Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2021; 9(4): 281-285

Received: 07-05-2021
Accepted: 09-06-2021

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# Population dynamics of mulberry leaf roller, *Diaphania pulverulentalis* (Hampson) (Lepidoptera: Pyralidae)

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**Abstract**
The quantity as well as quality of mulberry leaf and subsequent production of quality silk is greaterly hampered due to the incidence of various insect pests. The present study was aimed to analyse, the population dynamics of leaf roller, *Diaphania pulverulentalis* (Hampson) a key seasonal defoliating pest of mulberry. The results indicated that maximum population buildup of this pest was recorded during September to November of 2017 with the incidence range of 30.30 per cent to 34.07 per cent and June to July of 2018 with the incidence range of 31.26 per cent to 38.15 per cent. Correlation study indicated that, there is a linear relationship between the decreased in atmospheric temperature and increased relative humidity coinciding with increased pest population. Significant negative correlation was observed between maximum temperature and pest infestation. All other abiotic and biotic factors exhibited a positive correlation with the incidence of leaf roller.

**Keywords:** population dynamics, mulberry leaf roller, *Diaphania pulverulentalis* (Hampson)

## Introduction
Sericulture is an integral part of agrarian country like India. It helps to improve the livelihood and socio-economic conditions of the farming community. India ranks second amongst silk producing countries next to China and contribute about 12 per cent of the global raw silk production. The production and productivity of mulberry as well as silk cocoons is influenced by several factors. In sericulture ecosystem around 300 insect and non-insect pest species have been reported to be infesting the mulberry crop (Biradar, 1989) [2]. Among the various pests, the defoliators are considered to be major, as they cause extensive damage to the mulberry. These defoliating pests cause around 12 to 25 per cent leaf yield loss either by depletion in nutritive value or through defoliation (Rajadurai *et al*., 1999) [6]. The mulberry leaf yield loss in Mysore and Chamarajanagar districts due to *Diaphania pulverulentalis* (Hampson) was up to 30 per cent (Sengupata *et al*., 1990) [8].
In Karnataka, the incidence of *D. pulverulentalis* (Hampson) on mulberry ranged from 0 to 100 per cent, being severe in winter months (October to February) and reduced to 0 to 30 per cent in summer months (March to June) and yield loss is around 30 per cent in Koppa, Mandya, Mysore and Kanakapura Taluks (Siddegowda *et al*., 1995; Rahmathulla *et al*., 2015) [9]. The infestation and population build-up of a pest is influenced by weather parameters, several natural enemies hinder the population buildup of leaf roller in the mulberry eco-system. Thirty seven parasitoids and six predators are known to naturally regulate the leaf roller at its different life stages (Manjunath Gowda *et al*., 2005) and ten entomo pathogenic fungi were found to be minimize the incidence of leaf roller (Srinivasa Gowda *et al*., 2000). The present study was conducted to understand the influence of abiotic and biotic factors on population dynamics of leaf roller throughout the year in one of predominant silk producing area, Ramanagara district of Karnataka State.

## Material and Methods
The population dynamics was monitored at fortnightly intervals, by 'fixed plot method' as suggested by Govindaiah *et al*., (1995) [3] in Garkhihalli of Ramanagara district, the potential sericulture area of Karnataka state during 2017 – 2019. In each place, $V_1$ mulberry garden was selected, with similar cropping pattern and divided into five micro plots measuring two sq. mt fixed in the four corners and one in the centre of the garden.

In total 75 plants were randomly selected for recording of the pest population (15 plants/micro plot). At the same time the population of natural enemies associated with lepidopteron pests in mulberry ecosystem was also recorded. Fifteen plants were chosen randomly from each of five micro plots and labelled. The number of larvae present on the infested leaves of each plant was counted. Similarly, natural enemies' population associated with mulberry ecosystem was counted and the intensity of pest attack was calculated by using the following formula:

$$\text{Pest (P)or natural enemies (NE) population no / plant} = \frac{P1/N1 + P2N2+.....P10/N10}{\text{Total number of plants observed}}$$

Where $P_1$ to $P_{10}$ and $NE_1$ to $NE_{10}$ indicate the number of larvae/caterpillars and natural enemies present on the 15 observed plants in sequential manner respectively. The pest incidence was calculated as

$$\text{Percentage of pest incidence (PPI)} = \frac{\text{Number of infested plant}}{\text{Total number of plants observed}} \times 100$$

To determine the effect of weather parameters on the seasonal dynamics of leaf roller on mulberry, meteorological data of Garkhihalli village near Ramanagar was recorded. The weather data included max. & min. temperatures, morning & afternoon relative humidity and rainfall activity/abundance of natural enemies and leaf roller population (as dependent factors) were also recorded and subjected to correlation and multiple regression analysis to determine the overall influence of these factors on the activity of leaf roller during the cropping period.

## Results and Discussion

### Population dynamics of mulberry leaf roller

The per cent of pest incidence of leaf roller, *D. pulverulentalis* (Hampson) varied in different months in relation to abiotic and biotic factors (Table 1). The observation for the population dynamics of leaf roller indicated that, the infestation registered was more (30.30%) in the month of September with mean pest population of 2.92 per single plant. The peak population was noticed in November month (34.07%) with mean pest population of 2.86 which might be due to onset of northeast monsoon (Fig. 1 and Plate 1).

The infestation gradually declined over a period of time and continued up to April (6.30%), with mean pest population of 0.36 per single plants which might be due to continuous dry spell in summer season. During January, the incidence and pest population were 12.30 per cent and 0.48 numbers per plant, respectively and subsequently in the month of February both pest incidence and pest population were absent. However during the month of March (2.10% and 0.20, number per single plant, respectively) the least incidence might be again combination of higher temperature (31.5$^0$C to 35.6 $^0$C) and low decreasing relative humidity (68.40 to 54.20%). Further the pest incidence was increased during May (23.20%) with mean pest population of 1.52 per single plants which might be due to onset of south west monsoon which lead to increased atmospheric humidity. Further the leaf roller population was in increasing state from June to August and the peak infestation was recorded in the month of July (38.15%) with a mean population of 2.68 per single plant coinciding with increasing rainfall (164.30 mm), relative humidity (80.43%) and decreasing temperature (29.4 $^0$C) (Fig. 1) (Table 1).

With onset of winter season during 2017, the rainfall was declinied which caused decline in the incidence level and pest population throughout the year (Table.1). That scenario continued untill beginning of 2019 by recording minimum infestation and larval population during January (1.25%) and February (00.0%) (Table 1) (Fig.1). The disappearance of this pest from February to May could be due to pupal diapause as suggested by Rajadurai *et al*. (1999) [6]. Increased temperature leads to elicitation of heat shock proteins, decrease in pH which affects the function of proteins, nucleic acids and leads to hormonal imbalance. This effect makes the insect to be inactive during adverse climatic condition (Hochachka and Sommero, 1984).

**Table 1:** Mulberry leaf roller *D. pulverulentalis* (Hampson) infestation as influenced by abiotic factors

| Year | Months | Mean pest incidence (%)* | Mean pest population (Number/single plants) | Temperature ($^0$C) | | Relative humidity (%) | | Rainfall (mm) |
|---|---|---|---|---|---|---|---|---|
| | | | | Max. | Min. | Morning | Evening | |
| 2017 | September | 30.30 | 2.76 | 27.40 | 17.34 | 77.30 | 65.20 | 150.36 |
| | October | 32.40 | 2.92 | 28.40 | 18.36 | 72.70 | 64.30 | 120.34 |
| | November | 34.07 | 2.86 | 28.01 | 19.40 | 74.30 | 67.60 | 123.67 |
| | December | 21.30 | 1.24 | 30.10 | 16.40 | 68.40 | 56.20 | 56.43 |
| 2018 | January | 12.30 | 0.48 | 31.50 | 16.32 | 70.30 | 61.30 | 71.80 |
| | February | 00.00 | 0.00 | 33.33 | 15.36 | 50.36 | 40.30 | 00.000 |
| | March | 02.10 | 0.20 | 36.45 | 16.54 | 66.40 | 57.20 | 00.00 |
| | April | 06.30 | 0.36 | 35.60 | 17.39 | 54.20 | 42.30 | 03.70 |
| | May | 23.20 | 1.52 | 30.00 | 19.05 | 75.33 | 68.30 | 100.00 |
| | June | 31.26 | 3.00 | 28.38 | 16.54 | 77.44 | 66.30 | 126.30 |
| | July | 38.15 | 2.68 | 29.42 | 19.56 | 80.43 | 70.00 | 164.30 |
| | August | 30.30 | 2.44 | 32.30 | 18.36 | 78.50 | 68.36 | 90.30 |
| | September | 22.30 | 2.92 | 33.30 | 19.41 | 70.00 | 64.00 | 60.30 |
| | October | 18.36 | 1.36 | 34.15 | 18.13 | 68.00 | 56.00 | 80.00 |
| | November | 11.20 | 1.00 | 30.23 | 18.40 | 71.00 | 58.00 | 90.60 |
| | December | 06.32 | 0.64 | 35.36 | 16.50 | 63.00 | 57.00 | 06.32 |
| 2019 | January | 01.25 | 0.20 | 32.60 | 15.01 | 64.00 | 54.00 | 00.00 |
| | February | 00.00 | 0.00 | 34.30 | 16.32 | 67.00 | 50.00 | 00.00 |

* Mean value from 2 fortnight observation.

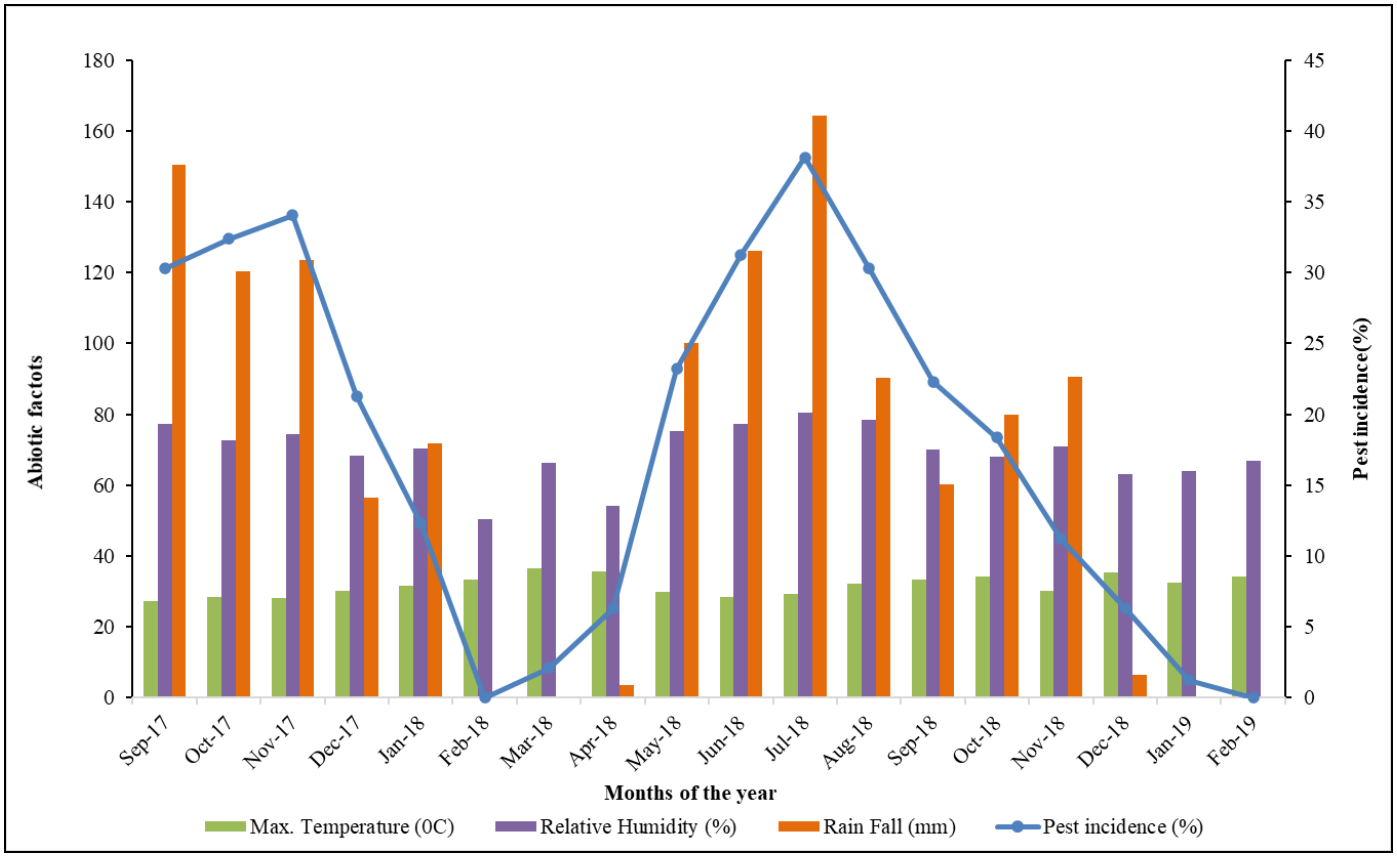


**Fig 1:** Incidence of mulberry leaf roller, *D. pulverulentalis* (Hampson) in relation to abiotic factors

**Table 2:** Mmulberry leaf roller, D. *pulverulentalis* (Hampson) infestation in relation to predatory fauna

| Year | Months | Mean pest incidence (%)* | Mean pest population (Number/single plants) | Lady bird beetle. *Cryptolaemus montrouzieri*, (Numbers/ 15 plants) | Lady bird beetle. *Cheilomenes sexmaculata* (Numbers/ 15 plants) | Mantids (Numbers/ 15 plants) |
|---|---|---|---|---|---|---|
| 2017 | September | 30.30 | 2.76 | 6 | 15 | 11 |
| | October | 32.40 | 2.35 | 2 | 17 | 5 |
| | November | 34.07 | 2.640 | 5 | 19 | 9 |
| | December | 21.30 | 1.24 | 2 | 8 | 0 |
| 2018 | January | 12.30 | 0.48 | 0 | 5 | 3 |
| | February | 00.00 | 0.00 | 1 | 0 | 0 |
| | March | 02.10 | 0.20 | 3 | 0 | 3 |
| | April | 06.30 | 1.16 | 4 | 5 | 0 |
| | May | 23.20 | 1.52 | 0 | 3 | 2 |
| | June | 31.26 | 3.00 | 2 | 16 | 6 |
| | July | 38.15 | 2.48 | 8 | 19 | 8 |
| | August | 30.30 | 2.64 | 3 | 15 | 2 |
| | September | 22.30 | 2.92 | 1 | 13 | 6 |
| | October | 18.36 | 1.36 | 0 | 9 | 2 |
| | November | 11.20 | 1.00 | 1 | 4 | 3 |
| 2019 | December | 06.32 | 0.64 | 0 | 5 | 0 |
| | January | 01.25 | 0.20 | 2 | 0 | 0 |
| | February | 00.00 | 0.00 | 5 | 0 | 0 |

* Mean value from 2 fortnight observation.

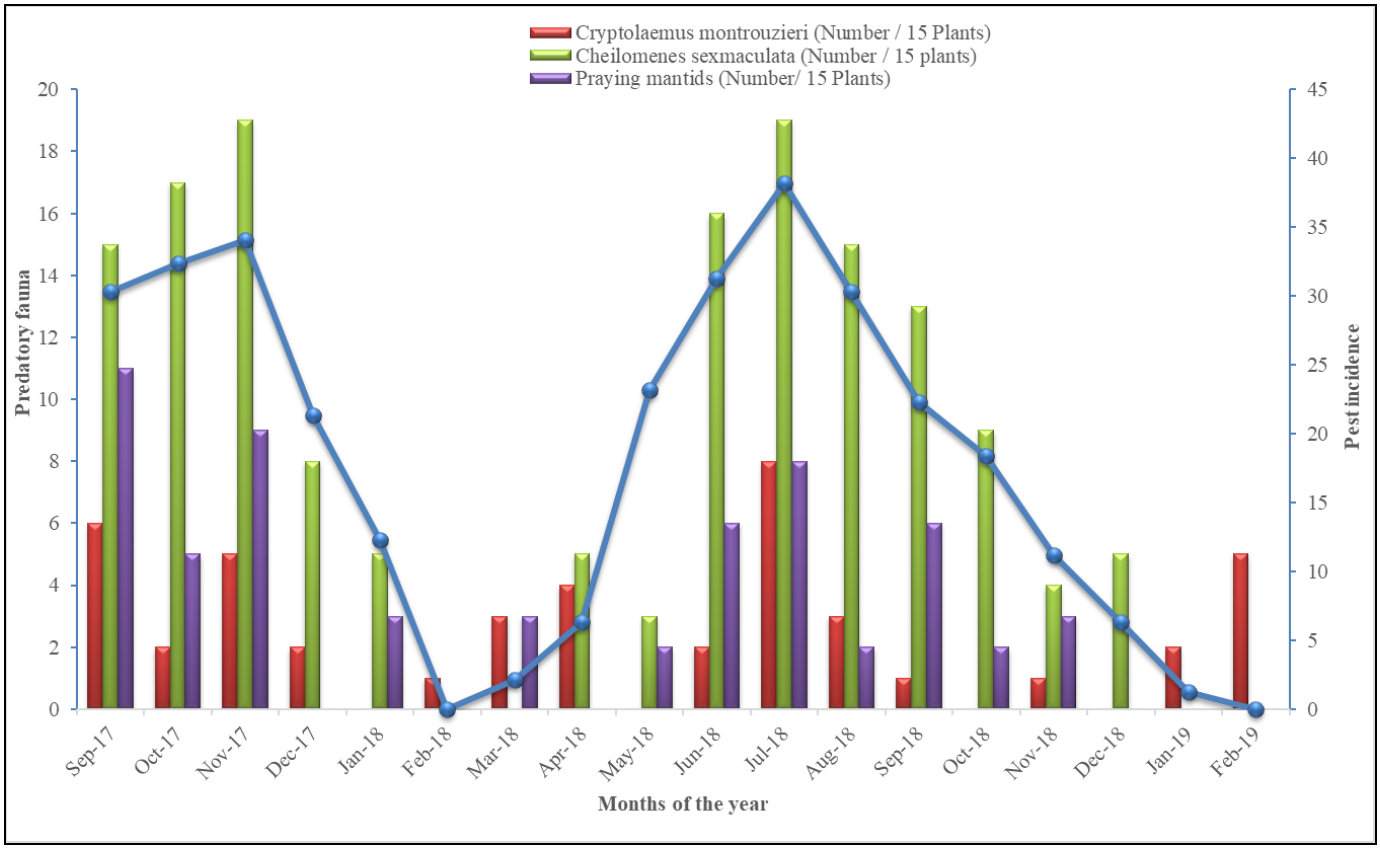


**Fig 2:** Incidence of mulberry leaf roller, *D. pulverulentalis* (Hampson) in relation to biotic factors

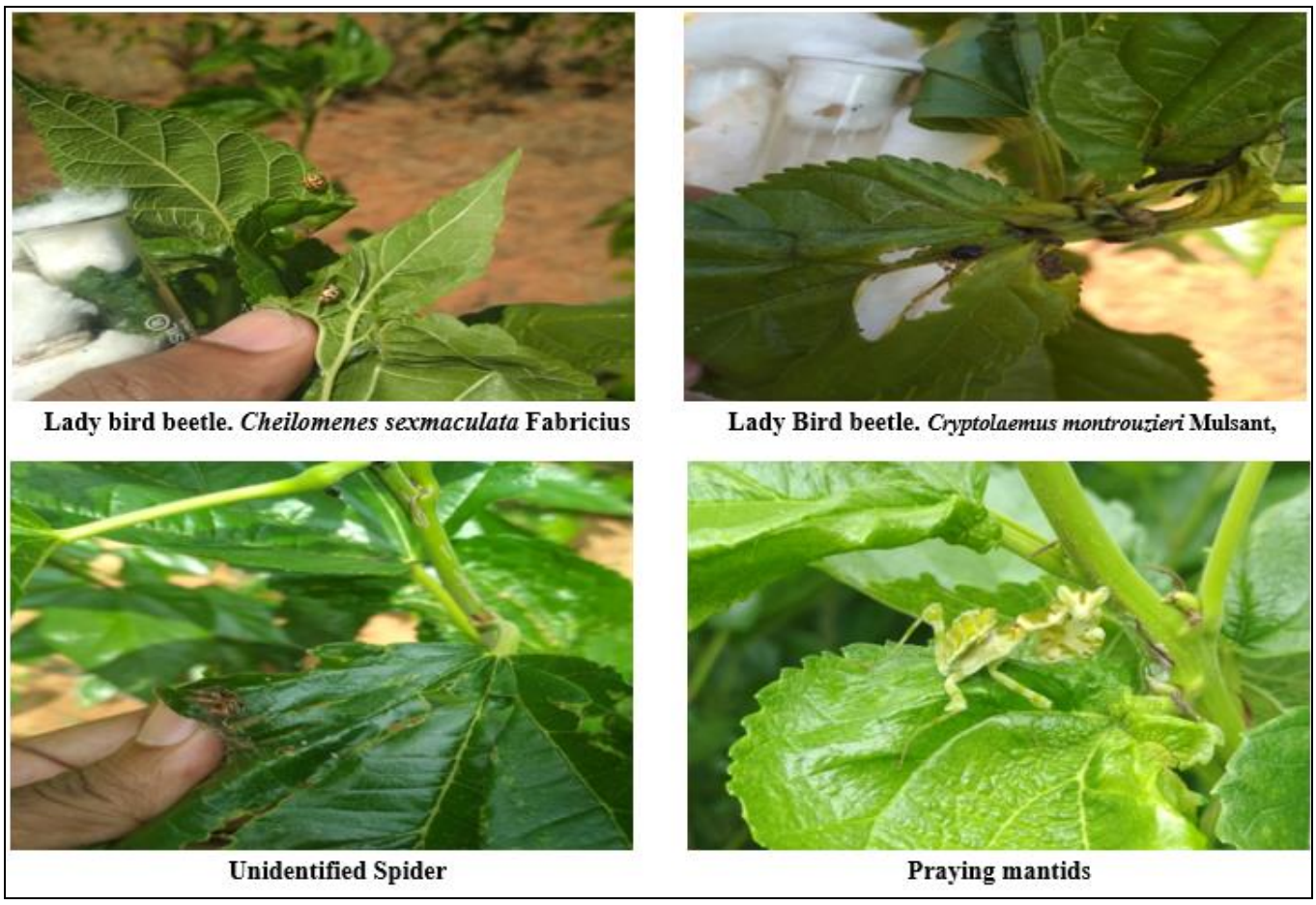


**Plate 1:** Natural enemies associated with mulberry ecosystem

**Table 3:** Correlation and Regression analysis of leaf roller population with abiotic (weather factors) and natural enemies

| Variables | Correlation | Multiple Regression |
|---|---|---|
| $X_1$ – Max Temperature | -0.638** | -1.507 |
| $X_2$ - Min Temperature | 0.731** | 5.106 |
| $X_3$ - Morning Relative humidity (%) | 0.723** | 0.058 |
| $X_4$ - Evening Relative humidity (%) | 0.759** | 0.598 |
| $X_5$ - Rainfall (mm) | 0.817** | - 0.14 |
| $X_6$ - Lady bird beetle. *Cryptolaemus montrouzieri* Mulsant | 0.408 | 0.573 |
| $X_7$ - Lady bird beetle. *Cheilomenes sexmaculata* Fabricius | 0.959** | 4.139 |
| $X_8$ - Mantids | 0.739* | - 0.739 |

**. Correlation is significant at 0.01 level (2-tailed).

*. Correlation is significant at 0.05 levels (2-tailed).

**Multiple regression analysis of leaf roller incidence with abiotic and biotic factors**

Y (Leaf roller incidence) = - 63.0198 -1.507 $X_1$ + 5.106 $X_2$ + 0.058 $X_3$+0.598 $X_4$ - 0.14 $X_5$ + 0.573 $X_7$ + 4.139 $X_7$ - 0.739 $X_8$+ 0.86 $R^2$

The leaf roller population showed a great sensitivity to variations in abiotic and biotic parameters occurring over the period of study. A significant and negative correlation was observed between the incidence of leaf roller and maximum temperature (r= -0.638**) (Table 3). The correlation coefficient data indicated that, when the temperature rises during the warmer months (January – April), the pest population recorded was very low. However, a significant positive correlation was recorded between the pest population and minimum temperature (r= 0.731**), morning relative humidity (r=0.723**), evening relative humidity (r= 0.759**) and rainfall (r= 0.817**) (Table 3). The rainfall during rainy season (June–October) leads to decreased temperature and increased relative atmospheric humidity and were directly proportional to the soil moisture status. Which favoured the for luxuriant growth of mulberry. This Resulted in availability of nutritious and succulent leaves which naturally favoured the population build-up of leaf roller and natural enemies (Samuthiravelu, *et al.*, 2003) [7]. Similar findings were made by Rahamathulla *et al*. (2012) [5] who reported that, the infestation and population build up of leaf roller is positively correlated with weather parameters like humidity and rainfall and negatively correlated with maximum temperature. Infestation of leaf roller occured both during southwest and northeast monsoon period and showed that rainfall and humidity were conducive for the multiplication of the pest (Geetha Bai and Marimadaiah, 2002) [1]. The present study clearly revealed that, there is a linear relationship between the decrease in atmospheric temperature and increase in relative humidity with increased pest population.

The population of insect predators, *viz*., lady bird beetle *Chillonus sexmaculata* (r= 0.959**) and mantids (r=0.739) were significantly and positively correlated with pest population. However, multiple regression analysis revealed that none of these factors together influenced incidence of leaf roller *D. pulverulentalis* (Hampson) significantly (Fig.2) (Table 2 and 3).

**Conclusion**

During the study period the overall influence of different weather parameters across study area revealed significant (negative) influence of maximum temperature and positive influence of minimum temperature, morning relative humidity, evening relative humidity, rain fall & natural enemies on the abundance as well as the activity of leaf roller. The maximum temperature which was apparent during summer season hindered the leaf roller activity. Abundance of pest was noticed especially in winter season (September - October) of 2017 and rainy season (June to August) of 2018, clearly indicated that, the population dynamics of leaf roller was positively correlated with minimum temperature, rainfall and relative humidity.

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