

Effect of Cardinal Directions and Weather Factors on Population Dynamics of Mango Mealybug, *Drosicha mangiferae* (Green) (Margarodidae: Homoptera) on Chaunsa Cultivar of Mango

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Abstract.- Infestations of the mango mealybug *Drosicha mangiferae* (Green) [Homoptera: Margarodidae], were affected by weather factors and the position of the infestation with respect to cardinal direction on the branch of the host plant, *Mangifera indica* var. 'Chaunsa'. Abundance of the scales according to position on the tree with respect to cardinal direction indicated that lower abundance occurred on the leaves and inflorescence on the north side of the tree. Multiple linear regression models relating seasonal abundance of the scales to maximum, minimum daily ambient temperatures and relative humidity explained 24.7% of the variation in the sampling data over 2 seasons. Abundance on the branches was similar in all sides of the tree. Abundance of the scales was correlated to weather factors viz., maximum temperature, minimum temperature, % relative humidity, and rainfall.

Key words: Weather factors, population dynamics, mango mealybug, *Drosicha mangiferae*, *Mangifera indica*.

INTRODUCTION

Mango mealybug *Drosicha mangiferae* (Homoptera: Margarodidae) is an important adventive (Kumar *et al.*, 2009), dimorphic (Chandra *et al.*, 1987), destructive (Karar *et al.*, 2009, 2010, 2012) polyphagous (Tandon *et al.*, 1978), and highly fecund (Nair, 1975) pest covered with waxy layer which makes the chemical control difficult (Ashfaq *et al.*, 2005). After it invades and becomes established in orchard it is very difficult for the growers to control. Unlike some species of scale insects, the mealybugs have well-developed legs that allow them to remain mobile throughout their life. Plant damage occurs by piercing-sucking mouthparts which consequently lowers plant photosynthesis resulting in decreased respiration curling, yellowing and leaf drop. Malformation, dwarfing, decreasing food production, and even plant death occur from feeding pressure (Karar *et al.*, 2010). Sooty mold which develops on honey

dew produced by the insect, inhibit photosynthesis and quality of plant.

Pakistan was the second world producer of mango, *Mangifera indica* L., in 1978 and was reduced by insect pest and disease infestations resulting in lower yield (Usman *et al.*, 2003), and a lower worldwide ranking (6th) (Government of Pakistan, 2011). Due to high pest attack in many orchards in southern Punjab some growers have uprooted their orchards in Pakistan.

Cardinal directions of plant influence the insect flight, movement, and dispersal pattern. Most of insects move towards east west axis than south north axis (Bancroft, 2005). This dispersal habit of insects helps in formulating particular monitoring and recommendation methods for pest control. Insects on the basis of habitat requirement try to settle on branches that meet their optimum requirements for obtaining heat, sunshine and humidity. Monitoring from these sites helps in formulation of earlier pest management approaches.

Drosicha mangiferae abundance is affected by several factors, especially microclimate created by irrigation methods and distance between trees. Pruning the trees can also reduced infestations (Bakr

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0030-9923/2013/0006-1541 \$ 8.00/0

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et al., 2009). Meteorological data viz., mean monthly maximum temperature, minimum temperature, morning and evening relative humidity affects population of coccids (Sundaraj and Muthukrishan, 2011). *D. mangiferae* females lay eggs in May to June, egg hatching is influenced by temperature and precipitation (Ashfaq *et al.*, 2005). During May returning to ground is dependent with average temperature. Temperature and moisture effect mealybug growth, development hatching and other life parameters (Kumar, 2009). Changes in climate can induce changes in species dynamics and this requires extensive attention in focusing on the role of changing climate on altering distribution, abundance, seasonality of individual species. Despite this immense challenge, the critical void must be addressed and in doing so represent an opportunity to bridge current studies on the level of individuals to future studies that incorporate trophic interactions.

Therefore, the present study was undertaken to determine the preference side of the plant that *D. mangiferae* infests for better management and to determine the impact of various weather factors in the population fluctuation of this monophlebid.

MATERIALS AND METHODS

The population of *D. mangifera* was investigated on mango, *Mangifera indica* var. 'Chaunsa', in two heavily infested orchards in district Multan during the 2005-06 and 2006-07 seasons. The effects of weather factors on seasonal abundance of the mealybugs were studied on 3 mango plants of each orchard. Selected trees were permanently marked as tree 1, 2, or 3 with iron sheeting fixed with two.

From each tree four fruit bearing branches of 30-cm in length were selected in four different directions *i.e.* east, west, south and north, were tagged. The tag was written with lead pencil as number 1, 2, 3 and 4. The abundances of *D. mangiferae* were enumerated weekly from the selected 30-cm branches including (leaves, inflorescence and branches). Average counts of individual insects (presented in parentheses) on six trees were calculated on leaves, branches and inflorescence with respect to their directions in each

year as well as cumulative average of two years. The meteorological data were collected from weather station at Central Cotton Research Institute, Multan.

Average population and abiotic factors was calculated by using Excel sheets and shown graphically. The data were subjected to square root transformation and simple correlation and multiple linear regression analyses were carried out using MSTAT-C (Anonymous, 1989) package for both the years individually, as well as on average basis, to determine the impact of abiotic factors on population of *D. mangiferae* on 'Chaunsa' mango. Means were separated using Duncan Multiple Range test at 0.05 level of significance.

RESULTS

Population of mealy bug

The population of mango mealybug was recorded from the four cardinal points of the tree mango cultivar 'Chaunsa' during 2005-06 and 2006-07. The results are presented under the following sub-heading.

On leaves

The southern side of the plant had significantly the highest abundance of *D. mangiferae* per 30 cm branch on leaves during both the study years as well as on an average basis (20.65 individuals/branch) followed by east and west sides (Fig. 1A). The north side of the mango plant showed significantly the lowest population of mango mealybug during both the study years.

On inflorescence

The south and west sides of the mango plants reflected the highest numbers of *D. mangiferae* during 2005-2006. The highest population of Mango mealybug was 10.65 individuals/inflorescence on south side followed by west (10.24 individuals/inflorescence) and east (8.93 individuals/inflorescence) sides (Fig. 1B). The north side of the plant had significantly the lowest population of Mango mealybug during, 2006-2007 (2.26 individuals/inflorescence) while west side of the plant showed maximum population of Mango mealybug on inflorescence (7.15 individuals/inflorescence) followed by south (5.44) and east

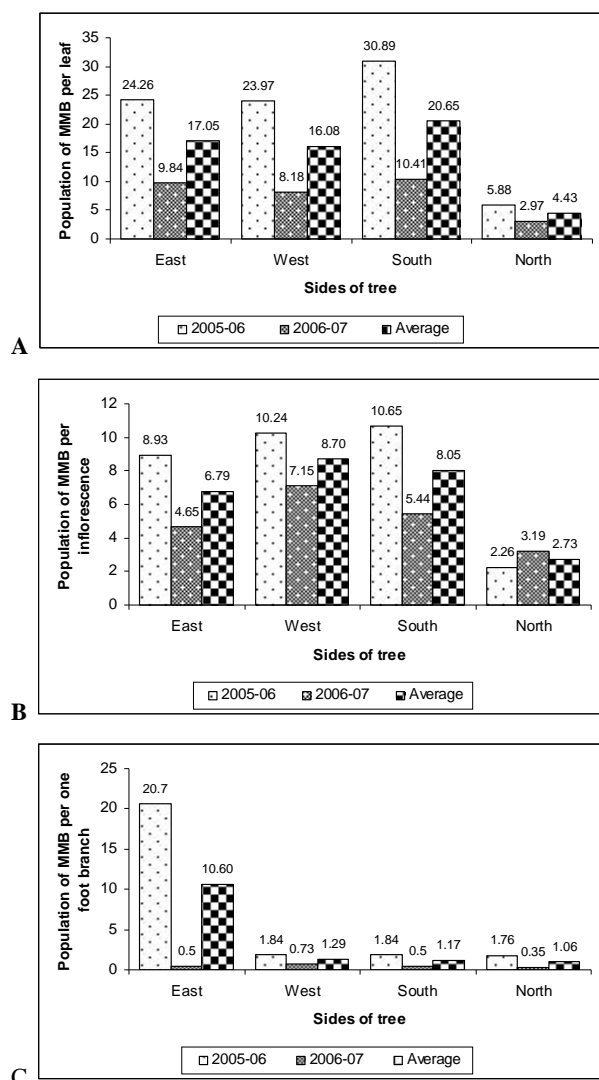


Fig. 1. Population of mango mealybug on leaves / 30 cm brach length (A), inflorescence (B) and on branch of mango cultivar 'chaunsa' (C) at various sides during 2005-06 and 2006-07.

(4.65) sides. The north side also showed the lowest population (3.19) of Mango mealybug during 2005-06. On an average of two year's data it was observed that west side of the plant had significantly maximum population of Mango mealybug followed by south (8.05) and east (6.79) sides (Fig. 1B). North side showed significantly the lowest population of Mango mealy bug on inflorescence *i.e.* 2.73 per inflorescence.

On branches

During 2005-2006, east side showed significantly maximum population of mango mealybug *i.e.* 20.7 individuals per 30 cm branch followed by west and south sides each showing 1.8 individuals per 30 cm branch. The north side of the plant had significantly the lowest population *i.e.*, 1.8 per 30-cm branch of mango mealybug. The results of the 2006-2007 season showed that the west side of the plants had maximum population of Mango mealybug, whereas minimum on north side of the plant. East and south sides showed similar population of Mango mealy bug and had intermediate trend. On an average of two years data, it was observed that east side of the plant had maximum population of Mango mealy bug 10.6 per 30-cm on branches and differed significantly from other sides. The minimum population of Mango mealy bug was observed on north side of the plant *i.e.*, 1.1 per 30-cm and did not show significant variation with those of observed on south (1.7 per 30- cm) and west (1.3 per 30-cm) sides of plant.

Population of mealy bug versus weather factors

Population *D. mangiferae* versus weather factors during 2005-2006 showed that the population of mango mealybug appeared on 18 Jan. 06 with 0.1 individual per 30 cm branch and this population increased consequently on the subsequent dates of observation and reached to a peak of 34.4 individuals per 30 cm branch on 22 Feb. 06 with maximum temperature of 26.1°C, minimum temperature of 16.1°C and average relative humidity of 77.9 percent. The decreasing trend in this population was observed thereafter on the subsequent dates of observation and reached to a minimum of 0.1 on 31 May 06.

Population of *D. mangiferae* per 30 cm branch versus weather factors during the 2006-2007 season revealed that the population of mealybug appeared on 18 Jan. 2007 and increasing trend was observed thereafter. The population reached its highest peak on 8 Feb. 2007 *i.e.* 22.0 per 30 cm branch and suddenly decreased down to 5.9 per 30 cm branch on 16 Feb. 2007. The increasing trend was again observed consequently on the subsequent dates of observation and reached to the second peak on 15 Mar. 2007 with 11.70 individuals per 30 cm

branch. The population pushed up again in decreasing trends by environmental factors thereafter up to the remaining dates of observation and reached to a minimum level of 0.1 individual per 30 cm branch on 31 May, 2007. From these results it was observed that maximum temperature of 23.5°C, minimum temperature of 11.5°C, and 80 percent RH were the most favorable for the development of *D. mangiferae* during 2006-2007.

Figure 2C show average population size of mango mealybug recorded from 30-cm branch, from leaves and inflorescence during 2005-2007 versus weather factors. The population appeared on Jan. 4 *i.e.* 0.01 individuals per 30-cm branch and increased up to the highest peak *i.e.* 26.6 individuals on Feb. 8. This population was decreased up to 19.8 individuals per 30 cm branch on Feb. 15. The second peak was observed *i.e.* 21.1 individuals per 30 cm branch on Feb. 22. A decreasing trend was again observed and the population reached down up to 17.2 individuals per 30 cm branch on Mar. 01. A third peak was again observed on Mar. 08 with 19.1 individual of mealybug. The decreasing trend was observed thereafter on the subsequent dates of observation with 0.1 individual of mealybug on May 31. The maximum temperature 24.1°C, minimum temperature 10.9°C, Relative Humidity 79.4 percent and rainfall 0.3 mm was observed at the highest peak *i.e.* 26.6 individuals per 30 cm branch on Feb. 8 and these conditions were found suitable for the development of the pest.

Correlation of weather factors with population of mango mealy bug

Table I shows that none of the weather factors resulted in significant effect on the population of mango mealybug during both the study years separately as well as on cumulative basis. However, the response of maximum temperature was negative whereas minimum temperature, relative humidity and rainfall exerted positive correlation values during both the study years individually as well as on cumulative basis.

The multiple linear regression models (Table II) and the coefficient of determination values indicated that during 2005-2006 max. temperature did not have an effect on the population fluctuation of the mango mealybug. The combined effect of

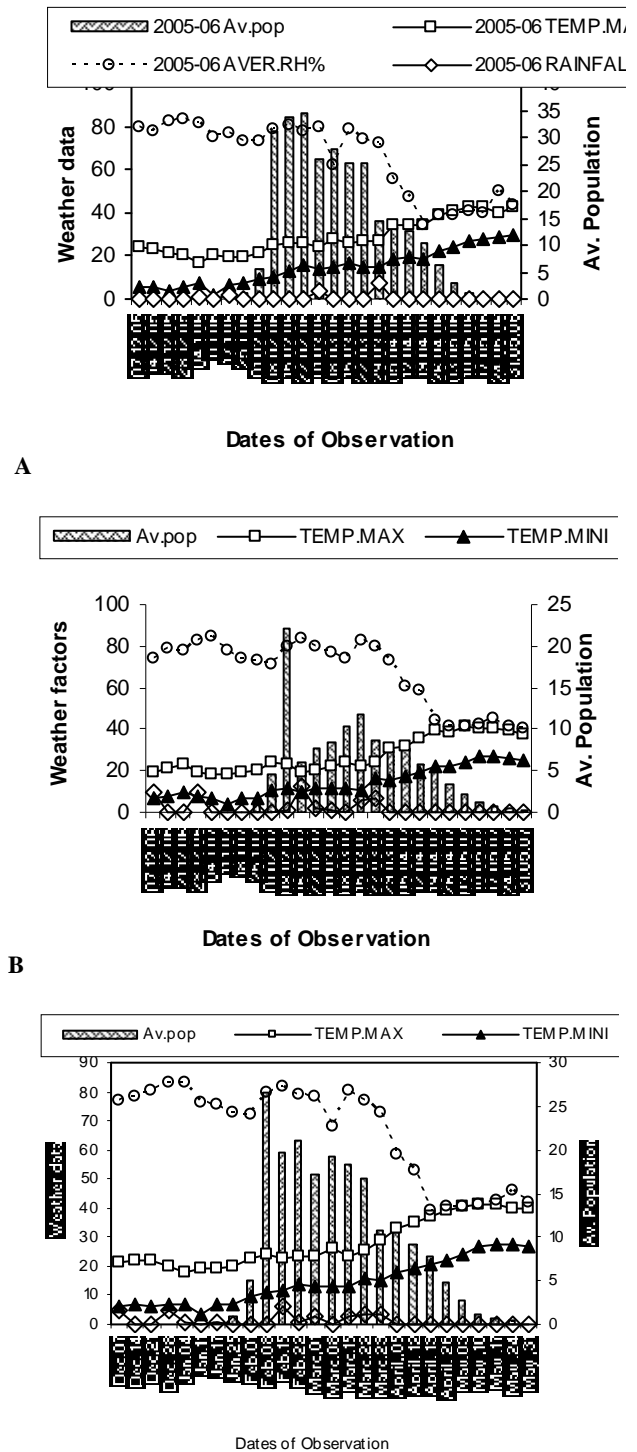


Fig. 2. Population dynamic and weather factors during 2005-2006 (A), 2006-2007 (B) and 2005-2007 (C) on 'Chaunsa' cultivar.

Table I.- Effect of weather factors on the population fluctuation of mango -mealybug during the study years 2005-2006 and 2006-2007.

Years	r-values			
	Weather factors			R.F. (mm)
	Temperature (°C)		R.H. (%)	
	Maxi.	Mini.		
2005-06	-0.009	0.182	0.144	0.157
2006-07	-0.165	0.097	0.266	0.101
Cumulative	-0.095	0.151	0.170	0.051

maximum and minimum temperature however was significant and models explained 21.5 percent of the variation in the insect counts. Stepwise addition of relative humidity to the model increased the percentage to 27.4 percent. Stepwise addition of rainfall to the model did not increase the percentage and thus had no significant effect of insect counts.

During 2006-2007, maximum temperature explained 2.7 percent of the variation in mealybug abundance and was a significant impact. Maximum and minimum temperature increased the percentage by 4 percent. The combination of maximum temperature, minimum temperature and relative humidity had a significant effect on insect counts and explained 48.3 percent of the variation in the mealybugs. Similarly, the model with all the weather variables explained 54.7 percent of the variation in the insect counts. In this model minimum temperature and relative humidity had significant positive effect on the insect counts, whereas, maximum temperature and rainfall had no significant effect. From these results, it was observed that relative humidity was the most important variable explaining 44.3 percent of the variation in the mealybug abundance.

On cumulative basis, maximum temperature again had no significant impact with minimum contribution *i.e.* 0.9 percent in population fluctuation of the pest. The impact was reached up to 4.1 percent when the effect of maximum temperature and minimum temperature was computed together. Relative humidity again proved to be the most important factor which alone contributed 24.7 percent role in population fluctuation of the pest when the effect of maximum and minimum temperatures were computed with

relative humidity. Rain fall did not show significant role in population fluctuation of the pest and contributed only 1.9 percent role.

DISCUSSION

The position of the infested branch, measured as its cardinal direction, affected mealybug abundance. The total number of mealybugs on the south side of the tree was significantly higher than the east, west or north sides. The mealy bug abundance on the leaves and inflorescence were higher on the east side. The mealy bug abundance on the branches was higher on the west side. The likely speculate that the reason that *D. mangiferae* were more numerous on the south side of the tree has something to do with ambient temperature. Because of the angle of the sun, the insects on east, west, north and south sides will get more degree day accumulation than insects on north cardinal directions. It is recommended that during pest scouting, pest monitoring or survey of the pests particularly mango mealybug, southern side of the plant should be sampled for better results. Present results with reference to mealybug abundance on north side were similar to Bakr *et al.* (2009) whose observation were in cool weather maximum population of mango mealybug were present on eastern side leaves in the front of sunrise while in the summer weather infested leaves were dense far from sunrise from western direction. Present studies were also in similar to Baovida *et al.* (2009) whose conclusion was a one time assessment of inter-canopy distribution of *D. mangiferae* were resulted in significant differences in quadrant but not between age of leaves *i.e.* upper and lower leaves. However, results of present studies were in contradiction with Gencsoylu (2007) who observed that *Bemisia tabaci* (Gennadius) were more abundant on north side than other sides. The most possible reason could be that these sides had more fruiting and sunshine as compared to northern side of the tree. Further it was also observed that the peak activity period of the pest was 2nd week of February to 2nd week of March and the population decreased thereafter. The results of present studies were similar to Kumar *et al.* (2009) who reported that population of mealybug increased to the middle

Table II. Multiple linear regression models between population of mango mealybug and weather factors.

Years	Regression Equation	D.F.	F-value	P- value	R ²	Individual Role (%)
2005-06						
Y =	2.8032 – 0.0233 X1	24	0.00	0.97	0.00	0.00
Y =	9.6369 – 2.6986 X1* + 1.9752 ** X2	23	3.59	0.62	0.22	21.50
Y =	-3.9438 – 1.4058 X1 + 1.8798 X2* + 0.8781 X3	22	2.12	0.08	0.27	5.90
Y =	-3.8621 – 1.4272 X1 + 1.8934 X2* + 0.8803 X3 – 0.0412 X4	21	2.98	0.09	0.27	0.00
2006-07						
Y =	2.2962 – 0.0625 X1	24	2.01	0.93	0.03	2.7
Y =	1.8111 – 0.0667 X1 + 0.1357 X2	23	2.41	0.75	0.04	1.3
Y =	-13.6903–0.0803X1 + 1.4100X2 + 1.338 X3**	22	4.60	0.01	0.48	44.3
Y =	-15.7025–0.1194X1+ 1.5534 X2 + 1.6068 X3** - 0.3814 X4	21	4.95	0.01	0.55	6.4
2005-06 + 2006-07						
Y =	2.7087 – 0.0724 X1	50	2.16	0.32	0.01	0.9
Y =	1.7959 – 0.1050 X1 + 0.2902 X2	49	3.97	0.26	0.04	3.2
Y =	-12.5385–0.1014 X1 + 1.3794 X2 + 1.2707 X3**	48	7.39	0.00	0.29	24.7
Y =	-13.4251–0.1307 X1 + 1.4598 X2 + 1.4078 X3 ** - 0.3361 X4	47	5.79	0.00	0.31	1.9

X1= Max. Temperature X2= Mini. Temperature X3= R.H percent , X4=Rainfall

R² = Coefficient of Determination

* = Significant at $P \leq 0.05$.

** Significant at $P \leq 0.01$.

of March and then declined. However results of present studies were in contradiction to already reported (Matokot *et al.*, 1992). The most probable reason could be the differences in the methods used to carry out previous studies. Further it was noted that none of the weather factor resulted in significant effect on the population of *D. mangiferae* during 2006 and 2007, separately as well as on cumulative basis. However, the response of maximum temperature was negative whereas minimum temperature, relative humidity and rainfall exerted positive correlation values during both the study years individually as well as on cumulative basis. Baovida *et al.*, (1995) depiction was contrary to present finding that Bavoida *et al.* (1995) stated that population density of *Rastrococcus invadens* (Green) decreased during the rainy seasons and peaked during dry seasons, however in the present studies Mango Giant scale increased with rainfall. The reasons might be different behavior of two different species to weather factors. Multiple Linear Regression Models revealed that the maximum

temperature did not show any impact on the population fluctuation of *D. mangiferae*. The role played by regulatory factors that control population dynamics still remains as an open and “hot” debate for most investigators (Meserve *et al.*, 2001).

ACKNOWLEDGMENTS

This paper is part of Ph.D. work of the first author. Authors are also grateful to Ministry of Agriculture Government of Pakistan for providing facilities for this research in University of Agriculture, Faisalabad, Pakistan.

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(Received 30 April 2013, revised 18 July 2013)