Short communication

Weather based forewarning models for coffee borer incidence

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Coffee berry borer(CBB) and shot hole borer are the two pests that damage coffee berries to a considerable extent in a favourable weather environment. The coffee berry borer can cause bean yield losses of 30–35% with 100% of perforated berries at harvest time; nevertheless, damage can be greater if harvest is delayed. All the commercial coffee varieties and species are attacked by this insect. The coffee growing areas of Niligiri district of Tamil Nadu, Wayanad district of Kerala and Kodagu district of Karnataka together form a contiguous coffee growing tract. The CBB infestation in this region had spread from the Niligiris towards the north covering Wayanad and south Kodagu over a period of four to five years(Anonymous, 2002). The shot-hole borer, which attack green succulent branches of robusta and green scales, which is a sucking pest of both arabica and robusta are major pests of coffee. Although they are major pets, they are not in serious nature except in some endemic areas. Therefore, an attempt has been made in this paper to investigate the statistical relationship exists between coffee berry borer and shot hole borer infestation and meteorological factors and also to develop forewarning models for predicting the population of these pests.

A study was conducted in Chundale, Wayanad district in Kerala, to assess the seasonal incidence and influence of weather on coffee berry borer, *Hypothenemus hampei*(Ferrari) and shot hole borer(*Scolytus rugulosus*) from January 2008 to December 2011 in the 30 years old Robusta coffee plantations (variety S.274 and CXR) at Regional Coffee Research Station, Chundale. The experimental plots consist of one acre plantation and 20 plants were selected for recording pest data at fortnightly interval. Observations were made from 20 randomly selected coffee plants and in each plant, three branches at top, middle and bottom were chosen to record the pest data. The damaged berries by berry borer were collected and adult beetle populations were counted. The number of adult beetle populations in shoots were counted to record population of shot hole borer. The data on weather

parameters, maximum temperature (°C), minimum temperature (°C), relative humidity (%) and rainfall (mm) were recorded from Automatic Weather Station installed in the station during the study period. The fortnightly mean of pest populations of 20 plants were calculated from the data on the incidence of coffee berry borer and shot hole borer and these were correlated with weather parameters.

Correlation coefficient (CC) between pest population and weather parameters has been worked out for fortnight when maximum infestation was observed. Student's 't' test (Fisher and Yates, 1938) was applied to test the significance. The fortnight's individual weather parameters having highest correlation coefficients which are statistically significant were selected. All these statistically significant parameters were subjected to multiple correlation and stepwise regression combining all the selected parameters for these selected fortnights and a 'F' test was performed for testing its significance. Regression equations were developed for the fortnight with maximum infestation using the significant weather parameters having highest correlation coefficients. Graphical analysis between significant weather parameters and pest population were made.

The coffee berry borer attack was mainly confined between first fortnight of January and second fortnight of April in both the varieties. The peak population was observed during first and second fortnight of April which correspond to fruit set of coffee in Wayanad (Table 1). From first fortnight of June with the onset of rainfall, the population of CBB decreased in the present study. Rainfall was possibly the factor that attributed to the low berry borer population (Ferreira *et al.,* 2000). Pest population during individual years showed considerable variations as a result of weather variations / aberrations. Maximum population of CBB was recorded in 2009 and minimum population was recorded in 2008, 2010 and 2011. During 2009, deficient rainfall in Kerala and dry conditions with high temperature may be attributed maximum pest

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Table 1 : Fortnightly variation of mean pest population (Number of pest / fortnight) at RCRS, Chundale

Fortnight	CBB		SHB	
	S.274	CXR	S.274	CXR
Jan I	1.85	2.13	5.36	5.93
Jan II	1.85	2.15	5.37	5.96
Feb I	2.71	3.10	4.91	5.06
Feb II	2.71	3.12	4.92	5.13
Mar I	2.72	2.76	1.77	2.75
Mar II	2.72	2.76	1.78	2.78
Apr I	6.42	8.41	1.83	1.74
Apr II	6.43	8.41	1.84	1.74
May I	0.31	0.30	2.40	1.70
May II	0.31	0.31	2.43	1.71
June I	0.29	0.50	1.41	1.64
June II	0.30	0.52	1.43	1.66
July I	0.49	0.41	0.68	0.60
July II	0.50	0.42	0.69	0.62
Aug I	0.58	0.69	2.36	1.95
Aug II	0.58	0.70	2.40	1.97
Sep I	0.63	0.56	4.00	3.67
Sep II	0.64	0.57	4.01	3.69
Oct I	0.68	0.59	2.60	1.59
Oct II	0.69	0.60	2.62	1.61
Nov I	0.75	0.66	4.43	4.00
Nov II	0.75	0.67	4.49	4.00
Dec I	0.89	0.80	5.28	5.21
Dec II	0.90	0.81	5.33	5.22

population compared to rest of the years.

Populations of SHB were observed throughout the year and peak population of the pest was observed between first fortnight of November and 2nd fortnight of January. The maximum attack was observed at 2nd fortnight of January followed by first fortnight of January which corresponds to budding stage of coffee in Wayanad. It is also a serious pest of Robusta attack on tertiary twigs, young primaries and suckers. Incidence start by mid-June and increases towards September-December. Maximum population of SHB was recorded in 2011 and minimum population was recorded in 2009.

A critical examination of various weather parameters showed that CBB population increases substantially when the maximum temperature was above 31.5^{0}C and minimum temperature was above 19.5^{0}C and rainfall below 21.1mm. Jaramillo *et al.* (2009) reported lower threshold values of temperature, lower optimal

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Table 2 : Correlation coefficient (C.C.) between pest population in coffee and weather parameters at RCRS, Chundale

Fortnight		Weather parameters			
Weather parameters	Pest parameters	Tmax	Tmin	RH	Rainfall
Coffee berry borer(April 2nd fortnight)					
April II	April II	0.91**	0.79*	-0.35	-0.73*
April I	April II	-0.05	0.11	0.25	-0.45
March II	April II	-0.11	0.73*	0.46	-0.01
March I	April II	-0.15	0.65	0.50	0.99**
February II	April II	-0.50	0.39	0.32	-0.32
Shot hole borer(January 2nd fortnight)					
January II	January II	-0.52	0.06	0.62	0.00
January I	January II	-0.60	0.10	0.63	0.94**
December II	January II	0.46	0.07	-0.39	-0.01
December I	January II	0.54	0.16	-0.41	-0.67
November II	January II	0.14	-0.67	-0.91**	0.69
November I	January II	-0.55	-0.82*	-0.90**	0.33
October II	January II	-0.21	-0.94**	0.15	-0.01

CCs significant at 5 % level*, CCs significant at 1% level**

temperature, upper optimal temperature and upper threshold temperature for population growth of CBB are 14.9, 23, 30 and 32^{0}C respectively. These critical limits of weather variables were mostly prevailed in maximum population year 2009. The maximum temperature and minimum temperature during previous four fortnights showed increasing trend towards the maximum infestation week at 2nd fortnight of April in 2009. Rainfall showed decreasing trend towards the maximum infestation at 2nd fortnight of April during 2009. Shot hole borer population increases substantially when minimum temperature was below 17.5^{0}C, mean RH was below 78% and rainfall above 11.4mm. These critical limits of weather variables were mostly prevailed in maximum population year 2011. Minimum temperature and mean RH showed decreasing trend towards the maximum infestation at 2nd fortnight of April during 2011. Rainfall showed decreasing trend towards the maximum infestation at 2nd fortnight of January during 2011.

Correlation coefficients worked out between

fortnightly adult beetle counts of CBB and different weather parameters (Table 1). Correlation studies indicated that different weather parameters influenced the pest population differently. In the present study population of CBB at 2nd fortnight of April was found to have highest positive correlation with maximum temperature and minimum temperature of 2nd fortnight of April. Rainfall of 2nd fortnight of April have highest negative correlation with pest population of 2nd fortnight of April. Relative humidity was not significantly correlated with CBB incidence. Minimum temperature during 2nd fortnight of October have highest negative correlation with SHB incidence of 2nd fortnight of January. Relative humidity during 2nd fortnight of November have highest negative correlation with SHB incidence of 2nd fortnight of January. Rainfall during first fortnight of January have highest positive correlation with SHB incidence of 2nd fortnight of January.

The multiple regression equation which describes the average relationship between the CBB population and

significant weather parameters is derived and expressed as below:

$Y = -292.148 + 9.965$ Tmax_Apl.II $- 0.109$ RF_Apl.II $(R^2 = 0.97)$

Y= CBB Population at 2nd fortnight of April. The multiple correlation coefficient was 0.98 which was significant. The results of the study indicates the population of CBB may be predicted with the current fortnight's weather data.

The multiple regression equation which describes the average relationship between the SHB population and significant weather parameters is derived and expressed as below:

$Y = -622.960 + 7.620$ RH_Nov.II $+ 0.656$ RF_Jan.I $(R^2 = 0.90)$

Y= SHB Population at 2nd fortnight of January. The multiple correlation coefficient was 0.95 which was significant. The model indicates the population of SHB may be predicted with the with mean RH data of four fortnights and rainfall data of previous fortnight of the incidence of pest.

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