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*Abstract-* Chilli (*C.annum* L.) is one of the main solaneaous crop in Pakistan and treated by many viral diseases. This experiment was performed to check the effect of environmental conditions on whitefly population and disease incidence development as well as correlation and regression analysis of environmental factors like maximum, minimum temperature, relative humidity, rainfall and wind speed with whitefly population on Chilli plants. For the determination of effect of environmental factors on the incidence of virus and whitefly Population, five environmental factors were kept in consideration which were maximum temperature, minimum temperature, relative humidity, rainfall and wind pace. The data recorded on disease incidence and whitefly population was subjected to correlation and regression analysis for determining the relationship between environmental variables and incidence of disease and whitefly population. All environmental parameters including (maximum temperature, minimum temperature, and relative humidity) showed positively significant correlation and wind speed and rainfall showed negatively significant correlation.

*Keywords:* *chiLCV, regression, correlation, epidemiology, conducive.*

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# Characterization of Environmental Conditions Conducive for Spread of Whitefly Population and Epidemic Development of ChiLCV

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*Abstract-* Chilli (*C.annum* L.) is one of the main solaneaous crop in Pakistan and treated by many viral diseases. This experiment was performed to check the effect of environmental conditions on whitefly population and disease incidence development as well as correlation and regression analysis of environmental factors like maximum, minimum temperature, relative humidity, rainfall and wind speed with whitefly population on Chilli plants. For the determination of effect of environmental factors on the incidence of virus and whitefly Population, five environmental factors were kept in consideration which were maximum temperature, minimum temperature, relative humidity, rainfall and wind pace. The data recorded on disease incidence and whitefly population was subjected to correlation and regression analysis for determining the relationship between environmental variables and incidence of disease and whitefly population. All environmental parameters including (maximum temperature, minimum temperature, and relative humidity) showed positively significant correlation and wind speed and rainfall showed negatively significant correlation.

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## I. Introduction

Chilli (*Capsicum annum* L.) originate from south and central America and are members of Solaneaous family. Viral diseases annually reduce the quality and yield of all kind of pepper. Symptoms of virus infection widely vary in expression and severity including mild mottle, mosaic, vein banding, ring spots, necrosis, leaf discoloration, deformation and blistering and severe stunting of the whole plant. Viruses could not just identified based on symptoms, because symptoms could vary with respect to the strain of the virus, the host cultivar, the age of the host, environmental conditions and co-infection with other viruses.

Different viruses may cause similar symptoms, as well as insect damage, particularly by thrips and mites, may mimic virus symptoms. Chilli leaf curl virus (ChiLCV), Chilli vein mottle virus (ChiVMV) and cucumber mosaic virus (CMV) are the main viruses in all Chilli growing areas of Pakistan and also in some other parts of the world. ChiLCV is the most important pathogen related to Chilli crops (Shah *et al*., 2001).

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ChiLCV is more susceptible to all Chilli varieties. Begomoviruses are the main cause of this disease. It is one of the largest group of Gemini viruses with more than 50 members described so far by different workers (Markham *et al.,* 1996). In worldwide review more than 65 viruses have reported to infect different crops. Viruses are most disturbing agents of chili crop, causing serious losses in reduction of both fruit quality and quantity (Green and Kim., 1999). Approximately 40 to 60 % losses in Pakistan and some other parts of world has been recorded due to ChiLCV because it is major virus most common in Chilli producing areas and decreasing yield badly (Shah and Khalid, 1999).

## II. Historical Background of Chilcv Disease

Chilli leaf curl virus for first time was reported by Verma (1962). The virus has been found to be transmitted though vector whitefly *Bemisia tabaci* Gen. (Moghe, 1977). Later on it was reported by venkatesh *et al*., (1998) that Chilli leaf curl complex caused by Chilli leaf curl geminivirus (ChiLCV) is transmitted by *Bemisia tabaci* and also by thrips (*S.dorsalis* and *polyphagotarsonemus latus*). In Pakistan Hussian *et al.,* (1992) reported chilli leaf curl complex in 1992. Severe yield losses in Chilli crop along with other Chilli varieties has been found. Tomato mosaic virus, Potato virus Y, Chilli leaf curl virus, Pepper veinal mottle virus, Tomato yellow leaf curl virus and Tomato spotted wilt virus has considered as economically most important viral diseases in Africa and Asia among the economically important vegetables (Nono-Womdim, 2001).

## III. Symptomology Of Chilcv Disease

Chilli pepper (*C.annum* L.) use as a spice and it is an important vegetable. For the cultivation of Chillies in Pakistan Diverse ecological, environmental and soil conditions are very suitable (Briddon *et al.*, 2003; Shih *et al*., 2003). Leaf curling, wrinkling, vein clearing and vein swelling and yellowing are major symptoms of ChiLCV. In severely affected plants the size of leaves and branches reduced resulting in a bushy appearance of plant. Such plants have very few flowers and very few fruits (Peiris, 1953; Joshi and Dubey, 1976). Begomoviruses are the major cause of Chilli leaf curl

disease (CLC), which is most important viral disease of chilies. Typical symptoms of ChiLCV include stunting, a reduction in leaf size, leaf curling as well as a reduction in fruit size and number (Hussian, 2009).

## IV. Influence Of Environmental Factors On Whitefly Population And Disease Incidence

An experiment was performed to check the effect of environmental conditions on whitefly population and correlation of environmental conditions like maximum, minimum temperature, relative humidity, rainfall and wind speed with whitefly population on tomato plants by (Zeeshan *et al.,* 2015). Maximum temperature has positive correlation with whitefly population. Whitefly population increase with increase in temperature and decrease with decrease in relative humidity

## V. Materials And Methods

*a) Establishment of disease screening nursery against ChiLCV disease incidence*

A disease screening nursery of eight varieties/Lines i.e.V1 (Maha), V2 (Hot Queen), V3 (7-Ph), V4 (9-Patayla), V5 (Tatapuri), V6 (Biaddy), V7 (Hot Shot), V8 (5-Glory) were established against ChiLCV disease.

*b) Epidemiological studies of ChiLCV disease*

Five varieties viz. 9-patayla, Hot-Shot, Five-Glory, 7-ph, Tatapuri were used in the experiment. The experiment was conducted in a randomized complete block design (RCBD) with three replications. Each variety was planted in a sub-plot with row length 3m, row to row spacing 60cm and plant to plant spacing of 30cm. The disease on every variety was assessed by coefficient of infection according to available disease rating scale.

*c) Collection of environmental and whitefly population data*

The data of different environmental factors (maximum, minimum temperature, relative humidity and rainfall) during the growth period of chili crop (April-July) was obtained from the Department of Crop Physiology, University of Agriculture Faisalabad. The data regarding whitefly population was recorded on weekly basis for each variety. Ten plants from each plot were selected at random and population of whitefly was recorded from upper middle and lower leaves/plant and averaged for 5 leaves.

*d) Correlation of environmental factors with ChiLCV incidence*

Correlation of ChiLCV incidence with maximum temperature, minimum temperature, relative humidity, rainfall and wind speed were determined on weekly basis at variety level. The variety used for this purpose were 9-Patyala, Hot Shot, 5-Glory, Maha and Hot Queen. A significant correlation was observed between maximum temperature and disease incidence. Similarly, minimum temperature showed significant correlation with disease incidence on all the varieties.

Relative humidity had a significant relationship with disease incidence on all the varieties. Rainfall showed a significant but negative correlation with disease incidence as increase in rainfall suppresses the rate of increase of disease on all varieties while wind velocity also showed the significant positive correlation on all varieties used.

*Table 1:* Correlation of environmental factors with ChiLCV

| Varieties | Max Temp | Min Temp | RH | Rainfall | Wind Speed |
|---|---|---|---|---|---|
| 9-Patyala | 0.5419*<br>0.0267 | 0.8960*<br>0.0157 | 0.7092*<br>0.0146 | -0.3593*<br>0.0483 | -0.6037*<br>0.0244 |
| Hot Shot | 0.6528*<br>0.0159 | 0.9044*<br>0.0133 | 0.6258*<br>0.0183 | -0.3187*<br>0.0351 | -0.3478*<br>0.0493 |
| 5-Glory | 0.5169*<br>0.0239 | 0.8935*<br>0.0164 | 0.7576*<br>0.0180 | -0.3218*<br>0.0354 | -0.5452*<br>0.0263 |
| Maha | 0.5607*<br>0.0247 | 0.9151*<br>0.0105 | 0.7374*<br>0.0494 | -0.3434*<br>0.0155 | -0.5313*<br>0.0287 |
| Hot Queen | 0.5812*<br>0.0264 | 0.9289*<br>0.0074 | 0.7272*<br>0.0114 | -0.3766*<br>0.0146 | -0.5532*<br>0.0254 |

Upper values indicate Pearson's correlation coefficient while lower values indicate significance at 5% level of probability.

*e) Correlation of environmental factors with whitefly population*

Correlation of whitefly population with maximum temperature, minimum temperature, relative humidity, rainfall and wind speed were also determined on weekly basis at variety level. Same varieties were used for this purpose i.e. 9-Patyala, Hot Shot, 5-Glory, Maha and Hot Queen. A significant correlation was observed between maximum temperature and whitefly population. Similarly, minimum temperature showed significant correlation with whitefly population on all the varieties.

Relative humidity had a significant relationship with whitefly population on all the varieties. Rainfall showed a significant but negative correlation with whitefly population as increase in rainfall suppresses the rate of increase of disease on all varieties while wind speed also showed significant but negative correlation with all varieties used.

*Table 2:* Correlation of environmental factors with whitefly population

| Varieties | Max Temp | Min Temp | RH | Rainfall | Wind Speed |
|---|---|---|---|---|---|
| 9-Patyala | 0.6204*<br>0.0188 | 0.9098*<br>0.0118 | 0.6762*<br>0.0143 | -0.2720*<br>0.0126 | -0.4227*<br>0.0437 |
| Hot Shot | 0.5988*<br>0.0291 | 0.8809*<br>0.0204 | 0.6850*<br>0.0132 | -0.1964*<br>0.0792 | -0.3129*<br>0.0456 |
| 5-Glory | 0.5020*<br>0.0132 | 0.8480*<br>0.0329 | 0.7767*<br>0.0296 | -0.1083*<br>0.0382 | -0.2783*<br>0.0359 |
| Maha | 0.4557*<br>0.0367 | 0.8006*<br>0.0557 | 0.7600*<br>0.0579 | -0.9576*<br>0.0283 | -0.2554*<br>0.0252 |
| Hot Queen | 0.4900*<br>0.0328 | 0.8732*<br>0.0231 | 0.7969*<br>0.0577 | -0.1836*<br>0.0277 | -0.4246*<br>0.0144 |

Upper values indicate Pearson's correlation coefficient while lower values indicate significance at 5% level of probability

*f) Correlation of ChiLCV disease incidence with whitefly population*

Correlation of ChiLCV disease incidence with its vector population was also determined at variety level. The results indicated that a significant correlation was observed between disease incidence and whitefly population on all varieties.

*Table 4.6:* Correlation of ChiLCV disease incidence with whitefly population on all chili varieties

| Varieties | Disease Incidence and Whitefly Population |
|---|---|
| 9-Patyala | 0.9152*<br>0.0105 |
| Hot Shot | 0.9025*<br>0.0138 |
| 5-Glory | 0.8923*<br>0.0168 |
| Maha | 0.9083*<br>0.0122 |
| Hot Queen | 0.9741*<br>0.0010 |

Upper values indicate Pearson's correlation coefficient while lower values indicate significance at 5% level of probability.

g) *Relationship between environmental factors with ChiLCV disease incidence*

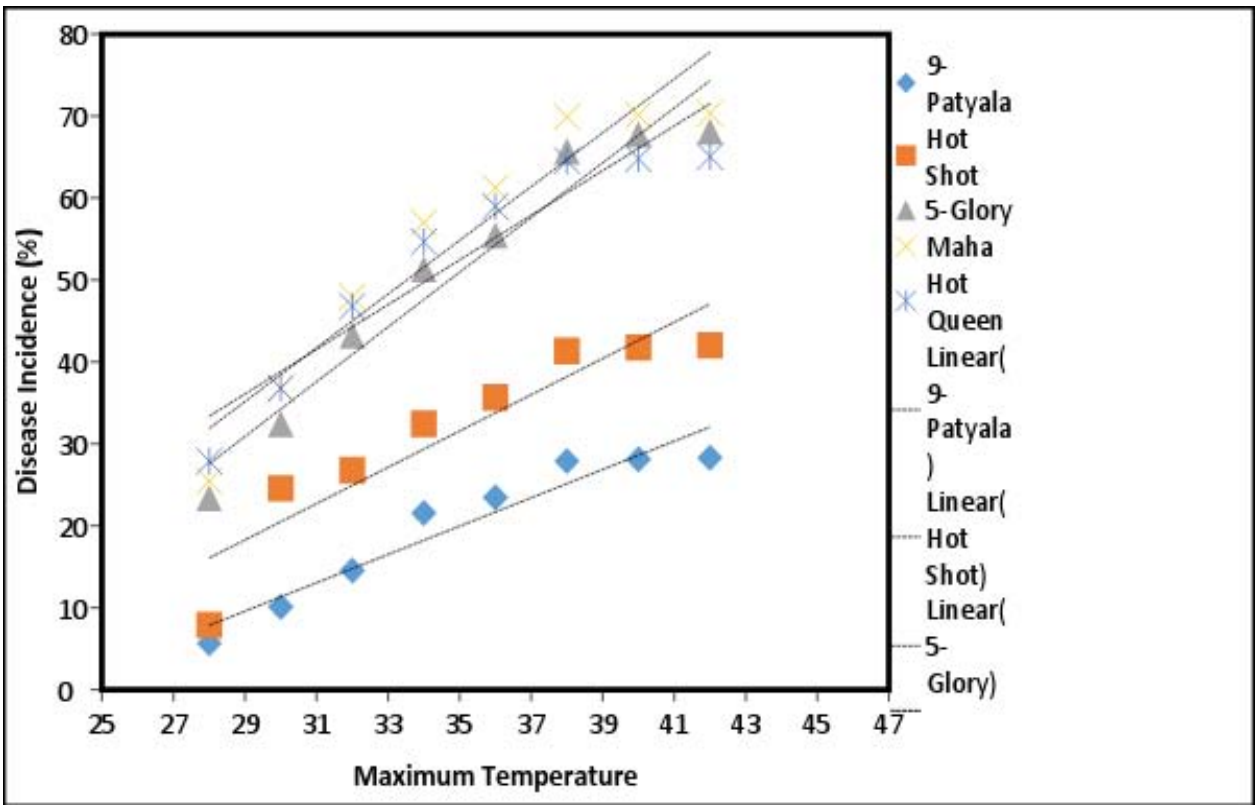


*Figure 1:* Effect of Maximum temperature on ChiLCV incidence

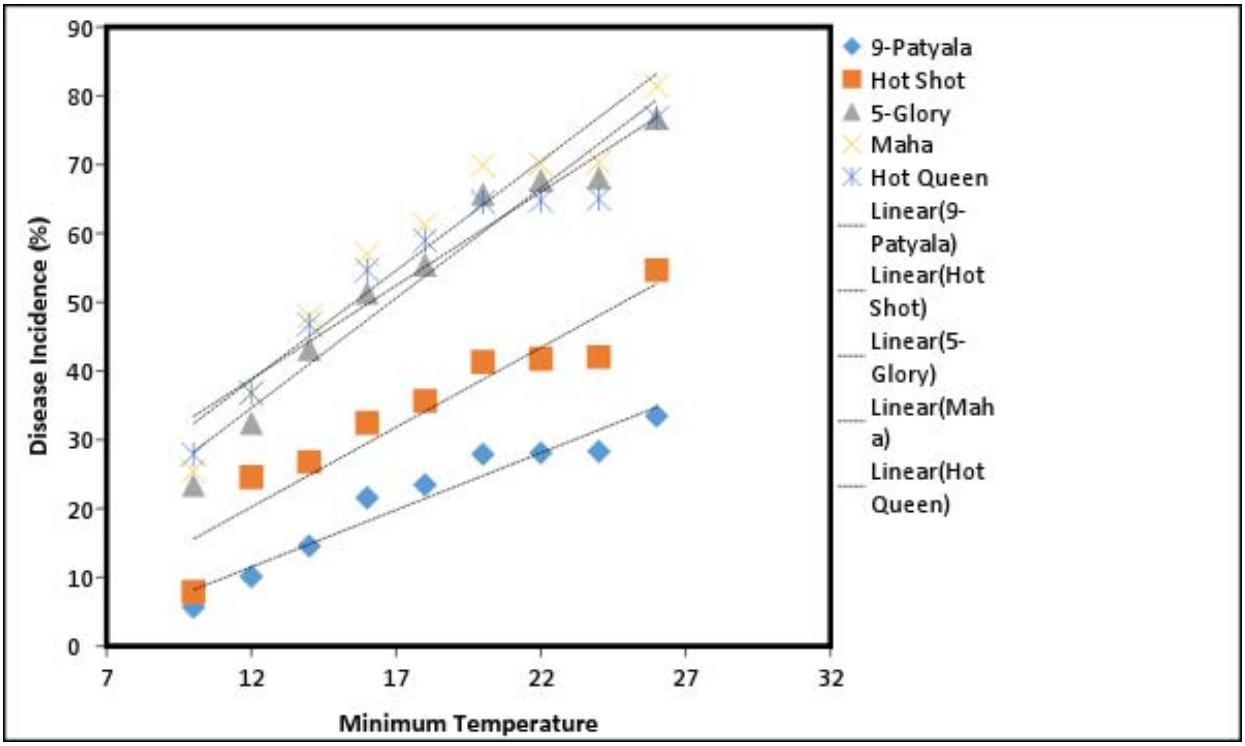


*Figure 2:* Effect of Minimum temperature on ChiLCV incidence

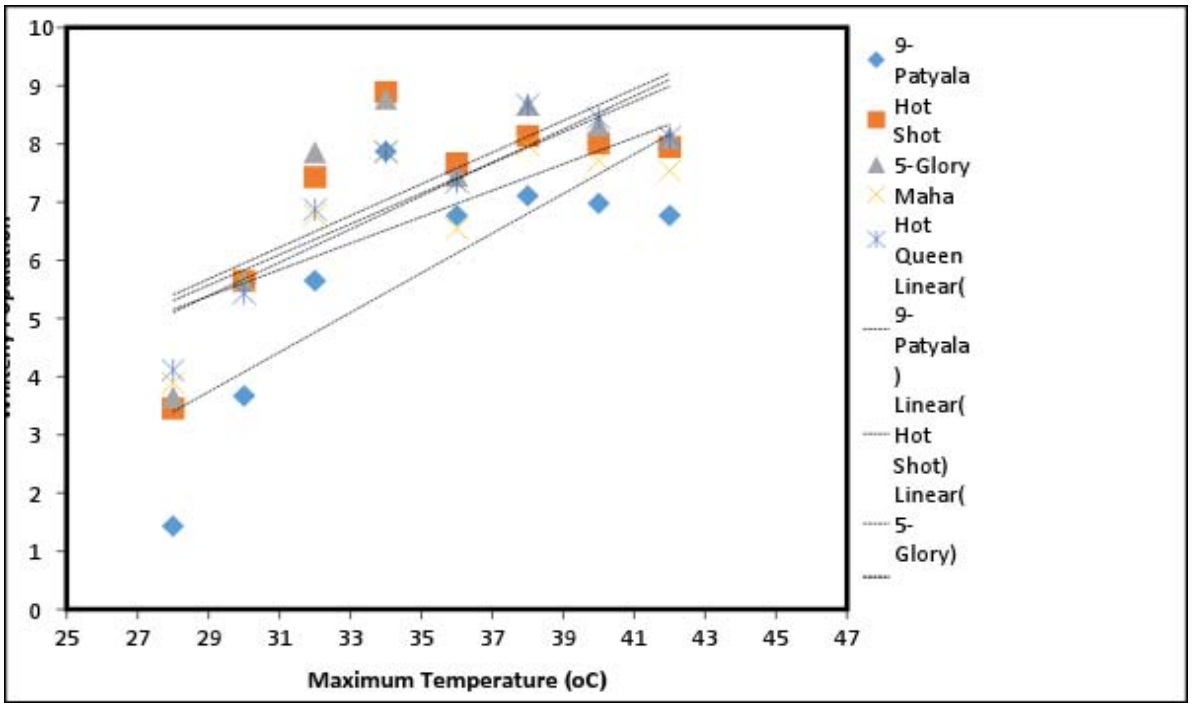


*Figure 3:* Effect of Maximum temperature on Whitefly Population

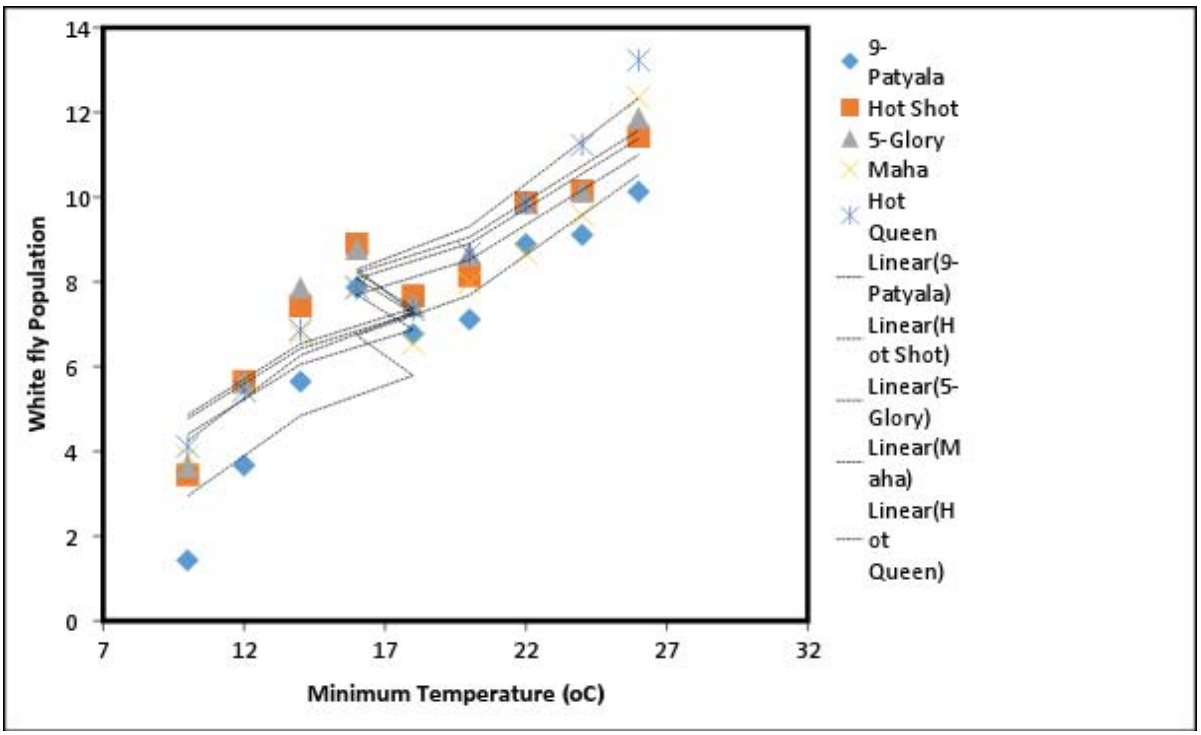


*Figure 4:* Effect of Minimum temperature on Whitefly Population

## VI. Result and Discussion

Correlation of weekly maximum and minimum air temperature, relative humidity, rainfall, wind speed and aphid population with ChiLCV disease incidence was determined at variety level. There was significant correlation between environmental factors, time and ChiLCV disease on chili varieties. A significant correlation was found between maximum temperature and disease incidence on five varieties/lines and non-significant on the three varieties/lines. Minimum

temperature had significant correlation with disease incidence on five varieties while three varieties and non-significant on the three varieties. There was a significant correlation of relative humidity with disease incidence on five varieties/lines while a non-significant correlation on three varieties. There was a significant correlation of rainfall on four lines/varieties and remaining lines/varieties showed non-significant correlation. Wind speed had significant correlation with disease incidence on five varieties while others showed non-significant correlation. A significant correlation was found between maximum temperature and disease incidence on five varieties and non-significant on three varieties/lines. Minimum temperature had also significant correlation with disease incidence. The relative humidity and rainfall had negative correlation with whitefly population.

The results indicated that there was negative impact of rainfall on whitefly population more rainfall resulted in decrease in whitefly population but it had positive effect on disease intensity. Similarly Singh (1990) reported that cooler weather with high relative humidity and rainfall negative impact on whitefly population and spread. Morales and jones (2004) also reported that the disease caused by various Gemini viruses were more intense in wet and humid climatic conditions than in dry conditions. Khan *et al.,* (1998) explained the relationship of weekly air temperature, relative humidity, wind velocity and wind speed to ChiLCV disease development by linear regression in eight varieties. Plant infection by ChiLCV increased on all varieties at maximum and minimum air temperature of 33-45 celercious and 25-30 degree celicus respectively.

However negative correlation between the minimum temperature sunshine hours and pest abundance and a positive correlation between maximum temperature and pest abundance of *B.tabaci* was found by Men *et al.,* (1997).

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