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Variation in Damage by Tea-Pests in Relation to Climatic Factors at a Terine Garden in North Bengal, India

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ABSTRACT

Work was conducted at a terine tea garden in northern part of Bengal. Damaged leaves and intensity of the damage was estimated and atmospheric temperature and relative humidity data were recorded during the study period, Correlation between the temperature and the intensity of damage was significantly negative while relative humidity appeared to render positive effect upon pest infestation and damages. Seasonal variation of damage was observed to be statistically significant ($p<0.05$).

Keywords: Tea plant, Pest, emperature, humidity, Season.

INTRODUCTION

Camelliasinensis or tea (family Theaceae), widely used as a beverage yielding plant, is of evergreen type. Its beight may go up to 10-15 m in the wild but maintained within 0.6-1.5 m in cultivated gardens. Flowers, bearing many stamens, yellow anther and white petala, are found in solitary or in clusters of two or four (Ross 2005). Fruits are of rounded capsule form bearing seeds of size of small nuits (Biswas 2006).

Different parts of the tea plants are associated with 1031 species from various arthropod groups around the world of which about 3% are found as pest in different parts of the world that may cause 11% to 55% of loss in tea production (Hazarika 2009). In north-eastern India. 167 species were recorded from the tea plants (Das et al. 2010). A current study has recorded 167 species belonging to 139 genera of 42 families under 6 orders of insects from the survey carried out in tea gardens of North Bengal (Mitra et al 2018).

Among 16 states of India where tea is successfully being cultivated Assam. West Bengal. Tamil Nadu and together produce around 95% of total yield (Hazarika and Borah 2013). In northern part of Bengal samll tea growers account for the 32.5% of the total production of the region (Chowdhury etal 2016). No literature however is available on the variation of pest infestation in relation to climatic factors in this region, the present work was taken upto address the paucity of data and examine the seasonal variation of damage by pests and the impact of temperature and humidity on the intensity of the damage.

MATERIALS AND METHODS

Survey was conducted at a private tea garden ($26^0 35'$ $46.15''$N,88^0 $41'$ $22.65''$ E) at Patkata, Jalpaiguti,

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Table 1. Number of total, damaged and percentage of damaged tea leaves (on upper surface) during the winter season.

Sl No.	24.11.18 Damaged	8.12.18 Damaged	22.12.18 Damaged	24.11.18 Total	8.12.18 Total	22.12.18 Total	24.11.18 % of damaged	8.12.18 % of damaged	22.12.18 % of damaged
1	113	80	66	289	196	324	39.1	40.82	20.37
2	130	83	54	441	256	356	29.48	32.42	21.09
3	123	79	86	361	256	400	34.07	30.86	21.5
4	93	46	59	256	289	196	36.33	15.92	30.1
5	99	69	46	361	269	196	27.42	40.83	23.47
6	92	34	42	289	225	369	31.83	15.11	24.85
7	119	98	86	625	169	225	19.04	57.99	38.22
8	88	63	50	484	324	169	18.18	19.44	29.59
9	102	89	72	676	289	289	15.09	30.8	24.91
10	250	95	81	529	361	289	28.36	26.32	28.03
Mean	110.9	73.6	64.2	431.1	253.4	251.3	27.89	31.05	26.21

during two seasons, winter and the spring. The garden was managed with organic manure and no chemical pesticide was used. Six visits (Three visits with an interval of two weeks during each of the seasons) were taken up from November, 2018 to March, 2019.

Number of damaged leaves on the upper surface of each of the ten plants were counted during every visit. Upper surface of the plants was in square shape and therefore estimation of total number of surface leaves were made taking squared value of the number of leaves of a side. Surface leaves were only considered in the current study as only the upper-most tea leaves are collected for tea production. Local temperature and relative humidity data were during the visit.

For statistical analysis, MINITAB 13 was used. Longarithmic tranformation of all the data were made to meet the requirement of parsmetric statistical analyses (gerard and Berthet 1996).

RESULTS AND DISCUSSION

Temperature varied from 21^{0}C to 26^{0}C while the relative humidity exhibited a range from 46% to 73% during the study period. Major infesting pests included tea mosquito bug (*Helopeltis* sp.) loopers (*Hyposedra* sp.), aphids (*Toxoptera* sp.), scale insect (*Saissetia* sp.), thrips (*Heliothrips* sp.), leafhopper (*Empoasea* sp.), red spider mite (*Oligonychus* sp.).

The numer of damaged leaves at surface (per plant) ranged from 46 to 150 in the tea plants sampled during the winter while the percentage of the damaged leaves varied from 15.11% to 57.99%. The mean

Table 2. Number of total damaged and percentage of damaged tea leaves (on upper surfacee) during the spring season.

Sl No.	2.2.19 Damaged	16.2.19 Damaged	2.3.19 Damaged	2.2.19 Total	16.2.19 Total	2.32.19 Total	2.2.19 % of damaged	16.2.19 % of damaged	2.3.19 % of damaged
1	63	28	33	289	256	361	21.8	10.94	9.14
2	70	30	26	289	289	256	24.22	10.38	10.16
3	97	35	47	196	169	324	49.49	20.71	14.51
4	39	31	33	256	289	289	15.23	10.73	11.42
5	70	35	26	256	625	400	27.34	5.6	6.5
6	55	46	49	225	225	225	24.44	20.44	21.78
7	48	29	33	169	169	169	28.4	17.16	19.53
8	38	19	24	196	289	289	19.39	6.57	8.3
9	59	33	17	256	196	196	23.05	16.84	8.67
10	43	24	32	361	169	256	11.91	14.2	12.5
Mean	58.2	31	32	249.3	267.6	276.5	24.52	13.35	12.25

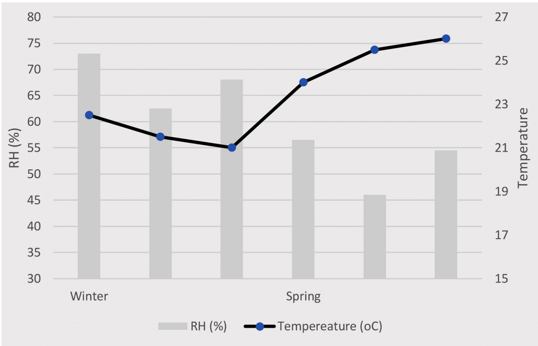

Fig. 1. Fluctuation of temperature (^{0}C) and relative humidity (RH, in %) during the collection period.

Table 3. Temperature, relative humidity, day-wise damaged leaves and percentage of the same

Seasons	Observation No.	Temperature (0C)	RH (%)	Damaged (mean)	%Damaged (mean)
Winter	1	22.5	73	110.9	27.89
	2	21.5	62.5	73.6	31.051
	3	21	68	64.2	26.213
Spring	1	24	56.5	58.2	24.527
	2	25.5	46	31	13.357
	3	26	54.5	32	12.251

number and the mean percentage ranged within 110.9 to 64.2 and 26.21% to 31.05% respectively (Table 1)

During the spring, the mean number of per plantdamaged leaves varied from 31 to 58.2 while the percentage of the same exhibited a range 12.25% to 14.2% (Table 2).

Both the number and the percentage of the damaged leaves declined during the spring (Table 1, 2, 3; Fig 1, 2, 3) which could be associated with relatively lower humidity and higher temperature as recorded during this period (Table 3, Fig 1). dry atmosphere and high temperature generally render negative impact on insect abundance (Matilda et al. 2012, Jaworski and Hilszczński 2013).

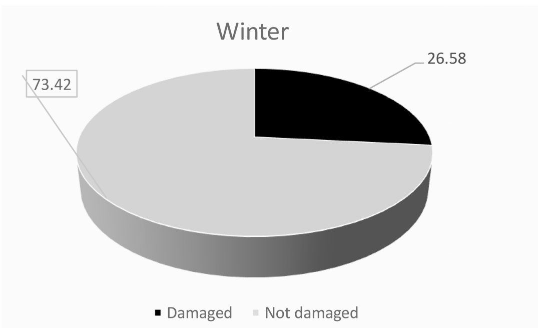

Fig. 2. Percentage of damaged and not damaged leaves during the winter.

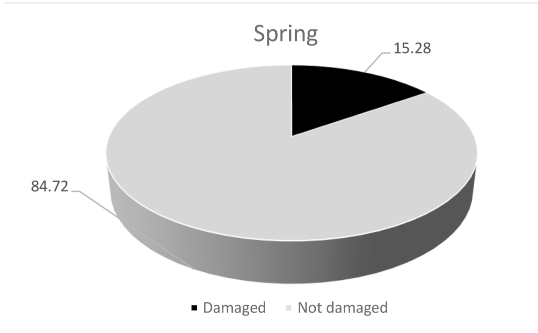

Fig. 3. Percentage of damaged and not damaged leaves during the spring .

Mean number of total leaves did not differ significantly between the seasons but, the mean number of per-plant damaged leaf and the percentage of the same exhibited statistically significant difference between the seasons as the t tests revealed ($p<0.05$) (Table 4, 5, 6). It may therefore be concluded that the intensity of damage was higher during the winter season.

Day-wise variation of mean number of leaves during winter was significant but the same was not significant for the spring season as the on-way ANO-

Table 4. test on plant-wise number of total leaves (on upper surface) of two seasons (total 6 for winter. Total _6 for winter, Total _7 for spring). (N= Number of observations; StDev= Standard deviation; SE=Standard Error; mu=mean).

Two - sample T for Total _6 va Total _7

	N	Mean	St Dev	SE Nean
Total _6	30	5.669	0.380	0.069
Total_7	30	5.531	0.298	0.054

Difference = mu Total _6 - mu Total_7
T -Test of difference = 0 (vs not =) ; T -value = 1.57
P-Value = 0.05

Table 5. *t* test on plant-wise number of damaged leaves (on upper surface) of two seasons (Damaged 6 for winter, damaged_7 for spring). (N= Number of observations; StDev= Standard deviation; SE=Standard Error, mu=mean).

Two-sample T for Damaged_6 vs Damaged_7

	N	Mean	StDev	EE Mean
Damaged_	30	4.360	0.356	0.065
Damaged_	30	3.618	0.400	0.073

Difference = mu Damaged_6 - mu Damaged _7
T - Test of difference = 0 (vs not +) T-value = 7.58
P-Value = 0.05

Table 6. *t* test on plant-wise percentage of damaged leaves (on upper surface) of two seasons (% of demaged_6 for winter, % of damaged_7 for spring). (N = Number of observations; StDev= Standard deviation; SE=Standard Error, mu=mean).

Two - sample T for of damaged_6 vs of damaged_7

	N	Mean	St Dev	SE Mean
% of dama	30	3.296	0.323	0.059
% of dama	30	2.692	0.505	0.092

Difference = mu %of damaged_6 - mu %of damaged_7
T- Test of difference = 0 (vs not =) : T-Value = 5.51
P-Value =0.05

VA indicated ($p<0.05$) (Tables 7, 8). day-specific differences of the number of damaged leaves was significant during the both season (Tables 9, 10), but, the percentage of damaged leaves per plant differ significantly ($p<0.05$) only during the spring as per the ANOVA done (Tables 11, 12).

Correlations were expectedly positive and significant ($p<0.05$) between the number and the percentage of the damaged leaves while significan negative correlations (p,0.05) were observed between the percentage of the damaged leaves and the total number of leaves during both the seasons surveyed (Tables 13, 14).

Significant positive correlation only existed

Table 7. One-way ANOVA on plant-wise total number leaves (on upper surface) of each day sampled during the winter. (Total for day 1; Total_1 for dya 2; Total_2 for day 3; DF = Degree of freedom; SS=Sum square; MS = Mean square; F= F statistic: p=Probability of error; StDev= Standard deviation).

One-way ANOVA : Total, Total_1, Total_2

Analysis of Variance

Source	DF	SS	NS	F	F
Factor	2	1.7952	9.8976	10.10	0.001
Error	27	2.3998	0.0889		
Total	29	4.1950			

Table 8. One-way ANOVA on plant-wise total number of leaves (on upper surface) of each day sampled during the spring. Total_3 for day 1; Total _4 for day 2; Total _5 for day 3; DF=Degree of freedom; SS=Sum square; MS= Mean square: F= F statistic; p= probability of error, StDev = standard deviation).

One-way ANOVA : Total_3, Total_4, Total_5

Analysis of Variance

Source	DF	SS	MS	F	P
Factor	2	0.0540	0.0270	0.29	0.752
Error	27	2.5281	0.0936		
Totak	29	2.5822			

Tatal 9. One-way ANOVA on plant-wise mumber of damaged leaves (on upper surface) of each day sampled during the winter. (Damaged for day 1; Damaged_1 for day 2; Damaged_2 for day 3; DF = Degree of freedom; SS= Sum square; MS = Mean square; F = f statistic; p=Probability of error; StDev=Standard deviation).

One-way ANOVA; Damaged, damaged_1, Damaged_2

Analysis of Variance

Source	DF	SS	MS	F	P
Factor	2	1.7583	0.8791	12.33	0.000
Error	27	1.9247	0.0713		
Total	29	3.6829			

Table 10. One-way ANOVA on plant-wise number of damaged leaves (on spper surface) of each day sampled during the spring. (Damaged_3 for day 1; Damaged_4 for days 2; Damaged_5 for day 3; DF = Degree of freedom; SS = Sum square; MS+ Mean square; F = F statistic; p= Probability of error; StDev=Standard deviation).

One-way ANOVA : Damaged_3, Damaged_4, Damaged_5

Analysis of Variance

Source	DF	SS	MS	F	P
Factor	2	2.4608	1.2304	15.24	0.000
Error	27	2.1796	0.0807		
Total	29	4.6404			

Table 11. One-way ANOVA on plant-wise percentage of damaged leaves 9on upper surface) of each day sampled during the winter. (% of damaged for day 1; % of Damaged_1 for day 2; % of Damaged_2 for day 3; DF= Degree of freedom; SS= Sum square; MS= Mean aquare; F= f statistic; p= Probability of error; StDev= Standard deviation).

One-way ANOVA: %of damaged, %of damaged_1, %of damaged_2

Analysis of Variance

Source	DF	SS	MS	F	F
Factor	2	0.057	0.029	0.26	0.773
Error	27	2.964	0.110		
Total	29	3.021			

Table 12. One -way ANOVA on plant-wise percentage of damaged leaves (on upper surface) of each day sampled during the winter. (% of damaged_3 for day 1; % of Damaged_4 for day 2; % of Damaged 5 for day 3; DF = Degree of freedom; SS = Sum square; MS = Mean square; F = F statistic; p = Probability of error, StDev=Standard deviation).

One-way ANOVA: %of damaged_3, %of damaged_4, %of damaged_5

Analysis of Variance

Source	DE	SS	MS	F	F
Factor	2	2.931	1.465	8.86	0.001
Error	27	4.465	0.165		
Total	29	7.396			

between the numberof total leaves andthe number of damaged ones in winter season and the correlation coeddicient was negative but was not statistically significant ($p>0.05$) in spring (Table 13, 14).

Table 13. Multiple correlation analysis among total, damaged and percentage of damaged leaves found during the winter,

Correlations : Damaged, Total, %of damaged

	Damaged	Total
Total	0.618	
	0.000	
% of damaged	0.376	-0.496
	0.041	0.005

Cell contents ; Pearson correlation
p-valua

Table 14. Multiple correlation analysis among total, damaged and percentage of damaged

Correlations : Damaged, Total, %of damaged

	Damaged_	Total
Total	-0.025	
	0.897	
%of damaged	0.907	-8.611
0.00	0.000	

Cell contents : Pearson correlation
P-value

Table 15. Multiple correlation analysis among temperature, relative humidity, total,damaged and percentag of damaged leaves (based on entire data).

Correlations : Temp, Rh, Damaged, % damaged

	Temp	RH	Damaged
RH	-0.802		
	0.055		
Damaged	-0.789	0.900	
	0.062	0.015	
% damage	-0.898	0.789	0.915
0.015	0.063	0.011	

Coll Contents ; Pearson correlation
P-Value

As observed based upon data from two seasons together, impact of temperature appeard to be significantly negative ($p<0.05$) on the intensity of the damage while the number of damaged leaves exhibited significant positive correlation with the relative humidity ($p<0.05$) (Table 15).

CONCLUSION

Intensity of damage varied significantly between the spring and the winter seasons, the same was greater during the winter season. temperature had negative impact on the intensity of damage while relative humidity appeared to favor thriving of the pests and therefore the damage by them.

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