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POPULATION DYNAMICS OF MULBERRY LEAF ROLLER, *DIAPHANIA PULVERULENTALIS* HAMPSON IN MANDYA DISTRICT (KARNATAKA) INDIA

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ABSTRACT

A field study on Population dynamics of mulberry leaf roller was conducted to record the seasonal incidence and abundance of *Diaphania pulverulentalis* at V. C. Farm, Mandya and Shivalli farmer field during March2018-May 2019. Study revealed that, the incidence of leaf roller was started from last week of April 2018 to first week of March 2019, which maintained a gradually increasing trend and reached its highest during September (3.95 larvae per plant) and population started declining gradually from 3rd week of November (3.12 larvae per plant). Later the population increased gradually and reached 3.74 larvae per plant at 50th standard week. Further the correlation study was also estimated between meteorological variables and larval population as well as per cent infestation. Correlation study of *Diaphania pulverulentalis* population with weather parameters showed significant negative correlation with the maximum temperature, minimum temperature, afternoon relative humidity and sunshine hours whereas, the morning relative humidity showed positive correlation with the larval population thus favouring the population build-up of the pest. The overall effect of all the weather factors on larval population and per cent infestation of leaf roller was 65 (R^2 = 0.65) and 69 (R^2= 0.69) per cent, respectively.

***Key words*:** Mulberry, Leaf roller, *Diaphania pulverulenatlis*, Defoliation, Weather parameters.

Introduction

Mulberry, *Morus alba* L. belonging to the family Moraceae, is a fast-growing tree which for the convenience of sericulture practices, maintained as a bush. It produces very large amount of renewable biomass in the form of branches, shoots, leaves and fruits. The mulberry foliage is the sole food for the silkworm, *Bombyx mori* L. and basic input for Sericulture. More than 300 insects and non-insect species of pests are known to infest mulberry at different stages of crop growth and seasons. The major insect species that cause economic damage to mulberry crop belong to the orders Hemiptera (28.13%), Thysanoptera (14.44%), Lepidoptera (14.06%), Coleoptera (13.30%), Orthoptera (6.84 %) and Isoptera (2.28%). The major defoliators of mulberry are leaf roller, *Diaphania pulverulentalis* Hampson, Bihar hairy caterpillar, *Spilarctia obliqua* Walker, Cut worm, *Spodoptera litura* and minor pests *viz*., wingless grasshopper *Neorthacris acuticeps nilgriensis* Uvarov, long horned grass hopper, *Cyrtacanthacris ranacea* Stol ((Reddy and Kotikal, 1988). The mulberry leaf roller, *Diaphania pulverulentalis* Hampson is the major pest of mulberry in South India causing a leaf yield loss of 12.8 per cent with an average incidence of 21.77 per cent (Rajadurai *et al.*, 1999). The early stage larvae feed on the apical part of mulberry shoots and tender leaves by bringing leaves together and bound through a silky web formed by the larvae. Sometimes a single leaf is rolled by the web with the larva inside, hence the name called leaf roller (or) leaf webber has been coined. Infested

plants show the symptoms of stunted growth, drying of apical parts, shoots and the burning of leaf edges (Narayanaswamy *et al*., 2003). In Karnataka mulberry is a major commercial crop and the mulberry leaf roller is attaining the major pest status. However, the information regarding seasonal incidence, nature of damage and extent of yield loss due to pest is scantly and hence, the present investigation was conducted to know the seasonal incidence which eventually helps in adapting timely management strategies against leaf roller.

Material and Methods

The investigation on population dynamics of the mulberry leaf roller *D. pulverulentalis* was conducted at ZARS, V. C., Farm, Mandya and nearby farmer field in Shivalli village during March 2018 to March 2019 with an objective to record the seasonal incidence and abundance of leaf roller in the crop growth period. V1 mulberry variety garden was selected and divided into six sub plots. Pruning schedules adjusted according to seasons *viz*., Summer 2018, Kharif 2018 and winter of 2019. The crop was raised as per the recommended package of practices according to Giridhar and Dandin (2010) except for plant protection measures. Ten plants from each sub plots were randomly selected for recoding the observations of pest incidence. Thus, sixty plants were observed at weekly intervals (Rahmathulla *et al*., 2012). The observations were recorded at from days after pruning and continued till harvest at weekly interval.

The per cent infestation was calculated by using the formulae

$$\text{Percent infestation} = \frac{\text{No. of infested plants}}{\text{Total no. of plants}} \times 100$$

Similarly, the larval count of *Diaphania pulverulentalis* per plant was also recorded and the data on the abundance of leaf roller was analyzed to calculate the mean population per plant for interpreting the percentage of infestation. To assess the influence of meteorological variables on the incidence of leaf roller, weekly data on meteorological factors, such as maximum and minimum temperatures, morning and afternoon relative humidity, sunshine hours and rainfall were collected from the agro-meteorological observatory unit at the College of Agriculture, V.C. Farm, Mandya.

To evaluate the relationship between meteorological variables *viz*., maximum and minimum temperatures, morning and evening relative humidity, sunshine hours, rainfall and the leaf roller population, the weekly mean larval population observations were subjected to Pearson's rank correlation analysis. Additionally, to determine the influence of meteorological variables on the abundance of the leaf roller population, the data were analyzed using multiple linear regression techniques (Pans and Sukhatme, 1967). Various functions were fitted using the statistical software *SAS Syntax Reference Guide 2016, version 16.0 (SPSS 16)*, developed by SPSS Inc., South Wacker Drive, Chicago, IL (SPSS, 2009).

Results and Discussion

Population dynamics of leaf roller, *D. pulverulentalis* on mulberry

A study was conducted at V.C. Farm and Shivali village in Mandya taluk from March 2018 to March 2019 to monitor the seasonal incidence of the leaf roller pest, *D. pulverulentalis*, on mulberry plants. Pest activity was first observed 10 days after pruning, in the 12th standard week of 2018 and continued until harvest.

Results revealed that the leaf roller population fluctuated between 0.00 and 3.95 larvae per plant, with a mean of 1.79 larvae per plant. The population gradually increased from the last week of April (0.07 larvae/plant) till the 1st week of August (3.02 larvae/plant) and the peak incidence was recorded in the 2nd week of September, with 3.95 larvae per plant. A gradual decline in population was observed from the 3rd week of November (3.12 larvae/plant) onwards. However, a slight increase was noted in the 50th standard week (3.74 larvae/plant). Subsequently, the population decreased steadily, reaching zero incidence in the 1st week of March (Table 1 and Fig. 1).

Population dynamics of leaf roller, *D. pulverulentalis* on mulberry

A study on seasonal infestation of *D. pulverulentalis* on mulberry plants was conducted from March 2018 to March 2019 revealed a significant seasonal variation. The data on the percentage of plant infestation by *D. pulverulentalis* from March 2018 to March 2019 is presented in Table 1. The infestation ranged from 0.00%

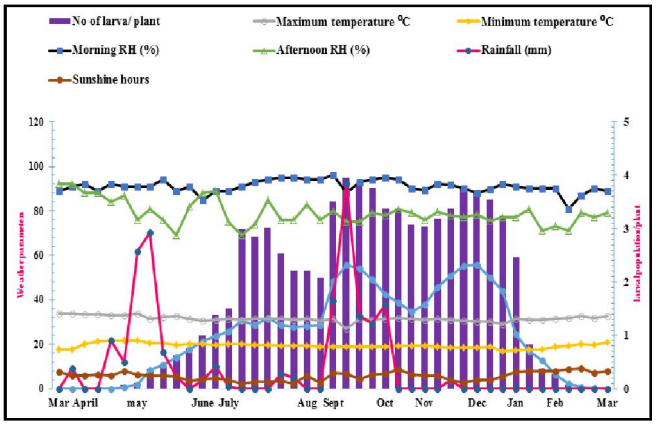

Fig. 1: Correlation between population of *D. pulverulentalis* and weather parameters- March 2018 to March 2019.

Table 1: Population dynamics of leaf roller, *D. pulverulentalis* on mulberry from March 2018 to March 2019.

Month	MSW	No. of Larvae/plant			Infestation (%)			Max. temp (°C)	Min. temp (°C)	Relative humidity (%)		Rain-fall (mm)	Sun shine hours per day
		VFM	SVM	Pooled mean	VFM	SVM	Pooled mean			Morn-ing	After-noon		
March-2018	12	0.00	0.00	0.00	0.00	0.00	0.00	34.0	17.9	89.0	92.0	0.0	7.5
	13	0.00	0.00	0.00	0.00	0.00	0.00	33.9	17.6	91.0	92.0	9.2	6.1
April-2018	14	0.00	0.00	0.00	0.00	0.00	0.00	33.6	20.2	92.0	88.0	0.0	6.0
	15	0.00	0.00	0.00	0.00	0.00	0.00	33.6	21.2	89.0	88.0	0.0	6.3
	16	0.00	0.00	0.00	0.00	0.00	0.00	32.9	21.6	92.0	84.0	21.6	6.0
	17	0.06	0.08	0.07	0.56	0.70	0.63	33.1	21.9	91.0	87.0	12.2	8.2
May-2018	18	0.09	0.13	0.11	1.03	2.49	1.76	33.9	21.7	91.0	76.0	62.0	6.5
	21	0.23	0.51	0.37	8.31	8.34	8.33	31.3	20.5	91.0	81.0	70.2	5.8
	22	0.31	0.64	0.48	9.14	12.15	10.65	32.4	20.7	94.0	76.0	16.6	6.0
June-2018	23	0.49	0.77	0.63	14.15	13.68	13.92	32.6	19.8	89.0	69.0	5.7	5.5
	24	0.68	0.83	0.76	17.32	18.50	17.91	31.4	20.2	91.0	82.0	0.0	3.6
	25	0.97	1.02	1.00	19.32	23.53	21.43	30.6	20.2	85.0	88.0	3.8	4.2
	26	1.23	1.53	1.38	22.74	24.63	23.69	30.9	19.6	89.0	89.0	10.2	4.9
July-2018	27	1.37	1.62	1.50	25.32	26.48	25.90	31.3	20.1	89.0	75.0	1.0	3.9
	29	2.98	2.98	2.98	29.23	31.82	30.53	31.1	20.1	91.0	69.0	0.0	2.4
	30	2.97	2.73	2.85	26.33	30.73	28.53	31.6	19.9	93.0	74.0	0.0	3.0
August-2018	31	3.02	3.01	3.02	32.23	31.65	31.94	31.4	19.6	94.0	85.0	0.0	3.1
	32	2.84	2.21	2.53	29.00	28.62	28.81	31.6	19.4	95.0	76.0	6.6	3.5
	33	2.37	2.07	2.22	27.25	28.24	27.75	31.1	19.2	95.0	76.0	5.0	2.2
	34	2.35	2.07	2.21	28.50	28.34	28.42	31.6	19.4	94.0	83.0	0.0	5.8
	35	2.13	2.03	2.08	28.70	28.45	28.57	30.6	19.1	94.0	76.0	0.0	2.8
September-2018	38	3.97	3.05	3.51	55.37	41.45	48.41	31.4	19.1	96.0	80.0	39.6	7.0
	39	4.23	3.67	3.95	60.23	51.34	55.79	27.2	18.9	88.0	75.0	92.4	6.6
October-2018	40	3.78	3.91	3.85	52.53	55.42	53.98	31.4	19.1	93.0	75.0	32.6	4.3
	41	3.51	4.02	3.77	41.23	57.61	49.42	31.2	19.1	94.0	79.0	29.6	6.2
	42	3.12	3.61	3.37	40.67	44.32	42.50	31.4	19.1	95.0	78.0	37.9	6.7
	43	3.34	3.42	3.38	37.62	39.73	38.68	31.9	19.4	94.0	81.0	0.0	8.9
November-2018	44	3.12	3.04	3.08	33.23	35.76	34.50	31.5	19.4	90.0	79.0	0.0	6.5
	47	3.16	2.92	3.04	44.24	31.65	37.95	31.2	19.2	89.3	75.8	0.0	5.8
	48	3.21	3.16	3.19	47.34	44.24	45.79	31.3	18.9	92.1	79.7	0.0	5.9
December-2018	49	3.53	3.21	3.37	54.23	47.34	50.79	31.0	18.7	91.7	77.8	3.8	4.1
	50	3.82	3.65	3.74	56.34	54.23	55.29	30.6	18.4	90.2	77.0	0.0	2.7
	51	3.98	3.42	3.70	57.67	53.62	55.65	30.1	18.4	88.0	78.5	0.0	3.8
	52	3.72	3.37	3.55	52.65	47.67	50.16	30.2	19.0	89.8	75.5	0.0	4.1
January-2019	1	3.23	3.24	3.24	43.35	44.62	43.99	29.2	16.7	92.0	77.0	0.0	5.7
	3	2.32	2.61	2.46	23.12	25.67	24.39	31.5	17.3	91.0	77.0	0.0	7.6
	4	0.72	0.94	0.83	12.5	21.35	16.93	31.2	17.6	90.0	81.0	0.0	8.1
February-2019	5	0.34	0.42	0.38	8.35	17.65	13.00	31.0	17.9	90.0	71.0	0.0	7.8
	6	0.18	0.37	0.28	3.15	9.64	6.40	31.6	19.0	90.0	73.0	0.0	7.8
	7	0.00	0.15	0.08	1.52	3.21	2.37	31.9	19.2	81.0	71.0	0.0	9.0
	8	0.00	0.03	0.02	0.65	1.00	0.83	32.5	20.1	87.0	79.0	0.0	9.2
March-2019	9	0.00	0.00	0.00	0.00	0.73	0.37	32.0	19.8	90.0	77.0	0.0	7.3
	10	0.00	0.00	0.00	0.00	0.00	0.00	32.8	20.8	89.0	79.0	0.0	8.1

N=43; MSW- Meteorological Standard Week: VFM - VC Farm, Mandya taluk: SVM –Shivalli Village, Mandya taluk;

Table 2: Correlation coefficient and regression equation for larval population of *D. pulverulentalis* - March 2018-March 20.

Mulberry leaf roller	Correlation co-efficient (r)				Rainfall (mm) (X_5)	Sunshine hours (X_6)	R^2	Regression equation
	Temperature (^{0}C)		Relative humidity (%)					
	Max.(X_1)	Min.(X_2)	Morning (X_3)	Afternoon (X_4)				
Larval population	-0.67**	-0.41**	0.38*	-0.30*	0.11	-0.43**	0.65	$Y=11.24-0.63X_1-0.21X_2+0.18X_3-0.01X_4-0.0002X_5-0.11X_6$
Per cent infestation	-0.74**	-0.44**	0.30*	-0.30*	0.14	-0.44**	0.69	$Y=224.69-9.02X_1 3.14X_2+1.77X_3-0.07X_4-0.03X_5-1.72X_6$
N= 43; * Significant at p ≤ 0.05; ** Significant at p ≤ 0.01								

to 57.67%, with an average of 24.56%. Infestation began in the 17th standard week (0.63%) and gradually increased to 31.94%. The highest infestation rate (55.79%) was recorded during the 39th standard week (last week of September).

The infestation started to decline from the first week of October (53.48%) to the first week of November (34.50%). However, a gradual increase was observed from the last week of November (45.79%) to the third week of December (55.79%). Later the infestation began to decrease and reached 16.93% in the third week of January and no infestation was recorded from the third week of March (Table 1 and Fig. 1).

Plate 1: Early instar larvae of leaf roller, *D. pulverulentalis* feeding on the mulberry leaf.

Plate 2: Larval webbings of *D. pulverulentalis* on mulberry leaf.

These findings align with the observations of Hemlatha and Pai (2009) who reported that *D. pulverulentalis* incidence began in June, persisted through February and disappeared from March to May. Severe infestations were observed during the northeast monsoon, with caterpillar populations reaching peak between September and October. Similarly, Kant and Kumar (2007) noted significant infestation during August, September and October in Doon Valley. Rahmathulla *et al.*, (2012) also reported peak infestation during September (39.56%) and observed that infestation gradually declined after October.

A slight increase in infestation was noted in December due to higher relative humidity, while infestation dropped to 4.3% in January and disappeared by February and March. Bhagyamma and Kumari (2016) highlighted that reduced temperatures from August to January favoured the plant growth and leaf quality, attracting defoliators like *D. pulverulentalis*. They reported peak infestations from November to January, with no infestation in March. The current findings are also consistent with Geethabai *et al.*, (1997) who observed a decline in infestation to below 50% as temperatures raise in January, with infestations disappearing entirely by March.

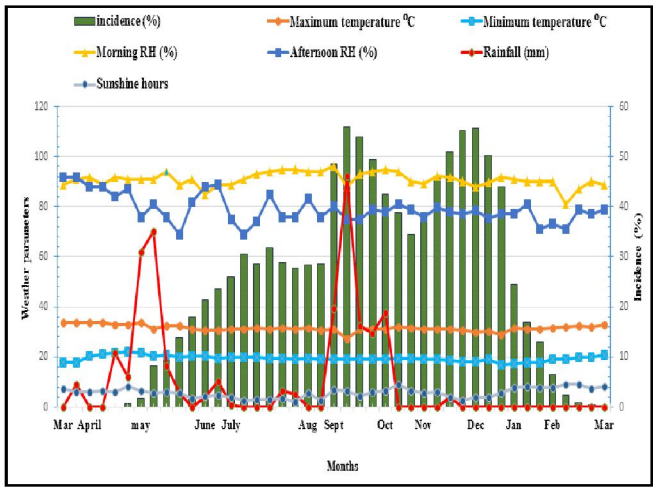

Fig. 2: Correlation between incidence of *D. pulverulentalis* and weather parameters from March 2018 to March 2019.

Correlation study between incidence of *D. pulverulentalis* and weather parameters

The data recorded on population dynamics of *D. pulverulentalis* and weather parameters clearly indicated that rainfall (r=0.11) showed a non-significant positive correlation with larval population, whereas, afternoon relative humidity (r=-0.30), sunshine hours (r=0.43), maximum temperature (r=-0.67) and minimum temperature (r=-0.41) recorded a significant negative correlation with the larval population. Whereas the morning relative humidity (r= 0.38) showed the significant positive correlation with larval population (Table 2 and Fig. 1).

Further, the data was subjected to Multi Linear Regression analysis (MLR), the results revealed that 65% (R^2 = 0.65) of the leaf roller population was negatively influenced by maximum and minimum temperatures, afternoon relative humidity and sunshine hours, whereas, morning relative humidity had a positive effect on larval population (Tables 2 and Fig. 1).

On the other hand, the per cent infestation and weather parameters was also analysed by using Multi Linear Regression Analysis (MLR) which revealed that, 69 percent ((R^2= 0.69) of leaf roller infestation was negatively influenced by maximum temperature, minimum temperature, afternoon relative humidity and sunshine hours negatively, whereas morning relative humidity influenced positively (Table 2, Fig. 2).

These findings align with the observations of Samuthiravelu *et al.,* (2010), who reported that the population of *D. pulverulentalis* was negatively affected by temperature in Tamil Nadu. Rahmathulla *et al.,* (2012) also documented a significant negative correlation between rising temperatures and pest infestation, while identifying a significant positive correlation between rainfall, minimum relative humidity and pest infestation.

Similar results were also observed by Hemlatha and Pai (2009) who found that mulberry leaf roller infestation showed a significant negative correlation with maximum and minimum temperatures and a significant positive correlation with relative humidity, which is in accordance with the present study.

Conclusion

Study revealed that, the incidence of leaf roller was started from last week of April 2018 to first week of March 2019, which maintained a gradually increasing trend and reached its highest during September (3.95 larvae per plant) and population started declining gradually from 3rd week of November (3.12 larvae per plant).

Forecasting the peak pest and disease outbreaks in advance is crucial for implementing timely and effective crop management strategies. Correlation and multiple regression analysis have demonstrated a strong link between weather factors and pest incidence.

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