Int. J. Biol. Res., 11 (1-2): 101-109, 2023.

EFFECTS OF TEMPERATURE AND HUMIDITY ON THE POPULATION DYNAMICS OF COTTON LEAFHOPPER *AMRASCA DEVASTANS* (DISTANT) (HOMOPTERA: CICADILIDAE)

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ABSTRUCT

A field experiment was conducted at the local field of Karachi University campus to study the effect of population controlling abiotic variable like mean minimum temperature, mean maximum temperature, and mean % humidity on the population dynamic of various nymphal stages (like 1st instars, 2nd instars, 3rd instars, 4th instars, 5th instars) and adults of cotton leaf hoppers *Amrasca devastans* (Distant) (Homoptera:Cicadilidae). The study was made during two consecutive cropping seasons on its alternate host *Habiscus esculentus* (ladyfinger). The samples were taken from randomly selected leaves and stems of 8 to 10 plants from top to bottom usually before sunset. The population of all the stages was calculated statistically and correlated with physical factors like maximum mean temperature, minimum mean temperature and mean percent humidity. The highest incidence of all the stages of cotton leafhoppers was recorded during summer seasons i.e. from June to July in first growing season and during May to July in 2nd growing season. The population declined markedly in August in both cropping seasons. The 1st instars nymph showed a strong positive and significant correlation (R^2 >75%) with mean minimum temperature and mean percent humidity. The population of other stages along with adult showed positive significant correlation with minimum mean temperature (R^2 = or >50% & P<05) and mean percent humidity (R^2 = or >40% & P<05). In addition all the stages of life cycle showed weak correlation with maximum mean temperature (R^2 < 40%).

Key words: leaf hopper, Sucking pests, Population dynamic, Correlation, Abiotic factors, IPM

INTRODUCTION

Cotton leafhopper *Amrasca devastans* (Distant) infest wide range crops including cotton *Gossypium*. Saeed *et al*., (2014) reported twenty four species as true breeding alternate host of the cotton leafhopper among them vegetables *Solanum melongena* and *Abelmoschus esculentus* (okra: lady finger) had the highest potential for harbouring *A. devastan*. In majority of the cases it brought about serious economic loss and reduces plant health by sucking cell sap and responsible to spread viral or other infectious diseases. The symptoms include discoloration of leaves, crinkling around the margins, leave curled and development of necrotic areas. Severe infestation may cause hopper burn in crop. Honey dew may induce fungal growth that reduces the quality of raw cotton. All the stages of life cycle have same double barrel piercing and sucking mouth parts. Two insects per leaf could be considered as the economic damage threshold of the leaf hoppers Ghori (1976). The loss and population dynamic of leaf hoppers is described by many worker on different hosts, Iqbal and Reddy 1980, Ahmed and Verma 1984, Borah 1995, Shah *et al*., 1994, Mahmood *et al*., (2002). Cotton when grown in those areas with leafhopper harbor alternate crop will badly affected by these pests. In view of the aforementioned importance of sucking pests of cotton *A. devastans* (Distant) the object of present work is to find out comprehensive knowledge about the population dynamic, and population fluctuation of the pests with physical variables like mean temperatures and relative mean % humidity. Knowledge of population of different immature nymphs and adult would be important to forecast population growth and resulting yield loss. It may provide an opportunity to minimize the utilization of pesticides by taking in consideration and integration of the knowledge of physical variables and population forecasts. It significantly improves the efficiency and sustainability of an ecofriendly integrated pests' management (IPM) system for cotton leaf hopper in Pakistan.

MATERIAL AND METHOD

The population dynamics of *A. devastans* have been studied in two consecutive growing seasons. The study was done on a local field of alternate host *Hibiscus esculentus* (okra) at Karachi University campus measuring 12 x 4 feet for each field. During sampling one to two persons worked for one hour usually before sunset on every 5th days. All the nymphal instars and adults of cotton leaf hopper were recorded by using leaf turn method following Ellsworth *et al*., (1995) and Naranjo *et al*., (1996).). For sampling cotton insects, searching method was also adopted following Johnson and Mellanby (1942) and Nelson *et al*., (1957). The samples were taken from randomly selected leaves and stems of 8 to 10 plants from top to bottom. The population of all the stages was calculated and analyzed statistically and correlated with physical factors like maximum mean temperature, minimum mean temperature and mean percent humidity by using MINITAB 11, 1998.

RESULT

Month wise population dynamics of all the five immature (nymph) stages and adult of leafhoppers is presented in Fig. 1 and its statistical calculation in Table 1 & 2. The activity of leafhopper started soon with emergence of seedlings of crop. The population raised as the plants grew; the highest incidence of all the stages of cotton leafhoppers was recorded during summer months i.e. from June to July in first growing season and during May to July in 2nd growing season and the population was declined markedly in August in both the growing seasons.

Correlation of population dynamics with the abiotic factors is shown in Table 2. The 1st instars nymph showed a strong positive and significant correlation with mean minimum temperature (Fig. 2), and mean percent humidity (Fig. 3). The 2nd, 3rd, 4th, 5th instars' populations also showed positive significant correlation with minimum mean temperature (Fig. 4 to 6; R^2 = or >50% & P<05) and mean percent humidity (R^2 = or >40% & P<05). Whereas all the stages of life cycle showed weak correlation with maximum mean temperature which might be associated with the high range of temperature (24.5 ± 1.15 to 36.83 ± 0.91) during the season (Fig.7-19).

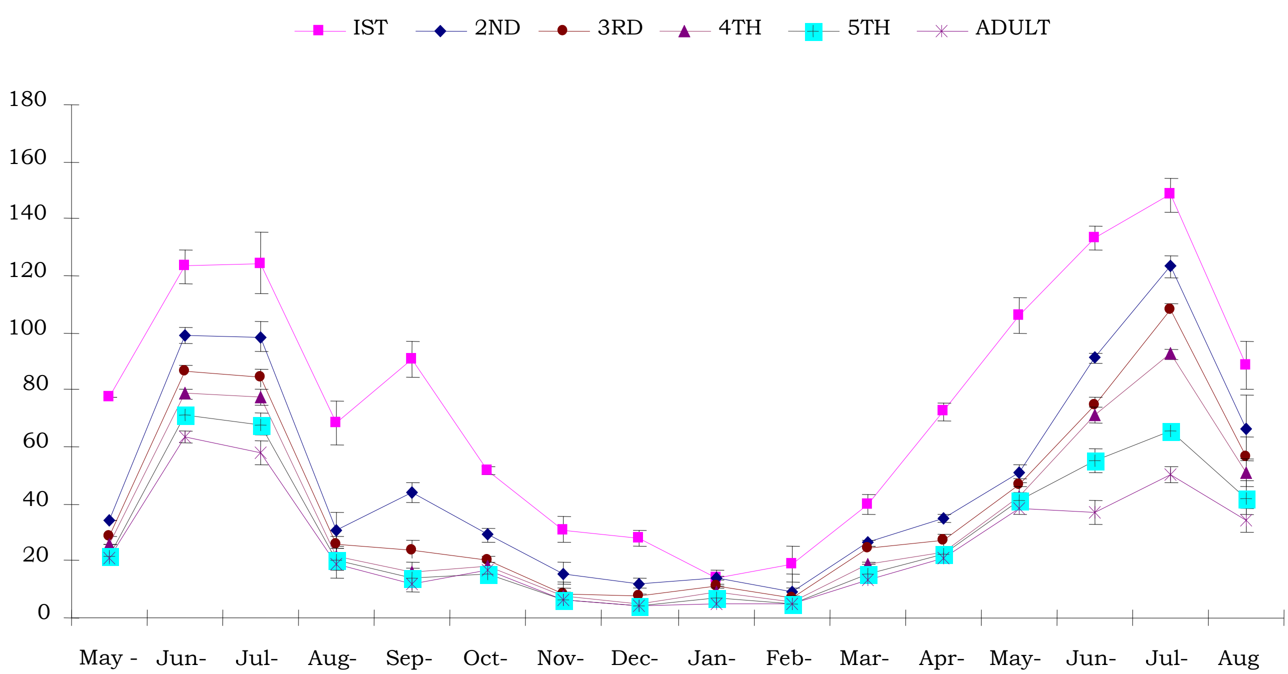


Fig. 1. Population Dynamics (Mean ± SE) of *A. Devastans*.

Table 1. Population of *A. devastans* During 1st Growing Season (Mean (± SE)).

(May to December)

Instars	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1st	77.5 ± 5.88	123.3 ± 10.7	124.29 ± 7.51	68.33 ± 6.41	90.50 ± 1.45	51.83 ± 4.78	31.0 ± 3.01	27.83 ± 3.05
2nd	34.5 ± 2.99	99.17 ± 4.9	98.71 ± 5.82	30.83 ± 3.28	44.0 ± 2.19	29.0 ± 3.71	15.50 ± 1.67	12.0 ± 1.0
3rd	28.83 ± 2.01	86.83 ± 3.22	84.14 ± 3.23	25.67 ± 3.07	24.0 ± 1.41	20.0 ± 3.79	8.67 ± 0.71	8.00 ± 0.68
4th	25.83 ± 1.82	78.50 ± 2.75	77.57 ± 2.51	21.83 ± 3.53	16.17 ± 1.11	18.17 ± 2.94	7.67 ± 1.48	4.83 ± 0.87
5th	21.83 ± 2.64	71.0 ± 4.0	67.86 ± 3.08	20.17 ± 3.12	14.33 ± 1.56	15.17 ± 2.71	6.33 ± 0.99	4.17 ± 1.25
Adult	20.67 ± 2.06	63.67 ± 4.14	58.14 ± 5.30	19.00 ± 3.04	12.0 ± 1.29	16.67 ± 2.12	6.33 ± 1.54	4.0 ± 1.0

Table 2. Population of *A. devastans* During 2nd Growing Season) Mean (± SE)).

(January to August)

Instars	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
1st	14.0 ± 6.11	18.83 ± 3.3	39.83 ± 9.96	72.3 ± 6.29	106.3 ± 4.14	133.0 ± 6.02	148.3 ± 8.4	88.71 ± 4.86
2nd	14.2 ± 6.02	9.33 ± 0.84	26.17 ± 1.42	34.83 ± 3.34	50.67 ± 1.86	91.17 ± 3.75	123.3 ± 11.5	66.43 ± 5.31
3rd	11.4 ± 3.67	7.0 ± 0.82	24.5 ± 1.91	27.33 ± 2.16	46.5 ± 2.66	75.0 ± 1.83	108.3 ± 7.03	56.57 ± 6.23
4th	9.0 ± 2.66	5.33 ± 0.21	19.17 ± 0.7	23.33 ± 3.78	42.50 ± 2.79	70.83 ± 1.54	92.50 ± 4.96	51.14 ± 6.98
5th	7.2 ± 3.82	4.83 ± 1.19	15.17 ± 0.31	22.17 ± 2.87	41.33 ± 3.98	55.0 ± 2.24	65.67 ± 5.7	42.14 ± 6.36
Adult	5.0 ± 1.48	4.83 ± 1.05	13.33 ± 1.31	21.0 ± 2.45	38.67 ± 3.91	37.0 ± 2.94	50.3 ± 4.14	34.0 ± 6.11

Fig. 2. Regression Plot Between Means Maximum Temperature and Means Population of 1st Instar of *A. devastans*

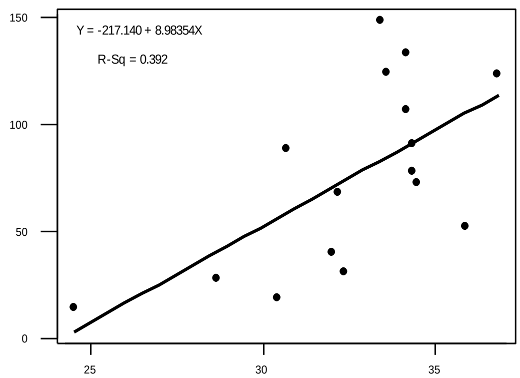


Fig. 3. Regression Plot Between Means Maximum Temperature and Means Population of 2nd Instar of *A. devastans*

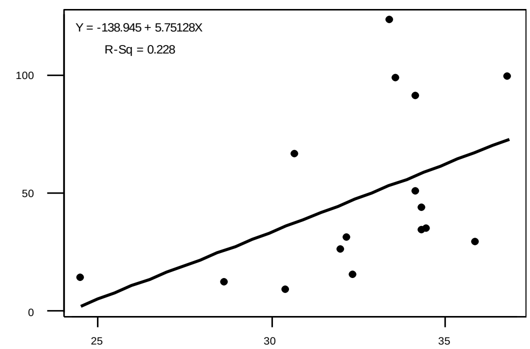
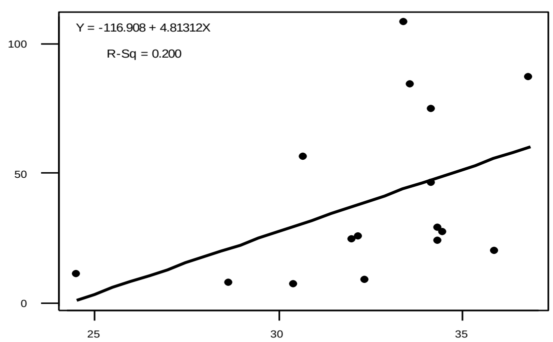


Fig.4. Regression Plot Between Means Maximum Temperature and Means Population of 3rd Instar of *A. devastans*



Fig, 5. Regression Plot Between Means Maximum Temperature and Means Population of 4th Instar of *A. devastans*

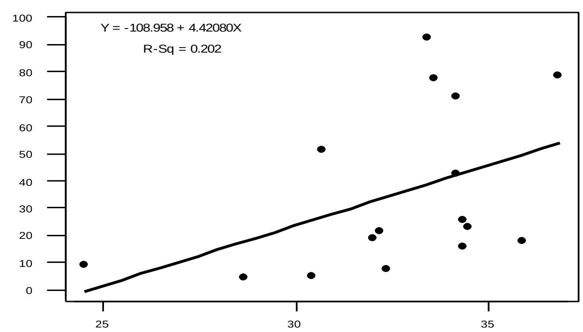


Fig.6. Regression Plot Between Means Maximum Temperature and Means Population of 5th Instar of *A. devastans*

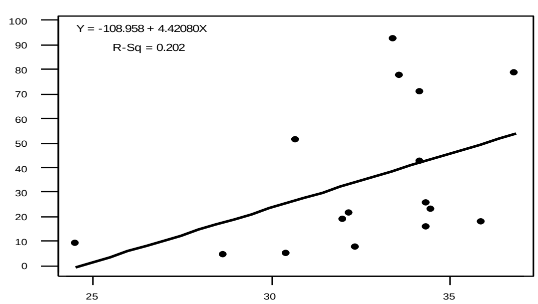


Fig. 7. Regression Plot Between Means Maximum Temperature and Means Population of Adults of *A. devastans*

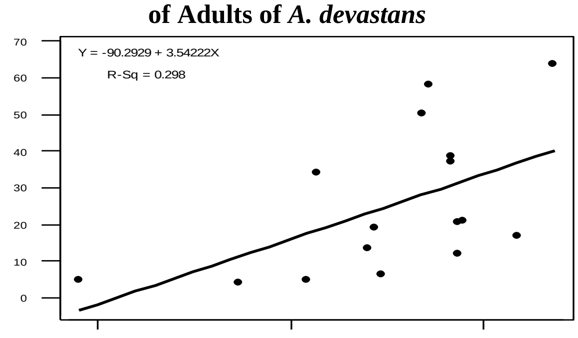


Fig. 8. Regression Plot Between Means Minimum Temperature and Means Population of 1st Instar of *A. devastans*

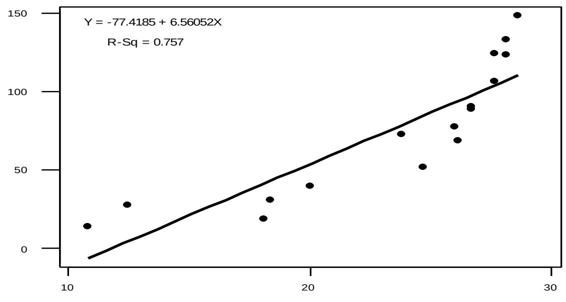


Fig. 9. Regression Plot Between Means Minimum Temperature and Means Population of 2nd Instar of *A. devastans*

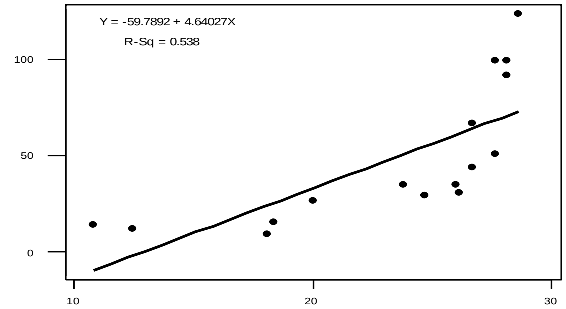


Fig. 10. Regression Plot Between Means Minimum Temperature and Means Population of 3rd Instar of *A. devastans*

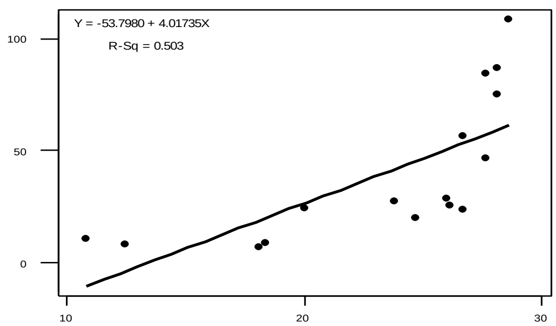


Fig. 11. Regression Plot Between Means Minimum Temperature and Means Population of 4th Instar of *A. devastans*

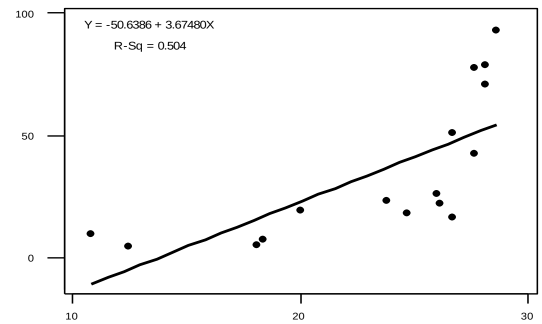


Fig. 12. Regression Plot Between Means Minimum Temperature and Means Population of 5th Instar of *A. devastans*

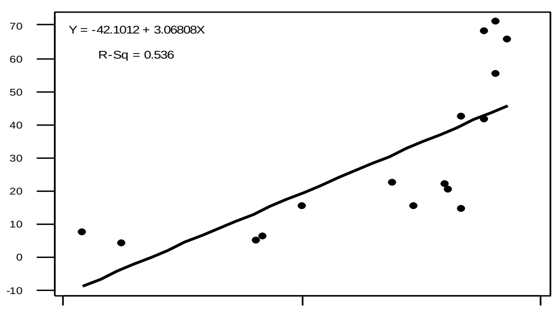


Fig. 13. Regression Plot Between Means Minimum Temperature and Means Population of Adults of *A. devastans*

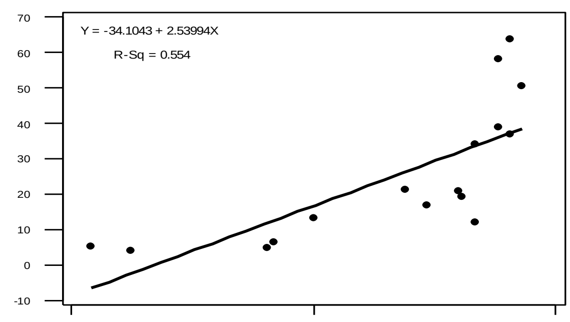


Fig. 14. Regression Plot Between Means % Humidity and Means Population of 1st Instar of *A. devastans*

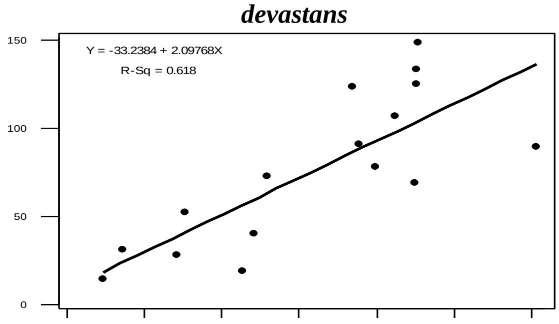


Fig. 15. Regression Plot Between Means % Humidity and Means Population of 2nd Instar of *A. devastans*

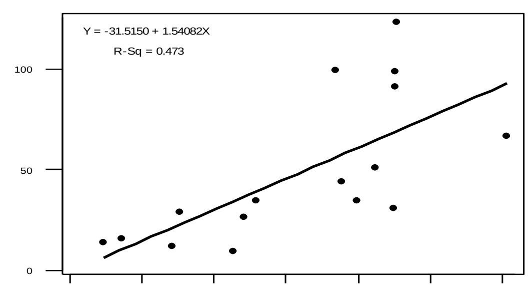


Fig. 16. Regression Plot Between Means % Humidity and Means Population of 3rd Instar of *A. devastans*

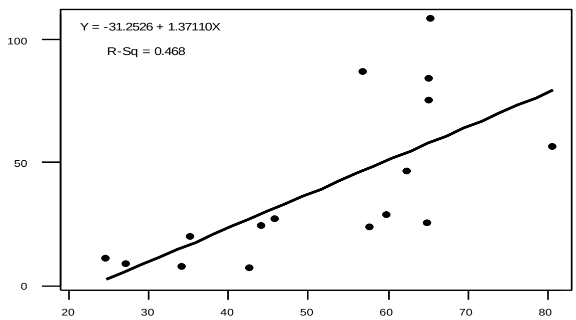


Fig. 17. Regression Plot Between Means % Humidity and Means Population of 4th Instar of *A. devastans*

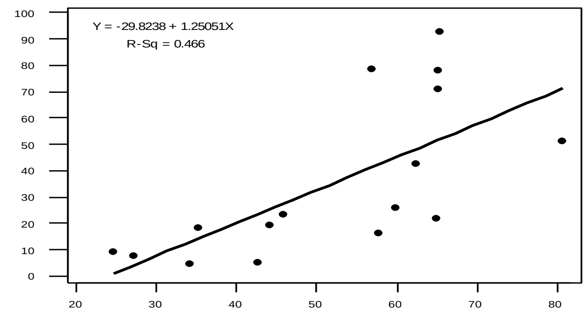


Fig. 18. Regression Plot Between Means % Humidity and Means Population of 5th Instar of *A. devastans*

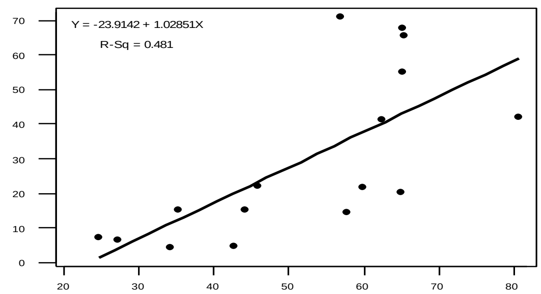


Fig. 19 Regression Plot Between Means % Humidity and Means Population of Adults of *A. devastans*

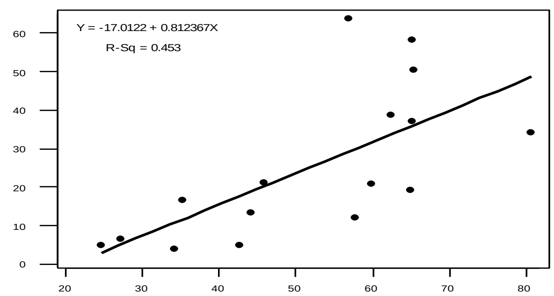


Table 2. Effects Of Abiotic Factors.

Age Classes	Minimum Mean Temperature			Maximum Mean Temperature			Mean % Humidity		
	R^2	Regression Equation	P	R^2	Regression Equation	P	R^2	Regression Equation	P
1st	75.7%	Y=-77.4+6.56X	0.00	39.2 %	Y=-217+8.98X	0.00	61.8 %	Y=-33.2+2.10 X	0.00
2nd	53.8%	Y=-59.8+4.64X	0.00	22.8 %	Y=-139+5.75X	0.06	44.3 %	Y=-31.5+1.54 X	0.00
3rd	50.3%	Y=-53.8+4.02X	0.00	20.0 %	Y=-117+4.81X	0.08	46.8 %	Y=-31.3+1.37 X	0.00
4th	50.4%	Y=-50.6+3.67X	0.00	20.2 %	Y=-109+4.42X	0.08	46.6 %	Y=-29.8+1.25 X	0.00
5th	53.6%	Y=-42.1+3.07X	0.00	24.2 %	Y=-98.3+3.92X	0.05	48.1 %	Y=-23.9+1.03 X	0.00
Adult	55.4%	Y=-34.1+2.54X	0.00	29.8 %	Y=-90.2+3.54X	0.02	45.3 %	Y=-17.0+ 0.81X	0.00

Maximum Mean Temperature: 24.50 ± 1.15 to 36.833 ± 0.910
Minimum Mean Temperature: 10.83 ± 1.74 to 28.600 ± 0.510
Relative % Humidity: 24.57 ± 5.05 to 80.71 ± 2.23

DISCUSSION

These results are in close conformity with Avidov (1956) and Singh *et al*. (1999) as temperature and relative humidity favors the pest abundance but rainfall decreases the abundance. In present investigation rainfall parameter is not included.

Ahmed and Naveed (1981) reported highest leafhopper population during the month of June on okra. The present result is in agreement with the above with high population during June but high population in July and August may associate with long summer.

Ahmad *et al*, (1995) studied the biology and population dynamics of legume bug *Piezodorus hybneri* (Gmelin) reported the population reached at its peak in April. The present findings showed high density in the field during May through August. The difference in findings could be associated with the difference in weather condition and crop season.

Jarosik and Dixon (1999) described the 19 years observation for population dynamics of the Turkey-oak aphid (*Myzocallis boerneri Stroyan*) and found that the aphids exhibited a distinct seasonal pattern of spring increase, summer decrease, early autumn increase, and late autumn decline. In the present findings differences in population density was also observed in different months and in different environmental conditions i.e. increase in population from May and maximum population from June to August and then declined. The difference in both the findings might be associated with different insect pests and different host plant.

Mahmood *et al*. (2002) also noticed higher activity of *A. biguttula biguttula* from 21st May to 6th Aug in their population studies on bringal. They also reported that the leafhopper population was positively correlated with both the minimum and maximum mean temperatures, whereas the relative humidity and rain fall were negatively correlated with population density. The present work is found to be in agreement with the above in which high population of cotton leaf hoppers were recorded during June to August. The population was positively correlated with minimum mean temperature and mean % humidity.

Munyaneza (2004) worked on the population dynamics of different leafhoppers in Columbia Basin and Oregon including *Balclutha* spp., *Latalus* spp., *Empoasca* (*Amrasca*) spp., and *Erythroneura* spp. He stated that the leafhoppers were observed on weeds near potato fields during early spring, but most species invaded potato fields during early summer. In the present investigation the activity of cotton leafhoppers started soon after emergence of seedlings, the incidence reaches at its peak in summer and was found to be present in the field during the whole seasons with variable densities.

Selvaraj *et al*. (2011) reported population of *Amrasca devastans* started from late February and acquired its peak in mid of March on different varieties of cotton. In present investigation the activity of pest started in February soon after the start of crop that acquired its peak in May to July, the difference is might be due to different host plants and different ecology of crop.

The present finding is found to be in agreement with the finding of Ahsan *et al*. (2018) reported in their field experiment highest incidence of cotton mealy bug *Phenacoccus* sp. during May to July in both the cropping years. The minor difference in result might be due to different experimental insect pests

Chand *et al*. (2017) reported population and peak of nymph and adult of sugar cane leafhopper were appeared in early June and mid of May respectively. Both the populations show significant positive correlation between maximum and minimum temperature. In present finding cotton leafhopper (nymph & adult) population reached at its peak in June and July in both seasons. The minimum mean temperature also showed positive correlation the difference might be due to difference in insect and host plant.

Pazhanisamy *et al*. (2020) in their field study reported minimum temperature favoured leafhopper population on bhendi plants in rabi season i.e. after monsoon the result is found to be in agreement with present findings.

Akhela *et al*. (2020) observed pest population from seedling emergence till harvest that found to be in agreement with the present findings. The maximum temperature showed significant positive response on the leafhopper population. The minimum temperature morning and evening relative humidity also showed non-significant positive correlation. In present finding all the above mentioned parameter found to be effect more or less in the same way however some variation might be associated with the difference in host plant and different ecological condition.

The present findings are comparable with work of Ramesh *et al*. (2021) they reported in their field study incidence of sucking leafhopper *Emposca* (*Distantasca*) *terminalis* throughout the cropping period and their incidence was found to be significantly and positively correlated with the maximum and minimum temperature, whereas rainfall and minimum RH; and maximum RH showed a non- significant negative correlation during Rabi crop i.e. after monsoon. The little difference might be due to different species of leafhopper or host plant and different ecological climate.

The present finding is comparable with the findings of Maduri *et al*. (2023) they studied population dynamics of leafhopper on castor and reported negative non-significant correlation with maximum mean temperature but significant negative correlation with minimum temperature and relative humidity the difference might be due to different host plant and different ecological condition.

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