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Influence of Abiotic and Biotic Factors on Population Build Up of Leaf hoppers on Mango Crop

M Ramaiah, V Ramasubba Rao, M S V Chalam, M G Balahussaini, C Madhumathi, K Gopal, D Sreenivasulu Reddy and M Balakrishna

Department of Entomology, S V Agricultural College, Tirupathi 517 502, Andhra Pradesh

ABSTRACT

Mango leafhoppers occur in all mango growing areas in India and are widespread through South-East Asia and Papua New Guinea. Damage (50% yield loss) caused by leafhoppers in mango is one of the major threats in production of mango. Herein, the taxonomic studies on the leafhopper fauna associated with mango orchards in Andhra Pradesh were performed in the department of Entomology, S.V. Agricultural College, Tirupati after collection of leafhoppers from different mango orchards of various places in Andhra Pradesh during 2006-08. The field experiments were conducted to study the influence of abiotic and biotic factors with population buildup of leafhoppers on mango crop. The leafhoppers and also the natural enemies were counted at 7 days interval. The relationship between the pest incidence, natural enemies and weather parameters was worked out through correlation and multiple linear regression analysis.

Key words : Abiotic factors , Bio-systematics, Biotic factors, Leafhoppers, Mango.

Mango (*Mangifera indica* Linn.) is an important fruit crop grown extensively under tropical and sub-tropical climate. It is an important commercial fruit crop of India with a great potential for export both fresh fruit and in its processed form. India contributes 65 per cent of the total world mango production and is being cultivated in about 1.2 m ha. (Yadav, 1997). Andhra Pradesh was in forefront with an annual output of about 32.6 lakh tons of fruits (Purushotham, 2007). On non-flowering mango trees, leafhopper populations are quite low and rather difficult to detect. Mango leafhoppers feed on vegetative flush tissue by sucking the sap. They lay eggs into the underside of the mid ribs of young leaves. Feeding and egg laying cause curling and distortion of new flush and young leaves. These pests can build up very rapidly on flowering trees and cause damage by their numerous egg laying punctures to the flower stems those then wither and fail to set fruitlets. The leafhoppers suck the sap from the flowers and heavy production of honeydew associated with sooty mould growth may retard tree vigour and lead to fruit drop. If left untreated, leaves and flowers will be damaged and fruit production can be severely affected. Smith and Brown (2014) reported that on heavily infested trees, crop losses of 50% or more had been recorded.

MATERIALS AND METHODS

The studies on the abiotic factors and seasonal incidence of mango leafhoppers and their natural enemies were carried out in the mango orchards of Regional Horticultural Research Station, Anantarajupet. The number of nymphs and adults and their natural enemies were counted per two twigs / panicles on all the three directions of the tree at each observation in the morning hours when they were less active. Data were recorded on 10 randomly selected mango trees at seven days interval for the two seasons *viz.*, during 2006-2007 and 2007-2008. Data on weather parameters *viz.*, minimum, maximum temperatures, relative humidity and rain fall were recorded at (standard) weekly internals at Regional Horticultural Research Station, Anantarajupeta. The population of mango leafhoppers were statistically correlated with the weather parameters to understand the influence of individual weather factors on the development and seasonal occurrence of leafhoppers and their biotic factors (natural enemies) in mango.

RESULTS AND DISCUSSION

Influence of abiotic and biotic factors on the population build up of leafhoppers on mango crop during 2006-2007

The data recorded on the incidence of mango leafhoppers *Amridotus atkinsoni* (Lethierry) (Table: 2 and Fig: 6) indicated their prevalence from the first week of September 2006 to May, 2007. The average of maximum and minimum temperatures during this period was 29.79°C and 24.29°C, respectively and the average relative humidity at morning and evening was 83.41 and 61.92 per cent, respectively. The population of leafhoppers, coccinellid predators and spiders during the period was 90.87, 4.09 and 9.22 per six twigs/ panicles respectively.

The leafhopper population increased gradually from first week of September, 2006 and reached to a peak by 2nd week of February, 2007 with a mean of 172.40 leafhoppers/6 panicles. The average of maximum and minimum temperatures during the peak level of population was 29.40°C and 21.40°C respectively and the average of morning and evening relative humidity's was 87.70 and 38.70 per cent respectively. The population of cocinellids and spiders during the peak incidence was 7.00 and 14.80 per 6 panicles respectively. There after the pest population declined gradually and reached a minimum by first week of May 2007 with a mean of 21.50 leafhopper/6 panicles. The average of maximum and minimum temperatures, prevailed during the period was 38.00°C and 30.60°C respectively and recorded values of average morning and evening relative humidity were 61.05 and 41.00 per cent, respectively. The populations of coccinellids and spiders during the period were 6.00 and 13.00 for 6 panicles respectively.

The correlations were worked out to find out the relationship between leafhopper population and the major weather parameters and natural enemies (Table 3). A significant negative correlation was noticed between the leafhopper population and minimum temperatures (r = -0.605) and evening relative humidity (r = -0.510), while the association between the leafhopper population and maximum temperature (r = -0.111), morning relative humidity (r = -0.116) and rainfall (r = - 0.127) was also negative but non significant. The relationship between leafhoppers, coccinellid predators (r = 0.759) and spiders (r = 0.715) was positive and significant.

The data on the incidence of leafhoppers population was subjected to multiple linear regression analysis (Table: 4) and the following equation was arrived.

$$Y = - 124.558 + 1.512\ X_1 - 7.597\ X_2 + 2.164\ X_3 - 1.412\ X_4 + 0.531\ X_5 + 8.867\ X_6 - 0.699\ X_7$$

The coefficient of determination (R^2) for leafhopper population showed that aboiotic and biotic factors together were able to explain the variation in the population of leafhoppers to the extent of 78.5 per cent.

Influence of abiotic and biotic factors on the population build up of leafhoppers on mango crop during 2007-2008

Data recorded on the incidence of mango leafhoppers *A. atkinsoni* (Table 5 and Fig. 7) revealed that pest population was observed from the first week of September 2007 to May, 2008. The average of maximum and minimum temperatures prevailed during this period was 28.84°C and 22.17°C, respectively and the average of morning and evening relative humidity was 87.03 and 62.02 per cent, respectively. The population of leafhoppers, coccinellid predators and spiders during the period was 80.05, 4.74 and 10.04 per 6 panicles, respectively.

The leafhopper population increased gradually from first week of September, 2007 and reached to a peak by fourth week of February, 2008 with a mean of 180.20 leafhoppers/6 panicles. The average of maximum and minimum temperatures during the peak level of population was 30.20°C and 21.14°C respectively and the average morning and evening relative humidity's were 87.42 and 39.57 per cent respectively. The population of cocinellids and spiders during the peak incidence was 7.00 and 15.50 per 6 panicles respectively. There after the pest population declined gradually and reached a minimum by first week of May 2008 with a mean of 26.40 leafhoppers/6 panicles. The average maximum and minimum temperatures prevailed during the period were 37.60°C and 27.71°C respectively and average morning and evening relative humidity's were 68.28 and 39.42 per cent respectively. The

Table 1. Influence of abiotic and biotic factors on the seasonal occurrence of mango leafhoppers on mango crop during the year 2006-07.

Sl. No	Date of Observation	Temperature (°C)		Relative humidity %		Rainfall mm	Natural enemies		Mango leafhopper population per 6 twigs/ panicles
		Max	Min	Morning	Evening		Coccinellids	Spiders	
1	6-Sep-06	30.40	27.40	92.00	74.20	0.00	0.00	0.00	16.40
2	13-Sep-06	30.20	27.80	94.20	75.20	0.00	0.00	0.00	21.20
3	20-Sep-06	31.40	27.80	90.00	77.20	4.00	0.00	0.00	30.40
4	27-Sep-06	30.00	27.00	91.20	77.00	0.00	0.00	0.00	30.80
5	4-Oct-06	29.60	26.40	90.20	80.00	0.00	0.00	0.00	44.20
6	11-Oct-06	29.20	25.80	90.80	82.00	0.00	0.00	0.00	52.30
7	18-Oct-06	28.20	25.00	91.20	82.00	0.00	0.00	0.00	56.70
8	25-Oct-06	28.00	25.20	92.40	80.00	0.00	0.00	0.00	57.80
9	01-Nov-06	27.20	25.40	93.20	78.20	18.86	0.00	0.00	58.50
10	08-Nov-06	27.50	25.50	94.00	75.80	4.20	0.00	6.00	62.30
11	15-Nov-06	27.20	23.10	93.20	83.20	33.80	3.20	8.00	70.80
12	22-Nov-06	27.60	24.30	90.20	79.70	0.00	3.80	9.40	82.40
13	29-Nov-06	27.10	23.50	90.40	76.40	0.00	4.00	10.20	86.80
14	06-Dec-06	25.70	22.70	74.80	81.00	25.10	3.80	10.20	90.40
15	13-Dec-06	24.50	20.00	85.40	71.80	0.00	5.00	11.40	82.40
16	20-Dec-06	24.70	21.10	90.60	73.00	0.00	5.00	11.80	88.40
17	27-Dec-07	24.60	20.20	88.50	72.50	0.00	4.80	12.00	98.50
18	03-Jan-07	24.70	18.80	78.10	80.40	0.00	6.00	12.00	100.40
19	10-Jan-07	25.80	19.40	86.10	65.80	0.00	6.20	16.00	118.50
20	17-Jan-07	25.80	18.90	76.10	58.90	0.00	7.00	16.00	128.30
21	24-Jan-07	28.10	18.80	84.00	45.00	0.00	7.00	14.00	160.80
22	31-Jan-07	29.50	21.00	82.70	39.70	0.00	8.00	14.40	165.20
23	07-Feb-07	29.20	22.50	90.80	56.40	0.00	8.00	15.20	170.40
24	14-Feb-07	29.40	21.40	87.70	38.70	0.00	7.00	14.80	172.40
25	21-Feb-07	30.85	23.71	85.14	42.57	0.00	6.40	16.60	168.20
26	28-Feb-07	31.28	24.00	81.28	58.71	0.00	6.00	14.40	170.40
27	07-Mar-07	33.42	25.00	61.42	35.38	0.00	7.00	15.20	160.20
28	14-Mar-07	35.55	26.57	77.14	29.85	0.00	6.20	12.00	150.60
29	21-Mar-07	32.80	25.70	78.30	42.20	0.00	6.00	10.00	138.20
30	28-Mar-07	35.00	26.50	77.03	42.60	0.00	6.00	10.80	110.40
31	04-Apr-07	34.00	25.50	76.04	40.70	0.00	5.80	14.00	88.40
32	11-Apr-07	35.00	26.50	72.05	43.60	0.00	5.00	12.00	62.40
33	18-Apr-07	34.00	27.50	70.00	43.40	0.00	5.00	10.80	40.30
34	25-Apr-07	37.10	29.60	62.14	43.14	0.00	5.00	12.60	23.40

population of coccinellids and spiders during the period was 6.00 and 13.00 for 6 panicles respectively.

The correlations were worked out to find out the relationship between leafhopper population and the major weather parameters and natural enemies (Table: 6). The results indicated negatively significant association between the leafhopper population and minimum temperatures (r = -0.523) and evening relative humidity (r = -0.481), while the association between the leafhopper population and maximum temperature (r = -0.119), morning relative humidity (r = -0.108) and rainfall (r = -0.007) was also negative but non significant. The relationship between leafhoppers, coccinellid predators (r = 0.760) and spiders (r = 0.749) was positive and significant. The data on the incidence of leafhoppers population was subjected to multiple linear regression analysis (Table: 7) and the following equation was arrived.

$$Y = -61.336 + 3.292\,X_1 - 8.320\,X_2 + 3.673\,X_3 - 1.057\,X_4 + 0.026\,X_5 + 7.759\,X_6 + 0.427\,X_7$$

Table 2. Correlation between abiotic and biotic factors and population of mango leafhoppers during the year 2006-07.

Sl. No	Variables	Correlation Coefficients (r)
1.	X_1 -Maximum Temperature (°C)	-0.111^{NS}
2.	X_2 -Minimum Temperature (°C)	-0.605**
3.	X_3 -Morning Relative humidity (%)	-0.116^{NS}
4.	X_4 -Evening Relative humidity (%)	-0.510**
5.	X_5 -Rainfall(MM)	-0.127^{NS}
6.	X_6 -Coccinellids	0.759**
7.	X_7 -Spiders	0.715**

** Significant at 1 per cent level ^{NS} Not Significant

Table 3. Multiple linear regression between temperature, relative humidity, natural enemies and population of mango leafhoppers.

Sl. No.	Variables	Partial Regression Co-efficient	Standard Error	t-value
1.	X_1 -Maximum Temperature (°C)	1.512	6.653	0.227^{NS}
2.	X_2 -Minimum Temperature (°C)	-7.597	6.507	-1.168^{NS}
3.	X_3 -Morning Relative humidity (%)	2.164	0.809	2.676**
4.	X_4 -Evening Relative humidity (%)	-1.412	0.835	-1.692^{NS}
5.	X_5 -Rainfall(MM)	0.531	0.652	0.814^{NS}
6.	X_6 -Coccinellids	8.867	7.692	1.153^{NS}
7.	X_7 -Spiders	-0.699	2.951	-0.237^{NS}

Intercept - 124.558, R^2 -0.785, Adjusted R square - 0.729
** Significant at 1 per cent level ^{NS} Not Significant

The coefficient of determination (R^2) for leafhopper population was – 0.723 which showed that aboiotic and biotic factors together were able to explain the variation in the population of leafhoppers to an extent of 72.3 per cent.

1. Coccinellid predator
   Anegleis cardoni (Weise)
2. Chrysopid
   Chrysopa lacciperda Kimmins

The spider, *Lyssomanes sikkimensis* was highly effective predator of *I. clypealis*. severale reports are conforming the above observations in the present investigation.

INFLUENCE OF ABIOTIC AND BIOTIC FACTORS ON THE POPULATION BUILDUP OF LEAFHOPPERS ON MANGO CROP

The leafhopper population increased gradually from the first week of September 2006 and reached to a peak by second week of February 2007 with a mean of 172.4 leafhoppers/6 panicles.

The average of maximum and minimum temperature during the peak level of population was 29.4°C and 21.40°C respectively and the average morning and evening relative humidity's was 87.70 and 38.70% respectively. The population of coccinellids and spiders during the peak incidence was 7.00 and 14.80/6 panicles respectively. There after the pest population declined gradually in the first week of May 2007 with a mean of 21.50 leafhoppers per 6 panicles. The average of maximum and minimum temperature during the period was 38.00°C and 30.60°C respectively and average morning and evening relative humidities were 61.05% and 41.00% respectively. The results

Table 4. Influence of abiotic and biotic factors on the seasonal occurrence of mango leafhoppers on mango crop during the year 2007-08.

Sl. No	Date of Observation	Temperature (°C)		Relative humidity %		Rainfall mm	Natural enemies		Mango leafhop-per population per 6 twigs/ panicles
		Max	Min	Morning	Evening		Coccinellids	Spiders	
1	6-Sep-07	30.60	26.80	92.00	70.40	0.00	0.00	0.00	12.40
2	13-Sep-07	30.20	26.40	93.40	76.20	0.00	0.00	0.00	18.20
3	20-Sep-07	29.50	25.20	91.20	78.40	0.00	0.00	0.00	24.60
4	27-Sep-07	29.00	24.60	93.40	79.20	8.00	0.00	0.00	28.60
5	4-Oct-07	28.70	23.40	89.10	78.20	0.00	0.00	0.00	30.40
6	11-Oct-07	28.10	23.50	88.20	80.40	0.00	0.00	0.00	32.80
7	18-Oct-07	27.20	23.10	92.40	82.40	0.00	0.00	0.00	34.20
8	25-Oct-07	27.00	22.00	90.10	80.00	0.00	0.00	0.00	36.40
9	01-Nov-07	26.42	22.57	91.85	79.14	23.30	0.00	0.00	40.40
10	08-Nov-07	26.85	23.28	91.57	61.71	0.00	0.00	7.00	42.40
11	15-Nov-07	25.42	19.42	91.28	63.28	0.00	4.20	9.00	44.80
12	22-Nov-07	25.95	19.28	92.27	67.71	14.06	4.80	10.40	58.00
13	29-Nov-07	25.00	20.14	92.71	69.42	3.20	6.00	11.20	68.00
14	06-Dec-07	25.28	20.28	83.42	70.71	16.00	4.80	13.00	72.00
15	13-Dec-07	24.71	20.00	89.57	66.71	0.00	6.00	12.50	66.00
16	20-Dec-07	25.57	19.14	85.85	76.71	27.45	7.00	13.00	79.40
17	27-Jan-08	25.14	17.85	88.28	70.85	5.40	5.00	13.50	86.40
18	03-Jan-08	24.85	17.57	76.00	62.85	0.00	7.50	13.00	82.20
19	10-Jan-08	25.75	17.85	83.00	63.71	0.00	7.50	17.00	98.00
20	17-Jan-08	28.28	19.28	86.42	57.14	0.00	8.00	18.20	116.60
21	21-Jan-08	26.20	19.20	83.50	62.80	0.00	8.50	15.00	131.20
22	31-Jan-08	28.28	20.00	82.14	61.28	0.00	9.00	15.50	148.40
23	07-Feb-08	27.85	20.71	90.42	57.42	0.00	9.00	16.50	162.80
24	14-Feb-08	28.42	20.28	90.14	47.85	8.40	8.00	15.50	166.40
25	21-Feb-08	29.14	20.57	87.28	54.57	0.00	7.00	17.50	172.30
26	28-Feb-08	30.20	21.14	87.42	39.57	0.00	7.00	15.50	180.20
27	07-Mar-08	30.42	21.00	81.57	41.57	0.00	7.00	16.20	160.40
28	14-Mar-08	30.70	22.14	88.14	55.14	0.00	7.20	13.00	142.20
29	21-Mar-08	30.50	23.00	89.14	49.00	0.00	6.00	11.00	124.00
30	28-Mar-08	30.00	24.80	87.00	51.50	45.20	6.00	12.50	100.30
31	04-Apr-08	33.00	25.28	86.00	55.28	5.20	5.80	15.00	86.40
32	11-Apr-08	34.85	25.78	84.14	38.14	0.00	6.50	13.00	58.20
33	18-Apr-08	35.57	25.80	82.28	41.00	0.00	6.00	11.00	40.90
34	25-Apr-08	37.28	26.85	76.42	41.00	0.00	6.00	13.50	30.00
35	02-May-08	37.60	27.71	68.28	39.42	0.00	6.00	13.00	26.40

indicated negative but significant association between the leafhopper population and minimum temperatures and evening relative humidity, while the association between the leafhopper population, maximum temperature, morning relative humidity and rainfall was also negative but non-significant.

The relationship between leafhoppers, coccinellid predators and spiders was positive and significant.

The data on the incidence of mango leafhoppers in relation to abiotic and biotic factors was also recorded from the first week of September 2007 to May 2008. The leafhopper population increased gradually from the first week of September 2007 and reached to peak by fourth week of February 2008 with a mean of 180.20 leafhoppers/6 panicles. The average of maximum and minimum temperatures during the peak level of population was 30.20°C and 21.14°C

Table 5.Correlation between abiotic and biotic factors and Population of mango leafhoppers during the year 2007-08.

Sl. No.	Variables	Correlation Coefficients (r)
1.	X_1 -Maximum Temperature (°C)	-0.119^{NS}
2.	X_2 -Minimum Temperature (°C)	-0.523**
3.	X_3 -Morning Relative humidity (%)	-0.108^{NS}
4.	X_4 -Evening Relative humidity (%)	-0.481**
5.	X_5 -Rainfall(MM)	-0.007^{NS}
6.	X_6 -Coccinellids	0.760**
7.	X_7 -Spiders	0.749**

** Significant at 1 per cent level * Significant at 5 per cent level
^{NS} Not Significant

Table 6. Multiple linear regression between temperature, relative humidity, natural enemies and population of mango leafhoppers.

Sl. No.	Variables	Partial Regression Co-efficient	Standard Error	t-value
1.	X_1 -Maximum Temperature (°C)	3.292	6.198	0.531^{NS}
2.	X_2 -Minimum Temperature (°C)	-8.320	6.914	-1.203^{NS}
3.	X_3 -Morning Relative humidity (%)	3.673	1.344	2.733**
4.	X_4 -Evening Relative humidity (%)	-1.057	0.977	-1.082^{NS}
5.	X_5 -Rainfall(MM)	0.026	0.590	0.044^{NS}
6.	X_6 -Coccinellids	7.759	5.703	1.360^{NS}
7.	X_7 -Spiders	0.427	3.165	0.135^{NS}

Intercept - 61.336, R^2 -0.723 Adjusted R square - 0.651
* Significant at 1 per cent level ^{NS} Not Significant

respectively and the average morning and evening relative humidity was 87.42 and 39.57 per cent respectively. The population of coccinellids and spiders during the peak incidence was 7.00 and 15.50/6 panicles respectively. There after the pest population declined gradually and reached a minimum by first week of May 2008 with a mean of 26.40 leafhoppers/6 panicles. The average maximum and minimum temperatures prevailed during the period 37.60°C and 27.71°C respectively and the average morning and evening relative humidity's were 68.28 and 39.42% respectively. The results indicated similar relationship between leafhopper population, the abiotic and biotic factors as in case of first year. Kudagamage *et al.,* (2001) reported that the population of *Idioscopus niveosparsus* and *Amritodus brevistylus* increased in February with a peak in March-April from Srilanka. Rahman and Gajendra Singh (2004) studied on the population of leafhopper *A. atkinsoni* and its relationship with abiotic factors from Uttaranchal. The population of *A. atkinsoni* was lowest during February and the population gradually increased from March reached its peak during April and later decreased. Sushil Kumar et al (2005) reported the peak incidence of mango leafhopper *A. atkinsoni* during the second fortnight of March coinciding the marble stage of the crop. All these findings are in confirmation with conformity with the results obtained in the present investigation.

The first appearance of mango leafhopper, *I. clypealis* in February which was correlated with maximum and minimum temperature and decreased in relative humidity and the peak hopper population was recorded in May. They reported that the maximum and minimum temperatures positively

Figure 1. Influence of abiotic and biotic factors on the occurrence of leafhoppers on mango during the year 2006-07.

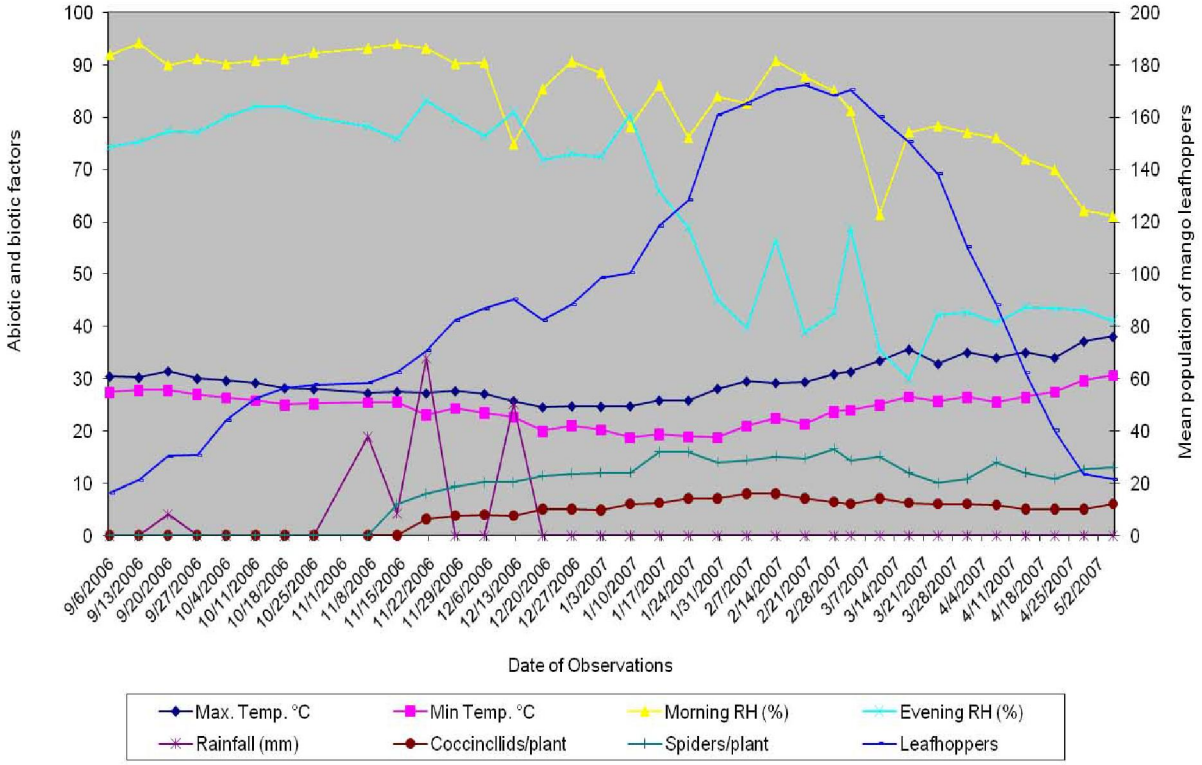
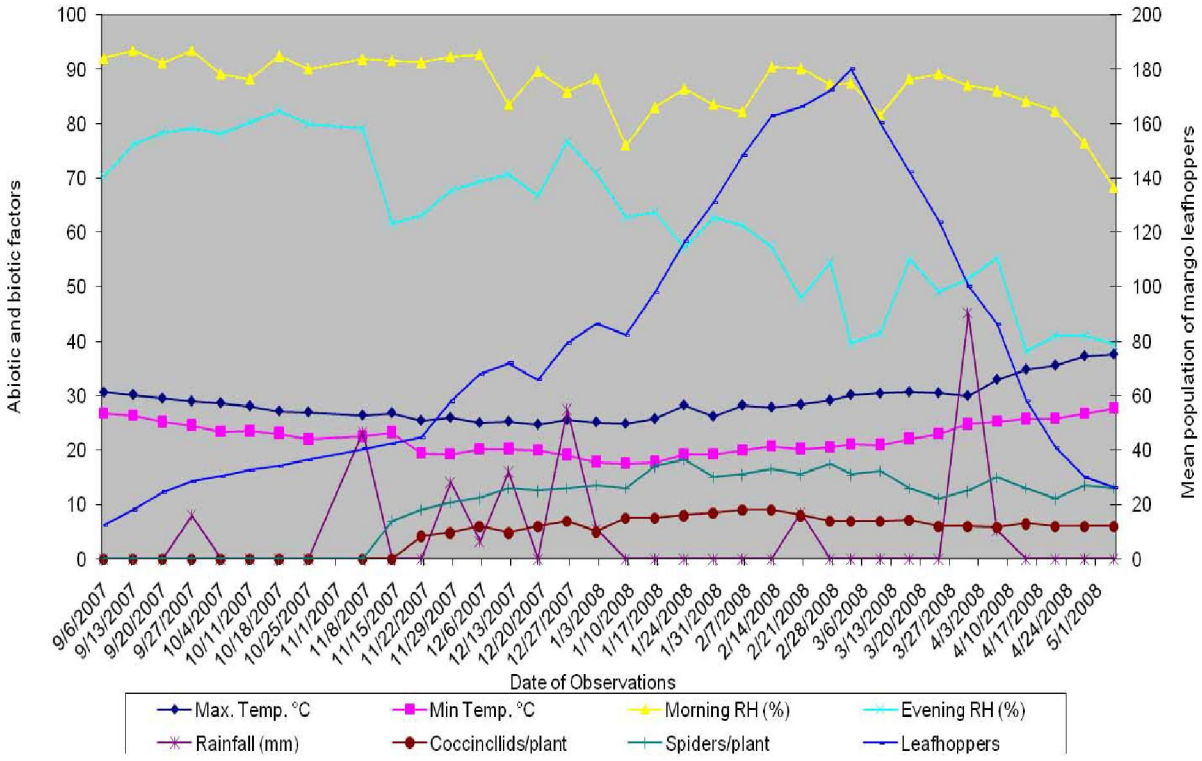


Figure 2. Influence of abiotic and biotic factors on the occurrence of leafhoppers on mango during the year 2007-08.



effected the hopper population, whereas the relative humidity had negative effect, but rainfall showed no significant effect as it was fluctuating. These results are in contrary to the results obtained in the present investigation and this may be due to the variation in weather parameters in North India.

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