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Influence of weather factors on the population dynamics of chewing pests of lowland paddy

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ABSTRACT

Chaetocnema spp. was active from the last week of August to second week of October with a peak level of population during first week of September (8.17). Monolepta signata Oliver was reached peak level of population during third week of September (5.17) followed by first week of September (5.00). The mean population of Chaetocnema spp. and M. signata over the season recorded was 4.53 and 2.88 beetles per 5 plants, respectively. Melanitis leda ismene Cramer was peak level of population during first week of September (3.42). Cnaphalocrocis medinalis Guenee recorded its peak level of population during third week of September (0.33). The mean population of M. leda ismene and C. medinalis over the season recorded was 1.56 and 0.14 larvae per 5 plants. Correlation coefficient between chewing pests and abiotic factors revealed that Chaetocnema spp. had positive significant correlation with maximum relative humidity (r=0.713), while C. medinalis established negative significant correlation with maximum temperature (r=-0.707). M. signata showed positive correlation with all the weather factors, whereas M. leda ismene had positive correlation with minimum temperature (r=0.633) and minimum relative humidity (r=0.114).

Key words: *Chaetocnema spp., Monolepta signata, Melanitis leda ismene, Cnaphalocrocis medinalis, population dynamics, weather factors, rice, chewing, insect, pests*

One of the major constraints of rice production in India is the occurrence of insect pests at various stages of crop growth. In India, 221 species of insects feeding on rice were reported by Arora and Dhaliwal (1996). Among these, *Chaetocnema* spp., *Monolepta signata* Oliver, *Melanitis leda ismene* Cramer and *Cnaphalocrocis medinalis* Guenee are the most important among chewing pests in Mizoram. Control of insect pests is a major problem for many rice farmers in India and is one of the major constraints in the realization of optimum yield. Abiotic factors influence field populations of insect pests of rice. The population dynamics studies are useful in devising economically feasible and ecologically sound integrated pest management. However, such studies have not been carried out on lowland paddy particularly in North Eastern Hill Region of India. Hence, an investigation was undertaken to study the the influence of weather factors on chewing pests in lowland paddy.

MATERIALS AND METHODS

The study was undertaken at the experimental farm, ICAR Research Complex for NEH Region, Mizoram, India during 2008 and 2009 to study the influence of weather factors on chewing insect pests *viz*., *Chaetocnema* spp., *M. signata*, *M. leda ismene* and *C. medinalis*. Twenty five days old rice seedlings var. IR-64 were transplanted with spacing of 20 x 15 cm in plot size of 20 m^2. All the recommended agronomic practices were followed as per the package of practices. Observations on the incidence of chewing insect pests were recorded at weekly interval starting from initial appearance to final disappearance or up to harvest. Observations on the incidence of *Chaetocnema* spp. and *M. signata* were recorded from 10 randomly selected plants by counting number of beetles per plant. The population of *M. leda ismene* and *C. medinalis* were recorded by counting the number of larvae per plant from 10 randomly selected plants.

The weather data on rainfall, relative humidity and temperature 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.

Linear correlation coefficient of *Chaetocnema* spp. (Y_1), *M. signata* (Y_2), *M. leda ismene* (Y_3) and *C. medinalis* (Y_4) incidence, 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. Further, a measure of goodness-of-fit, the values of Co-efficient of determination (R^2) was calculated for developing models (Agostid'no and Stephens, 1986).

RESULTS AND DISCUSSION

During the study, *Chaetocnema* spp., *M. signata* and *C. medinalis* were the first to invade the crop during last week of August, whereas *M. leda ismene* was recorded during second week of September (Table 1). *Chaetocnema* spp. was active from the last week of August to second week of October with a peak level of population during first week of September (8.17) followed by second week of September (7.42), while the lowest population recorded during first week of October (0.08). The mean population of *Chaetocnema* spp. over the season recorded was 4.53 per 5 plants.

Table 1. Seasonal incidence of chewing pests of lowland paddy and weather parameters

SMW	Chewing pests of lowland paddy per 10 plants					Weather parameters				
						Temperature (0C)		Relative humidity (%)		Rainfall (mm)
	Chaetocnema spp.	*M.signata*	*M.ledaismene*	*C.medinalis*	Mean	Maximum	Minimum	Maximum	Minimum	
35	7.25	0.50	0.00	0.08	1.96	31	23	91	68	3
36	8.17	5.00	0.00	0.17	3.34	29	21	93	60	134
37	7.42	2.50	3.42	0.17	3.38	29	24	89	54	27
38	3.00	3.58	2.50	0.33	2.35	25	23	84	75	0.5
39	4.67	5.17	2.25	0.08	3.04	26	23	88	77	20
40	4.50	3.25	2.25	0.08	2.52	33	23	73	73	7
41	0.08	1.83	1.08	0.08	0.77	30	24	76	63	0
42	1.17	1.17	1.00	0.08	0.86	28	23	83	63	14
Mean	4.53	2.88	1.56	0.14	2.28	28.9	23.0	84.6	66.6	25.7

SMW: Standard meteorological week

Table 2. Multiple regressions of *Chaetocnema* spp. with weather parameters

Multiple regression	Temperature (^{0}C)		Relative humidity (%)		Rainfall (mm)
	Maximum (X_1)	Minimum (X_2)	Maximum (X_3)	Minimum (X_4)	(X_5)
Coefficient	1.109	2.845	0.450	0.224	0.071
Standard Error	0.403	1.527	0.130	0.121	0.037
T-value	2.75ns	1.86ns	3.46ns	1.86ns	1.94ns
F value	4.01ns				
R^2	0.91ns				
Regression equation	Y_1= -148.248 + 1.109 (X_1) + 2.845 (X_2) + 0.450 (X_3) + 0.224 (X_4) + 0.07 (X_5)				

ns : non significant, Y_1 : Number of *Chaetocnema* spp. per 10 plants

Table 3. Multiple regressions of *Monolepta signata* with weather parameters

Multiple regression	Temperature (ºC)		Relative humidity (%)		Rainfall (mm)
	Maximum (X_1)	Minimum (X_2)	Maximum (X_3)	Minimum (X_4)	(X_5)
Coefficient	-0.022	0.794	-0.042	0.144	0.051
Standard Error	0.364	1.378	0.117	0.109	0.033
T-value	-0.06ns	0.58ns	-0.35ns	1.33ns	1.56ns
F value	1.35ns				
R^2	0.77ns				
Regression equation	$Y_2 = -22.379 - 0.022\ (X_1) + 0.794\ (X_2) - 0.042\ (X_3) + 0.144\ (X_4) + 0.051\ (X_5)$				

ns : non significant, Y_2 : Number of *M. signata* per 10 plants

Table 4. Multiple regressions of *M. leda ismene* with weather parameters

Multiple regression	Temperature (ºC)		Relative humidity (%)		Rainfall (mm)
	Maximum (X_1)	Minimum (X_2)	Maximum (X_3)	Minimum (X_4)	(X_5)
Coefficient	0.054	1.124	-0.013	0.020	0.015
Standard Error	0.409	1.552	0.132	0.123	0.037
T-value	0.13ns	0.72ns	-0.10ns	0.16ns	0.40ns
F value	<1				
R2	0.45 ns				
Regression equation	$Y_3 = -26.722 + 0.054\ (X_1) + 1.124\ (X_2) - 0.013\ (X_3) + 0.020\ (X_4) + 0.015\ (X_5)$				

ns : non significant, Y_3 : Number of *M. leda ismene* per 10 plants

Catling and Islam (1999) reported that *Chaetocnema pulicaria* was commonly present during pre-flood period i.e., during the months of April and May. *M. signata* was reached peak level of population during third week of September (5.17) followed by first week of September (5.00), whereas the lowest population registered during last week of August (0.50). The mean population of *M. signata* over the season noticed was 2.88 per 5 plants. *M. leda ismene* was reached peak level of population during first week of September (3.42) followed by second week of September (2.50). The mean population of *M. leda ismene* over the season recorded was 1.56 per 5 plants. *C. medinalis* was recorded peak level of population during third week of September (0.33). Islam *et al*. (1996) reported that the population of *C. medinalis* had reached its highest level during September to November. The highest chewing pests population was observed during second week of September (3.38) followed by first week of September (3.34), whereas lowest chewing pests

Table 5. Multiple regressions of *C. medinalis* with weather parameters

Multiple regression	Temperature (ºC)		Relative humidity (%)		Rainfall (mm)
	Maximum (X_1)	Minimum (X_2)	Maximum (X_3)	Minimum (X_4)	(X_5)
Coefficient	0.002	0.121	0.002	0.005	0.003
Standard Error	0.015	0.055	0.005	0.004	0.001
T-value	0.15ns	2.19ns	0.42ns	1.05ns	2.17ns
F value	2.57ns				
R^2	0.87ns				
Regression equation	$Y_4 = -3.283 + 0.002\ (X_1) + 0.121\ (X_2) + 0.002\ (X_3) + 0.005\ (X_4) + 0.003\ (X_5)$				

ns : non significant, Y_4 : Number of *C. medinalis* per 5 plants

population was registered during first week of October (0.77).

All the abiotic factors jointly had the significant impact (F = 4.01) on *Chaetocnema* spp. infestation (Table 2). The coefficient of determination (R^2) was found to be 91 per cent. T-value had non-significant with all the abiotic factors. All the abiotic factors jointly recorded the non-significant impact (F = 1.35) on *M. signata* infestation (Table 3). The coefficient of determination (R^2) was found to be 77 per cent. T-value had non-significant with all the abiotic factors. All the abiotic factors jointly recorded the non-significant impact (F = <1) on *M. leda ismene* infestation (Table 4). The coefficient of determination (R^2) was found to be 45 per cent. T-value had non-significant with all the abiotic factors. All the abiotic factors jointly recorded the significant impact (F = 2.57) on *C. medinalis* infestation (Table 5). The coefficient of determination (R^2) was found to be 87 per cent. T-value had non-significant with all the abiotic factors.

Correlation coefficient (Table 6) worked out among chewing pests of lowland paddy revealed that *Chaetocnema* spp. established positive correlation with *M. signata* (r = 0.202) and *C. medinalis* (r = 0.089), but was negative correlation with *M. leda ismene* (r = -0.074). *M. signata* showed positive correlation with *M. leda ismene* (r = 0.249) and *C. medinalis* (r = 0.308). Similarly, *M. leda ismene* had positive correlation with *C. medinalis* (r = 0.338). Correlation coefficient between chewing pests and abiotic factors (Table 7) revealed that *Chaetocnema* spp. had positive significant correlation with maximum relative humidity (r = 0.713), while *C. medinalis* established negative significant correlation with maximum temperature (r =

Table 6. Correlation coefficients of chewing pests of lowland paddy with weather parameters

Abiotic factors	Chewing pests of lowland paddy			
	Chaetocnema spp.	*M. signata*	*M. leda ismene*	*C. medinalis*
Maximum Temperature (^{0}C)	0.203ns	0.376ns	-0.301ns	-0.707*
Minimum Temperature (^{0}C)	-0.489ns	0.307ns	0.633ns	0.432ns
Maximum relative humidity (%)	0.713*	0.186ns	-0.262ns	0.208ns
Minimum relative humidity (%)	-0.239ns	0.309ns	0.114ns	0.096ns
Rainfall (mm)	0.563ns	0.550ns	-0.393ns	0.109ns

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

Table 7. Calculated error variation for predicted chewing pests of lowland paddy

SMW	*Chaetocnema* spp.		*M. signata*		*M. leda ismene*		*C. medinalis*	
	Predicted values	Error variation between observed and predicted values	Predicted values	Error variation between observed and predicted values	Predicted values	Error variation between observed and predicted values	Predicted values	Error variation between observed and predicted values
35	8.019	-0.769	1.387	-0.887	1.015	-1.015	0.064	0.019
36	8.514	-0.347	5.340	-0.340	0.422	-0.422	0.161	0.006
37	6.308	1.109	1.521	0.979	2.135	1.282	0.181	-0.014
38	3.110	-0.110	4.353	-0.770	3.036	-0.536	0.301	0.032
39	4.346	0.321	3.797	1.370	1.219	1.031	0.137	-0.054
40	3.539	0.961	3.021	0.229	1.515	0.735	0.067	0.016
41	1.667	-1.584	1.952	-0.119	2.136	-1.053	0.121	-0.038
42	0.748	0.419	1.630	-0.463	1.022	-0.022	0.050	0.033

SMW: standard meteorological week

-0.707). *M. signata* showed positive correlation with all the weather factors, whereas *M. leda ismene* had positive correlation with minimum temperature (r = 0.633) and minimum relative humidity (r = 0.114) but was negative correlation with maximum temperature (r = -0.301), maximum relative humidity (r = -0.262) and rainfall (r = -0.393). The error variation between observed and predicted values (Table 8) was ranging from -1.584 to 1.109 (*Chaetocnema* spp.), -0.887 to 1.370 (*M. signata*), -1.053 to 1.282 (*M. leda ismene*) and -0.054 to 0.033 (*C. medinalis*).

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