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Studies on the seasonal incidence of different insect pests and their natural enemies of Mulberry and their correlation with weather parameters under Terai Region of West Bengal

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Abstract
A study on different insect pests and natural enemies of mulberry under Terai agro-ecological region was conducted in mulberry garden of Department of Agricultural Entomology, Uttar Banga Krishi Vishwavidyalaya, Pundibari, Coch Behar, West Bengal, India from January 2017 to March 2018. During this experiment different insects i.e. two species of cowbug, grey weevil, spittle bug, thrips, bihar hairy caterpillar, papaya mealy bug, pink mealy bug were found to infest the mulberry plantation. Among the natural enemies, three species of ladybird beetle were identified. Peak population of 1st and 2nd cowbug species were recorded on 42nd STW, 2017 and 52nd SMW, 2017 respectively with 0.9 and 0.8 number of insect/ plant. Distinct peak period of grey weevil and spittle bug were observed on 21st SMW and 26th SMW, 2018 respectively with 0.7 and 0.9 number of insect/ plant. Highest population of thrips / leaf (8) were recorded on 45th SMW, 2017. Peak population of Bihar hairy catterpillar (4.7 number of insect/ plant) were recorded on 24th SMW, 2017**.** The peak population of pink mealy bug and papaya mealy bug was observed on 31st and 35th SMW, 2017 respectively with 61.9 and 164.9 number of nymph and adult per 10 cm twig.

Keywords: Mulberry, pests, population, natural enemy

1. Introduction
Mulberry (*Morus* sp) is a fast growing plant. There are about 68 species of the genus *Morus* and most of them are found in Asia [1]. In India, there are four main species - *M. indica, M. alba, M. serrata* and *M. laevigata*, which grow naturally in the northern part of the country [2]. In West Bengal, the area under mulberry production during the year 2010-11 was 12,994 hectare which contributes about 11.52% of total production in the country [3]. Mulberry leaf is a major economic component in sericulture as the quality and quantity of leaf produced per unit area have a direct bearing on cocoon harvest. Mulberry leaf is the only food for mulberry silkworm (*Bombyx mori)* due to the presence of morin, β sitosterol and swallowing factors [4]. Sericulture is highly concentrated in Malda, Murshidabad and Birbhum districts of West Bengal contributing about 90 percent of the total state's silk production. Sericulture in Cooch Behar district is popular for development of rural economy. There is around 457 acre of land under cultivation of mulberry in Cooch Behar and around 1370 numbers of farmers are associated with mulberry cultivation. There are several factors that reduce the productivity and quality of mulberry leaves among which the incidence of pests and diseases acts as major one. About 300 insect and non-insect pest species are known to attack mulberry [5]. The perennial nature of mulberry plants in combination with monoculture practices increases the chances of infestation of several pests throughout the year [6]. The important insect pests of mulberry are mealy bugs, hairy caterpillars, thrips, cutworms and leaf Webbers [7]. Among these, pink mealy bug is a major pest which causes tukra disease in mulberry and the loss in mulberry leaves caused by this pest is estimated to be 34.24% and 4500 kg/ha/year [8]. In West Bengal, mulberry plants are seriously infested by different types of sap sucking insect pests among which mealy bug, white fly and thrips are of great importance. Recently the invasive exotic pest, papaya mealy bug, *Paracoccus marginatus* got entry into West Bengal and was reported to infest mulberry during 2013-14 [9]. The study of mulberry pests is of great importance particularly for those areas where sericulture can be taken as an alternative source of income to enhance livelihood of people.

Mulberry sericulture is very popular and can be adopted in large scale for improving socio-economic condition of the area where the present study is being conducted. For a healthy sericulture unit it is important to have healthy mulberry plants and for maintaining a healthy mulberry garden, it is important to gather information on its insect pests and their management.

2. Materials and Methods

The field experiment was conducted in mulberry garden of Department of Entomology, Uttar Banga Krishi Vishwavidyalaya, Pundibari, Cooch Behar, and West Bengal, India from January 2017 to March 2018. This region lies between 25^0 57' to 27^0 N latitude and 88^0 27' to 58 ^{0} 57' E longitude. Mulberry variety- S1 was used for the study purpose planted in a plot sized 6m x 4 m. Population of different insect pests & natural enemies were monitored throughout the year by absolute method (visual searching & counting) to point out the species showing maximum population or damage. For that purpose five plants were selected randomly observations were recorded on weekly interval throughout the year.

a. Leaf feeding insects: Number of adult or grub or larva / plant was recorded at weekly intervals.

b. Sucking pests: Number of adults & nymphs was counted visually from 10 cm of twig and count was taken from 3 randomly chosen shoots.

c. Thrips: Top 5 leaves were considered for recording observation on thrips population and data was taken with the help of a hand lenses.

d. Natural enemy: Per plant population of natural enemy were recorded throughout the year. Weekly data on different abiotic parameters were also recorded. Data obtained were then subjected to statistical analysis for correlation and test of significance.

3. Result and Discussion

3.1. Seasonal incidence of pests

Studies on field incidence of insect pests and natural enemies revealed that two species of cow bugs, two species of mealy bug, thrips, spittle bug, grey weevil and Bihar hairy caterpillar were observed to be associated with mulberry plants at the experimental site during the year 2017-18. Among these insects, mealy bugs have found as major pests and other pests have been found as minor pests.

Cowbug *Leptocentrus leucaspis,* Membracidae, Hemiptera

Periodical observations on the different insect pests of mulberry revealed that incidence of *Leptocentrus leucaspis* (Plate no-1) was recorded in the field from 1st week of January to 4th week of February and again from first week of October to 4th week of December. The peak population were recorded on 3rd week of October that is 0.90 number of insect/ plant. The statistically analyzed data (Table-1) revealed that the population of this pest were found to be significant and positively correlated with maximum and minimum RH, bright sunshine hour and evaporation but significant and negatively correlated with Rainfall. On the other hand this pest was found to be non-significant and positively correlated with wind speed and negatively correlated with maximum and minimum temperature. Other species of cow bug/ tree hoppers (*Oxyrachis tarandus*) was reported as a pest infesting mulberry trees in Andhra Pradesh [10].

Cowbug- *Otinotus oneratus,* Membracidae, Hemiptera

The population of Cow bug (Plate no-1) was recorded in the field from first week of October to 4th week of December. The peak population were recorded on 4th week of December that is 0.74 number of insect/ plant. This cowbug population was noticed to be significantly and positively correlated with maximum temperature and evaporation. Maximum and minimum RH was found to be non-significant and positively correlated with the incidence of cow bug whether minimum temperature, rainfall, sunshine hour and wind speed were negatively correlated (Table -1).

Grey weevil (*Myllocerus maculosus*), Curculionidae, Coleoptera

The incidence of grey weevil (Plate no-1) was first recorded on the crop during 3rd week of May to 2nd week of August where the peak population were recorded on 4th week of May (0.68 number of insect/ plant). Grey weevil incidence had significant and positive correlation with minimum RH and Bright sunshine hours but negative correlation with minimum temperature. On the other hand it had non-significant and positive correlation with maximum temperature, maximum RH and evaporation and negative correlation with rainfall and wind speed (Table-1).

Spittle bug- Ptylus spp, Aphrophoridae, Hemiptera

The appearance of spittle bug on mulberry (Plate no-1) was recorded during 3rd week of May to 4th week of August and the peak population / plant were recorded on the 4th week of June (0.85). Spittle bug population showed significant and negative correlation with minimum RH and bright sunshine hours and significant and positive correlation with maximum temperature and rainfall. Minimum temperature and evaporation were found to be non-significant and positively correlated and maximum RH and wind speed were found to be non-significant and negatively correlated with the population of spittle bug (Table no-1).

Thrips *Pseudodendrothrips mori,* Thripidae, Thysanoptera

Mulberry Thrips was observed in the field almost throughout the year of 2017-2018 (Plate no-1). The highest population was recorded on 2nd week of November (7.94 no of insect/ leaves). The population of thrips was noticed to have positive significant correlation with minimum temperature, maximum RH and wind speed and significant negative correlation with maximum temperature, minimum RH and evaporation. On the other hand it has shown non-significant and negative correlation with rainfall and sunshine hour (Table -1). It was reported that the increase in thrips population was positively correlated with higher temperature, relative humidity and rainfall, but negatively correlated with the difference between maximum and minimum temperature [11]. But another study revealed that population of thrips showed significant positive correlation with maximum temperature and significant negative correlation with relative humidity [12].

Bihar hairy caterpillar *Spilaractia oblique*, Arctidae, Lepidoptera

Infestation of Bihar hairy caterpillar (Plate no-1) was observed from 1st week of June to 3rd week of August and the

peak population (4.67 numbers of insect/ plant) was recorded on 2nd week of June. There was significant and positive correction between pest population and maximum temperature and significant and negative correlation with minimum temperature, maximum RH and sunshine hour. Minimum RH and wind speed was found to be non-significant and positively correlated the population of the pest whereas non-significant and negatively correlated with rainfall and evaporation (Table no-1). Infestation of Bihar hairy caterpillar was found to be highest from March to November in sub-tropical area of Doon valley [13]. In another study, the incidences of defoliators in mulberry were found to be significantly and negatively correlated with maximum temperature and the incidence of sap suckers were significantly and positively correlated with maximum temperature [14].

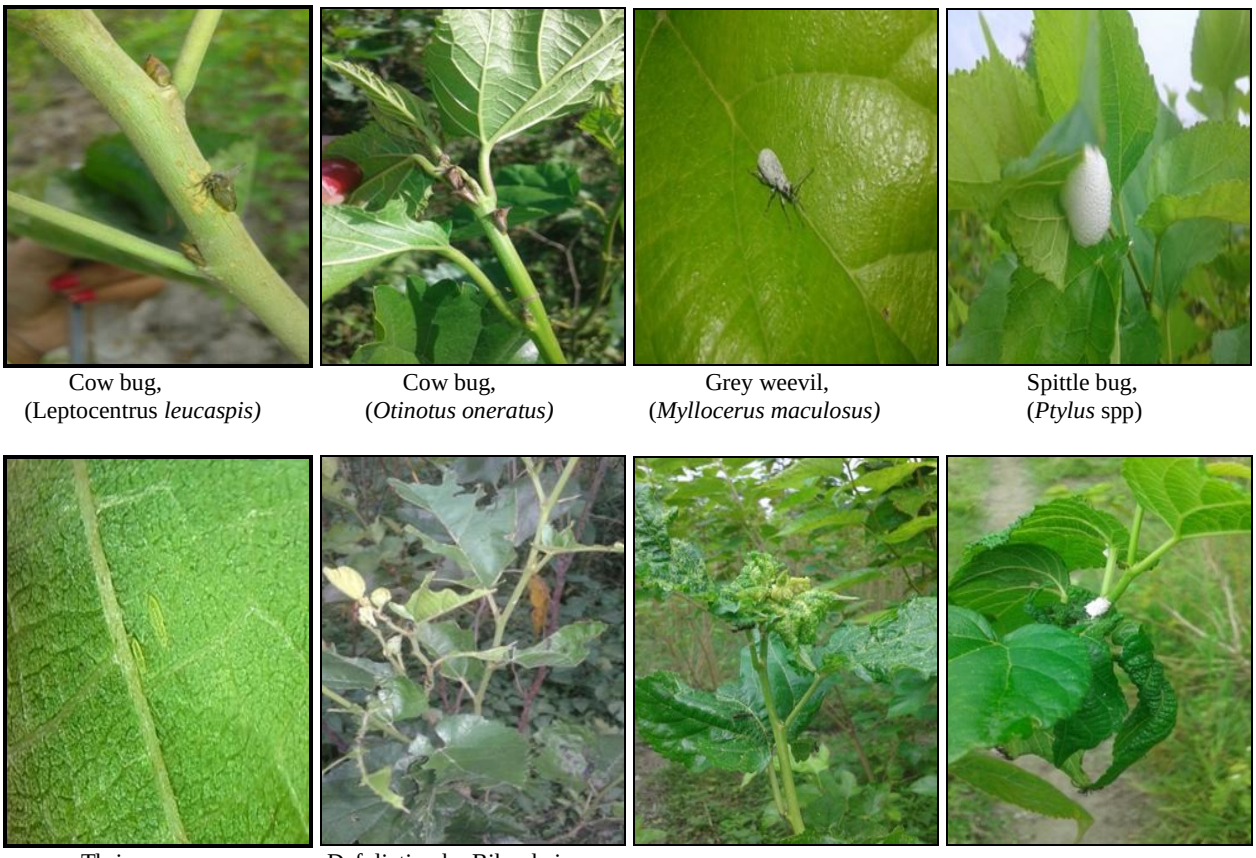
Pink mealy bug *Maconellicoccus hirsutus*, Pseudococcidae, Hemiptera

The incidence of Pink mealy bug (Plate no-1) was recorded from the 4th week of June to 4th week of September. The peak population of pink mealy bug 1st week of August with 61.93. The population of Pink mealy bug was found to be significantly and positively correlated with maximum temperature but significantly negatively correlated with rainfall. At the same time minimum temperature, RH, sunshine hour and wind speed was found to be non-significant and positively correlated and evaporation was found to be non-significant and negatively correlated with the population of pink mealy bug (Table-1). High incidence of pink mealy bug was reported in March and declined in August with a least population during December [15]. The present study also reveals that the mealy bug population has declined with decreasing temperature and the pest was not present in the winter season.

Papaya mealy bug Paracoccus *marginatus*, Pseudococcidae, Hemiptera

The incidence of Papaya mealy bug (Plate no-1) was recorded from 1st week of July to 4th week of September. The peak population of papaya mealy bug was observed on4th week of August with 164.88 no of nymph and adult per 10 cm twig. The population of Papaya mealy bug was found to be significantly and positively correlated with maximum temperature but negatively correlated with rainfall. But the population of the pest has shown non-significant and positive correlation with RH, sunshine hour and evaporation and negative correlation with minimum temperature and wind speed (Table no-1).

The Multiple Regression Analysis [Table 1] provides the rate of change in the insect population for per unit change of the value of a particular weather variable. From the table it is evident that in case of Papaya Mealy Bug the weather variables are responsible for about 54% of the total variability of its population which is the highest among the all insects considered in this study. It was also observed from the table that in case of Spittle Bug, the weather parameters are least responsible for its variation in the population as the adj. R^2 value is the lowest (0.09)



Cow bug, (Leptocentrus *leucaspis)* | Cow bug, (*Otinotus oneratus)* | Grey weevil, (*Myllocerus maculosus)* | Spittle bug, (*Ptylus* spp)

Thrips (*Pseudodendrothrips mori*) | Defoliation by Bihar hairy caterpillar (Spilaractia *obliqua*)

Plate 1: Insect pests observed in the mulberry field during the year 2017-18, UBKV, Cochbehar.

Table 1: Multiple regression analysis of effect of different weather parameters on insect pest population in Mulberry

Weather variable	Name of the insect pests							
	Cow Bug *L. leucaspis*	Cow Bug *O. oneratus*	Papaya Mealy Bug	Pink Mealy Bug	Grey weevil	Spittle Bug	Thrips	Defoliator
Max. temp (^{0}C)	-0.0162	0.043*	42.75*	6.11*	0.012	0.039**	-0.048**	0.131**
Min. temp (^{0}C)	-0.007	-0.026	-33.32	4.29	-0.039**	0.005	0.058**	0.213**
Max RH (%)	0.011*	0.005	13.75	1.67	0.001	-0.005	0.005*	-0.034**
Min. RH (%)	0.010**	0.004	24.86	3.08	0.013**	-0.012*	-0.021**	0.010
Rainfall (mm)	-0.007**	-0.012	-2.18*	-0.21*	-0.010	0.002**	-0.001	-0.003
Sunshine Hour	0.034**	-0.027	24.46	7.73	0.028**	-0.049**	-0.011	-0.076**
Evaporation	0.064*	0.162*	20.16	-14.27	0.001	0.016	-0.066**	-0.044
Wind Speed (kmph)	0.064	-0.236	-6.02	0.54	-0.001	-0.023	0.029**	0.024
Multiple Correlation Coefficient	0.420	0.390	0.936	0.949	0.390	0.340	0.333	0.560
Adj. R^2	0.16	0.13	0.54	0.70	0.13	0.09	0.10	0.29

**1%level of significance,*5% level of significance.

3.2 Seasonal incidence of natural enemies: Three species of ladybird beetle were observed to be associated with different pests of mulberry throughout the year.

***Coccinella septumpunctata*, Coccinellidae, Coleoptera**

C. septumpunctata (Plate no-2) made their first appearance in the field from 2nd week of January to 3rd week of March where the highest population (0.92 beetle/ plant) was recorded on 3rd week of February. Maximum temperature was found to be significant and positively correlated with the population whereas minimum temperature is negatively correlated (Table-2).

***Illeis indica* Coccinellidae, Coleoptera**

During the study period *I. indica* was observed in the field (Plate no-2) from 3rd week of April to last week of July and the highest population was observed on the 2nd week of July (0.93 numbers of insects /plant). The population of *I. Indica* was found to be significant and positively correlated with minimum temperature and evaporation but negatively correlated with Wind speed (Table-2).

***Micraspis yesumatsui* Coccinellidae, Coleoptera**

This predatory beetle (Plate no-3) was recorded during August to October and the peak population was recorded on the 1st week of October *i.e* 1.06 beetles / plant. The population of this predator had shown significant and positive correlation with evaporation whereas negative correlation with rainfall and wind speed [Table 2]. The study about the diversity of predators in sucking pest complex of a mulberry garden in West Bengal in the year 2013-14 revealed that the predators associated with the thrips and psuedococcid population includes *Micraspis discolor* Fab. And *Micraspis crocea*. Fab. Along with this *Menochilus sexmaculatus* Fab. And *Coccinella septempunctata* Fab [16]. These results are almost similar to our finding.

In addition, the Multiple Regression Analysis also provides us the rate of change in the predator population that can occur due to the per unit change in the value of a particular weather variable. The contribution of weather parameters on the variability of the population of a particular insect species can be known from the Adj. R^2 value (the model fit statistics). From the table number 2 it is evident that in case of *C. septumpunctata* the weather variables were responsible for about 21% of the total variability of its population which is the highest among the predators considered in this study. It was also observed from the table that in case of *I. indica* and *M. yesumatsui* the weather parameters are responsible for about 18% and 10% of the total variability of the predator population respectively.

Coccinella septumpunctata *Illeis indica* *Micraspis yesumatsui*

Plate 2: Natural enemies observed in the mulberry field during the year 2017-18, UBKV, Cochbehar.

Table 2: Multiple Regression Analysis of Effect of different weather parameters on natural enemy population in Mulberry

Weather parameter	Name of natural enemy		
	C. septumpunctata	*I. indica*	*M. yesumatsui*
Max. temp (^{0}C)	0.057*	-0.004	0.007
Min. temp (^{0}C)	-0.032**	-0.010	-0.002
Max RH (%)	-0.002	0.003	0.004
Min. RH (%)	0.003	0.005*	0.008
Rainfall (mm)	0.005	0.001	-0.023**
Sunshine Hour	-0.023	0.002	-0.003
Evaporation	-0.073	0.076*	0.218*

Wind Speed (kmph)	-0.049	-0.119**	-0.459*
Multiple Correlation Coefficient	0.481	0.444	0.355
Adj. R^2	0.210	0.1808	0.1014

. **1%level of significance,*5% level of significance.

Conclusion

Mulberry leaves are the primary components of mulberry sericulture. So it is very important to know about the different pests which can reduce the quality as well as the quantity of mulberry leaves which are directly feed to the silkworms. The present study concluded that that two species of cow bugs, two species of mealy bug, thrips, spittle bug, grey weevil and bihar hairy caterpillar were observed to infest the mulberry field at the experimental site during the year 2017-18. Apart from this three different species of ladybird beetle were found to be associated with those pests during different time of the experiment period.

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