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CORRELATION OF ENVIRONMENTAL CONDITIONS WITH BACTERIAL BLIGHT DISEASE ON SIX COMMERCIALLY GROWN COTTON CULTIVARS IN FIVE DISTRICTS OF THE PUNJAB

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Bacterial blight disease severity was recorded on ClM-lIOO, ClM-109, ClM-435, NlAB-78, NlAB-Krishma and SLS-1 cultivated in Rajanpur, D.G.Khan, Muzaffarghar, Multan and Jhang districts of cotton belt of Punjab. Three locations were selected randomly from each of the five districts and bacterial blight disease severity was recorded according to a scale on twenty randomly selected cotton plants of each variety. Environmental data consisted of maximum and minimum air temperature, rainfall and relative humidity and disease severity data. These were subjected to correlation and regression analysis. Environmental parameters and disease severity differed significantly among the districts and cotton varieties respectively. Except maximum air temperature, all the environmental variables were significantly correlated with bacterial blight disease severity. The cotton varieties responded differently to environmental conditions. Maximum disease severity was observed at 26-27 QC minimum temperature, 100-147 mm rainfall and 67-77% relative humidity. There was a poor linear relationship of varying environmental conditions with disease severity recorded on six varieties in five districts.

Key **words:** bacterial blight, cotton cultivars, environmental conditions

INTRODUCTION

Bacterial blight of cotton caused by *Xanthomonas campestris* pv. *maluacearum.* (Smith) Dye recorded near Multan in 1965 is one of the destructive diseases of this crop in Pakistan (Evans, 1976). According to Hussain and Ali (1975) bacterial blight can induce *5orfr,* losses to the yield of cotton crop under favourable environmental conditions of disease development. Losses are especially severe in the Punjab where summer rains favour disease development (Brinkerhoff, 1977). Currently, none of the available high yielding commercial varieties of cotton has durable resistance against bacterial blight. This is mainly due to the presence of diverse virulences of X, *campestris* pv. *malvacearum* reported by several research workers (Brinkerhoff and Hunter, 1965; Bird and Tsai, 1975; Randhawa and Singh, 1980; Hussain, 1984). Race 18, the most virulent so far recorded in the world, has also been recorded from Pakistan (Hussain and Brinkerhoff, 1978). The cultivation of less resistant cotton varieties and favourable environmental conditions may also contribute to bacterial blight disease development,

In the absence of durable resistance possessing varieties. application of chemicals on moderately resistant to moderately susceptible varieties may not be economical because the bacterium causing this disease is systemic in nature and requires several sprays to control disease (Khan and Ilyas, 1989; Hussain and Tahir, 1993; Khan, 1995). The frequent use of chemicals is neither economical nor beneficial for the environment. The frequency of chemical application can be minimized by forecasting disease. Environmental conditions play a crucial role in the epidemic development of bacterial blight of cotton. Very little is understood about the epidemiology of bacterial blight in Pakistan. The objective of this study was to determine the correlation of certain environmental conditions with bacterial blight.

MATERIALS AND METHODS

A survey was conducted in the cotton growing areas of Rajanpur, Der» Ghazi Khan, Muzaffargarh, Multan and Jhang districts of Punjab province to record the incidence of bacterial blight disease. A sample of twenty plants was taken randomly from three locations (Table 1) visited from each of the five districts and the data on disease severity of ClM-1100, ClM-109, NlAB-78, CIM-435, NlAB-Krishma and SLS-1 were recorded. Twenty plants of each variety at each location were taken randomly and the disease ratings were taken according to the scale of Brinkerhoff (1977) in the month of July, 1997. Monthly environmental data consisting of maximum and minimum air temperatures, relative humidity and rainfall were recorded by

conventional instruments placed in the environmental observatories of meteorological stations situated at Rajanpur, D.G.Khan, Muzaffargarh, Multan and Jhang districts. The environmental and disease severity data were subjected to analysis of variance and the comparison of environmental parameters and disease severity on each variety was done by LSD test. The relationship of environmental conditions with disease severity was determined by correlation and regression analysis (Steel and Torrie, 1980).

Table 1. Districts and locations within the districts in the Punjab province, visited for recording bacterial blight disease severity data

District	Locations
Rajanpur	Jatwala, Gadanwala, Bulaywala
D.G. Khan	Darkhawast Jamal Khan, Farooqabad, Saifen Area
Muzaffargarh	Mauza Azmatpur, Mauza Malkani Basti, Mauza Ghalloon
Multan	Mauza Bahadurpur, Jhoke Gamoon Near Lar, Mauza Kukree Khord Malsi
Jhang	Athara Hazari, Malu More, BaghArea

RESULTS AND DISCUSSION

Two-way interaction among districts and varieties was statistically significant (Table 2). The individual effect of districts or varieties was also significant. Environmental conditions and bacterial blight disease severity differed significantly among different districts of Punjab (Table 3). The maximum air temperature was significantly higher in Multan followed by Rajanpur, Muzaffarghar and D.G. Khan in that order. At Jhang, maximum and minimum air temperatures were significantly lower than other districts. The rainfall at Multan was significantly heavier compared to other districts which had statistically similar amount of rainfall. Similarly, relative humidity at D.G. Khan, Multan and Jhang did not differ significantly (Table 3).

Bacterial blight disease severity differed significantly on all the six varieties cultivated in five districts (Table 3). Thus at Rajanpur the lowest bacterial blight severity was recorded on NIAB-Krishma followed by CIM-435, SLS-1, CIM-109, NIAB-78 and eIM-HOO respectively. NIAB-78 had the maximum disease severity at D.G. Khan, while CIM-HOO had the minimum disease severity at all locations of this district. The bacterial blight disease severity on either CIM-HOO and CIM-109 or NIAB-78, CIM-435, NIAB-Krishma and SLS-1 did not differ significantly at Muzaffarghar. At Jhang, disease severity on NIAB-Krishma was significantly lower compared to CIM-HOO, CIM-109, NIAB-78, CIM-435 and SLS-1, which did not differ significantly from one another.

Except for maximum air temperature, overall correlation of minimum air temperature, rainfall and relative humidity with disease severity was significant (Table 4). The significant nature of correlation of environmental conditions was not reflected in disease severity in majority of cotton varieties. This may be attributed to differential response of these varieties to different environmental conditions. Thus the correlation of rainfall with disease severity recorded on NIAB-78 and NIAB-Krishma was statistically significant, while the correlations of minimum temperature with disease severity on NIAB-Krishma and relative humidity with disease severity on SLS-1 were also significant. All other correlations were non-significant.

Maximum bacterial blight disesae severity was observed at 26-27 °C minimum temperature, 100-147 mm rainfall and 67-77% relative humidity (Fig.I), The relationship of these environmental conditions with disease severity was not perfectly linear as indicated by low r values for most of the varieties. With the increase in temperature from 26 to 28°C disease severity tended to decrease on all the varieties and this trend was best explained by linear regression in CIM-109 as indicated by fairly good r value (0.61). From Jhang to Rajanpur, a disease curve pertaining to all varieties indicated that disease severity was maximum at 26-27.5 °C minimum temperature prevailing at Multan, D.G. Khan and Muzaffarghar while it was lower at Jhang and Rajanpur. There seem to be common epidemiological factors influencing disease-development in Multan, D.G.Khan and Muzaffarghar districts. Hussain (1984) reported 75.7% isolates of race 18 of *Xanthomonas campestris* pv. *malvacearum* from *Gossypium hirsutum* cultivated at Multan, Rahimyar Khan, Bahalwalpur and Haroonabad. Less than 7.5% isolates of race 8, 10 and 12 were reported from Faisalabad,

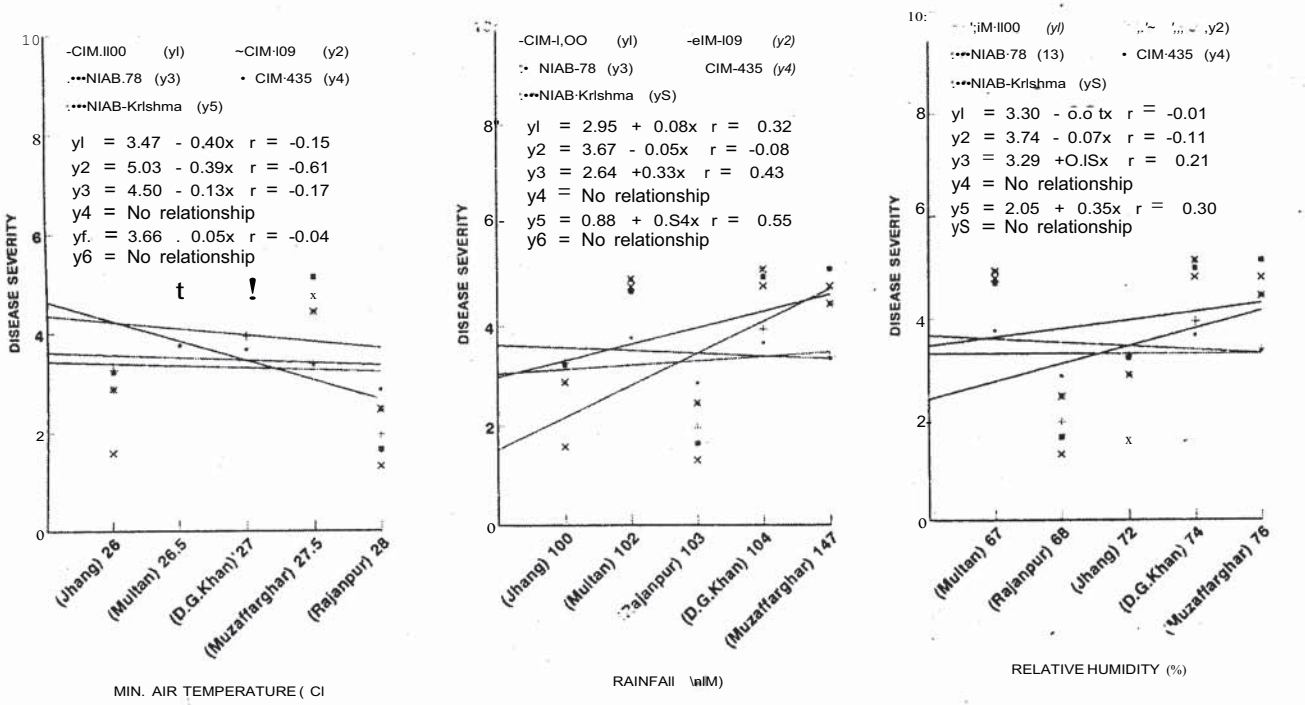

Fig. 1. Relationship of monthly minimum air temperature, rainfall and relative humidity with bacterial blight disease severity recorded on six cotton varieties in five districts of Punjab.

Sahiwal, Lahore, Vehari and Bahawalpur from G. *hirsutum* and G. *arboreum.* Thus, except CIM-HOO all the five cotton varieties cultivated at Multan had statistically similar disease severity. This district had all the four races of X. *campestris* pv. *malvacearum.* Majority of the cotton cultivars grown in cotton belt of Punjab lack durable resistance against the diverse virulences against X. *campestris* pv. *malvacearum.* Of 60 cotton lines screened for resistance to X. *campestris* pv. *malvacearum,* only three lines i.e. B-284, B-822 and TxCAB were moderately resistant, 32 lines/varieties were moderately susceptible and 18 susceptible to bacterial blight indicating the scarcity of resistance in the available test germplasm (Khan and Rashid, 1997).

The bacterial blight disease severity increased with increase in rainfall from 100 to 147 mm from Jhang to Muzaffarghar (Fig. 1). At D.G. Khan and Muzaffarghar, rainfall varied from 104 to 147 mm and maximum disease severity was recorded on NIAB-78 and NIAB-Krishma, being greatly affected by high rainfall at these locations. 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 severity on all the varieties. Probably the high relative humidity required for disease development was either not prevalent or was available for very short durations. According to Mofett and Wood (1985), bacterial blight pathogen was transmitted from infested cottonseed to cotyledonary leaves of cultivar Deltapine-60 at 28 QC and 90% relative humidity. According to Brinkerhoff (1977), bacterial blight of cotton in Punjab may be more severe depending upon heavy summer rains.

During this study monthly environmental data were used for correlation because disease ratings were taken once only dup to non-availability of resources for frequent travelling to record disease uevelopment at different locations of Punjab. Moreover, environmental data were collected from 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 monthly minimum air temperature, rainfall and relative humidity 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 bacterial blight development. Overall disease severity was not high since it was

Table 2. Analysis of variance for cotton bacterial blight disease severity recorded in five districts of Punjab during 1997

Source of variation	df	Sum of squares	Mean sum of squares	F-value	Prob.> F
Districts CD)	4	93.888	23,472	81.8576	0.0001'
Varieties (V)	5	7.349	1,470	5.1259	0.0006,
DxV	20	21,603	1,080	3.7671	0.0001*
Error	60	17.205	0.287		
Total	89	140.046			

*Significant at P= 0.05.

Table 3. Comparison of environmental conditions and bacterial blight disease severity recorded in five districts of Punjab during 1997

	Environmental parameters						
	Air temperatures						
Districts	Maximum		Minimum		Rainfall	Relative humidity	
Rajanpur	41.80 a		27.80 a		102.9 c	67.20 c	
D.G. Khan	40.00 a		26.90 c		103.3 b	73.30 b	
Muzaffarghar	40.40 c		27.30 b		147.3 c	77.20 c	
Multan	42.70 b		26.10 d		101,9 d	70.30 d	
Jhang	39.80 c		26.00 c		99.7 c	70.90 c	
LSD	0.506		0.051		0.619	0.507	
	Bacterial blight disease severity						
	CIM-100	CIM-109	NIAB-78	CIM-435	NIAB-Kris.	SLS-1	LSD
Ranjanpur	2.86 a	1.96 be	2,46 ab	1,65 be	1,32 c	1,87 be	0.871
D.G. Khan	3.67 c	3.94 be	5.13 a	4.98 a	4.80 ab	4,47 abc	0.877
Muzaffarghar	3.35 b	3.38 b	4,44 a	5.13 a	4.79 a	4.90 a	0.875
Multan	3.76 b	4.73 ab	4.93 a	4.69 a	4.78 a	4.83 a	0.819
Jhang	0.87 a	3.26 a	2.88 a	3.22 a	1.59	3.55 a	0.819

*Mean values sharing similar letters in a column for environmental parameters and in a row for disease severity on' cotton varieties are not significantly different as determined by LSD test (P=0.05)

Table 4. Correlation of environmental conditions with bacterial blight disease severity recorded on six cotton varieties cultivated in five districts of Punjab during 1997

		Correlation by varieties					
Environmental parameters	Overall correlation	CIM-1100	CIM-109	NIAB-78	CIM-435	NIAB-Kirshma	SLS-1
Maximum	0.11903	0.29534	0.08441	0.25969	0.01146	0.33729	0.06184
temperature	0.2638	0.2852	0.7649	0.3501	0.9677	0.2189	0.8267
Minimum	0.20026"	0.31208	0.07471	0.34242	0.5995	0,44428*	0.03674
temperature	0.0586	0.2575	0.7913	0.2101	0.14766	0.0971	0.8966
Rainfall	0.36276*	0.33729	0.04676	0,44958"	0.39446	0.61207*	0.31277
	0.0004	0.2189	0.8686	0.0927	0.1457	0.0153	0.2564
Relative	0.20997'	0.08411	0.25029	0.08127	0,40191	0.10483	0,44793*
humidity	0.0471	0.7656	0.3683	0.7734	0.1375	0.7101	0.0941

'Significant at 5(l(J or 10% level of probability.

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 was that these varieties were not highly susceptible to bacterial blight. 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 be communicated by radio-frequency telemetry system to the main computer to process it for accurate disease forecasting.

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