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Forecasting tea mosquito bug (*Helopeltis antonii.*) of cashew (*Anacardium occidentale* L.)

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ABSTRACT

A field experiment was conducted to monitor pest surveillance on tea mosquito bug(TMB) of cashew orchards in relation to weather parameters at fortnightly intervals for ten years from 1988 to 1998 except during 1995 at the Agricultural Research Station, Chintamani (13° 24' N; 78° 34' E and 857 AMSL), Karnataka. Path coefficient analysis was carried out to understand the direct and indirect effects of the individual weather elements on tea mosquito incidence. Prediction equations were developed using multiple regression analysis with respect to TMB population and percentage damage. A minimum temperature between 15 and 20°C, cloudiness and relatively dry weather (afternoon relative humidity between 40 and 60 per cent) may be optimum for triggering the pest population of TMB; this coincides with flushing and flowering of cashew. The pest population is low under cold (< 12°C of minimum temperature) and hot (>35°C of maximum temperature) weather conditions. The regression equations accounted for 59 and 90 per cent variability in TMB population in individual years. However, it was only more than 50 per cent when the data were pooled for all the ten years.

Key words: Cashew, Tea mosquito,Weather effects, Pest forecasting

The tea mosquito bug (TMB), *Helopeltis antonii* Signoret (Heteroptera: Miridae) is one of the menacing pests of cashew orchards across the west coast and Maidan parts of Karnataka. In Kerala, a bumper crop of two lakh tonnes of cashewnut was expected in 1998-99 as profuse flowering was noticed in December/January due to favourable weather. However, the crop was severely damaged due to a pest complex (Tea mosquito and the fungus *colletotrichum* sp.) and the crop harvested was only half of the expected. It is obvious that the TMB alone can cause a loss up to 50 per cent in yield of cashew. It revealed that the minimum temperature below 20°C along with relatively dry weather in the afternoon during the majority of the days from December to January might have triggered the pest population during 1998-99 across the cashew tract of Kerala (Anonymous, 1999). The most favourable period for the rapid multiplication and population build up of the pest was between December and February synchronizing with flowering and flushing of cashew (Pillai *et al.*, 1984). The population builds up of pest negatively correlated with the meteorological factors like minimum temperature, minimum relative humidity and rainfall and positively with sunshine. Similar was the observation made by Rai (1981). At

Vittal, the pest was observed almost throughout the year with a high incidence from February to March (Sathiamma, 1978). Though several studies on seasonal abundance are seen across the west coast, none of the above quantified the effect of weather elements on tea mosquito incidence. Moreover, such studies are scarce across Maidan parts of Karnataka located at high ranges where cashew is grown. Hence, a field experiment was conducted at the Agricultural Research Station, Chintamani (13° 24' N; 78° 34' E and 857 amsl) located in the eastern dry zone of Karnataka from 1988 to 1998, falling under semi-arid zone. This zone is one of the predominant cashew areas of Karnataka.

MATERIALS AND METHODS

An experiment was initiated during January 1988 to study the seasonal incidence of tea mosquito bug (TMB) on cashew. Every year 12 randomly selected trees were used for observations. Each tree was divided into four sections directionally viz., north, east, south and the west. In each direction, one square meter area was marked and labeled. Observations were taken on total number of new shoots, damaged shoots, total number of panicles, damaged panicles, total number of nuts and damaged nuts along with total number of nymphs and adults of TMB at fortnightly interval. Observations were recorded in each quadrant from January 1988 to December 1994 and from January 1996 to December 1998. Simultaneously, weather data pertaining to maximum and minimum temperatures, forenoon and afternoon relative humidity, rainfall, number of rainy days and bright sunshine hours were also recorded during each year. Percentage damage and mean population per tree of tea mosquito bug were worked out for each fortnight. Simple correlations among weather parameters, between weather parameters and incidence of TMB population/per cent damage were worked out. Path coefficient analysis (Dewey and Lu., 1959) was carried out as it reveals the extent of direct and indirect contribution of individual weather parameters which triggered the TMB population. The data were subjected to multiple linear regression analysis taking each of the weather parameters as the independent and the population of TMB per cent damage as dependent variable for development of forecasting models.

RESULTS AND DISCUSSION

Seasonal incidence of TMB

The mean population of TMB per tree varied from zero (May, June and July) to 12 (February). The population was low (<2 per tree) between April (second fortnight) and September (second fortnight). Thereafter, a gradual increase was noticed towards its peak (≥ 10 per tree) between December and February coinciding with flushing and flower initiation (Fig 1a). Similar was the trend in case of percentage damage during reproductive phase of cashew due to incidence of tea mosquito bug (Fig 1b). The damage was above 20 per cent from December to February reaching a peak of 32 per cent in January.

The yearly peak population of TMB per tree varied between 12.1 (1994) and 19.1 (1991) during the study period (Table 1). Similar was the trend with respect to percentage damage, which varied between 21 per cent (1988) and 51 per cent (1991). Most preferred period appears to be February 1[st] fortnight. In eight out of ten years, damage

Table 1 : Peak population of tea mousquito bug (TMB) and its damage from 1988 to 1998 at ARS, Chintamani.

Year	Population per tree	Percentage damage	Fortnight during which peak incidence of TMB is noticed
1988	12.9	21.2	February-I
1989	17.1	40.3	December-II
1990	18.1	46.3	January-I
1991	19.1	51.4	February-I
1992	17.6	46.8	January-II
1993	15.1	36.8	December-II
1994	12.1	30.3	January-I
1996	15.2	41.3	February-I
1997	17.1	46.3	February-I
1998	16.1	48.3	February-I

was above 40 per cent when population per tree was more than 15. The domain of peak population was during flushing rather than flowering time unlike across the west coast of India though the peak season of incidence was from December to February. This might be due to delay in flushing and flowering phases over Maidan areas of Karnataka when compared to those of the west coast of India.

Weather parameters

Rainfall is bimodal and maximum (80 mm 4.8 rainy days) during the first fortnight of October, followed by second fortnight of September (76.5 mm in 3.6 days). Interestingly, the seasonal rainfall was negligibly small during winter (December to February), which coincides with the flushing period of cashew and high TMB population. In general, bright sunshine hours were more than eight hours per day during the flushing time. During the flushing period (December-February), maximum temperature varied between 26.1°C and 30.8°C. It shoots occasionally beyond 35°C during April and May, which might be a reason for rapid decline of pest population from March onwards (Fig.1). During flushing period, the minimum temperature was generally around 14.0°C. Maximum (26.0-31.0°C) and minimum (around 15.0°C) temperatures were low during flushing period, while they were high (34.6 °C maximum and 22.6 °C minimum) during summer, coinciding with flowering and fruiting stages (Table 2).

The mean forenoon relative humidity remained high throughout the year. During the flushing period, it varied between 70 and 79 per cent and dropped below 71 per cent from March onwards. The mean afternoon relative humidity varied between 35 and 67 per cent and during flushing period (December-February), it was between 42 and 60 per cent.

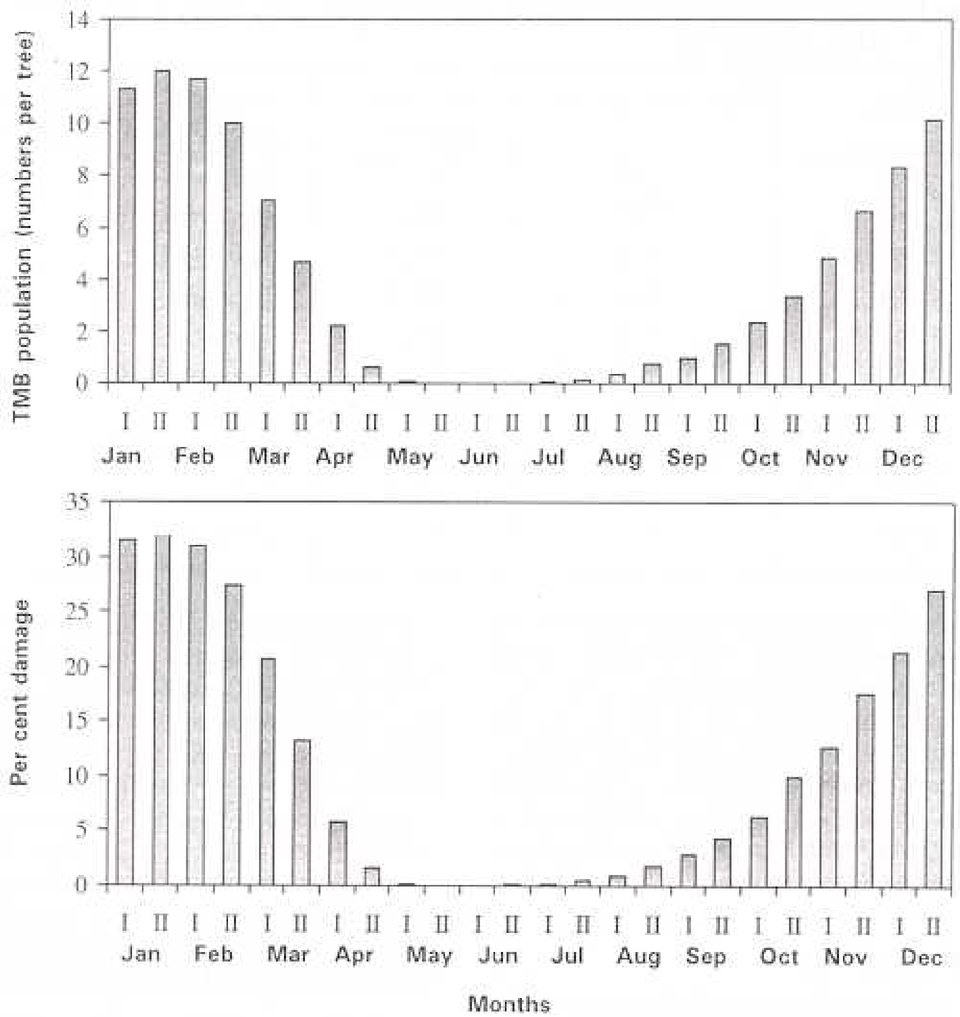

Fig. 1 : Mean march of fortnightly TMB population and per cent damage on cashew from 1988 to 1998 at ARS, Chintamani

Correlations between weather parameters and TMB incidence

The pest population with various meteorological parameters showed significant negative correlation between fortnightly rainfall and TMB incidence (Table 3). The same was the case between maximum, minimum temperatures, afternoon relative humidity and TMB. The bright sunshine hours showed a positive correlation with the pest population and pest damage as reported by Pillai *et al.*, (1984). Among the weather

Table 2: Mean fortnightly meteorological observation from 1988 to 1998.

Month	Fort-night	Air temperature (°c)		Relative Humidity (%)		Rainfall (mm)	Number of rainy days	Bright sunshine (h day⁻¹)
		Max.	Min.	Forenoon	Afternoon			
January	I	26.7	13.2	75.8	49.2	3.8	0.4	8.9
	II	28.0	14.3	72.0	43.8	0.0	0.0	8.7
February	I	29.0	15.3	73.1	43.0	0.0	0.0	9.5
	II	30.8	16.8	69.9	42.2	1.3	0.1	9.6
March	I	32.0	17.4	64.8	40.6	2.6	0.3	10.0
	II	34.1	18.8	68.7	35.0	5.3	0.5	10.0
April	I	34.1	21.0	70.8	39.7	16.4	0.9	9.9
	II	34.6	22.1	70.3	40.6	13.0	0.8	9.1
May	I	34.6	22.6	68.0	39.8	24.1	1.4	9.1
	II	34.4	22.5	67.1	42.6	41.9	3.2	8.1
June	I	32.3	21.4	72.1	51.8	61.1	2.7	6.6
	II	30.9	20.6	73.5	52.0	19.7	1.7	6.9
July	I	29.7	20.4	78.8	60.2	53.1	3.0	5.1
	II	29.1	20.6	80.9	59.9	30.1	3.1	4.7
August	I	29.0	20.7	81.1	60.1	40.6	2.9	5.0
	II	28.7	20.4	80.5	64.1	61.0	3.1	5.3
September	I	28.9	20.0	80.8	65.2	70.9	3.9	6.3
	II	28.9	19.9	79.8	60.2	76.5	3.6	5.9
October	I	28.6	19.7	80.8	66.7	80.0	4.8	5.2
	II	28.4	19.2	77.1	62.0	56.1	3.2	5.7
November	I	27.1	18.0	80.6	64.8	31.1	2.9	4.9
	II	26.9	16.1	77.0	59.5	13.0	1.0	7.3
December	I	26.3	14.4	78.6	60.4	18.6	1.2	7.2
	II	26.1	14.3	78.0	58.5	1.5	0.2	7.5
Annual / Mean		30.0	18.7	75.0	52.6	721.7	44.9	7.4

elements, the minimum temperature had the highest negative correlation with TMB population/per cent damage as the pest population coincides with winter.

Path coefficient analysis

The path coefficient analysis for pooled data (Table 3) revealed that the highest magnitude of negative direct effects were exerted by maximum (-0.36) and minimum temperatures (-0.35), afternoon relative humidity (-0.18) and number of rainy days (-0.11), while positive direct effect by sunshine (0.26) and rainfall (0.016). All the weather elements had negative indirect effect via minimum temperature except bright sunshine.

Table 3: Direct (bold) and indirect effects of different weather parameters on population density of TMB from 1988 to 1998.

Pooled	Effect via							Correlation with TMB population
	SSH	RF	NRD	RHM	RHE	Max.T	Min.T	
Sunshine hours(SSH)	**0.262**	-0.006	0.060	-0.038	0.120	-0.141	0.083	0.339 **
Rainfall (RF)	-0.107	**0.016**	-0.087	0.027	-0.080	-0.030	-0.104	-0.305 **
No.of rainy days(NRD)	-0.141	0.012	**-0.110**	0.029	-0.088	0.035	-0.133	-0.397 **
Rel. humidity morning(RHM)	-0.127	0.006	0.041	**0.077**	-0.138	0.156	-0.027	-0.095
Rel. humidity evening(RHE)	-0.171	0.007	-0.053	0.058	**-0.182**	0.198	-0.029	-0.173 **
Max.temperature(Max.T)	0.101	-0.001	0.010	-0.033	0.099	**-0.364**	-0.197	-0.385 **
Min.temperature(Min.T)	-0.062	0.005	-0.042	0.060	-0.015	-0.205	**-0.351**	-0.664 **
Residual	0.475							

**Significance at 1% level.

The pest population was high during flushing and flower initiation, coinciding with winter season (December to February) during which the maximum and minimum temperatures were relatively low when compared to that of the other seasons. The negative direct effect of maximum surface air temperature could be explained on pest population as it was declining rapidly during summer months though the reproductive phase is active through flowering and fruiting phases. Interestingly, the pest population was low (< 10 per tree) whenever the minimum temperature went below 15°C (Fig. 2a) and vice versa, indicating that the pest population followed the minimum temperature during flushing and flowering of cashew (Fig. 2b). In contrast, the peak population was also very low (< 4 per tree) when the minimum temperature was below 12°C. It revealed that the pest population was low under cold weather conditions during the season whenever the minimum temperature was below 12°C. However, the negative correlation of pest population with minimum temperature on annual pattern could be explained due to low night temperature that prevails during winter when compared to that of other seasons. The pest population during the rainy season was absent as they may be washed off due to heavy rains or hiding in alternate host plants. Another reason might be non-availability of the succulent plant parts in cashew during the rainy season as the trees are in dormant phase. Dry weather with low relative humidity in the afternoon may also favour the pest population during the winter as evident from the path coefficient analysis. It is evident that the minimum temperature between 15 and 20°C, cloudiness and relatively dry weather with the afternoon relative humidity between 40 and 60 per cent may be optimum for triggering pest population of TMB, which coincides with flushing and flowering of cashew. The finding is similar to that of observations made at RARS, Pilicode

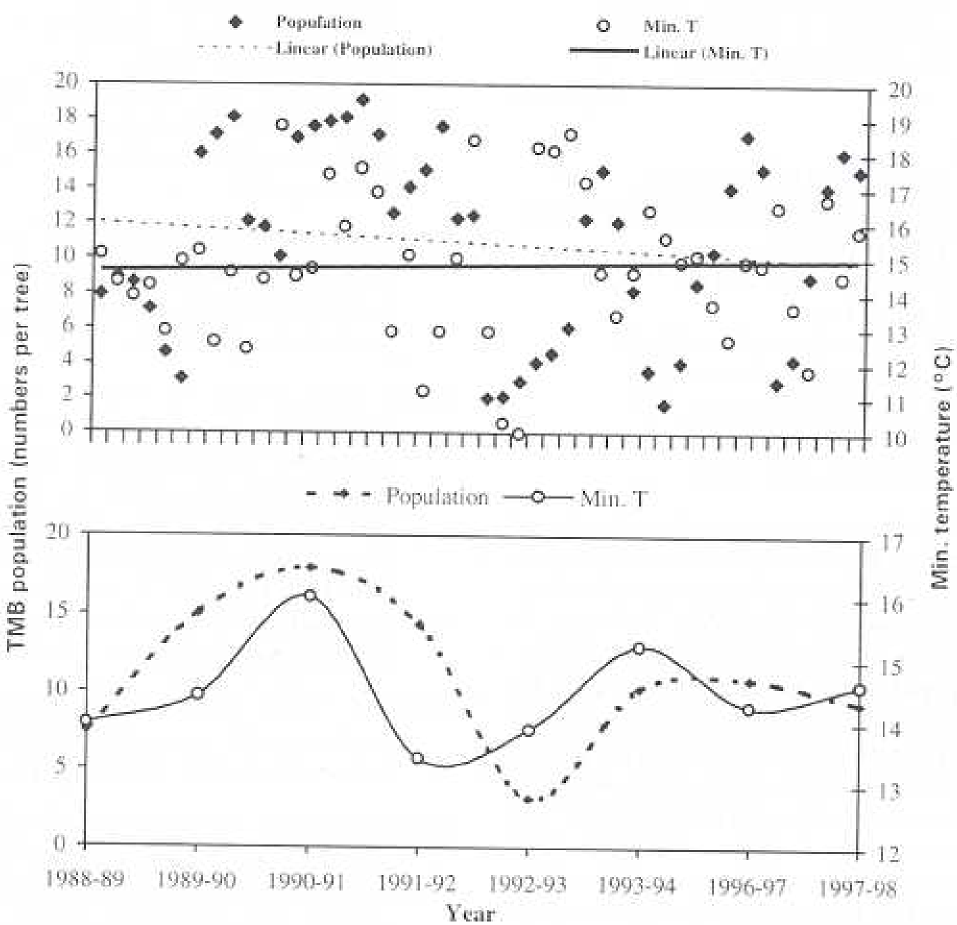

Fig. 2 : Minimum temperature (°C) versus peak population of tea mosquito during flushing and flowering initiation (December to first fortnight of February) from 1988 -89 to 1997-98 at ARS, Chintamani.

(Anonymous, 1999). This may be one of the reasons for heavy manifestation of TMB over cashew plantations across the west coast and Maidan parts of Karnataka.

The prediction equations were derived through multiple regression analysis for each year as well as pooled data for all the ten years with respect to TMB population. The prediction equations for pooled data are as follows

$$Y1 = 0.648\,X1 + 0.002X2 + 0.048X3 - 0.073\,X4 - 0.642X5 - 0.597\,X6 - 0.272\,X7 + 30.473 \quad (R^2=0.53)$$

$$Y2 = 1.738X1 + 0.013X2 + 0.138X3 - 0.230\,X4 - 1.762\,X5 - 1.589\,X6 - 0.791\,X7 + 83.629 \quad (R^2=0.54)$$

where,

Y1 = Predicted TMB population;

Y2 = Predicted percentage damage due to TMB population;

X1 = Sunshine hours ($hday^{-1}$)

X2 = Rainfall (mm)

X3 = Morning relative humidity (%)

X4 = Evening relative humidity (%)

X5 = Maximum temperature (°C)

X6 = Minimum temperature (°C)

X7 = Number of rainy days

Both the regression equations explained greater than 50 per cent accountability in pest build up of TMB as well as percentage damage based on weather variables, however, it accounts up to 90 per cent in individual years. The prediction models developed by Sathapathy (1993) also explained between 80 and 90 per cent variability in TMB population and per cent damage, respectively based on weather variables during individual years. The optimum weather conditions derived through the present study will be a useful tool for integrated pest management of tea mosquito bug in minimising the crop losses across the west coast of India and Maidan parts of Karnataka.

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