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Effect of weather factors on the population dynamics of litchi stink bug, *Tessaritoma papillosa* (Drury)

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ABSTRACT: Studies were conducted to understand the population dynamics of Litchi stink bug, *Tessaritoma papillosa*. It was found high in summer (92.13), moderate during monsoon season (81.34) and low in winter season (73.55). The correlation of monthly *T. papillosa* incidence was positive with maximum temperature (r = 0.533), minimum temperature (r = 0.181), relative humidity (r = 0.205) and rainfall (r = 0.071) About 54 percent of the variation in *T. papillosa* incidence have been collectively explained when all the weather parameters are incorporated in the model. Though the developed model resulted in considerably high R^2 value (54%), none of the regression coefficient was significantly related to *T. papillosa* incidence as indicated by the t-test statistic value (being less than 2.0). $Y= 12.23 + 0.86 (X_1) + 0.60 (X_2) - 0.90 (X_3) + 0.84 (X_4) - 0.02 (X_5)$ with all abiotic factors considered as full regression model.

Keywords: Litchi, *Tessaritomca papillosa*, population dynamics, weather factors

INTRODUCTION

Litchi is a tropical fruit tree native to southern China. It is also commonly found in Madagascar, India, Bangladesh, Pakistan, southern Taiwan, northern Vietnam, Indonesia, Thailand, the Philippines, and Southern Africa. India ranks second in area and production after China, accounting for the production of 4.33 lakh MT from an area of 0.6 lakh ha with productivity of 7.2 MT (Kumar and Kumar, 2008).In India it is grown mainly in Bihar, Utter Pradesh and West Bengal. Several bugs belonging to family Tessaritomidae attack litchi and longan throughout Asia and Australia. *Tessaritoma papillosa* (Drury) occurs in southern China, Vietnam, Thailand, Myanmar, the Philippines and India, although Butani (1977) notes that *T. javanica* Thunberg and *T. quadrata* Distant, are the main species in India. In Australia, *Lyramorpha rosea* Westw. is known as the litchi stink bug, but rarely causes damage. The most destructive enemy of the litchi in India is this stinkbug, *T. papillosa* with bright-red markings. It sucks the sap from young twigs and they often die; at least there is a high rate of fruit-shedding. Liu and Lai (1998) claimed that up to 30 per cent of fruits in commercial orchards are damaged due to this pest.

Perusal of literature showed that studies on influence of weather factors on *T. papillosa* incidence are lacking in India, which is essential for development of management strategies. Recent studies showed that though the infestation was observed throughout the year, it was found high in summer, moderate during post rainy season and low in rainy season. Liu and Lai (1998) recorded a peak egg-laying in March in Guangdong, China, lasting till September. The first nymphs mature in June, while there are still old adults in the trees. These old adults may have lived for up to a year and generally die by August.

Therefore, these studies clearly indicate that besides the availability of new flowers and shoots, weather factors also play an important role in *T. papillosa* incidence. Since the information available on this aspect is meager, studies to understand the role of weather factors in influencing *T. papillosa* incidence is need of the hour in North Eastern Hill (NEH) Region of India. This will not only help in taking right management decisions but also in their execution at right time. Hence the present study was undertaken as a first step towards the development of empirical model for predicting *T. papillosa* incidence based on abiotic factors. Further, the effect of weather data range for accurate assessment of *T. papillosa* incidence was also explored.

MATERIALS AND METHODS

The present study was carried out during March 2009 to March 2010, in eight year old litchi orchard (cv. Shashi) at ICAR Research Complex for NEH Region, Mizoram Centre, Kolasib, Mizoram, India. Ten trees were randomly selected for the study and were kept free from insecticides during the period of observation. Sampling

was done at weekly interval. In each tree, four terminal shoots were selected at random from the entire canopy. Thus, 40 shoots growing in all directions were sampled per week.

The weather data on rainfall, relative humidity (maximum and minimum) and temperature (maximum and minimum) collected from ICAR Research Complex for NEH Region, Mizoram Centre meteorological observatory were used in the study. The monthly and season-wise data on *T. papillosa* incidence were subjected to correlation analyses with average monthly and season-wise weather data to find out the influence of abiotic factors on *T. papillosa* infestation.

Statistical analysis

As a first step, linear correlation coefficient of *T. papillosa* incidence (Y) in litchi, for weather parameters *viz*., maximum temperature (X_1), minimum temperature (X_2), maximum relative humidity (X_3), minimum relative humidity (X_4) and rainfall (X_5) was worked out. Then a statistical model relating *T. papillosa* incidence with all the weather parameters was developed following the procedure of least square technique (Ryan, 1997). Further, a measure of goodness-of-fit and Co-efficient of determination (R^2) (Agostid'no and Stephens, 1986) were calculated for developed models.

RESULTS AND DISCUSSION

Seasonal incidence of *T. papillosa*

The population of *T. papillosa* varied from 9.64 to 39.94 (Table 1). The peak population (39.94) of *T. papillosa* was noticed during April 2009 followed by May 2009 and June 2009 with corresponding values of 33.35 and 30.92, respectively. It is clear from Table 1 that with an increase in minimum temperature (20 to 23^{0}C), maximum temperature (26 to 30^{0}C), maximum relative humidity (61 to 91%) and minimum relative humidity (37 to 71%) during April 2009 to July 2009 favours the population build-up of *T. papillosa*. The perusal of the *T. papillosa* population count and respective meteorological parameters revealed that an increase in maximum temperature (3-4^{0}C from normal of 26^{0}C), minimum temperature (2-3^{0}C from normal of 21^{0}C), decrease in maximum relative humidity (above 79%) and minimum relative humidity (above 56%) by 40 to 50% favour the population build-up of *T. papillosa*. The infestation of *T. papillosa* (season-wise) showed that though the infestation was observed throughout the year (Table 2). It was found high in summer (92.13), moderate during monsoon season (81.34) and low in winter season (73.55). These results are conformity with Liu and Lai (1998).

Correlation of *T. papillosa* incidence with weather parameters

Linear correlation coefficient analysis among monthly *T. papillosa* incidence with weather parameters was worked out and presented in Table 3. The correlation of *T. papillosa* incidence was positive correlation with maximum temperature (r = 0.533), minimum temperature (r = 0.181), minimum relative humidity (r = 0.205) and rainfall (r = 0.071) but was negative correlation with maximum relative humidity (r = -0.095). Among the intra-class linear correlation coefficient based on maximum temperature was significantly positively correlated with rainfall (r = 0.639). However, maximum relative humidity had the strong significant positive correlation with minimum relative humidity (r = 0.908) and minimum temperature showed significantly positively correlated with rainfall (r = 0.667).

Correlation of *T. papillosa* incidence (season-wise) with weather parameters

The correlation of *T. papillosa* incidence (Table 4) was positive correlation with rainfall (r = 0.113) but was negative correlation with maximum temperature (r = -0.798), minimum temperature (r = -0.855), maximum relative humidity (r = -0.979) and minimum relative humidity (r = -0.897).

Statistical models along with goodness of fit statistics

As a next step, statistical model was developed, by regressing monthly *T. papillosa* incidence with all the weather parameters. Perusal of Table 5 indicated that about (54%) of the variation in *T. papillosa* incidence have been collectively explained when all the weather parameters are incorporated in the model. Though the developed model resulted in considerably high R^2 value (54%), none of the regression coefficient was significantly related to *T. papillosa* incidence as indicated by the t-test statistic value (being less than 2.0). $Y = 12.23 + 0.86 (X_1) + 0.60 (X_2) - 0.90 (X_3) + 0.84 (X_4) - 0.02 (X_5)$ with all abiotic factors considered as full regression model. The error variation between observed and predicted values was ranged from 9.20 to 15.47 (Table 6).

Table 1. Seasonal incidence of *T. papillosa* on litchi and weather parameters during 2009 and 2010 (Month wise)

Months	Mean No. of *T. papillosa* per plant	Average weather parameters						
		Temperature (^{0} C)			Relative humidity (%)			Rainfall (mm)
		Maximum	Minimum	Mean	Maximum	Minimum	Mean	
March, 2009	18.84	26.7	20.7	23.7	61.2	37.8	49.5	5.0
April, 2009	39.94	29.7	20.3	25.0	83.3	61.8	72.5	192.0
May, 2009	33.35	30.6	21.3	25.9	78.0	66.0	72.0	231.9
June, 2009	30.92	30.3	23.7	27.0	85.2	71.0	78.1	235.0
July, 2009	29.36	29.9	23.5	26.7	91.1	69.1	80.1	329.0
August, 2009	9.64	29.1	23.4	26.2	90.8	66.7	78.8	389.0
September, 2009	11.42	28.8	23.3	26.0	85.2	56.9	71.0	564.0
October, 2009	10.55	24.8	18.7	21.8	84.0	61.1	72.6	128.0
November, 2009	14.02	24.7	18.6	21.7	86.1	61.9	74.0	2.0
December, 2009	13.52	21.8	14.7	18.3	84.6	53.8	69.2	0.0
January, 2010	14.05	22.7	14.7	18.7	75.2	46.9	61.0	0.0
February, 2010	21.41	24.1	16.4	20.3	61.3	37.1	49.2	0.0
March, 2010	24.76	29.9	21.4	25.6	61.1	36.6	48.8	241.0
Mean	20.91	26.6	20.6	23.6	79.0	55.9	67.5	178.2

Table 2. Seasonal incidence of *T. papillosa* on litchi and weather parameters during 2009 and 2010 (season wise)

Months	Mean No. of *T. papillosa* per plant	Average weather parameters						
		Temperature (^{0} C)			Relative humidity (%)			Rainfall (mm)
		Maximum	Minimum	Mean	Maximum	Minimum	Mean	
Summer (March, 2009 to May, 2009)	92.13	29.0	20.8	24.9	74.2	55.2	64.7	428.9
Monsoon (June, 2009 to September, 2009)	81.34	30.2	21.8	26.0	82.2	66.3	74.2	1517.0
Winter (October, 2009 to February, 2010)	73.55	30.2	22.8	26.5	84.8	68.7	76.7	130.0
Mean	82.3	29.8	21.8	25.8	80.4	63.4	71.9	692.0

Table 3. Correlation coefficient (r) among monthly *T. papillosa* incidences and weather parameters

Variables	*T. papillosa* incidence	Maximum temperature (^{0}C)	Minimum temperature (^{0}C)	Maximum relative humidity (%)	Minimum relative humidity (%)	Rainfall (mm)
T. papillosa incidence	1.000	0.533ns	0.181ns	-0.095ns	0.205 ns	0.071ns
Maximum temperature (^{0}C)		1.000	0.379ns	0.030ns	0.309 ns	0.639*
Minimum temperature (^{0}C)			1.000	0.485ns	0.542 ns	0.667*
Maximum relative humidity (%)				1.000	0.908**	0.434ns
Minimum relative humidity (%)					1.000	0.454ns
Rainfall (mm)						1.000

** = significant at 1% level, * = significant at 5 % level, ns : non significant

Table 4. Correlation coefficient (r) among monthly *T. papillosa* incidences and weather parameters (season-wise *T. papillosa* incidence)

Variables	*T. papillosa* incidence	Maximum temperature (^{0}C)	Minimum temperature (^{0}C)	Maximum relative humidity (%)	Minimum relative humidity (%)	Rainfall (mm)
T. papillosa incidence	1.000	-0.798ns	-0.855ns	-0.979ns	-0.897ns	0.113ns
Maximum temperature (^{0}C)		1.000	0.995ns	0.904ns	0.982ns	0.509ns
Minimum temperature (^{0}C)			1.000	0.943ns	0.996ns	0.419ns
Maximum relative humidity (%)				1.000	0.969ns	0.094ns
Minimum relative humidity (%)					1.000	0.337ns
Rainfall (mm)						1.000

ns : non significant

Table 5. Multiple regressions of monthly *T. papillosa* incidences with meteorological parameters

Multiple regression	Meteorological parameters				
	Temperature (^{0}C)		Relative humidity (%)		
	Maximum (X_1)	Minimum (X_2)	Maximum (X_3)	Minimum (X_4)	Rainfall (mm) (X_5)
Coefficient	0.860	0.603	-0.896	0.843	-0.018
Standard Error	1.381	1.377	1.011	0.880	0.033
T-value	0.62ns	0.44ns	-0.89ns	0.96ns	-0.56ns
R^2	0.54ns				
F value	1.54ns				
Regression equation	$Y= 12.23 + 0.86 (X_1) + 0.60 (X_2) - 0.90 (X_3) + 0.84 (X_4) - 0.02 (X_5)$				

ns : non significant, Y : Number of *T. papillosa*

Table 6. Calculated error variation for predicted monthly *T. papillosa* incidences

Months	Predicted *T. papillosa* incidences	Error variation between observed and predicted *T. papillosa* incidences
March, 2009	25.41	-6.57
April, 2009	24.47	15.47
May, 2009	33.05	0.30
June, 2009	31.88	-0.96
July, 2009	23.09	6.27
August, 2009	18.84	-9.20
September, 2009	12.56	-1.14
October, 2009	19.00	-8.45
November, 2009	20.37	-6.35
December, 2009	7.77	5.75
January, 2010	13.49	0.56
February, 2010	19.06	2.35
March, 2010	22.80	1.96

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