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Correlation of Environmental Conditions with Citrus Canker Disease Severity at Two Locations in Faisalabad

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Abstract: During Jan.-May, 1999, correlation of biweekly maximum air temperature with citrus canker disease severity recorded on sweet orange and mandarin was significant at University of Agriculture, Faisalabad (UAF) and Post-graduate Agricultural Research Experiment Station (PARS), Jhang Road, Faisalabad. There was no correlation of biweekly minimum air temperature, rain fall and clouds with disease severity on any of the citrus varieties grown at two locations. Biweekly wind speed was significantly correlated with citrus canker disease severity recorded on all the three varieties grown at two locations. The correlation of relative humidity was also significant with citrus canker disease severity recorded on three varieties at UAF and sweet orange and mandarin at PARS.

Key words: Citrus canker, correlation, environmental conditions, sweet orange, mandarin, lime, locations

Introduction

Citrus industry in Pakistan is demonstrated by its wide distribution on an area of 196100 hectares and a large scale annual production of 2037000 tons (Anonymous, 1998). However, citrus cultivation in Pakistan is concentrated in the Punjab province where it is grown on an area of 185400 hectares with annual production of 1946500 tons (Anonymous, 1998). In the Punjab, citrus is mainly grown in Sargodha, Faisalabad, Sheikhupura and Multan districts (Khan, 1987). Although citrus crop is kept in great esteem, yet the present status is threatened by a number of factors which impede the fruit yield and quality (Ahmad, 1977). Citrus diseases are one of the major factors which may affect the plant health and fruit development adversely. Among these, citrus canker caused by *Xanthomonas campestris* pv. *citri* (Hasse) Dows is important one. Canker is important throughout the citrus growing countries of the world (Koizumi, 1985). This disease occurs commonly in citrus growing regions of the Punjab and is one of the major diseases of citrus that affects leaves, twigs and fruits of plants (Hafiz and Satter, 1952). Survey conducted in the three Tehsils of Faisalabad district revealed 10-12% incidence of citrus canker disease (Khan *et al*., 1992).

The use of Bordeaux mixture and other copper fungicides to manage citrus canker has been reported (Hafeez, 1986; McGuire, 1988). However, the extensive use of chemicals is neither economical nor beneficial for the environment. The frequency of chemical sprays can be minimized at their proper timing of application. The successful management of citrus canker needs a study of epidemiological factors influencing this disease. The objective of these studies was to record citrus canker disease severity in relation to environmental conditions at two locations in Faisalabad. The results of this study could provide information regarding the development of a disease forecasting model in future.

Materials and Methods

Citrus canker disease severity was recorded on Lime, Sweet orange and Mandarin grown at University of Agriculture, Faisalabad and Postgraduate Agricultural Research Station, Jhang Road, Faisalabad. Ten trees of each variety selected randomly were tagged on four sides indicating East, West, North and South sides of each tree. Data on disease intensity was recorded on randomly sampled 10 leaves from each side of citrus tree according to the scale as described by Croxall *et al*. (1952). Biweekly environmental data consisting of maximum and minimum temperature, relative humidity, average rainfall, wind speed and clouds were collected from meteorological stations situated at Ayub Agricultural Research Institute and Crop Physiology Department of University of Agriculture, Faisalabad. All the environmental and disease severity data were subjected to analysis of variance and the difference in the disease severities recorded on citrus varieties were determined by least significant difference test (LSD at $p = 0.05$). The influence of environmental conditions with citrus canker was determined by correlation (Steel and Torrie, 1980).

Results and Discussion

Analysis of variance of disease severity data of citrus canker collected from UAF and PARS at the interval of two weeks, indicated significant individual effect of location, variety and date of disease ratings (Table 1). The two way interaction of location and dates of disease rating was significant. There was also significant interaction of dates of disease rating and variety. The three way interaction among locations, dates of disease rating and varieties was not significant. The interaction between location and variety was also non-significant. This indicated that citrus canker disease severity appeared at different times on two locations and it varied by variety. Citrus canker at PARS was higher compared to UAF (Table 2). At PARS the maximum disease severity at the end of disease rating period was 17.27% while at UAF the maximum disease severity was 15.23%. While it was 1.7 and 2.15% at the start of disease rating period at UAF and PARS, respectively. Based on citrus canker disease severity rating taken on citrus varieties statistically significant differences were found among varieties. Thus on lime, canker severity was greater than other two varieties (Table 3).

Among varieties there was statistically significant differences at different dates, in which lime showed 19.675% at the end of March and mandarin having least 1.225% at the beginning of January (Table 4).

The correlation of maximum temperature with citrus canker recorded on sweet orange and Mandarin at both locations was significant (Table 5, 6) specially sweet orange at PARS was significantly influenced by the maximum temperature, while East, West and North sides of mandarin showed significant disease development. The citrus canker recorded on south side of sweet orange showed significant correlation with maximum temperature at UAF (Table 6). The correlation of

Table 1: Analysis of variance of citrus canker severity recorded at two locations in Faisalabad during 1999

S.O.V.	D.F.	S.S.	M.S.	F. val	Prob. > F
Location	1	122.408	122.408	7.5157*	0.0337*
Error	6	97.722	16.287		
Date of disease rating	9	4442.518	193.613	597.4131	0.0000**
Location × date	9	15.910	1.768	2.1395	0.0286*
Variety	2	399.889	199.944	241.9900	0.0000**
Location × var	2	1.540	0.770	0.9321	N.S.
Date × variety	18	115.914	6.440	7.7939	0.0000**
Loc. × var. × date	18	8.296	0.461	0.5578	N.S.
Error	174	143.768	0.826		
Total	239	5347.967			

* Significant, **Highly significant

Table 2: Comparison of citrus canker disease severity at two locations

	3-1-99	17-1-99	31-1-99	14-2-99	28-2-99	14-3-99	28-3-99	11-4-99	25-4-99	9-5-99
U.A.F.	1.733L	3.617K	5.450I	7.317G	10.48E	12.77D	15.23B	12.37D	10.18E	8.283F
PARS	2.150L	4.467J	6.417H	8.167F	12.12D	14.82B	17.27A	13.87C	12.08D	8.917E

LSD = 0.7323 α = 0.05

Table 3: Ranking of varieties according to citrus canker disease severity

Variety	Means
Lime	11.20 A
Sweet orange	9.057 B
Mandarin	8.115 C

LSD = 0.2836 α = 0.05

Table 4: Comparison of means of citrus canker disease severity recorded on three varieties on different dates at two locations.

Name of Variety	3-1-99	17-1-99	31-1-99	14-2-99	28-2-99	14-3-99	28-3-99	11-4-99	25-4-99	9-5-99
Lime	2.575N	5.700L	7.625K	10.025I	13.825E	15.875B	19.675A	15.300BC	12.225GH	9.175IJ
Sweet orange	2.025NO	4.300M	5.675L	6.775K	10.150I	13.300EF	14.875CD	12.575FG	11.300H	9.600I
Mandarin	1.225O	2.125NO	4.500M	7.100K	9.925I	12.200GH	14.200DE	11.475H	9.875I	8.525J

LSD= 0.8969 α = 0.05

Table 5: Correlation of environmental variables with citrus canker at Post graduate Agriculture Research Station

Name of variety	Dimension	Maximum temperature	Minimum temperature	Relative humidity	Rain fall	Wind speed	Clouds
Lime	E	0.564	0.424	-0.585	-0.413	0.758**	-0.368
	W	0.577	0.438	-0.617	-0.336	0.722**	-0.250
	N	0.375	0.234	-0.401	-0.239	0.659*	-0.179
	S	0.502	0.357	-0.530	-0.287	0.687*	-0.220
Sweet orange	E	0.743**	0.637	-0.753**	-0.378	0.820**	-0.381
	W	0.806**	0.719	-0.815**	-0.375	0.836**	-0.379
	N	0.666*	0.562	-0.693*	-0.371	0.838**	-0.337
	S	0.677*	0.569	-0.700*	-0.402	0.843**	-0.383
Mandarin	E	0.752**	0.627	-0.759**	-0.470	0.798**	-0.462
	W	0.693*	0.559	-0.700**	-0.480	0.785**	-0.436
	N	0.645*	0.518	-0.666*	-0.423	0.778**	-0.383
	S	0.545	0.411	-0.572	-0.424	0.722**	-0.364

E = East W = West N = North= S = South

r > 0.6429* at 10% r > 0.7381** at 5%= r > 0.8810*** at 1%

Table 6: Correlation of environmental variables with citrus canker at University of Agriculture, Faisalabad

Name of variety	Dimension	Maximum temperature	Minimum temperature	Relative humidity	Rain fall	Wind speed	Clouds
Lime	E	0.589	0.475	-0.765**	-0.499	0.888***	-0.422
	W	0.509	0.385	-0.699*	-0.311	0.869**	-0.264
	N	0.390	0.270	-0.609	-0.259	0.781**	-0.219
	S	0.501	0.387	-0.699*	-0.315	0.855**	-0.269
Sweet orange	E	0.630	0.518	-0.805**	-0.377	0.910***	-0.354
	W	0.609	0.500	-0.785**	-0.343	0.893***	-0.319
	N	0.636	0.537	-0.802**	-0.371	0.910***	-0.344
	S	0.666*	0.570	-0.828**	-0.388	0.904***	-0.385
Mandarin	E	0.683*	0.580	-0.844**	-0.448	0.912**	-0.439
	W	0.684*	0.570	-0.833**	-0.490	0.936***	-0.459
	N	0.649*	0.526	-0.822**	-0.449	0.914***	-0.434
	S	0.590	0.467	-0.772**	-0.440	0.877***	-0.424

r > 0.6429* at 10% r > 0.7381** at 5% r > 0.8810*** at 1%

relative humidity with citrus canker on most sides of every variety showed statistically significant results except lime at PARS (Table 5). Rainfall had no correlation with citrus canker on any of the variety. There was a significant correlation between wind velocity and citrus canker on all varieties at both locations. There was no correlation between clouds and disease severity at both locations.

Biweekly maximum air temperature of both locations ranged from 15-42.5°C during disease rating period in 1999. Relative humidity had negative correlation with the citrus canker severity and relative humidity ranged from 50 to 70%. There was a significant correlation between wind velocity and citrus canker severity at both locations specially in the case of sweet orange and mandarin. The significant correlation of wind speed with all the three varieties at both locations indicates spread of inoculum in a specific direction so wind direction data may be more meaningful rather than just wind speed.

Citrus canker disease development appears to be a function of maximum and minimum temperature accompanied by relative humidity and wind speed. Reedy (1984) reported that citrus canker was favoured by mild temperature ranging from 20 to 35°C with wet weather. Koizumi (1983) reported that strong winds and any other factors causing damage to the leaves, even in the absence of rainfall, were included as important factors influencing the incidence of citrus canker.

It was found that the rainfall had no correlation but Gottwald *et al*. (1997) reported that once citrus canker disease established the most important ways of disease spread were rain splash and winds.

The incidence of citrus canker was relatively higher in PARS as compared to UAF i.e., 10.2 and 8.74% respectively. This may be attributed to be difference in environment of two locations. Khan *et al*. (1992) reported that survey conducted in the three Tehsils of Faisalabad district revealed 10-12.5% incidence of citrus canker disease.

Canker was more severe on lime, followed by sweet orange and mandarin at PARS. The susceptibility of lime to citrus canker has already been reported (Hafeez, 1986). Wang and Chung (1991) concluded that canker occurs widely on grapefruit, sweet orange, lemon and other citrus species. Govinda (1954) reported that canker was more on lime and less commonly on mandarin and sweet orange.

Citrus canker was prominent at the end of March, when maximum (29-29.4°C) and minimum (14-14.4°C) temperature prevailed. Peltier (1920) described 20-30°C as the optimum temperature for the citrus canker disease development.

Chu (1935) found that temperature ranges of 19-20.6 and 20.5-23.3°C prevalent from April through October were favourable for the rapid development of citrus canker.

During this study out of six variables (Maximum and minimum temperatures, relative humidity, rainfall, wind speed and clouds) only maximum air temperature, relative humidity and wind speed had significant correlation with citrus canker disease severity while other variables were statistically non-significant.

There was no correlation of rainfall with citrus canker. This may be due to the fact that data used in the analysis consisted of mean biweekly rainfall. It did not account for frequency and amount of rain showers and wind velocity which greatly influence bacterial, dispersal and distribution. Several years environmental and disease severity data may be useful in accurate disease prediction.

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