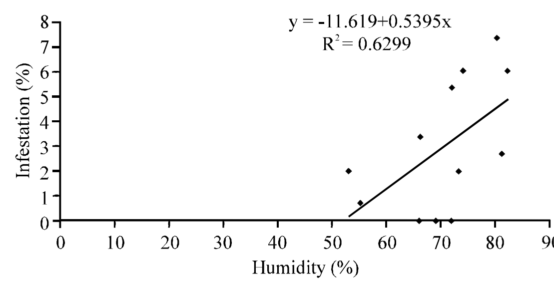

Fig. 9: Relationship between humidity and trunk borrer infestation

Table 3: Regression analysis equation fitted to the trunk borer infestation "y" as dependent variable and meteorological factor as independent variable

Weather parameters	Regression equation y = a + bx	Coefficient of determination (R^2)	F value	Probability
Maximum temperature	y = 5.7932X-15.3673	0.473	8.97*	0.013
Minimum temperature	y = 1.3239X-2.98326	0.099	1.10^{NS}	0.319
Average temperature	y = 9.8421X-2.66434	0.037	0.38^{NS}	0.550
Average rainfall (mm)	y = 7.1605X-1.15165	0.674	20.71**	0.001
Average relative humidity (%)	y = 1.3923X-9.78125	0.452	8.26*	0.017

*Indicates significant at p<0.05, ** Indicates significant at p<0.01, ^{NS}Not significant.

Table 4: Stepwise multiple regression analysis between the independent weather parameters and dependent incidence of infestation by trunk borer

Weather parameters	A	R^2	R^2 change	Variation explained (%)	F-value	Probability
Average temperature(X_1)	-2.6643	0.037	-	3.7	0.38	ns
Minimum temperature (X_2)	-2.9832	0.099	0.062	6.2	1.10	ns
Maximum temperature(X_3)	-15.3670	0.473	0.353	35.3	8.97*	p<0.05
Average rainfall (X_4)	-1.1516	0.674	0.021	2.1	20.71**	p<0.01
Average relative humidity (X_5)	-9.7812	0.452	0.201	20.1	8.26*	p<0.05
Multiple regression models	-40.8070	0.913	0.239	23.9	12.61**	p<0.01
$Y = a+b_1X_1+b_2X_2+b_3X_3+b_4X_4+b_5X_5$						

*Indicates significant at 5% level, **Indicates significant at 1% level, ^{NS}Not significant. A = Intercept, R^2 = Coefficient of determination contributions of these variables are presented below. Data presented in the Table 4 depicted five independent variables in stepwise regression equation that pooled variation explained 67.4% of the total variance. Stepwise regression showed that maximum temperature was the most important to influence 35.3% infestation and the average rainfall was resulted lowest (2.1%) infestation.

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