The Ecoscan 10(1&2): 111-115, 2016
AN INTERNATIONAL QUARTERLY JOURNAL OF ENVIRONMENTAL SCIENCES
www.theecoscan.com

INFLUENCE OF ABIOTIC FACTOR ON LEAF CURL VIRUS DISEASE IN DIFFERENT COTTON CULTIVARS UNDER TWO GROWING ENVIRONMENTS

VED PRAKASH*, RAM NIWAS, M. L. KHICHAR AND M. K. NAYAK
Department of Agricultural Meteorology, CCS HAU, Hisar - 125 004, INDIA
e-mail: jyanivedpraksh486@gmail.com

ABSTRACT

Studies were carried out to instigate the impact of abiotic factors on leaf curl virus disease progression in cotton ecosystem. The Cotton leaf curl disease (CLCuD is caused by whitefly-transmitted Gemini viruses in association with specific, symptom-modulating satellites. The materials for the present investigation comprised of three cotton cultivars Viz. HS-6, RASI-134 and MRC-6304 including two dates of sowing Viz. 30th April and 30th May. Among various weather parameters, Leaf curl virus disease was positively correlated with morning relative humidity and sunshine hours and negatively correlated with temperature, relative humidity evening, wind speed and vapour pressure deficit in both growing environments. The minimum temperature and wind speed both explained 90, 75 and 85 percent variability in leaf curl disease incidence in RASI 134, HS 6 and MRC 6304, respectively. The correlation coefficient of pooled data shows that the minimum temperature played an important role in explaining the variation (90% variability) in leaf curl virus

KEY WORDS
Leaf curl virus disease
Bemisiatabaci
Cotton
Sowing date and disease incidence

Received : 27.05.2015
Revised : 11.01.2016
Accepted : 13.02.2016

***Corresponding author**

INTRODUCTION

Cultivated cotton, *Gossypium* species (L.), has been a major source of food, feed, and fiber worldwide for at least 7,000 years.Globally about 32.6 million hectares are devoted to cotton cultivation (Sattar *et al*., 2013). China, India, the United States, and Pakistan accounting for more than 70 percent of global cotton production in 2013-14 (Meyer *et al.,* 2013). In India, it occupies an area of about 117.27lakh ha with total production 398.00 lakh bales and average yield is 477 kg/ ha. In Haryana, cotton is grown on area of 6.39 lakh ha with total and average production of 27 lakh bales and 721 kg/ ha, respectively (Anonymous, 2014).Cotton, being an important cash crop, is vulnerable to be attacked from a large number of pest insects, throughout its growth period. Among the various factors responsible for its low production and productivity during the last one and a half decade, cotton leaf curl virus disease (CLCuD) has been found to be one of the major limiting factors. Cotton leaf curl disease is a serious disorder of several plants pecies in the family *Malvaceae*,the most important of which is cotton (Genus: *Gossypium*L. Plants affected by the disease exhibit very unusual symptoms, consisting of vein swelling, upward or downward cupping of the leaves, and the formation of enations on the main veins on the undersides of leaves (Fig. 1). However, symptoms are variable with cotton variety and, particularly, the age of the plant at in faction. Among four cotton species, only two *viz.,G. hirsutum* L. and *G. arborium* L. are grown in Haryana *G. hirsutum*L. Issu sceptible where as, *G. arboreum*is resistant to Cotton leaf curl disease (CLCuV). Maximum area under Cotton cultivation in Haryana is covered under *hirsutum* varieties *viz.,* HS 6 and H 1098, which are susceptible to CLCuV.

The disease has assumed serious proportions in the most potential irrigated cotton belt of north India comprising an area of around 15.2 lakh hectares. The disease caused by a whitefly transmitted Gemini virus was first noticed in Nigeria on Gossypiumperuvianum and G. vitifolia (Farquhars on, 1912). In India, cotton leaf curl virus disease was first reported on American cotton (G hirsutum) in Sriganganagar area of Rajasthan state during 1993 (Ajmera,1994) and during 1994 it appeared in Haryana and Punjab (Rishi and Chauhan,1994) states on hirsutum cotton and posed a major threat to its cultivation in northern India (Verma *et al*., 1995). The meteorological factors play a vital role in the development and population build- up of insect species. Among the weather parameters, temperature and relative humidity are the most important to build up the insect and diseases. Temperature was found positively associated with whitefly population and relative humidity was negatively associated (Rote and Puri, 1991). The maximum population was observed during the standard meteorological weeks (SMW) of 37-39 where cloudy conditions prevailed during this period contributes the increased in population of whitefly (Babu and Meghwal, 2014). The total influence of all the weather parameters was high and significant on the whitefly population. Sharma (1998) found that, a number of insect- pests have been reported to cause up to 57.9 per cent reduction in seed cotton yield. White fly is a vector of leaf curl virus disease. Therefore, relationship of leaf curl virus disease was studied with microclimate.

MATERIALS AND METHODS

A field experiment was carried out at the Research Farm of the Department of Plant breeding (cotton section), Chaudhary Charan Singh Haryana Agricultural University Hisar, during *Kharif* 2011. Hisar is situated in the semi-aridzone at an elevation of 215.2 m with a longitude of 75º46′ E and latitude of 29°10′N. The treatments comprised of two dates of sowing *Viz*. 30th April and 30th May with three cotton cultivars recommended HS-6, RASI-134 and MRC-6304 in a factorial randomized block design with four replications to relate leaf curl virus disease intensity in cotton with microclimate under two growing environments and two protection conditions (Protected: - Cotton crop was sprayed by systemic insecticides to control whitefly and Unprotected: - Unsprayed). The Observation was taken at different stages of crop growth, first after 30 days after sowing and consequently at 7 days interval. Randomly 10 plants were tagged and each and every plant was examined in field and grades were allotted to them according to the extent of infection in disease plants. The total No. of plants showing leaf curl virus disease symptoms was counted every time during the period of observations. Dry and wet bulb temperatures were measured at an interval of three hours from 8:00 AM to 5:00 PM at three levels of crop canopy: lower, middle and upper with the help of Assmann Psychro meter at different phenophases of cotton. These values were used to find out relative humidity and vapour pressure in the crop with the help of psychometric tables. The vapour pressure deficit was calculated using the following formula (Monteith and Unsworth, 1990).

VPD = (es-ea)

Where,

es = Saturated vapour pressure = (AVP/ RH) x100

ea = Actual vapour pressure (mm of Hg)

RH = Relative humidity (%)

The number of infected plants but without any rating scale has been locally used to calculate percent disease incidence. This formula was used by Naveed *et al*., 2007. Formula is as follows.

%Disease incidence = Number of infected plants / Total no. of plants

Other weather variables were taken from agro meterological observatory. Stepwise regression techniques were used to quantify the regression equation for leaf curl virus disease using weather parameters.

RESULTS AND DISCUSSION

The correlation and regression analysis were carried out to quantify the relationship of leaf curl disease with weather parameters maximum temperature, minimum temperature, relative humidity (M), relative humidity (E), wind speed and vapour pressure deficit for crop sown on two environments with two Protection conditions (Protected and Unprotected) and pooled data for both environments.

Correlation of different weather parameters with cotton cultivars

Correlation (r) coefficient between leaf curl disease incidence and different environmental factors for cotton cultivars (HS-6, RASI-134 and MRC-6304) have been evaluated and presented in Table 1 to 3. The correlation values showed that environmental factors either positively or negatively correlated with leaf curl virus disease in cotton. Leaf curl disease showed positive correlation with sunshine hours, morning and evening relative humidity and vapour pressure deficit, when crop was sown on 30th April but correlation coefficient were non significant in case of sunshine hours, evening relative humidity and vapour pressure deficit. Negative and significant correlation was observed with maximum temperature, minimum temperature, wind speed and vapour pressure deficit. Under late sown conditions (30th May) leaf curl disease showed positive correlation with maximum temperature and sunshine hours but correlation was negligible with maximum temperature. Negative correlation was recorded with minimum temperature, morning and evening relative humidity, wind speed and vapour pressure deficit but was non-significant for morning relative humidity, and vapour pressure deficit. The pooled data of leaf curl disease for both sowing environments showed significant positive relation with sunshine hours and morning relative humidity but it was non-significant. Leaf curl disease showed non-significant negative relationship with maximum temperature. Leaf curl disease was negatively and significantly associated with minimum temperature, evening relative humidity, wind speed, and vapour pressure deficit

Regression model of different cotton cultivars in respect of weather parameters

The best fit regression models were developed for prediction of leaf curl disease with significant weather parameters using step wise multiple regression technique which are presented in table 4. (30th April), table 5 (30th May) and table 6 (pooled). For crop sown on 30th April, variability in leaf curl disease can be explained up to 81 percent by vapour pressure deficit in RASI 134, 84 percent in HS 6 and 86 percent in MRC 6304. The accuracy of the above model can be improved with the addition of the maximum temperature in the case of HS 6 and relative humidity in the case of RASI 134 and MRC 6304.

Variability in leaf curl disease can be explained up to 77, 78 and 76 percent by minimum temperature for RASI 134, HS 6 and MRC 6304 sown on 30th May, respectively. Accuracy can be improved by the addition of wind speed (Table 5) in case of all the cultivars. In cultivars RASI 134, HS 6 and MRC 6304 the variability in leaf curl disease can be explained up to 79, 62 and 76 percent by minimum temperature, when data of both the sowing environment was pooled. The predictability of the above models can be increased up to 90, 75 and 85 percent for RASI 134, HS 6 and MRC 6304, respectively with addition of wind speed.

The pooled data of leaf curl disease showed significant and positive relationship with sun shine hours, significant and negative with relative humidity at evening, wind speed and vapour pressure deficit. Singh *et al*. (2005) reported significant

Table 1: Correlation of disease incidence in cotton cultivars sown on 30th April, 2011 with different weather parameter (P = Protected and UP = Unprotected)

Parameters	RASI 134(P)	RASI 134(UP)	HS 6(P)	HS 6(UP)	MRC 6304(P)	MRC 6304(UP)
$T_{MAX.}$	-0.66*	-0.75*	-0.81*	-0.81*	-0.69*	-0.73*
$T_{MIN.}$	-0.82*	-0.78*	-0.75*	-0.69*	-0.85*	-0.82*
SS(hrs)	0.43	0.35	0.29	0.26	0.45	0.41
$RH\%_M$	0.77*	0.82*	0.84*	0.80*	0.76*	0.79*
$RH\%_E$	0.29	0.41	0.42	0.45	0.27	0.34
WS (km/ hr)	-0.67*	-0.60*	-0.61*	-0.52	-0.63*	-0.61*

* - Significant at 5% level

Table 2: Correlation of disease incidence in cotton cultivars sown on 30th May 2011 with different weather parameter (P = Protected and UP = Unprotected)

Parameters	RASI 134(P)	RASI 134(UP)	HS 6(P)	HS 6(UP)	MRC 6304(P)	MRC 6304(UP)
$T_{MAX.}$	0.10	0.04	0.00	0.03	0.04	0.02
$T_{MIN.}$	-0.90*	-0.82*	-0.83*	-0.73*	-0.84*	-0.77*
SS(hrs)	0.75*	0.70*	0.71*	0.67*	0.70*	0.65*
$RH\%_M$	-0.41	-0.24	-0.27	-0.10	-0.29	-0.15
$RH\%_E$	-0.81*	-0.69*	-0.71*	-0.67*	-0.71*	-0.63*
WS (km/ hr)	-0.78*	-0.82	-0.79*	-0.81*	-0.80*	-0.83*

* - Significant at 5% level

Table 3: Correlation of disease incidence in cotton cultivars with different Weather parameter (Pooled data of both sowing environments), (P = Protected and UP = Unprotected)

Parameters	RASI 134(P)	RASI 134(UP)	HS 6(P)	HS 6(UP)	MRC 6304(P)	MRC 6304(UP)
$T_{MAX.}$	-0.26	-0.39	-0.42	-0.40	-0.35	-0.41
$T_{MIN.}$	-0.91*	-0.84*	-0.83*	-0.70*	-0.86*	-0.79*
SS(hrs)	0.69*	0.63*	0.62*	0.50*	0.66*	0.60*
$RH\%_M$	0.10	0.19	0.18	0.32	0.12	0.28
$RH\%_E$	-0.63*	-0.47*	-0.48*	-0.30	-0.53*	-0.39
WS (km/ hr)	-0.70*	-0.73*	-0.72*	-0.69*	-0.72*	-0.75*

* - Significant at 5% level

Table 4: Multiple regression models for prediction of leaf curl disease incidence incotton cultivars under unprotected condition and different weather parameters for crop sown on 30th April, 2011

Sr. No.	Cultivars	Equations	R^2
1	RASI 134	Y= 54.25 -11.08 VPD	0.81
	RASI 134	Y= 581.46 -26.9 VPD-5.35RHm	0.88
2	HS 6	Y= 93.50 -14.61 VPD	0.84
	HS 6	Y= 252.00 -10.00 VPD -0.52Tmax.	0.90
3	MRC 6304	Y= 71.60 -14.29 VPD	0.86
	MRC 6304	Y= 672.36 - 32.6VPD – 6.11RHm	0.91

Y = Disease incidence (%); (VPD = vapor pressure deficit, RHm = Relative humidity of morning, Tmax = Maxi. temperature)

Table 5: Multiple regression models for prediction of leaf curl disease incidence in cotton cultivars under unprotected condition and different weather parameters for crop sown on 30th May, 2011

Sr. No.	Cultivars	Equations	R^2
1	RASI 134	Y = 178.90 -5.96 Tmin.	0.77
	RASI 134	Y = 158.00 -3.7 Tmin.- 6.0 WS	0.92
2	HS 6	Y = 188.0 -6.25 Tmin.	0.78
	HS 6	Y = 166.00 -3.2 Tmin.- 7.3 WS.	0.94
3	MRC 6304	Y = 173.89 -5.90 Tmin.	0.76
	MRC 6304	Y = 158.30 -3.2 Tmin.- 6.9 WS	0.90

Y = Disease incidence (%); (Tmin = Mini. Temperature, WS = wind speed)

negative correlation of whitefly population with maximum and minimum temperatures. The pest population was negatively associated with vapour pressure deficit (Singh *et al.,* 2005). Maximum and minimum temperatures exerted significant negative influence on whitefly population (Prasad *et al.,* 2008). Leaf curl disease severity illustrated, on the whole, an imperative negative correlation with maximum and minimum temperatures and wind velocity (Rashida *et al.,*

Table 6: Multiple regression models for prediction of leaf curl disease incidence in cotton cultivars under unprotected condition and different weather parameters (pooled data of both sowing)

Sr. No.	Cultivars	Equations	R^2
1	RASI 134	Y = 193.50 -6.74Tmin.	0.79
	RASI 134	Y = 174.60 -4.99 Tmin.- 4.0 WS	0.90
2	HS 6	Y = 197.50 -6.00 Tmin.	0.62
	HS 6	Y = 174.40 -3.86 Tmin.- 4.9 WS.	0.75
3	MRC 6304	Y = 206.28 -6.97 Tmin.	0.76
	MRC 6304	Y = 181.50-4.78 Tmin.- 5.1 WS	0.85

Figure 1: Typical symptoms of CLCuD in cotton. The disease induces vein darkening, vein swelling and either upward or downward leaf curling. In severe infections, enations on the undersides of leaves develop into leaf-like structures (inset centre left; to some degree these are variety-specific). Plants infected early remain stunted with very small leaves (inset centre right). The lower two of first photographs show the symptoms exhibited in cotton for a recent outbreak of CLCuD

2010). The minimum temperature and wind speed in cultivar RASI 134, HS 6 and MRC 6304 explained the variability up to 90, 75 and 85 percent respectively when the data of both the growing environment was pooled. Singh *et al.* (2010) found that linear regression analysis also revealed that meteorological arameters *i.e.* temperature and relative humidity along with vector of leaf curl disease played a significant role in appearance of the disease.

ACKNOWLEDGMENT

It is a pleasure to thank and acknowledge Dr.Ram Niwas, Professor, of Agro meteorology for her inspiring guidance and encouragement. I am also thankful to my respected Sir Dr.M .L. Khichar,Associate Professor,for his cooperation for to do this work.

REFERENCES

Ajmera, B. D.1994. Occurrence of leaf curl virus on American Cotton (G. hirsutum) in north Rajasthan. *Paper presentation, National Seminar on Cotton Production Challenges in 21st Century, April 18-20 Hisar. India.*

Anonymous 2014. Annual report. *AICCIP, 2013-14.CICR, Nagpur, India.*

Babu, S. R. and Meghwal, M. L. 2014. Population dynamics and monitoring of sucking pests and bollworms on bt cotton in humid zone of southern Rajasthan. *The Bioscane.* **9(2):** 629-632.

Farquharson, C. O. 1912. A report of the mycologist.A report Agric. Deptt. Nigeria. In M A siddique and L C hungus (Eds) Cotton growth in Gezira environment. *Whaffer and sons ltd Cambridge England.* p.106.

Meyer, L., McDonald, S. and Kiawu, J. 2013. United States Department of Agriculture, Economic Research Service, Situation Outlook; *Cotton and Wool Outlook*/CWS-13e/ May 14, 2013.

Mansoor, S., Zafar, Y. and Briddon, R. W. 2006. Geminivirus disease complexes: the threat is spreading. *Trends Plant Sci.* **11:** 209-212.

Monteith, J. L. and Unsworth, M. H.1990. On the computation of saturated vapour pressure. *J. Appl. Meteoro.* **6:** 2003-2004.

Naveed, M., Nadeem, M. and Islam, N. 2007. AMMI analysis of some upland cotton genotypes for yield stability in different milieus. *W. J. Agric. Sci.* **3(1):** 39-44

Prasad, N., Rao, N. and Maha lakshmi, M. S. 2008. Population dynamics of major sucking pests infesting cotton and their relation to weather parameters. *J. Cotton Res. Dev.* **22(1):** 85-90.

Rashida, P., Fani, I., Islam, N., Haider, S., Chohan, S. and Rehman,A. 2010. Correlation of biweekly environmental conditions on CLCuV disease growth in Pakistan. *European J. Scientific Research.* **42:** 14-621.

Rishi, N. and Chauhan, M. S. 1994. Appearance of leaf curls disease of Cotton in northern India. *J. Cotton Res. Dev.* **8:** 174-180.

Rote, N. B. and Puri, S. N. 1991. Population dynamics of whitefly on cotton and its relationship with weather parameters. *J. Cotton Res. Dev.* **5(2):** 181-189.

Sattar, M. N., Kvarnheden, A., Saeed, M. and Briddon, R. W. 2013. Cotton leaf curl disease-an emerging threat to cotton production worldwide. *J. Gen. Virol.* **10:** 695-710.

Sharma. P. D. 1998 Annual Repor. *AICCIP, Cotton Entomology*. p. 64.

Singh, D., Singh, P., Gill, J. S. and Brar, J. S. 2010. Weather based prediction model for forecasting cotton leaf curl disease in American cotton. *Indian J. Phytopathology*. **61(1):** 87-90.

Singh, S., Butter, G. S. and Singh, S. 2005. Heat use efficiency of Bt cotton cultivars in the semi- arid region of Punjab, *J. Agrometeorology*. **9(1):** 122-124.

Varma, A., Puri, S. N., Raj, S., Bhardwaj. R. P., Kannan, A., Jayaswal, A. P., Srivastava, M. and Singh, J. 1995,"Leaf curl disease of cotton in North-West-India" Report of the ICAR Committee, September, 1995.

Babu, S. R. and Meghwal, M. L. 2014. Population dynamics and monitoring of sucking pests and bollworms on bt cotton in humid zone of southern Rajasthan. *The Bioscane*. **9(2):** 629-632.