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# Epidemiological Studies on Leaf Blights of Maize Caused by *Exerohilum turcicum* (Pass.) Leonard and Suggs and *Bipolaris maydis* (Nisik. and Miyake)

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

The Field experiments conducted at Maize Research Station,Vagarai, Tamil Nadu, India during *kharif* 2019, 2020 & 2021 to study the disease development in relation to weather parameters, *viz*., temperature, relative humidity, rainfall with the leaf blights of maize. Observations on the spore load and disease grade were taken from 33rd standard week to 44th standard weeks at weekly interval. Increased spore load of 13 to 48 Nos. / Microscopic observations for TLB and 3 to 5

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Nos./microscopic observations with the temperature ranges between 22-35◦C, Humidity 48-72% and 19-24° Dew will lead to the TLB & MLB disease incidence with the grade of 1to 4 was observed. Based on the observations, the first appearance of leaf blight diseases were observed between 35$^{th}$ and 45$^{th}$ days after sowing with the grade of 1 (34$^{th}$ meteorological standard week). The disease grade increased from 1 to 4 as the age of the crop increases. There was a sudden increase in disease intensity because of increased scattered showers and increased relative Humidity (44$^{th}$ meteorological standard week). Temperature has not much influenced the disease development, since it was almost uniform throughout the cropping season in these three years. From the dataset, we would like to highlight that 34$^{th}$ and 44$^{th}$ meteorological standard weeks are highly critical for leaf blight disease development. Hence, spraying with mancozeb or zineb @ 2-4 g/l or propiconazole 25% EC @ 1ml/l during 34th and 44th meteorological standard week is recommended to manage the disease during *kharif* seasons in Tamil Nadu.

*Keywords: Temperature; relative humidity; rainfall; number of rainy days; PDI; Turcicum and Maydis leaf blight.*

## 1. INTRODUCTION

The preferred energy cereal maize being utilized approximately 47% in India is being used as poultry feed [1], 13% as livestock feed and 12% to meet the human food demand. “Further, 12% of the maize yield is used for industrial purposes. Maize is helpful in improving the digestive health and reducing the risk of chronic diseases such as cardiovascular disease, diabetes and obesity” [2]. Thus, its' demand is increasing among the populace.

“Turcicum leaf blight is also called as Northern leaf blight of maize caused by *Exserohilum turcicum* (Pass) Leonard and Suggs (Syn: *Helminthosporium turcicum* Pass.) is of global importance” [3]. “The species *Bipolaris maydis* [(Nisikado and Miyake) causing southern corn leaf blight disease (SCLB) is an important pathogen that affects the *Zea mays* species in warm, humid regions of the world” [4]. “The yield loss occurs due to leaf surface lesion increase, compromising the photosynthetic area of plants” [5]. “When favorable environmental conditions provide the multiplication of pathogens, the yield of susceptible maize genotypes can be reduced by more than 70%” [6]. Artificial Intelligence has been used for many applications such as medical, communication, object detection, and object tracking. Disease forecasting systems are one among the AI, will help farmers and other end-users at early stages, as they can help prevent the spread of disease and reduce the use of chemicals. These systems rely on data mining and machine learning techniques to extract knowledge from large datasets with certain features. Any disease is the outcome of an interaction of the pathogen, environment and host. Hsieh et al. [7] created “a classification model for predicting the occurrence rate of rice blast disease based on air temperature and humidity”. Nettleton et al. [8] and Kaundal et al. [9] tried “to predict rice blast severity with a numeric target class, using weather features such as air temperature and relative humidity as input variables”.

“Severe losses in maize grain yield due to epiphytotics have been noticed in various parts of India and these loses vary from 25 to 90 percent depending upon the severity of the disease” [10]. These pathogens are easily wind disseminated and apparently most consistent in their occurrence and severity across the diverse maize growing environments. Keeping this in view, epidemiological study was undertaken to find out how the different weather parameters are influencing the disease and spore load for the incitement of disease by installing “T” shape spore trap inside the field.

## 2. MATERIALS AND METHODS

### 2.1 Field Experiments

Field Experiment was conducted during *Kharif* 2020, 2021 & 2022 at Maize Research Station, Vagarai, Tamil Nadu Agricultural University, which is located at 10.58°N latitude, 77.57°E longitude with an altitude of 254 MSL in the Dindigul region of Tamil Nadu state, India to study correlation of the disease with, weather parameters. Maize hybrid CoHM 6 was sown in 500m$^2$ area in randomized block design with three replications maintaining spacing of 60 cm between rows and 20 cm between plants and designed “T” shape spore trap was fixed inside the maize field at Maize Research Station, Vagarai.

### 2.2 Spore Load Counting and Disease Scoring

The periodical occurrence of the spores and incipient of the spot was recorded and correlated with weekly mean of daily weather parameters. Weather data was collected from Observations on spore load and leaf blight severity were taken at weekly interval starting from the onset of disease till harvesting of the crop following 0-9 scale of Mayee and Datar [11] and further per cent disease index (PDI) was calculated using the formula of Wheeler (1969). Weather parameters were taken from the Observatory of Maize Research Station, Vagarai.

## 3. RESULTS

The effect of weather parameters on the severity of leaf blight development was assessed using the CoHM 6 maize hybrid during *Kharif* 20, 21, 22 at Maize Research Station, Vagarai. The intensity of disease was recorded at weekly interval as described by Mayee and Datar [11]. The data reveals that, the first appearance of leaf blight disease was observed between 35 DAS for MLB and 45 DAS for TLB with PDI of 15% (34$^{th}$ MSW). The PDI was increased from 15% to 50% as the age of the crop increases. There was a sudden increase in PDI from 26% to 50% because of increased scattered showers and increased relative Humidity (44$^{th}$ MSW). Temperature has not much influenced the disease development, since it was almost uniform throughout the cropping season (Tables 1,2,3).

During *Kharif* 2019, average spore load trapped was 4.50 for TLB with the disease incidence of 23.45% and 2.75 for MLB with the disease incidence of 13.50%. Temperature –ve correlation with increase of the disease (22.0°C to 34.75°C). Wind Speed +ve correlation with the increase of the disease (11.5 kmph). Relative Humidity +ve correlation with the increase of the disease (85.75%). Dew +ve correlation with the increase of the disease (21.25°).

During *Kharif* 2020, the average spore load trapped is 8.75 for TLB with the maximum disease incidence of 56.7% and 4.10 for MLB with the maximum disease incidence of 13.8%. Temperature –ve correlation with the increase of the disease (23.4°C to 32.7°C). Wind Speed +ve correlation with the increase of the disease (13.8 kmph). Relative Humidity +ve correlation with the

**Table 1. Leaf Blight Incidences during *Kharif* 2019**

| Sl. No. | Stage of the crop | Type of spore | No. of spore & Grade | | Temperature °C | | Wind kmph | Humidity % | Dew° |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Max. | Min. | | | |
| **1** | 29$^{th}$ MSW | TLB | 5 | 0 | 23 | 34 | 10 | 85 | 21 |
| | (Knee high) | MLB | 3 | 1 | | | | | |
| **2** | 31$^{st}$ MSW | TLB | 3 | 1 | 22 | 35 | 13 | 88 | 22 |
| | (Tasselling) | MLB | 2 | 1 | | | | | |
| **3** | 33$^{rd}$ MSW | TLB | 5 | 1 | 21 | 33 | 12 | 85 | 21 |
| | (Silking) | MLB | 3 | 1 | | | | | |
| **4** | 37$^{th}$ MSW | TLB | 5 | 2 | 22 | 37 | 11 | 85 | 21 |
| | (Milking) | MLB | 3 | 1 | | | | | |

**Table 2. Leaf blight incidences during *Kharif* 2020**

| Sl. No. | Stage of the crop | Type of spore | No. of spore & Grade | | Temperature °C | | Wind kmph | Humidity % | Dew° |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Max. | Min. | | | |
| 1 | 29$^{th}$ MSW | TLB | 10 | 1 | 33 | 22 | 20 | 59 | 17 |
| | (Knee high) | MLB | 2 | 1 | | | | | |
| 2 | 31$^{st}$ MSW | TLB | 26 | 2 | 34 | 22 | 21 | 60 | 18 |
| | (Tasselling) | MLB | 4 | 2 | | | | | |
| 3 | 33$^{rd}$ MSW | TLB | 30 | 2 | 33 | 23 | 15 | 74 | 21 |
| | (Silking) | MLB | 5 | 2 | | | | | |
| 4 | 37$^{th}$ MSW | TLB | 35 | 3 | 30 | 21 | 8 | 60 | 20 |
| | (Milking) | MLB | 4 | 2 | | | | | |
| | | MLB | 5 | | | | | | |

**Table 3. Leaf Blight Incidences during *Kharif* 2021**

| Sl. No. | Stage of the crop | Type of spore | No. of spore & Grade | | Temperature °C | | Wind kmph | Humidity % | Dew° |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Max. | Min. | | | |
| **1** | 29th MSW (Knee high) | TLB | 15 | 1 | 34 | 22 | 43 | 48 | 17 |
| | | MLB | 3 | 1 | | | | | |
| **2** | 31st MSW (Tasselling) | TLB | 25 | 2 | 30 | 25 | 19 | 56 | 18 |
| | | MLB | 5 | 2 | | | | | |
| **3** | 33rd MSW (Silking) | TLB | 45 | 2 | 30 | 23 | 9 | 81 | 21 |
| | | MLB | 5 | 2 | | | | | |
| **4** | 37th MSW (Milking) | TLB | 50 | 3 | 30 | 22 | 8 | 66 | 22 |
| | | MLB | 5 | 2 | | | | | |

increase of the disease (69.4%). Dew +ve correlation with the increase of the disease (23.38°).

During *Kharif 2021*, the average spore load trapped was 8.25 for TLB with the maximum disease incidence of 37.50% and 4.60 for MLB with the maximum disease incidence of 18.30%. Temperature –ve correlation with the increase of the disease (23.44°C to 30.66°C). Wind Speed +ve correlation with the increase of the disease (21.11kmph). Relative Humidity +ve correlation with the increase of the disease (56.22%). Dew +ve correlation with the increase of the disease (19.33°).

**Table 4. Correlation of weather parameters with disease severity**

| Disease | Grade | Temperature | Relative Humidity | Wind | Dew |
|---|---|---|---|---|---|
| Turcicum Leaf Blight | 0.6-3.3 | -0.971061 | 0.956572 | -0.94772 | 0.798118 |
| Maydis Leaf Blight | 1.0-2.0 | -0.838052 | 0.832647 | -0.904853 | -0.693103 |

**Fig. 1. Spore trap for correlation studies of maize leaf blight diseases**

**Table 5. Regression of weather parameters with disease severity**

| Disease | Grade | Temperature | Relative Humidity | Wind | Dew |
|---|---|---|---|---|---|
| Turcicum Leaf Blight | 0.6-3.3 | -1.23X+30.80 | 11.60X+38.50 | -9.28X+37.64 | 0.64X+19.59 |
| Maydis Leaf Blight | 1.0-2.0 | -2.96X+32.99 | -1.3X+24.07 | 28.19X+17.48 | 1.56X+18.41 |

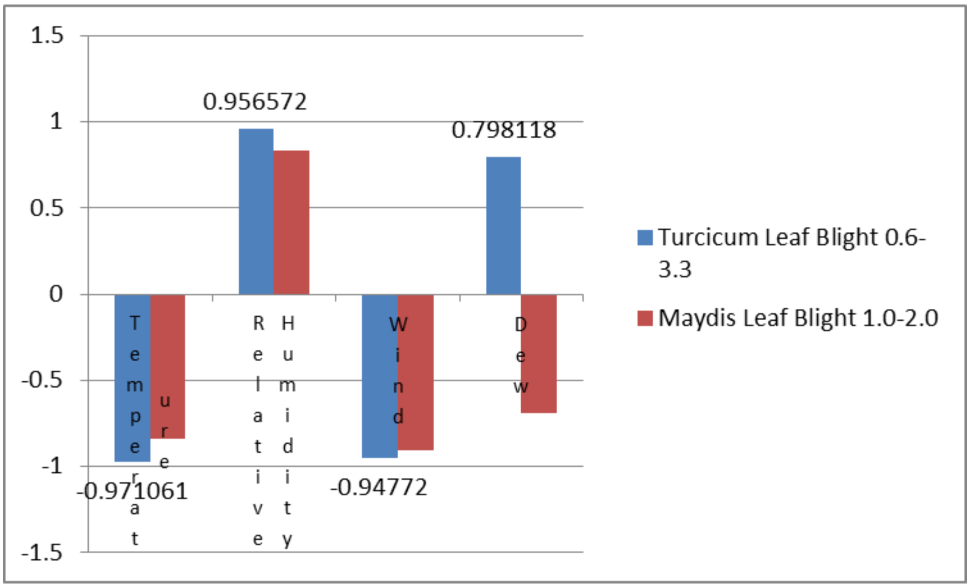


**Fig. 2. Graphical presentation of weather parameters with disease severity**

## 4. DISCUSSION

"Fungal foliar diseases tend to occur epidemically in maize production, particularly northern corn leaf blight (NCLB), southern corn leaf blight (SCLB). NCLB/SCLB can cause destructive and hazardous foliar blight, resulting in over 10% loss in yield. Therefore rapid detection of NCLB damage's prevalence and extent is an urgent problem for corn producers. With accurate detection, NCLB/SCLB may be controlled effectively by applying fungicides and by planting of resistant cultivars. Diagnosis and detection of NCLB are essential preconditions for managing the disease" [12]. To date, traditional naked eye survey of the field is the most popular method to detect NCLB/SCLB in corn production. In India, maize is grown in two seasons, rainy (*kharif*) and winter (*rabi*). *Kharif* maize represents around 83% of maize area, while *rabi* maize correspond to 17% maize area.

Vishal Meti et al., [13] explained earlier occurrence of disease in 63 DAS, 48 DAS and 80 DAS, hence the role of meteorological factors in disease is supported. In the lead time concept, the results indicated that weather variables viz., the morning relative humidity at top of canopy, morning relative humidity at middle of canopy and morning relative humidity at bottom of canopy as well as with the afternoon relative humidity in the observatory and they could explain the variability in disease incidence to an extent of 82 per cent is the best for the forewarning of turcicum leaf blight (TLB) disease.

Based on the spore load and weather parameters observed in this region, spore load / microscopic field, temperature –ve correlation with the increase of the disease, wind Speed -ve correlation with the increase of the disease, relative humidity +ve correlation with the increase of the disease, dew +ve correlation with the increase of the disease and scattered showers will play vital role for the incitement of *turcicum* and *maydis* leaf blights (Table 2). Harlapur et al., [14] reported that high rainfall coupled with low temperature during September increased the incidence of TLB and caused significant yield loss. Kiran et al., [15] indicated that, significantly positive correlation was observed with morning and evening relative humidity, rainfall and number of rainy days without any association with maximum and minimum temperature at 0.01 level. Pandurangegowda et al., [16] also observed that "the incidence of TLB in maize increased from June to October". Pandurangegowda et al., [17] studied "the incidence of *E. turcicum* on the susceptible cv. CM-201 sown at fortnightly intervals and reported that meteorological factors like temperature 22 to 38°C, relative humidity 72 to 98 per cent and rainfall 134 to 165 mm were correlated with increased disease intensity". The TLB incidence ranges from 10% to 50% and MLB 10% to 25% were positively correlated with relative humidity ranges from 45% to 75%, dew ranges from 20% to 22% along with drizzling and when the temperature coming down from 30ºC to 27◦C. Meena Shekhar and Nirupma Singh, [18] stated that TLB Overwinters as mycelium and chlamydospores on debris and sporulate when cool/moderate temp. (18–27°C) coupled with high humidity and Warm & humid conditions temp (20–32°C), damp condition favours severe infection causes a premature death and up to 83% yield reductions due to MLB.

From these three years data, we would like to propose hypothesis is the first appearance of leaf blight disease was observed between 35th and 45th days after sowing with PDI of 15% (34th meteorological standard week). The PDI was increased from 15% to 50% as the age of the crop increases. There was a sudden increase in PDI from 26% to 50% because of increased scattered showers and increased relative Humidity (44th meteorological standard week). Temperature has not much influenced the disease development, since it was almost uniform throughout the cropping season. Leaf blight Incitement prevails with the following parameters viz., a. Occurrence of the spore – 4.0 to 8.0 /microscopic field, b. Relative humidity – 42 to 81%, c. Minimum temperature – 25 to 34 °C, d. Dew fall – 17 to 21, e. Rain fall- Scattered showers. Hence, Spraying of mancozeb or zineb @ 2-4 g/l or propiconazole 25% EC @ 1ml/l during 34$^{th}$ and 44$^{th}$ meteorological standard week might be practiced to manage the leaf blights is the strategy formulated from these studies.

Similar observations were found by Kiran et al., [15], Frederiksen, [19] as significantly positive correlation was observed with morning and evening relative humidity, rainfall and number of rainy days without any association with maximum and minimum temperature at 0.01 level in Leaf blight caused by the *Exserohilum turcicum* affecting the sorghum.

## 5. CONCLUSION

Increased spore load of 5-10 Nos. / microscopic observations with the temperature ranges between 22-34◦C, Humidity 48-81% and 17-22° Dew accompanied with scattered showers will be the conducive environment for the incitement and development of TLB & MLB disease incidence with the grade of 1 – 4.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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