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Weather based Citrus Canker disease prediction under New alluvial zone of West Bengal

S. HANSDA, S.K.RAY* AND S. DUTTA
Department of Plant Pathology, Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur 741235, Nadia, West Bengal

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Studies on citrus bacterial canker disease *(Xanthomonas axonopodis* pv. *citri*) (CBCD) prediction model in acid lime (*C. aurantifolia*) on the basis of agro-meterological parameters were undertaken at Horticultural Research Station, Moundari, B.C.K.V., Mohanpur, Nadia during April to December 2010. The weather parameters viz. maximum and minimum temperature, maximum and minimum relative humidity, sunshine hour and rainfall were taken into consideration for epidemiological study. Among weather variables the correlation coefficient of RH (min), sunshine hour and also rainfall with disease severity were found to be significant with maximum contribution of RH (min). A prediction model for accounting the rate of disease severity of CBCD was developed in this study using different weather variables through step wise technique. Minimum relative humidity and sunshine hour were found to be the most important weather variables jointly contributed for 76.1 % of the variability of disease severity and could be used as predictor for assessing Citrus Canker Disease severity in warmer sub humid region of West Bengal. The intensity of disease was more severe during the period of August (13-19) to September (24-30).

Key words: Citrus Canker disease, epidemiology, *Xanthomonas axonopodis* pv. *citri*, weather parameters

INTRODUCTION

Citrus Canker is one of the most feared diseases of citrus, affecting all types of important citrus crops. The disease causes extensive damage to citrus and severity of this infection varies with different species and varieties and the prevailing climatic conditions. This disease is endemic in India, Japan and other South- East Asian countries, from where it has spread to all other citrus producing continents except Europe. (Das, 2003). The present status of citrus crop is threatened by a number of problems, including low production caused by diseases. Citrus plant is attacked by number of diseases like Citrus Canker, gummosis, citrus decline, Citrus Tristeza Virus (CTV), and citrus greening etc. But citrus canker caused by the bacterium *Xanthomonas campestris* pv. *citri.* (Hasse) Dows, is probably the worst enemy to the citrus plantations. The Asiatic form of citrus canker also known as (canker A, cancrosis A or true canker), is a destructive disease that seriously affects most commercially important citrus cultivars grown throughout the world. *Xanthomonas axonopodis* pv. *citri* has broad host range among members of the Rutaceae, although difference in susceptibility exists in citrus species (Stall and Civerola,1991). It causes severe symptoms on the grapefruit (*Citrus paradisi*. Macf), limes (*C. aurantifolia*, *C. limettioides*), trifoliate orange (*Ponicirus trifoliate)* and their hybrids. This is considered to be the most widespread and destruc-

*E-mail: sujitkray2005@yahoo.com

tive form of the citrus bacterial canker in the world (Koizumi, 1981; Stall and Seymour, 1983; Koizumi, 1985; Schoulties *et al.*, 1987., and Gotwald *et al.*, 1993).In West Bengal citrus occupies an area of 11.3 thousand hectare with a production of 100.9 thousand metric tons (Indian Horticulture Database, 2010).

Among the commercial cultivars, acid lime (*C. aurantifolia*) is the most susceptible one and up to 50-60% yield reduction has been reported (Das, 2003). Worldwide, millions of dollars are spent annually on prevention, Quarantines, eradication programs and for control the disease. The study of epidemiological factors that helps in taking management decisions, keeping in view conducive environmental conditions. Derso and Sijam (2007) have reported that citrus canker severity is significantly correlated with temperature but not with rainfall, elevation or tree age. The objective of these studies is to determine the correlation of environmental conditions with citrus canker disease development under natural conditions.

MATERIALS AND METHODS

Epidemiological factors and recoding meteorological data

The meteorological data of temperature in °C (maximum & minimum), relative humidity in % (maximum & minimum), average rain fall in millimeter and Sun shine hour in hour/day were recorded at 7 days interval from April to December 2010 and these data have been collected from Department of Agricultural Meteorology and Physics, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia on daily basis taking into account on the meteorological parameters. The Epidemiological study of Citrus canker disease was done at Horticultural Research Station, Mondouri, B.C.K.V, Nadia, West Bengal. Then these data were framed in meteorological weeks and average (weekly) of each parameter was calculated.

Observation and estimation of citrus canker disease severity

Disease observations were made at weekly interval based on fixed plot survey in the experimental citrus orchard. Disease data were recorded on the basis of symptomps on leaves of four branches of randomly selected ten plants at different direction (N-E-W-S) at 7 days interval from April to December 2010. The disease intensity was determined by using (0-5 scale) described as 0 = appearance of no symptom, 1 = 1-10 % leaf area infected, 2 = 11-20% leaf area infected, 3 = 21-40% leaf area infected, 4 = 41-60% leaf area infected and 5 = 61-e"80% leaf area infected.

PDI (%) was calculated by using the following formula

$$PDI = \frac{\text{Summation of numerical ratings}}{\text{Total number of leaf observed} \times \text{Maximum rating}} \times 100$$

RESULTS AND DISCUSSION

Results obtained on disease severity in acid lime plantation during April to December, 2010 are presented in Fig.1. It was evident from the disease severity data that the disease was more severe during the period of August (13-19) to September (24-30). In these periods warmer temperature, high humidity and less sunshine prevails.

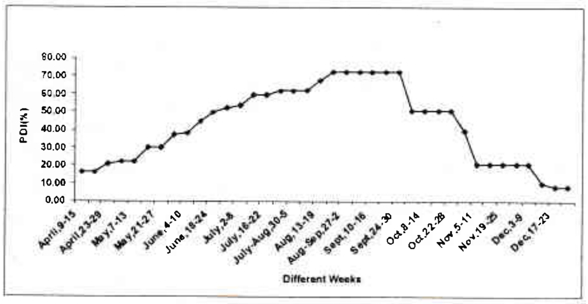

Fig. 1 : Year round disease severity of Citrus Canker

Prediction of citrus canker on the basis of agrometerological parameters was undertaken at Horticultural Research Station, Moundari, B.C.K.V., Mohanpur, Nadia during April to December 2010. Correlation coefficients obtain between weather variables and citrus canker disease severity was presented in Table 2. The weather parameters max. and min. air temperature, max. and min. relative humidity, sunshine hour and rainfall were taken into consideration for correlation study with disease severity. Disease severity was found to be positively correlated with maximum and minimum temperature, maximum and minimum RH and rainfall and negatively with sunshine hour. Among weather variables the correlation coefficient of RH (min), sunshine hour and also rainfall with disease severity (Fig. 3) were found to be significant at 1% level (Table.2) with maximum contribution of RH

Table 1 : Meteorological parameters considered in the epidemiological study of citrus canker

Weeks	T.max.	T.min.	Avg.Temp	RH.Max.	RH.Min.	Avg.RH.	SS (Hr)	Rainfall	Disease severity
April,9-15	38.29	27.31	32.80	84.57	42.86	63.71	8.93	0.00	16.00
April,16-22	37.97	27.43	32.70	89.14	49.71	69.43	8.87	0.00	16.00
April,23-29	36.66	25.37	31.01	85.43	49.57	67.50	9.00	37.50	20.50
AprilMay30-6	35.72	24.50	30.11	88.00	55.00	71.50	7.00	34.60	22.00
May,7-13	36.26	26.64	31.45	89.00	60.00	74.50	9.39	10.20	22.00
May,14-20	35.89	27.14	31.51	88.86	62.00	75.43	8.06	33.20	30.00
May,21-27	33.74	25.40	29.57	92.43	69.57	81.00	4.93	19.90	30.00
May-June,28-3	35.70	25.80	30.75	89.71	64.29	77.00	7.39	29.10	37.00
June,4-10	36.33	26.43	31.38	89.86	63.43	76.64	6.87	76.5	38.00
June.11-17	33.30	27.03	30.16	90.86	74.57	82.71	4.44	8.6	44.50
June,18-24	34.61	26.90	30.76	91.14	68.29	79.71	5.67	30.9	49.50
June-July,25-1	31.99	26.60	29.29	96.29	80.43	88.36	1.76	19.90	52.50
July,2-8	34.51	26.47	30.49	91.31	68.94	80.12	5.59	7.60	53.50
July,9-15	33.46	26.79	30.12	91.71	75.14	83.43	4.63	29.60	59.50
July,16-22	33.77	27.04	30.41	92.57	71.14	81.86	5.61	17.70	59.50
JULY,23-29	34.00	26.75	30.37	91.96	71.71	81.83	4.94	16.80	61.50
July-Aug,30-5	31.50	25.80	28.65	97.00	79.57	88.29	5.07	141.50	61.50
Aug,6-12	33.80	26.96	30.38	93.71	70.57	82.14	6.44	5.10	62.00
Aug,13-19	33.29	26.63	29.96	93.51	73.93	83.72	4.86	35.00	67.50
Aug,20-26	33.43	26.94	30.19	93.86	69.00	81.43	5.37	17.00	72.50
Aug-Sep,27-2	32.87	26.60	29.74	94.71	77.86	86.29	6.37	35.00	72.50
Sept,3-9	33.31	26.77	30.04	95.86	75.57	85.71	6.77	28.90	72.50
Sept,10-16	31.93	25.93	28.93	96.29	84.57	90.43	4.11	133.30	72.50
sept,17-23	31.59	25.09	28.34	97.57	82.00	89.79	4.66	82.80	72.50
Sept,24-30	33.79	25.77	29.78	94.71	67.29	81.00	7.06	26.90	72.50
Oct,1-7	32.77	25.50	29.14	92.71	74.29	83.50	5.29	30.80	50.50
Oct,8-14	31.33	24.04	27.69	96.43	74.29	85.36	5.27	31.40	50.50
Oct,15-21	33.70	25.24	29.47	95.00	69.00	82.00	8.47	27.00	50.50
Oct,22-28	32.43	23.94	28.19	93.43	64.86	79.14	5.89	0.00	50.50
Oct-Nov,29-4	29.97	20.61	25.29	92.14	62.86	77.50	6.40	0.70	39.50
Nov,5-11	32.27	20.51	26.39	92.00	54.14	73.07	9.27	0.00	20.50
Nov,12-18	32.16	21.04	26.60	92.43	55.86	74.14	6.97	0.00	20.50
Nov,19-25	30.49	17.77	24.13	92.14	50.86	71.50	7.43	0.00	20.50
Nov-Dec,26-2	28.99	17.46	23.22	92.43	51.29	71.86	7.56	0.00	20.50
Dec,3-9	25.07	16.36	20.71	95.57	70.43	83.00	2.80	2.74	20.50
Dec,10-16	30.20	19.67	24.93	92.88	58.61	75.74	6.62	0.30	10.00
Dec,17-23	25.01	9.40	17.21	94.14	43.86	69.00	8.63	0.00	8.00
Dec,24-31	25.80	8.85	17.33	93.13	43.25	68.19	8.01	0.00	8.00

(min) (fig. 2). This result illustrated that disease was more prevalent at relatively higher temperature, and humid condition (Fig. 3). These data is also in accordance with several earlier reports of Aiyappa (1958), Reddy (1984), Palazzo *et al.* (1987) etc. Srivastava *et al.* (1997) also reported that disease incidence was severe at 29-29.4ÚC, 80-90.5% relative humidity coincided with 8.9-9.97 mm rainfall. Average temperature of 25-30^{O}C, average RH more than 75% and rainfall found to be mainly associated with the disease severity. In order to predict the rate of disease severity a linear multiple regression model was developed using different weather variables through step wise technique. Using step wise regression technique com-

Table 2 : Correlation coefficients of different weather variables with rate of disease severity

Variables	Rate of disease severity (Y)
Disease severity (Y)	1.000
Max Temperature (X1)	0.176
Min Temperature (X2)	0.600**
Max RH (X3)	0.540**
Min RH (X4)	0.852**
Sunshine hour (X5)	-0.546**
Rainfall (X6)	0.489**

Multiple Regression Equation following Stepwise technique (Among the all weather variables)

Rate of disease severity = - 63.797 + 1.626 (RH.min); R^2 = 0.726; Adj. R^2 = 0.719

Rate of disease severity = - 115.05 + 2.064 (RH.min)** + 3.544**(sunshine hour);

R^2 = 0.761; Adj. R^2 = 0.747

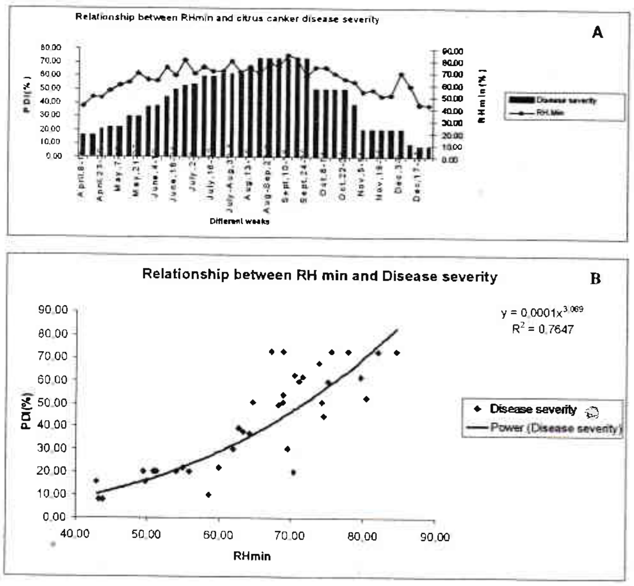

Fig. 2 : Relationship of minimum relative humidity with Citrus Canker disease severity (A) with graph and significance of correlation (B)

bination of some weather variables (minimum relative humidity and sunshine hour) were selected, which jointly found to account for 76.1 % of variability of disease severity and can be used as predictor of disease severity on the basis of measured weather variables. Thus from the above finding it may be concluded that minimum relative humidity (Fig. 2) and sunshine hours are the two most important weather based disease predictor significantly contributing towards the rate of disease progress. Peltier and Frederich (1926) pointed out that citrus canker is severe in regions where temperature and rainfall ascend and descend together

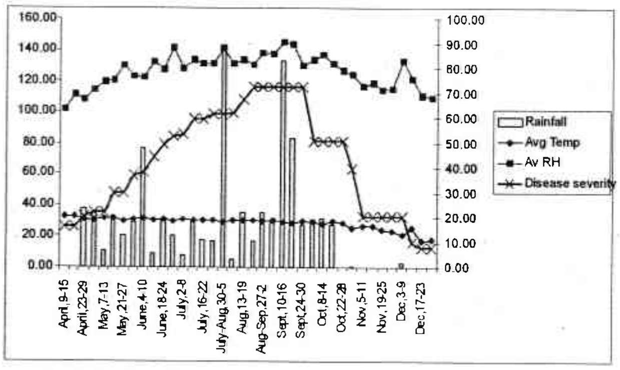

Fig. 3 : Relationship of average RH, average temperature and rainfall with disease severity

during the year. Therefore the disease occurs in severe form in seasons and/or areas characterized by warm and humid weather conditions. Das (2003) reported that onset of rain fall and reaching its peak by end of July, the pathogen was favoured for presence of high humidity and water on the plant surface under West Bengal condition. Bock *et al.* (2005) assessed dynamics of dispersal of the bacteria that caused citrus canker (*Xanthomonas axonopodis* pv. *citri*) in simulated wind-driven rain splash. Aslam and Abid (2007) conducted studies on influence of meteorological parameters in relation to citrus canker disease development on 15 varieties, i.e., Musambi, Chinese line, Malta Succari, Tangrin, Jaffa, Feutrell's early, Sweet Lime, Pine apple, Mungal singh, Blood Red, Grape fruit, Mayer Lime, Kinnow and Valencia Late in Pakistan. He found that the disease development had a significant correlation with relative humidity and rain fall and negative correlation with maximum temperature. The disease development increased with the increase in rain fall and relative humidity and decreased with the increase in maximum temperature. But wind speed and minimum temperature did not effect the disease development significantly.

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