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Influence of Weather Factors on the Incidence of the Mulberry Aleyrodid, *Dialeuropora decempuncta* (Quaintance and Baker) and Their Relation to Yield Loss

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The seasonal occurrence and influence of abiotic factors *viz.*, maximum and minimum temperature, maximum and minimum humidity and rainfall on population fluctuation of aleyrodid, *Dialeuropora decempuncta* on a evolved mulberry (*Morus alba* L.) variety known to be susceptible to aleyrodid infestation was assessed during the period from 1999 – 2001 in twenty-five villages under nine blocks of Malda district of West Bengal. The results indicate that the aleyrodid population is practically very low or absent during January to June and thereafter increases gradually. The increase in population of various stages of aleyrodid is significantly correlated with increase in previous 7 days of average maximum relative humidity.

Key words: Aleyrodid, Abiotic factors, Average maximum relative humidity

Introduction

So far a varied pest pest complex is known to infest mulberry during different stages of the field crops. Among them three are major mulberry pests like Thrips, which are observed during February to April, Mealybug observed during May to June, and the dreaded pest whitefly are observed during July – December. Aleyrodids, commonly known as whitefly are often overlooked despite their abundance, due to their small body size. Whiteflies (Homoptera: Aleyrodidae) ranks among the most noxious insect pests attacking agricultural and ornamental fields and greenhouse crops around the world. In last decade among different whiteflies in the agricultural and ornamental fields (David and Selvakumaran, 1990; Singh and Singh, 1991; Rao and Chari, 1992; Selvakumaran, 1995; Jesudasan *et al.*, 2003; Loganatham, 2003) the mulberry whitefly, *Dialeuropora decempuncta*, a polyphagous pest has gained considerable notoriety in traditional sericultural zone of Malda district of West Bengal (Bandyopadhyay *et al.*, 1999), Assam and Manipur.

This pest occurs during monsoon and post monsoon period when there are no other major mulberry pests and damages mulberry leaf by extracting large quantity of juices from the lower surface of the tender leaves that causes chlorosis. In severe cases leaf curl and sooty mould disease were observed which render the entire leaves unsuited for silkworm rearing. Population dynamics of the whitefly is governed by a number of abiotic factors, which exert influence over the incidence of whitefly (Verma *et al.*, 1989). Population dynamics in insects are the result of interactions between population movements and both density dependent and independent factors. Selvakumaram (1995) noted the temperature; humidity and rainfall associated with population build up of jasmine whitefly, *Kanakarajiella cardamoni*.

In a restricted pocket of mulberry fields of Central Sericultural Research & Training Institute, Berhampore, West Bengal the influence of abiotic factors on the population fluctuation of this insect in the mulberry ecosystem was

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studied by Bandyopadhyay *et al.* (2000). But the present study is first of its kind to investigate the population size of whitefly on mulberry at farmers' level in relation to weather factors and to study the crop loss in relation to the population size. This will help to develop an effective control strategy for whitefly menaces though the population dynamics and understanding of field trends. Estimates of crop loss are required to determine the relative importance of particular pest and thus decide upon the level of resource that should be devoted to research and pest management inputs (Amin and Macdonald, 1984) and provide a basis for understanding the often complex interaction between the pest and its host plant (Bardner and Fletcher, 1974)

Materials and Methods

Population counts
The population size of whitefly was studied in the farmers' mulberry fields from 25 villages under 9 blocks involved in sericulture of Malda district of West Bengal during the year July 1999 to December 2001. Population of whitefly was recorded by visual counts in randomly selected 7 mulberry plots per village. Ohnesorge and Rapp (1986) recorded the population in this way. The horizontal population of whitefly was assessed by taking adult population from top two leaves of 10 randomly selected plants because in general, adults are most abundant on tender leaves, where as the vertical population was assessed by considering top two, middle two and bottom two leaves of 10 plants. To reduce disturbance, counts were done in each plant from top, middle and bottom portions for counting adults, early nymphs and late nymphs respectively. As the three different stages of whitefly stay at three different areas of twigs and as the adults and nymphal stages are related with leaf curl and sooty mould disease respectively, for that reason counts were needed at different position. Counts were made during cooler hrs of day preferably in the early morning of the day.

Assessing leaf loss %
For assessing leaf loss percentage, leaves affected by leaf curl and sooty mould were counted alongwith healthy leaves per plant. Similarly 10 plants were selected at random for data collection from each plot. Average leaf loss percentage was assessed by counting the infested leaves versus total number of leaves per plant (no. of infested leaves / total number of leaves × 100). The leaves, which were affected with leaf curl and sooty mould disease, were unfit for silkworm rearing for that those leaves were estimated as leaf loss.

Data recording of abiotic factors and analysis
The abiotic factors *viz.,* maximum and minimum temperature and relative humidity (R. H.) and also rainfall were recorded daily and mean values of each of the population observation were taken into consideration for analysis. The data thus obtained were subjected to statistical analysis involving the abiotic factors as independent variables and population as dependent variables for simple correlation and multiple regression analysis. In multiple regressions all the independent factors may not be equally responsible for explaining variation in the dependent factors. So the objective comes out to identify the most important independent factors (X) explaining the most variation in the dependent factors (Y) through step down regression process. As because there is a difference in the abiotic factors in consecutive year of the study for that three years of field data has become necessary to draw a conclusion. Hence, year wise study of relationship between the pest population and abiotic factors was adhered to. Multiple Regression Analysis (Draper and Smith, 1981) is applied to judge the relationship between the whitefly population and abiotic factors.

Results and Discussion

After completion of three years survey in 9 blocks of Malda district, it was found among nine blocks, two blocks were severely infested by whitefly whereas seven blocks were sporadically infested. It may be due to close and continuous plantation in the two blocks, which were heavily infested than other seven blocks where plantations are discontinuous and not close. During survey population of whitefly at different plant canopy level of mulberry is found to be different. Similar type observation was found by Buttler and Vir (1990) in cotton. They recorded various stages of *Bemisia tabaci* on cotton plant at different canopy level in 16 genotypes grown in green house. It is evident that the freely exposed top leaves were highly attractive to adult flies for oviposition while the concealed bottom leaves were least preferred but most preferred by the late nymphs. In 1999 and 2001 the whitefly incidence was from August to November, whereas the same for the year 2000 was from July to November. As the abiotic conditions were differ from season to season and year-to-year, for that the whitefly population was different. The whitefly incidence started rising from July and reached its peak during August and November. Further the decline in pest population started from December and remained negligible during January to May. During 1999, in the present study peak population of whitefly adult was 10.76 and 2.89 / leaf in August & November and percent leaf loss

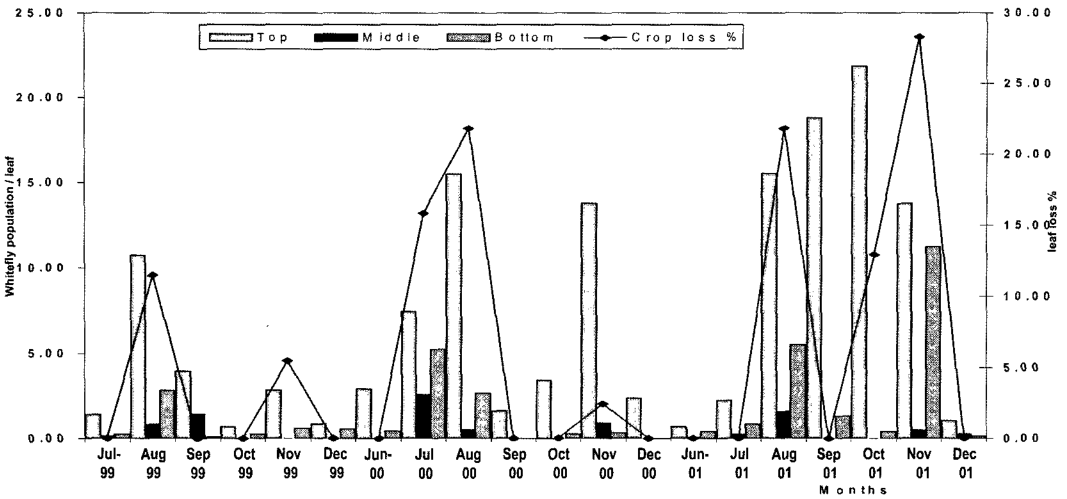

Fig. 1. Whitefly population in relation to leaf loss% in Malda district.

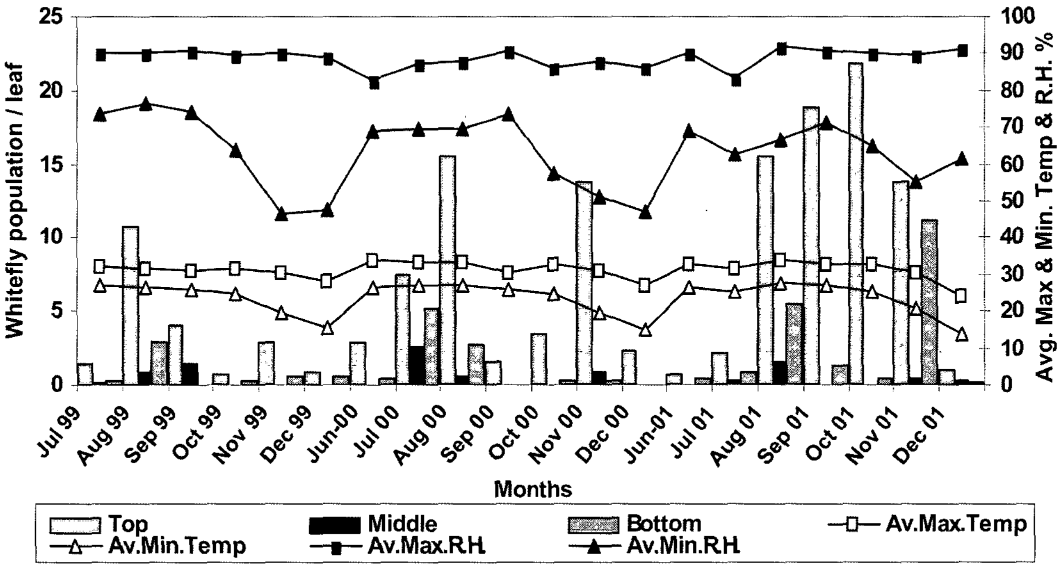

Fig. 2. Whitef
ly population in relation to Temp. and R. H. factors in Malda district.

was 11.46 and 5.46 in August and November with average maximum temperature and R. H. was 26.33°C and 90.25% respectively and total rainfall was 705.90 mm (Fig. 1 and 2). But in the year 2000 the population increased more and the peak population was 7.45, 15.46 and 13.77 / leaf and percent leaf loss was 15.82, 21.79 and 2.45% respectively in July, August and November respectively (Fig. 1) with average maximum.temperature 33.27°C, and R. H. 87.39% and rainfall was 128.00 mm (Fig. 2). In 2001, the maximum whitefly population was mostly similar to that of the year 2000 and it was recorded during August, October and November *i.e.*, 15.58, 21.82 and 13.77 / leaf with a percent leaf loss of 21.79, 12.93 and 28.29% respectively (Fig. 1). It was observed that temperature 25 – 30°C, R. H. 75 – 80% and Rainfall 165 – 255 mm helps to build up the whitefly incidence. This temperature range is quite ideal for hatching of whitefly eggs. Gameel (1978) reported 25°C is suitable for 92 – 98% hatching of *B. tabaci*. During survey it has been observed that Bhaduri (*i.e.*, August) and Aghrayni (*i.e.*, November) commercial crop of Malda district experience the shortage qualitative leaf because of heavy infestation of whitefly during August and November. It was revealed that there is a positive relation in increase population with increase in crop loss. Mound (1965) has shown the correlation equation between the yields of cotton, *Gossypium barbadense* and whitefly *Bemisia tabaci*. He has shown the percent loss of yield in cotton by *B. tabaci* in Sudan. Satpute (1988) reported a net loss of 4.6% in seed cotton yield by the whitefly, *B. tabaci*. The pest caused heavy economic damage with percent leaf loss by direct feeding and by interfering photosynthesis through secretion of honeydew by sooty mould fungus (Bandyopadhyay *et al.*, 2001). Mound (1965) opined that increase of reduction in cotton yield is correlated with the increase of whitefly *B. tabci* incidence in Sudan.

Rainfall is found to be associated with pest population as maximum whitefly populations were generally observed during rainy periods *i.e.*, in August. Though no significant correlation was found between rainfall and numbers of adult and late nymphal population of *Dialeuropora decempuncta* (Table 2), but it may be suggested that rainfall has an indirect effect on whitefly population through the host plant mulberry, resulting in the abundance production of succulent young leaves on which the whiteflies feed. Correlation analysis revealed that not all the abiotic factors are equally important to boost up the pest population at different canopy level. It was revealed that the difference in maximum and minimum of both temperature and R. H. are negatively correlated with the

Table 1. Relation of whitefly population at different canopy level with abiotic factors for previous seven days in Malda district

Stage	Regression	Equation
Adult at top canopy	Multiple	Y= −146.49 + 5.92X1 − 5.26X3 + 1652.44X5 − 1650.67X7 826.71X8 − 0.88X9 R^2 = 0.15 F = 14.61**
	Stepdown	Y= −201.36 + 1947.67X5 − 1945.02X7 − 973.35X8 − 1.11X9 R^2 = 0.18 F = 28.76**
Early Nymph at mid canopy	Multiple	Y= −22.79 − 139.95X1 + 194.99X2 − 55.04X3 + 167.67X4 − 69.36X5 +166.30X6 − 97.18X7 +117.63X8 + 0.15X9 R^2 = 0.23 F = 16.87**
	Stepdown	Y= 21.81 − 164.61X1 + 164.61X2 + 164.90X4 + 130.61X6 −130.84X7 + 65.07X8 + 0.12X9 R^2 = 0.24 F = 22.31**
Late Nymph at bottom canopy	Multiple	Y= −114.94 + 125.31X1 + 89.40X2 − 214.69X3 − 18.83X4 + 1253.75X5 + 277.81X6 − 1529.97X7 − 487.61X8 − 0.91X9 R^2 = 0.23 F = 17.15**
	Stepdown	Y = −105.84 + 1086.57X5 + 329.97X6 − 1415.09X7 R^2 = 0.22 F = 27.95**

Notation: - Y = Population of different stages of whitefly.
X1 = average maximum temperature °C, X2 = average minimum temperature °C, X3 = difference in temperature °C, X4 = average of average temperature °C, X5 = average maximum temperature R. H. %, X6 = average minimum temperature.R. H. %, X7 = difference in R. H. %, X8 = average of average R. H. %, X9 = Total Rainfall (mm).

Table 2. Results of correlation between the population levels of *Dialeuropora decempuncta* and abiotic factors at Malda district

Variables	Lag correlation												
	Y1	Y2	Y3	Y4	X1	X2	X3	X4	X5	X6	X7	X8	X9
Bottom Pop (Y1)													
Mid Pop (Y2)	0.568**												
Top Pop (Y3)	0.479**	0.388**											
Leaf loss % (Y4)	0.701**	0.507**	0.680**										
Max. Temp. (X1)	0.100*	0.129**	0.163**	0.136**									
Min. Temp. (X2)	0.116**	0.149**	0.167**	0.161**	0.945**								
Avg. Temp. (X3)	0.112**	0.144**	0.168**	0.154**	0.977**	0.993**							
Diff. in Temp. (X4)	-0.118**	-0.152**	-0.150**	-0.168**	-0.761**	-0.930**	-0.880**						
Max. R. H. (X5)	-0.019	-0.070	-0.021	0.051	-0.085	0.073	0.016	-0.249**					
Min. R. H. (X6)	0.086	0.174**	0.179**	0.158**	0.611**	0.801**	0.741**	-0.911**	0.434**				
Avg. R. H .(X7)	0.074	0.145**	0.159**	0.153**	0.541**	0.742**	0.678**	-0.872**	0.572**	0.987**			
Diff. in R. H. (X8)	-0.096	-0.201**	-0.197**	0.159**	-0.673**	-0.844**	-0.792**	0.926**	-0.257**	-0.982**	-0.939**		
Rainfall (X9)	-0.043	0.094*	0.068	0.059	0.436**	0.603**	0.550**	-0.714**	0.604**	0.816**	0.848**	-0.748**	
Correlation current													

Note : *significant at $p = 0.05$ and **significant at $p = 0.01$.

pest population (Table 2). In both the cases it was noticed that higher fluctuation in temperature and humidity are detrimental for incidence of whitefly population. That means a steady temperature and relative humidity are preferable for the build up of whitefly population. Lal (1981) observed that stable maximum temperature, high rainfall and high relative humidity favored the population build up of *B. tabaci* on cassava.

Further analysis of the data through Step down Regression analysis, revealed that among the factors, the increase in population positively correlated with the average maximum R. H. value of the previous 7 days (Table 1), which reflects higher the maximum relative humidity in atmosphere, higher will be the pest population. Thus higher relative humidity is suitable for incidence of whitefly. David (1963) opined that the high degree of association between aleyrodid and humidity in combination shows that under tropical conditions humidity in general plays a more important role in conditioning the infestation of aleyrodid than any other weather factors.

From a pest management perspective, control strategies to prevent such population explosions seem to be a more effective approach than to control the pest ones a given threshold has been reached.

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