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'T'- shaped Spore Trap Aids to Predict the occurrence of Turcicum Leaf Blight Disease in Maize caused by *Helminthosporium turcicum*

V. Malavika[1], V. Sendhilvel[1]*, R. Kannan[1], R. Ravikesavan[2] and Ga. Dheebakaran[3]
[1]Department of Plant Pathology, Tamil Nadu Agricultural University,
Centre for Plant Protection Studies, Coimbatore (Tamil Nadu), India.
[2]Centre for Plant Breeding and Genetics,
Tamil Nadu Agricultural University, Coimbatore (Tamil Nadu), India.
[3]Agro Climate Research Centre,
Tamil Nadu Agricultural University, Coimbatore (Tamil Nadu), India.

(Corresponding author: V. Sendhilvel)*
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ABSTRACT: Turcicum leaf blight (TLB) or Northern corn leaf blight (NCLB) caused by *Helminthosporium turcicum* Pass. (Syn. *Exserohilum turcicum* Pass.) is one of the destructive disease in maize and causes yield loss up to 70%. During the monsoon season, the rapid outbreak of the disease and spread of the inoculum is causing the disease incidence from 65 to 73%. The primary inoculum is playing vital role for the outbreak of the disease. The present investigation relies on monitoring the inoculum load and interaction with weather factors for the occurrence of TLB. 'T'-shaped spore trap was designed and placed in the maize field to assess the spore load at weekly intervals. The results revealed that the air borne conidia of *H. turcicum* was trapped on 35 days after sowing (DAS) followed by the disease occurrence which was noticed on 7th day after trapping of the spore (*i.e.* 42 days after sowing). The highest spore load and the disease incidence was recorded on 84 DAS fetched with 17th and 18th Standard Meteorological Week (SMW). The correlation and regression analysis revealed that minimum temperature, Relative humidity and dew were played critical role for disease development. The Area under disease progress curve (AUDPC) analysis indicated that the sudden disease progression was noticed on 13th SMW with AUDPC value of 134.05 with AUDPC of 81.5 in the previous week. This finding forewarns the occurrence of the TLB disease based on the inoculum.

Keywords: *H. turcicum*, Spore trap, weather factors.

INTRODUCTION

Maize (*Zea mays* L.) is also known as 'Queen of cereals' and 'Miracle crop' because of its high yielding potential (Kumari *et al*., 2020). It is third commercially cultivated cereals next to rice and wheat. It originated in Mexico which belongs to the family *Gramineae*. In India, it is cultivated in more than 9.72 million hectares with yield of 2945 Kg/hectare (Anonymous, 2020). Maize is used for both food and fodder purposes. Turcicum leaf blight (TLB) or Northern corn leaf blight (NCLB) incited by *Exserohilum turcicum* (Pass) Leonard and Sugg. (Syn. *Helminthosporium turcicum* (Pass)) is considered as an important disease because of its severe infestation under favourable conditions. The perfect stage of this pathogen, *Setosphaeria turcica* (Syn. *Trichometaspheria turcica*) described first by Luttrell in 1957, is rarely found in nature. This disease was first reported by Passerini from Perma, Italy. In India, the disease was first identified by Butler in 1907 from Bihar. Reddy *et al*. (2014) studied the yield losses of Turcicum leaf blight disease and reported that seventy percent of yield losses were due to reduced kernel weight. The disease primarily affects photosynthetic processes, resulting in a decrease in photosynthate production and correspondingly reduced the yield. The pathogen, *H. turcicum* over wintering as mycelium or conidia on the infected plant debris (Levy, 1983). Presence of alternate host crops and volunteer crops acts as primary inoculum and also found to be seed transmissible (Richardson and Noble 1968). The environmental factors such as temperature, relative humidity and rainfall have an impact on disease development and spread. The spread of the disease is influenced by air borne conidia and the severe outbreak was reported by Levy (1983) due to sudden increase of the inoculum. The studies on the device for monitoring the spore load of pathogen is limited and there is no

user-friendly device available at present. Hence, the study was proposed to assess the spore load of *H. turcicum* in maize field and predict the TLB disease under different weather factors.

MATERIALS AND METHODS

Designing of 'T'- shaped spore trap: To monitor the air borne conidia of *H. turcicum* in maize canopy, a spore trap was designed. The trap consisted of microscopic slide platform grooved with holders. The platform was mounted on the iron rod of 180 cm length. The trap was installed in the ground by burying to a depth of 30 cm. From the ground, the first platform was placed at 60cm height and then at 90cm, 120 cm and 150 cm (Fig. 1).

Installation of spore trap in the field:

The maize crop was raised with an area of 80 m^2. The susceptible inbred CM 500 was sown on 28 January 2022. The plant protection and fertilization practices were carried out as per the agronomic practices for maize cultivation. The spore trap was installed one week after sowing. The microscopic slides smeared with vaseline was placed on the platform tilted with opposite orientations. The conidia of *H. turcicum* was confirmed as described by Drechsler (1923) and Meredith (1966). The spore load at ten microscopic fields were assessed and from this final spore load/microscopic field/week was calculated.

Assessment of TLB disease incidence: For measuring the severity of the TLB disease, 25 plants were randomly selected and tagged. The disease severity was recorded by using 1 to 5 scale given by Payak & Sharma (1983) as given below.

1.0- Very slight to slight infection. One or two to few scattered lesions on lower leaves only

2.0- Light infection, moderate number of lesions on lower leaves

3.0- Moderate infection, abundant lesions on lower leaves, few on middle leaves

4.0- Heavy infection, lesions abundant on lower and middle leaves, extending to upper leaves

5.0- Very heavy infection, lesions abundant on almost all leaves, plants prematurely dry or killed by the disease

The percent disease index (PDI) was calculated as described by Wheeler (1969) as follows

$$PDI = \frac{\text{Total sum of individual ratings}}{\text{No. of leaves examined} \times \text{maximum rating}} \times 100$$

Collection of weather parameters: Daily meteorological data were collected from the Meteorological Observatory maintained by Agro Climate Research Centre, TNAU, Coimbatore. The weather parameters, including maximum and minimum temperatures, relative humidity, rainfall and dew were acquired to determine the role of various weather conditions in the disease spread.

Correlation and Regression analysis:

To study the interaction of weather parameters and disease development, correlation and multiple regression analysis were carried out as described by Gomez and Gomez (1984). For this, the average maximum and minimum temperatures, relative humidity, rainfall and dew for the six days preceding disease observation were used.

Analysing Area Under Disease Progress Curve: To study the disease progress, the AUDPC analysis was carried out using the given formula (Wilcoxson *et al*. 1975).

$$AUDPC = \sum_{i=1}^{n-1} \left(\frac{y_i + y_{i+1}}{2}\right)(t_{i+1} - t_i)$$

y_i = Amount of disease at i^{th} time, i ranges from 1 to n

y_{i-1} = Amount of disease at $(i-1)^{th}$ time.

$t_2 - t_1$ = Number of days between two observations.

n = Number of successive evaluation of disease

RESULTS AND DISCUSSION

The conidia of *H. turcicum* was first detected at 9^{th} Standard Meteorological Week (SMW) *i.e*. between Feb 26 to March 4 with the spore load of 0.06 spore/ microscopic field/ week (Table 1). The intensity of conidial load increased gradually and it attains the maximum value nearer to crop maturity. The Turcicum leaf blight disease was reported first in 10^{th} SMW with PDI of 3.2%. These findings revealed that the duration for the spore occurrence and disease incipient was seven days which forewarns the disease development. The sudden spore load increase was recorded at 16^{th} SMW which is accompanied by the average rainfall of 4.28mm. The maximum disease incidence was recorded at 18^{th} SMW with PDI of 53.5%. It is clearly witnessed that 14 days incubation time between the sudden increase of spore load (16^{th} SMW) and the outbreak of the disease (18^{th} SMW). Similarly Meredith (1966) studied and reported that the conidial concentration of *H. turcicum* increases with rainfall in the previous day. Leach (1980) reported that the conidia of *H. turcicum* disperse both in active and passive manner. The passive discharge through the strong wind and high rainfall. The active dispersal of conidia occurs when relative humidity becomes low.

Table 1: Assessment of TLB spore load and disease incidence with weather parameters.

Sr. No.	Weeks	SMW	Spore load*	Tem (max) (ºC)	Tem (min) (ºC)	RH 1 (%)	RH 2 (%)	Rainfall (mm)	Dew	Percent Disease Index (PDI) (%)
1.	1st week (Feb 14- Feb 18)	7	0	31.07	20.9	83.57	43.71	0	0.018	0
2.	2nd week (Feb 19-Feb 25)	8	0	32.86	22.14	83	39.57	0	0.013	0
3.	3rd week (Feb26 - Mar 4)	9	0.06	33.13	19.21	77.57	27.28	0	0.018	0
4.	4th week (Mar 5 - Mar 11)	10	0.13	33.47	21.26	75.71	39.28	0	0	3.2
5.	5th week (Mar12-Mar18)	11	0.47	35.39	21.74	78.71	33.57	0	0	7.5
6.	6th week (Mar 19 - Mar 25)	12	0.87	34.89	23.3	85.86	44.71	0.14	0.067	15.8
7.	7th week (Mar 26 - Apr 1)	13	1.53	35.14	24.14	87.29	44.28	1.17	0.122	22.5
8.	8th week (Apr 2 - Apr 8)	14	1.8	35.42	24.64	82.86	40.43	0	0.036	28.4
9.	9th week (Apr 9 - Apr 15)	15	2	35.02	23.78	84.86	57.43	1.46	0.022	36.4
10.	10th week (Apr 16 - Apr 22)	16	2.8	35.17	24.71	84.43	48.29	4.28	0.071	43.9
11.	11th week (Apr 23- Apr 29)	17	2.87	35.33	25.18	85	46.14	0.14	0.033	51.3
12.	12th week (Apr 30- May 6)	18	2.87	34.93	24.5	83	53.86	0.14	0.006	53.5

SMW – Standard Meteorological Week; * - Spore load/ week/microscopic field; RH 1-Morning relative humidity; RH 2- Evening relative humidity

The simple linear correlation analysis was studied between the environmental factors and TLB disease incidence. It revealed that all the meteorological parameters has a substantial impact on percent disease intensity of Turcicum Leaf Blight disease. The results showed that during the crop season, all the weather factors such as minimum and maximum temperature, morning and evening relative humidity, rainfall and dew had a positive relationship with the severity of Turcicum leaf blight disease (Table 3). Among that, evening relative humidity has a significant positive relation with the disease incidence of TLB. As it is known that, no weather factors can independently influences the Turcicum leaf blight disease. So, the multiple regression analysis will provide additional insight on the influence of various weather factors on this disease. The data was then subjected to multiple linear regression analysis, yielding six regression coefficients of -0.753, 9.732, -2.580, 0.847, 1.352, 24.188 for independent weather variables such as maximum and minimum temperature, morning and evening RH, rainfall and dew, with an R^2 value (i.e. coefficient of multiple determination) of 0.82, indicating 83 percent variation in disease severity due to weather parameters (Table 4). As a result, the congenial weather parameters for the TLB disease was assessed at 30 to 35ºC of maximum temperature, 20 to 25ºC of minimum temperature, 83 to 85% of morning relative humidity, 45 to 53% of evening relative humidity.

Similar results were recorded by Berger (1970); Benedict (1979); Frederikson (1986); Hennessy *et al.* (1990). They reported that the TLB disease epidemic is favoured by high relative humidity and rainfall, moderate temperature and availability of large amount of inoculum. Levy (1983) reported that the conidial germination occurs at 30 to 35ºC and reaches the maximum of 100 percent germination under 20 to 25ºC after two hours of dew. The germination of conidia and its penetration on the maize leaf surfaces occurs in the presence of free moisture in the dark at temperatures ranging from 10 to 35ºC with optimum temperature of 25ºC (Levy, 1984). Nwanosike (2015) reported that Turcicum leaf blight was most influenced by the Relative humidity. Palaversic *et al.* (2012) has shown that the disease occurs in areas where high humidity and moderate to high temperatures occur during three leaf stage to grain development stage.

AUDPC for Turcicum leaf blight on leaves was analysed at weekly interval from the recorded PDI value. AUDPC assessment at weekly intervals gives the information about the weather conditions that favours the disease development. The sudden disease Progression was noticed on 13th SMW with AUDPC value of 134.05. The log Phase was recorded up to 17th SMW i.e. until crop maturity (Table 2). Adipala *et al.* (1993) reported that the AUDPC values can give an estimation about the yield losses due to TLB disease in the field. In maize crop, it is clearly evident that the plant protection measures should be taken soon after assessing the spore load to reduce the yield losses.

Table 2: Area under Disease Progress Curve (AUDPC) for TLB disease in maize.

Sr. No.	SMW	PDI (%)	AUDPC
1.	7	0	0
2.	8	0	0
3.	9	0	0
4.	10	3.2	11.2
5.	11	7.5	37.45
6.	12	15.8	81.55
7.	13	22.5	134.05
8.	14	28.4	178.15
9.	15	36.4	226.8
10.	16	43.9	281.05
11.	17	51.3	333.2
12.	18	53.5	366.8

SMW- Standard Meteorological Week

Table 3: Correlation analysis between TLB disease incidence and weather factors.

	Tem (Max)	Tem (Min)	RH 1	RH 2	Rainfall	Dew	DI
Tem (Max)	1.000						
Tem (Min)	0.981	1.000					
RH 1	0.986	0.980	1.000				
RH 2	0.852	0.912	0.880	1.000			
Rainfall	0.180	0.244	0.188	0.336	1.000		
Dew	0.305	0.370	0.356	0.322	0.505	1.000	
DI	0.382	0.510	0.363	0.627	0.454	0.289	1.000

Table 4: Regression analysis between TLB disease incidence and weather factors.

	Regression equation	R^2 value
TLB disease	Y(DI) = -0.61 – 0.753(max temp)+9.73(min temp) – 2.58(RH1) + 0.847(RH2) + 1.35(rainfall) +24.18(Dew)	0.82

Fig. 1. 'T'- Shaped spore Trap installed in the Maize field.

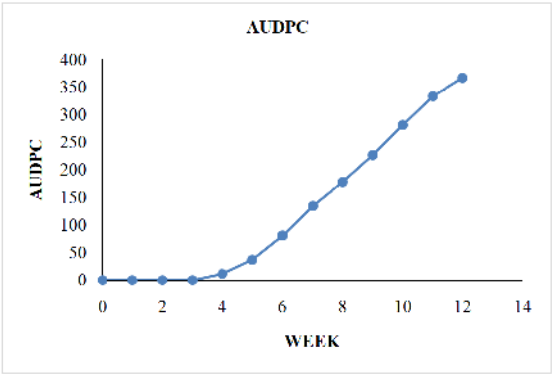

Fig. 2. Area Under Disease Progress Curve for Turcicum Leaf Blight disease in Maize.

CONCLUSION

Turcicum leaf blight disease in maize causes severe blightening, finally drying of the leaves and reduction in grain yield. The 'T'- shaped spore trap was designed that can monitor the spore load earlier and gives the warning about the primary inoculum. The management practices can be done as soon as monitoring the spore which reduces the severity of the disease in the field.

Conflict of Interest. None.

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