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Cotton Leaf Curl Virus Disease Severity In Relation to Environmental Conditions

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Abstract: Cotton leaf curl virus (CLCuV) disease severity was recorded on CIM-1100, CIM-109, CIM-435, NIAB-78, NIAB-Krishma and SLS-1 cultivated in Rajanpur, Dera Ghazi Khan, Muzaffarghar, Multan and Jhang districts of cotton belt of Punjab. Three locations were selected randomly from each of the five districts and CluCV was recorded according to a scale on a sample of 60 plants divided to those lots/replications each containing 20 plants for each variety at each location. Enviromental parameters and disease severity differed significantly among the districts and cotton cultivars. Expect significant correlation of monthly rainfall with CLCuV on NIAB-78 and relative humidity with disease severity on CIM-1100, CIM-435 and SLS-1, all other correlation were riot significant. Maximum disease severity was recorded at 40-43°C and 26-28°C maximum and minimum air temperature, 102-147 mm rainfall and 67-74% relative humidity. There was a poor linear relationship of majority of environmental variables with disease severity on most of the cultivars with few exceptions. Environmental data recorded on daily or weekly basis by sensitive sensors attached with weather stations installed at hot spots of cotton belt of Punjab is required for accurate disease forecasting.

Key words: Leaf curl virus, cotton cultivars, environmental conditions

Introduction

Leaf curl virus disease caused by a Gemini virus is a devastating disease of cotton crop in Pakistan. This disease is transmitted by white fly *(Bemisia tabaci)* and is characterized by thickening of veins, enations and twisting of leaves. The disease affected veins appear abnormal, dark green and opaque (Mirza *et al*., 1994). In Pakistan CLCuV disease was observed for the first time near Multan in the year 1967 (Hussain and Ali, 1975). In the beginning the disease did not attract much attention because of its casual occurrence and of minor economic importance, but in the years 1991-1995 it became a disease of major economic importance and induced significant yield losses (Anonymous, 1992a; Ali *et al*., 1995; Mirza *et al*., 1994).

Environmental conditions play a crucial role in the development of plant disease in epidemic form. In view of the great losses induced by CLCuV it was found necessary to record the actual occurrence of disease and study its relationship with environmental conditions in various districts of Punjab. This information could provide a basis for the development of a forecasting system in future.

Materials and Methods

A survey was conducted in the Punjab during the cotton growing season of 1997. Cotton leaf curl virus (CLCV) disease severity was recorded on CIM-1100, CIM-109, CIM-435, NIAB-78, NIAB-Krishma and SLS-1 cultivated in Rajanpur, Dera Ghazi Khan, Muzaffarghar, Multan and Jhang districts of cotton belt of Punjab. Three locations (Table 1) were selected randomly from each of the five districts and CLCuV was recorded according to a scale (Anonymous, 1996) on a sample of 60 plants divided to those lots/replications each containing 20 plants for each variety at each location. Environmental data consisting of maximum and minimum air temperature, rainfall and relative humidity and disease severity data were subjected to correlation and regression analysis (Steel and Torrie, 1980).

Results and Discussion

Two way interaction between districts and varieties for cotton leaf curl virus disease severity was significant (Table 2). The individual effect of districts and varieties was also highly significant indicating that CLCuV appeared at different times on different varieties in five districts of Punjab (Table 2). This was also evident by significant differences in the environmental condition of five districts and the disease severity recorded on six commercially grown cotton cultivars (Table 3).

Table 1: Districts and locations within the districts in the Punjab province, visited for recording cotton leaf curl virus disease severity data

District	Locations
Rajanpur	Jatwala, GadanWaia, Bulayvvaii3
D. G. Khan	Darkhawast Jamal Khan, Faroogahad, Saiten Area
Muzaffargarh	Mauza Azmatpur, Mauza Malkani Basti, Mauza Ghalloon
Multan	Mauve Bahadurpur, Jhoke Gamoon Near Lar, Mauza Kukree Khord Malsi
Jhang	Athara Hazari, Malu More, Bagh Area

The maximum air temperature was higher in Multan followed by Rajanpur, Muzaffarghar and D.G. Khan in that order. At Jhang, maximum and minimum air temperatures were lower than other districts. The rainfall at Multan was heavier compared to other districts which had almost similar amount of rainfall. Similarly, relative humidity at D.G. Khan, Multan and Jhang did not differ much (Table 3). Leaf curl virus disease severity differed significantly on all the six cultivars grown in five districts (Table 3). Thus at Rajanpur the lowest CLCuV was recorded at NIAB-Krishma followed by SLS-1, CIM-435, CIM-1100, CIM-109 and NIAB-78, respectively. NIAB-78 had the maximum CLCuV disease severity at D.G. Khan, Muzaffarghar and Multan while CIM-109 had the minimum CLCuV at these districts. The CLCuV disease severity on NIAB78, CIM-435 and SLS-1 did not differ significantly at D.G. Khan, Muzaffarghar and Multan, respectively (Table 3). At Rajanpur disease severity was comparatively lower cm all the six cultivars than other districts with two exceptions (CIM1100 at Multan and NIAB-Krishma at Jhang). At D.G. Khan, Muzaffarghar and Multan CLCuV was comparatively higher on majority of cotton cultivars than other districts. Maximum temperature or rainfall of Rajanpur and D. G. Khan or Muzaffarghar and Jhang did not differ much. The minimum temperature of all the districts differed from one another.

Table 2: Analysis of variance for cotton leaf curl virus disease seveity recorded in five districts of Punjab during 1997

Source of varience	Degree of freedom	Sum of squares	Mean sum of squares	F-value	Prob.>F
Districts	4	27.418	6.854	27.2078	0.0000*
Varieties	5	55.316	11.634	43.9143	0.0000*
Districts × varieties	20	31.377	1.584	6.2869	0.0000*
Error	60	15.116	0.252		
Total	89	129.527			

Significant at p+0.05

Table 3: Comparision of evnv ronmental conditions and bacterial blight disease severity recorded in five districts of Punjab

Environmental parameters					Cotton Leaf Curl Virus Disease Severity					
Air temperature					C1M-1100	CIM-109	N1AB-78	CIM-435	NIAB-Kris,	SLS-1
Districts	Maximum	Minimum	Rainfall	Relative Humidity						
Ralanpur	41.8	27.8	102.9	67.2	2.86 be	3.16ab	3.86	2.63bc	2.08c	2.32c
❑.G. Khan	40.1	26.9	103.3	73.3	3.06c	3.07a	5.00a	4.36b	4.54b	4.23b
Mlizaffarghar	40.4	27.3	147.3	77.2	4.13b	2.73c	5.00a	4.26b	3.62b	4.20b
Multan	42.7	26.1	101.9	70.3	2.74c	3.88b	5.00a	3.28bc	3.56b	3.606
Jhang	39.8	26	99.7	70.9	3.63a	3.44a	3.88a	3.44a	2.356	3.88

Ironmental paparneters and in a row for disease severity on cotton ferent as by LSD test (p = 0.05)

Table 4: Correlation of environmental conditions with leaf curl virus disease severity recorded on six cotton varieties cultivated in five districts of Punjab during 1997

Environmental parameters	Overall correlation	Correlation by varieties					
		CIM-1100	CIM-109	NIAB-78	CIM-435	NIAB-Kris	SLS-1
Maximum temperature	0.02091	0.25111	-0.05239	0.39147	-0.1489	0.22466	-0.35113
	0.8449	0.3667	0.8529	0.149	0.5962	0.4208	0.1994
Minimum temperature	0.09604	0.05969	-0.24537	0.45113*	0.06677	0.37297	-0.19619
	0.3679	0.8326	0.3781	-0.0914	0.8131	0.1709	0.4834
Rainfall	0.22268*	0.26991	-0.35639	0.66843*	0.28242	0.45636*	0.05181
	0.0349	0.3306	0.1923	0.00634	0.3078	0.0873	0.8545
Relative humidity	0.19746*	0.60077*	-0.19553	0.07213	0.50273*	0.12504	0.61935*
	0.0621	0.0179	0.4851	0.7984	0.0561	0.6571	0.0138

Significant at 5% or 10% level of probability

Maximum relative humidity was recorded at Muzaffarghar and the minimum at Rajanpur. Lowest rainfall was recorded at Jhang while heaviest rainfall was recorded at Muzaffarghar Overall correlation of rainfall and relative humidity with CLCuV disease severity was significant (Table 4). The significant correlation of environmental conditions was not found with disease severity in majority of cotton varieties. This may be attributed to differential response of these varieties to varying environmental conditions. Thus the correlation of minimum temperature with NIAB-78, rainfall with NIAB-78 and NIABKrishma and relative humidity with CIM-1100, CIM-435 and SLS-1 were significant. All other correlations were not significant (Table 4). The Highest CLCuV was recorded at 39-43°C maximum and 26-28°C minimum air temperatures (Fig. 1). The rainfall varied from 100-147 mm with relative humidity of 67-76 in all the five districts of Punjab. The relationship of these environmental conditions with disease severity was not perfectly linear as indicated by low r values for most of the varieties. Thus with the increase in temperature from 26-28°C disease severity tended to decrease on some varieties and this trend was explained by linear regression in CIM-109 and SLS-1 as indicated by r values (-0.60 and -0.50). From Jhang to Multan a disease curve pertaining to all varieties indicated that disease severity was maximum at 40-43°C maximum air temperature prevailing at Multan, D.G. Khan and Muzaffar while it was lower at Jhang and Rajanpur. Multan region has been characterized by semi-arid subtropical continental climate, with 300-500 mm rainfall, while Muzaffarghar is arid to semiarid continental; 5-40°C and 150-350 mm rainfall (Anonymous, 1992b). Dera Ghazi Khan has been characterized in piedmont plains of Suleiman range; temperature upto 48°C and 125-250 mm rainfall. Although these three districts are in different agro-ecological zones CLCuV was statistically similar on NIAB-78, CIM-435, NIAB-Krishma and SLS-1. Majority of the cotton cultivars grown in cotton belt of Punjab lack durable resistance (which can last for 10-20 years) against the virus strains. Of the 60 varieties/cotton advance lines screened for resistance to CLCuV, except for three arboreum types (Ravi, FDH-170 and R-231) and five exotic upland cotton lines, none of the linesivarieties was resistant to leaf curl virus disease (Khan and Rashid, 1996).

CLCuV disease severity increased with increase in rainfall frotn 100 to 147 mm from Jhang to Muzaffarghar (Fig. 1). At D.G. Khan and Muzaffarghar, rainfall varied from 104-147 mm and maximum disease severity was recorded on NIAB-78, CIM-435 and SLS-1 being greatly affected by high rainfall at these regions. The relationship of disease development on these varieties was explained by linear regression as indicated by better "r" values compared to other varieties. There was a very poor relationship of increasing relative humidity (67-77%) with disease development on majority of cotton varieties. Probably the high relative humidity for disease development was either not prevalent or was available for very short duration. The greatest percent plant infection caused by CLCuV was recorded on BH-36, 5-12, FH-682, GOHAR-87 and MNH-93, NH-26, NIAB-78 and SLH-41 at a relative humidity of 70-80% (Khan *et al*., 1998).

During this study monthly environmental data were used for correlation because disease ratings were taken only once due to non-availability of resources for frequent travelling to record disease development at different locations of Punjab. Moreover environmental data were collected from

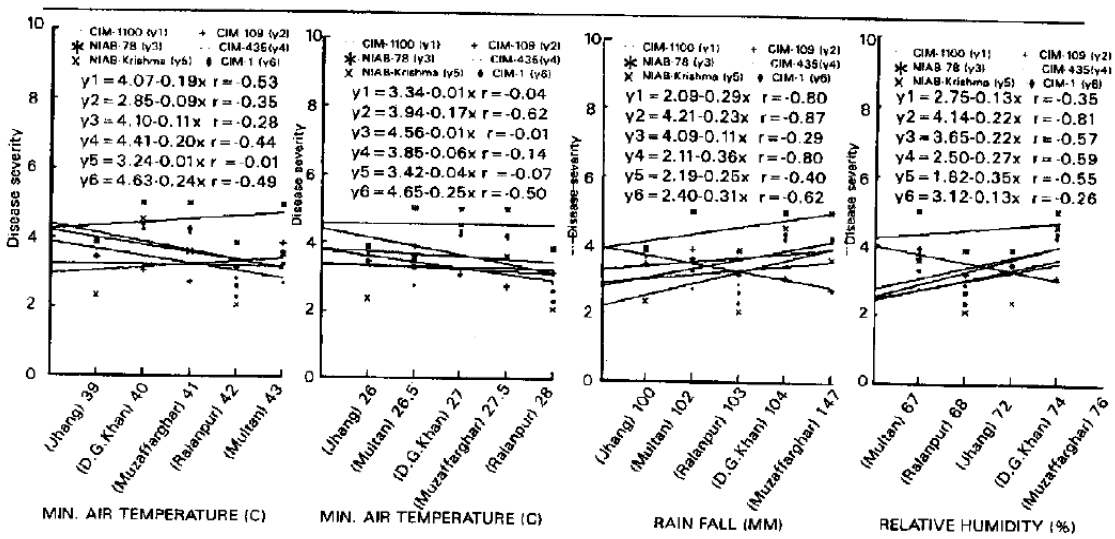

Fig. 1: Relationship of monthly maximum, minimum air temperatures, rainfall and relative humidity with leaf curl virus disease severity recorded on six cotton cultivars in five districts of Punjab during 1997

meteorological stations keeping in view the vast expansion of an agro-ecological zone. Environmental data could not be recorded in the fields of pertinent districts due to lack of resources. Although some monthly environmental variables had significant correlation with disease severity, yet it failed to explain the relationship with disease severity on majority of cotton varieties. Weekly environmental and disease rating data should be more useful for determining the accurate relationship with CLCuV development. Overall disease severity was not high since it was recorded on commercially grown high yielding varieties generally declared disease resistant. One possible explanation of poor relationship of environmental conditions with disease severity on these varieties is that these were not highly susceptible to CLCuV. Highly susceptible varieties may show significant relationship with environmental conditions but such varieties are not recommended for cultivation due to risk of low production. Under such conditions, daily or weekly environmental and disease severity data may prove useful for accurate disease prediction.

This requires the installation of weather stations connected with sensitive sensors at hot spots of cotton belt of Punjab which may be used for recording environmental data. These data need to communicated by radio-frequency telemetry system to the main computer to process it for accurate disease forecasting (Khan and Ilyas, 1998).

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