The Bioscan 7(2) : 441-443, 2012
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.in

EPIDEMIOLOGY OF TURMERIC (*CURCUMA LONGA* L) LEAF SPOT CAUSED BY *COLLETOTRICHUM GLOEOSPORIOIDES* (PENZ AND SACC)

S. K. CHAWDA*, A. N. SABALPARA[1] AND J. R. PANDYA[2]
Department of Entomology, N.M.College of Agriculture, Navsari Agricultural University, Navsari - 396 450, Gujarat
[1]Director of Research and Dean PG Studies, Office of the Director of Research,
Navsari Agricultural University, Navsari - 396 450, Gujarat, INDIA
[2]Office of the Director of Research, Sardarkrushinagar Dantiwada Agricultural University,
Dantiwada - 385 506, Gujarat, INDIA
E-mail: sk_pathology@yahoo.com

KEY WORDS
Colletotrichum
Correlation
Multiple linear regressions
Turmeric

Received on :
14.02.2012

Accepted on :
12.06.2012

***Corresponding author**

ABSTRACT
Young crops (2 to 2.5 months) were mostly remained free from the infectivity of the leaf spot. The infection was started during August and attained its peak on completion of major rainfall *i.e.* after 37th MSW. During the major progress (37th to 40th MSW), average temperature remained around 28ºC and 80 per cent relative humidity with moderate rainfall. Correlation coefficient study between weather parameters and disease intensity indicated that all the parameters jointly played an important role in the development of disease. The multiple regression equation [$\overline{Y}$ = 77.39 + 1.04 (X_1) – 3.69 (X_2) – 0.0000000007 (X_3) + 17.32 (X_4) + 17.89 (X_5) - 35.16 (X_6) - 0.014 (X_7) – 1.51 (X_8) where X_1 = Maximum temperature, X_2 = Minimum temperature, X3 = Average temperature, X_4 = Morning relative humidity, X_5 = Evening relative humidity, X_6 = Average relative humidity, X_7 = Rainfall, X_8 = Rainy days] was developed for the forecasting (R = 0.81).

INTRODUCTION

Turmeric (*Curcuma longa* L.) (Family: *Zingiberaceae*) is one of the major spices cultivated for its underground rhizome, which is also called as "hidden Lilly" or "turmeric of commerce". It suffers from a serious foliar disease *i.e.* leaf spot caused by *Colletotrichum gloeosporioides*. In Gujarat, leaf spot caused by *C. gloeosporioides* was first time reported in Sugandham variety by Patel (2005). Since then, it was found increasing and occurring regularly every year. It has become as major constraint in successful cultivation of turmeric in south Gujarat. The disease resulted in drastic reduction in rhizome yield. This reduction in yield was accompanied by a slight increase in the oil content and a moderate increase in curcumin (Nair and Ramakrishnan, 1973). The control of *Colletotrichum* leaf spot (CLS) is difficult because of rapid disease development. Additionally, most of the economic and efficacious fungicides used for the control of CLS are only protectants. Therefore, it is risky to wait for the first disease symptom to initiate spray applications. On the other hand, preventive use of fungicides may represent increased and unnecessary costs. Usually, growers apply fungicides at an interval of 15 days up to the harvest. Our strategy for optimizing disease management is to predict its occurrence. This can be done by monitoring the environmental factors needed for infection. This research was oriented to study the environmental factors that lead to CLS infection and to the need for disease control. The information needed to develop a forecast system for such disease. The knowledge on effect of environmental factors on development and progress of CLS is important in order to device an appropriate and effectual disease management tactic. The farmers of South Gujarat have a preference to grow Sugandham and local cultivars which are found to be highly susceptible to this disease during the survey. Hence, efforts were made to study the effect of weather parameters, to know the time/stage of initiation, progress of leaf spot during the entire crop season, susceptible stage of the crop and window period of the disease.

MATERIALS AND METHODS

To study the effect of different weather parameters on leaf spot of turmeric, this study was carried out at Soil and Water Management Research Unit, Navsari Agricultural University, Navsari during 2008-09 and 2009-10. Fifty plants were tagged for the observation of leaf spot intensity. The normal agronomic practices were adopted to raise the crop except spraying of any fungicides. The observations on leaf spot intensity were recorded starting from the germination to the harvesting of the crop. The disease rating was recorded by adopting 0-6 scale (Palarpawar and Ghurde, 1989) at weekly interval, where 0 = no infection, 1 = 0.1 to 10 per cent

necrotic leaf area, 2 = 10.1 to 20.0 per cent necrotic leaf area, 3 = 20.1 to 30 per cent necrotic leaf area, 4 = 30.1 to 40 per cent necrotic leaf area, 5 = 40.1 to 50 per cent necrotic leaf area, 6 = more than 50 per cent necrotic leaf area (Fig. 1). The disease intensity (PDI) was calculated according to the formula suggested by Datar and Mayee (1981) given as below.

$$PDI = \frac{\Sigma \text{ of rating of infected leaves on plant}}{\text{No. of leves observed x Maximum disease score}} x100$$

RESULTS

Leaf spot intensity was recorded after 81 and 75 days of sowing in susceptible variety Sugandham which was grown at 15th and 27th May of 2008-09 and 2009-10, respectively. Since then, there was linear progress of the disease during both the seasons. It was initiated on 4th August (2.46%) and reached at its highest on 1st December (43.02%) during 2008. In 2009, it was initiated on 24th August (2.11%) and reached at its highest on 7th December (38.51%). There was maximum increase in leaf spot intensity during 8th to 15th September (13.11 to 21.28%) and 28th September to 5th October (17.42 to 26.27%) during 2008-09 and 2009-10, respectively. Hence from 8th September to 5th October can be considered as window period for the leaf spot of turmeric for entire season (Table 1).

Correlation of leaf spot intensity with weather parameters

The disease started appearing in the younger stage of the crop and epidemiological studies were performed right from initiation to harvesting of crop. The leaf spot infection in susceptible cv. Sugandham and corresponding weather parameters at weekly interval were recorded which are presented in Fig. 2. The data trend showed that the disease gradually increased and progressed up to the harvesting stage continuously. The disease was more progressive during 37th to 40th Std. week (12.86 to 26.68%) when maximum, minimum and average temperatures were around 31ºC, 24ºC and 28ºC, respectively; morning, evening and average humidity were around 91, 68, and 80 per cent, respectively; rainfall and rainy days were 50 mm and 2 days respectively (Table 2). Correlation matrix worked out and showed that maximum temperature (0.6124) were significantly and positively correlated while minimum temperature (-0.8604), morning relative humidity (-0.5798), evening relative humidity (-0.8082), average relative humidity (-0.7807), rainfall (-0.5497) and rainy days (-0.6412) were significantly and negatively correlated with the leaf spot intensity. All these factors played an important role in the development of disease. It is very clear from the data that young crop (2 to 5 months) mostly remaining free from the infection of leaf spot. The infection starts during August and attained its peak on completion of major rainfall *i.e.* after 37th MSW. During the major progress (37th to 40th MSW), average temperature remains around 28ºC and 80 per cent relative humidity with moderate rainfall. Thus temperature and humidity plays an important role for the development of disease.

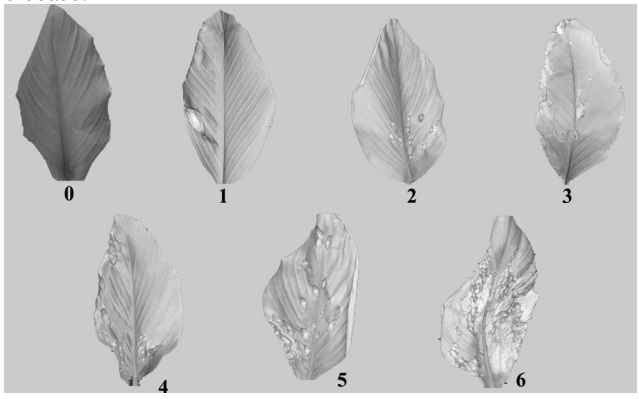

Figure 1: Disease scale (0-6) for turmeric leaf spot
Scale per cent area infection
0 = No infection; 1 = 0.1 to 10.0% necrotic leaf area; 2 = 10.1 to 20%necrotic leaf area; 3 = 20.1 to 30% necrotic leaf area; 4 = 30.1 to 40% necrotic leaf area; 5 = 40.1 to 50% necrotic leaf area; 6 = More than 50% necrotic leaf area

Table 1: Progress in leaf spot during entire crop season in cv. Sugandham under natural conditions during the year 2008-09 and 2009-10 at Navsari

Sr. No.	Std. week	2008-09		2009-10	
		Date of observation	Leaf spot intensity (%)	Date of observation	Leaf spot intensity (%)
1	32	4th August	2.46	10th August	0.00
2	33	11th August	4.03	17th August	0.00
3	34	18th August	6.11	24th August	2.11
4	35	25th August	6.76	31st August	8.09
5	36	1st September	9.76	7th September	10.44
6	37	8th September	13.11	14th September	12.61
7	38	15th September	21.28	21st September	14.22
8	39	22nd September	25.00	28th September	17.42
9	40	29th September	27.09	5th October	26.27
10	41	6th October	30.94	12th October	28.30
11	42	13th October	30.97	19th October	30.81
12	43	20th October	32.48	26th October	31.55
13	44	27th October	35.22	2nd November	33.08
14	45	3rd November	36.75	9th November	33.31
15	46	10th November	38.98	16th November	35.67
16	47	17th November	41.34	23rd November	36.87
17	48	24th November	41.54	30th November	36.35
18	49	1st December	43.02	7th December	38.51

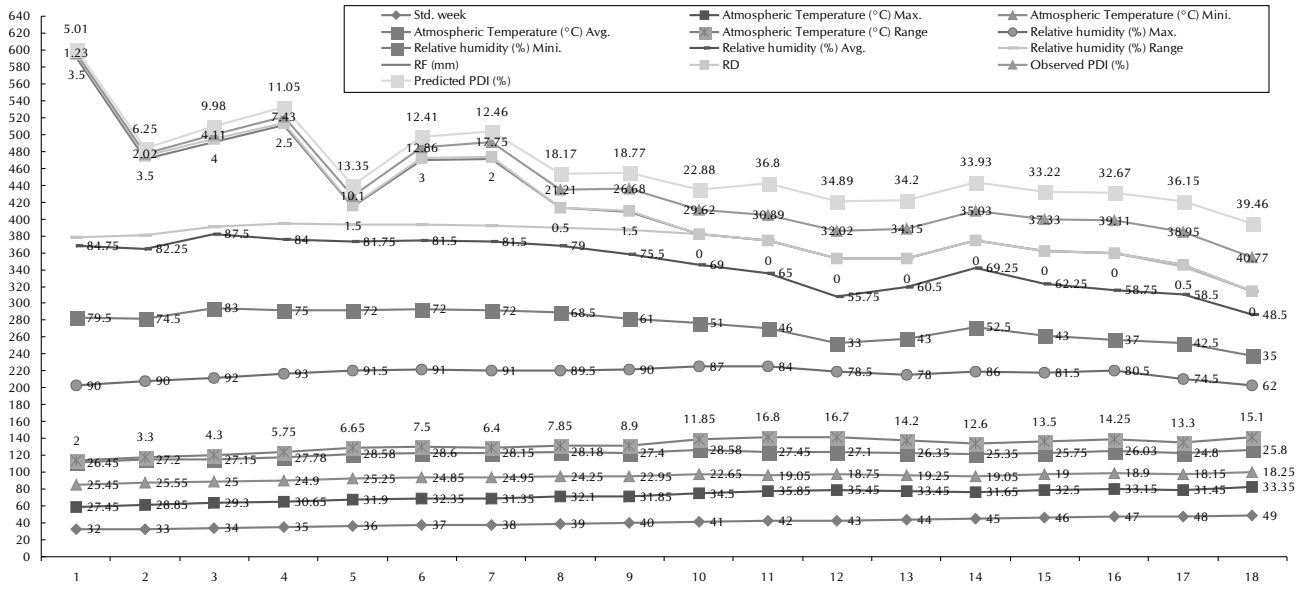

Figure 2: Meterological parameters and leaf spot intensity on turmeric cv. Sugandham in Navsari (Pooled: 2008-09 and 2009-10)
MSW:Meteorological Standard Week;Max.T:Maximum Temperature;Min.T:Minimum Temperature;Avg.T:Average Temperature; Max.RH:Maximum Relative Humidity;Min.RH:Minimum Relative Humidity;Avg.RH:Average Relative Humidity;RF: Rainfall;RD- Rainy Days;PDI: Percent Disease Intensity

Multiple linear regression

The regression co-efficient based on multiple linear regression analysis for percent leaf spot intensity of turmeric with respect to weather parameters have been worked out. The regression co-efficient for maximum temperature was found to be positive and significant. It has been also observed that multiple correlation R value was high (0.81) indicating a strong association between per cent disease intensity and maximum temperature. The co-efficient of determination value was found to be high *i.e.* 69.72 per cent. This clearly indicates that at least 81 per cent of variation in leaf spot intensity can be explained by the function of weather parameters as evident from multiple linear regression equation [$\overline{Y}$ = 77.39 + 1.04 (X_1) – 3.69 (X_2) – 0.0000000007 (X_3) + 17.32 (X_4) + 17.89 (X_5) - 35.16 (X_6) - 0.014 (X_7) – 1.51 (X_8) where X_1 = Maximum temperature, X_2 = Minimum temperature, X3 = Average temperature, X_4 = Morning relative humidity, X_5 = Evening relative humidity, X_6 = Average relative humidity, X_7 = Rainfall, X_8 = Rainy days]. The observed and predicted leaf spot intensity plotted in clearly indicated that both the lines were closer justifying the validity of the regression equation formulated.

DISCUSSION

Results were clearly suggested that the young crop (2 to 2.5 month) was mostly remaining free from the infection of leaf spot. Observed leaf spot intensity and predicted leaf spot intensity found closely related and regression equation established as $\overline{Y}$ = 77.39 + 1.04 (X_1) – 3.69 (X_2) – 0.0000000007 (X_3) + 17.32 (X_4) + 17.89 (X_5) - 35.16 (X_6) - 0.014 (X_7) – 1.51 (X_8). The infection starts during August and attained its peak on completion of major of rainfall. Temperature and humidity plays an important role for the development of CLS infection. After its validation in different turmeric fields and growing season, this forecast system will contribute to improve the control of *Colletotrichum* leaf spot and to reduce fungicide usage. Also the loss caused by the leaf spot can be saved giving forewarning to the farmers and there by controlling the same at proper time. Recently, no work has been done particularly on this aspect as well as crop and it's incitant (*C. gloeosporioides*) also. But, the present research findings are moderately supported the work done by Singh (2006) and Singh (2009).

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