International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

Effect of Weather Parameter in the Spread of TLB Disease and Epidemiology of (*Exserohilum turcicum*) of Maize (*Zea mays L.*)

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Abstract: ***Maize (Zea mays L.) is one of the important cereal crop of the world. It belongs to family Poaceae and ranking the world's third cereal crop after wheat and rice. It is also consider as queen of the cereal. Maize grains are widely used for human consumption; poultry feed livestock, edible oil extraction and also helpful in starch and glucose production industry. Yield of maize was reduced as much 86 percent when weeds were not controlled in maize cultivation in our countries. Maize (Zea mays L.) also called as corn. It became a staple food in many parts of the world. Production of maize being reduces due to one of the important disease that is TLB caused by Exserohilum turcicum. The infected maize plants exhibits typical symptoms of long spindle shaped necrotic lesions with grey colour centre, immature and chaffy ears. The turcicum leaf blight disease reduces the green chlorophyll area of plant which manufactures food for the plant. If considerable leaf area reduces results in loss of the vigour, restrict formation of starch which results in chaffy kernels and ultimately reduces the yield. TLB disease directly affected by many abiotic factors. The finding of this paper reveals that abiotic factors such as temperature, humidity, rainfall and wind are beeline helpful in the spread of TLB in maize. Maximum disease severity was noticed in the months of June and July when temperature ranges about (25-30^{o}C), humidity (75-90%). and rainfall 46 mm. When these parameters fluctuate, temperature more than 30^{o}C, humidity 75% than the severity of disease become low. This present finding reveals the positive and negative correlation of disease in maize.***

Keywords: Disease, *Exserohilum turcicum*, humidity, parameters, TLB

1. Introduction

The TLB caused by *E. turcium* (Pass.) Leonard and suggs, is an important, foliar disease on maize and quite often it attains epidemic form in the maize growing areas of India.

Turcicum leaf blight (TLB) of maize caused by *Exserohilum turcicum* (Pass.) Leonard and Suggs is an important foliar disease apart from leaf spots, rusts and stalk rot in almost all maize growing regions of India. The maize growing regions in Karnataka, Andhra Pradesh, Bihar, Maharashtra, Uttaranchal and Tamil Nadu have been identified as endemic areas for the disease, where reduction in yield has been to the extent of 98 percent. Payak and Renfro (1968) reported turcicum leaf blight epidemics at an early stage causing premature death of blighted leaves which lose their value as fodder. Among the foliar diseases of maize, the Turcicum leaf blight (TLB) also called as Northern corn leaf blight caused by *E. turcicum (*Pass.) Leonard and Suggs. (syn. *Helminthosporium turcicum* Pass.) is of worldwide importance (Carlos, 1997). More than 50 percent loss in grain yield was reported in USA (Robert, 1953; Raymundo and Hooker, 1981). The turcicum blight injures reduces the area of green chlorophyll and leaf tissues which is helpful to produce food for the plant. If considerable leaf area reduces results in loss of the vigour, restrict formation of starch which results in chaffy kernels and ultimately reduces the yield. Pant *et al*., *(*2001) who reported about 91 percent reduction in the rate of photosynthesis when severity of TLB in maize exceeded 50 percent.

In maize, TLB is caused by *Helminthosporium turcicum* Pass. F was first reported by Passerini (1876) in Italy. Later on, Pammel *et al*. (1910) and Drechsler (1923) confirmed it to be the same as *Trichometasphaeria turcica* Luttrell. Further, Leonard and Suggs (1974) renamed it as *Setosphaeria turcica* and described the conidial stage as *E. turcium*in which the conidial hilum is strongly protuberant. In India, the disease was for the first time reported by Butler during (1907) from Bihar. Later it was reported from many parts of the country, viz., Lalmardi, Srinagar Kaul (1957), Punjab Mitra (1981), Himachal Pradesh Chenulu and Hora, (1962) and Kashmir Valley Payak and Renfro (1968). The sexual stage of the fungus *Trichometasphaeriaturcica* Luttrel rarely occurs in nature Lutrell (1958). The causal agent of TLBis identified due to its imperfect stage i.e. *E. turcium*on maize. Leonard and Suggs (1974) have proposed the new nomenclature of the organism as *E. turcium* (Pass.) Leonard and Suggs (imperfect stage) and *Setosphaeria* turcica (Lutrell) Leonard and Suggs (perfect stage). *E. turcium* having their taxonomic position is division Eumycota, sub-division Deuteromycotina, order Moniliales and family Dematiaceae. The teleomorph *Setosphaeria* turcica belongs to division Eumycota, sub-division: Ascomycotina, order:

Pleosporales and family: Pleosporaceae. Conidia of the fungus are olive grey and spindle shaped, measuring 5 x 20 cm with one to nine septa. *E. turcium*is well identified by the presence of specific protruding hilum. Pelmus *et al., (*1986) studied the incidence of TLB on maize was favored by relative humidity greater than 80 percent, average daily temperature greater than 25°C, delayed sowing and high plant density. Sharma and Mishra (1988) reported that, disease appeared during fourth week of November when temperature was 21.10°C and relative humidity 75.20 percent. Leaf blight was positively correlated with temperature and negatively correlated with relative humidity in sowing dates from 21st October to 21st December. However, disease development was slow in December-January sowings.

Khatri (1993**)** reported that in Georgia and Russia, the most favourable conditions for development of maize leaf blight were 22 to 25°C temperature and 75 to 90 percent relative humidity.

Harlapur *et al., (*2000) found that high rainfall coupled with low temperature during September increased the incidence of TLB and caused significant yield loss. Further they showed that, the weather factors like lower temperature, high relative humidity and rainfall favoured the development of disease from July to October. The disease assumed serious proportions in crops sown between 1st August and 16th September. The intermittent rains during this period resulted in lower air temperature and higher relative humidity, cloudy weather and long leaf wetness which predisposed the crop to infection and further spread of the disease. In subsequent sowing beyond 16th December, TLB incidence reduced considerably probably due to no rainfall or less rainfall, higher temperature and lower relative humidity.

The environmental parameters had definite relations with the disease development with the maximum initial disease incidence (100%) and significant disease severity (4.00) was recorded during February (Rai *et al.,* 2002b).

In the starting of disease, symptoms can be seen on the leaves are small elliptical spots which are greyish green in colour and water soaked lesions. At the age the spots turn greenish become larger in size and at last change into spindle shape. Individual spots are usually 4cm wide and 2cm to long. Spores of the fungus develop abundantly on both sides of the spot. Heavily infected field present a scorched appearance (Chenulu and Hora, 1962). Ullstrup (1966) described the symptoms of the disease in United States. The disease is recognised by long elliptical greyish or tan lesions. When fully expanded, the spots may be 1cm by in size. These lesions appear first on the lower leaves and as the season progresses, the lesion number increases and all the leaves are covered. The plants look dead and grey.

Nieuwoudt *et al., (*2018) was to compare the genetic structure of *E. turcicum* isolates and collected from adjacent maize and sorghum fields in Delmas and Greytown in South Africa. The mode of reproduction of this pathogen was also investigated. Isolates from maize (N = 62) and sorghum (N = 64) were screened with 12 microsatellite markers as well as a multiplex mating type PCR assay. Analysis of molecular variance indicated higher among-population variation when comparing populations from different hosts, than comparing populations from different locations. Lack of shared haplotypes, high proportion of private alleles, greater among-population variance between hosts than locations and significant pair wise population differentiation indicates genetic separation between isolates from maize and sorghum. The high haplotypic diversity in combination with unequal mating type ratios and significant linkage equilibrium indicates that both sexual and asexual reproduction contributes to the population genetic structure of *E. turcicum* in South Africa.

Several studies were conducted on the effect of abiotic factors for the development of the disease. abiotic factors such as temperature, rainfall, humidity, wind were reported positive correlation for the spread of disease. Fungus growth rate is completely dependent on abiotic factors. Severity of disease can be seen when temperature ranges in favour of the pathogen development.

2. Materials and Method

The TLB injures reduces the area of green chlorophyll and leaf tissues which are helpful to produce food for the plant. If considerable leaf area reduces results in loss of the vigour, restrict formation of starch, which results in chaffy kernels and ultimately reduces the yield.

Collection of diseased samples: The leaves of maize plants severely infected by *E. turcium (*Pass.) Leonard and Suggs showing typical symptoms of TLB necrotic lesion were collected from maize fields.

Table 1: Procedure of recording disease reaction: The scale consists of five broad categories designated by numerical 1 to 5 Payak and Sharma (1983)

Grade	Infection type	Percent damaged area	Reaction
1	Very slight to slight infection, one or two to few scattered lesions on lower Leaves	0 - 5	Highly resistant
2	Light infection, moderate number of lesions on lower leaves only	5.1 - 15	Resistant
3	Moderate infection, abundant lesion on lower leaves, few on middle leaves	15.1 - 30	Moderately Resistant
4	Heavy infection, lesions abundant on lower and middle leaves, extending to upper leaves	30.1 - 75	Susceptible
5	Very heavy infection, lesions abundant on almost all leaves, plants prematurely dry or killed by the disease	> 75	Highly susceptible

$$PDI = \frac{Sum\ of\ all\ individuals\ disease\ ratings}{Total\ no.of\ plants\ observed\ x\ Max.grade} X100$$

Epidemiological of TLB Conidial germination of *E. turcium* at various incubation periods: The germination of conidia was studied from 4 to 36h at an interval of 4h incubation period. 15 days old culture of *E. turcium*s pore suspension (10^6spores/ml) was prepared in sterilized tap water. A drop of spore suspension was placed on clean sterilized cavity slides. Such slides were kept in moist chamber at room temperature. Observations on spore germination were recorded at 4, 8, 12, 16, 20, 24, 28, 32 and 36 hours after incubation. Three replications were maintained for each treatment. From each slide, 100 spores count was taken and calculated for percent germination and data were analyzed statistically.

Survival of the pathogen in soil: The survival of *E. turcium* infected plant debris and sorghum grain meal culture was carried out both in sterilized and unsterilized soils at 5 cm and 10 cm depth. 250 grams of soil was filled in 500 ml conical flasks and sterilized at 1.10 kg per cm^2 pressure for 2h. Unsterilized soil was also used separately. The diseased leaves were cut into pieces of one cm^2size and kept in nylon pockets of three cm^2size. Similarly, 10 grams of *E. turcium* multiplied on sorghum grain culture was also placed in 2 kg polythene cover. These pockets were buried at 10 cm depth into conical flasks containing sterilized and unsterilized soils separately. The soil moisture was maintained at 30 percent on oven dry basis. Such inoculated flasks were incubated at room temperature for further observations. The culture and infected leaf pieces were recovered and plated at monthly interval on selective medium containing potato agar, carbendazim, streptomycin sulphate and terramycinhydrochloride maintained for each treatment. From each slide, 100 spores count was taken and calculated for percent germination and data were analyzed statistically.

Influence of weather factors on TLB of Maize: A field experiment was laid out with susceptible cultivar CM-202 in randomized block design with a plot size of 5 m x 4 m. Sowing was done in the month June 2020. The disease severity was recorded using 1-5 scale from the date of sowing at weekly interval till grain maturity stage.

3. Results and Discussion

Symptomatology: TLB infected maize plants produced characteristic symptoms such as water soaked light green spindle shaped lesions followed by long, elliptical, grayish green or tan lesions measuring 5 to 15 cm in length and 2 to 4 cm width. The lesions first appeared on the lower leaves and increased in size. In high relative humidity condition, lesions may be covered with masses of dark green conidia of the fungus. The conidia are olive grey and brownish and spindle shaped with 1 to 9 septations. The disease progressed upwards till maturity and destroyed large photosynthetically active leaf area, giving the plant a scorched or burnt appearance and led to premature killing of leaves (Plate1 - Plate3).

The present findings are supported by the research work of Harlapur *et al.*, (2000) who reported that high rainfall coupled with low temperature during September increased the incidence of TLB and caused significant yield loss. Pandurangegowda *et al.*, (1994) also observed that the incidence of TLB of maize increased from June to October. Meteorological factors like temperature (22-38°C), relative humidity (72-98%) and rainfall (134-165 mm) have shown highly significant correlation with disease intensity.

The present results are also conformity with the observations of Sharma and Mishra (1988), Khatri (1993) and Rai *et al.*, *(*2002b) who reported that frequent rainfall, high relative humidity and low temperature were favourable for both vertical and horizontal spread of the disease. Anahosur *et al.*, *(*1982) also observed similar results in case of sorghum rust. Thus, it is established that the meteorological factors, *viz*., temperature, relative humidity and rainfall above as well as interaction of these factors play a significant role in epidemiology of turcicum leaf blight of maize.

Influence of weather parameters on severity of TLB of maize:

Environmental factors play an important role in development of the disease. In the present study, the results revealed that, the weather factors such as lower temperature, high relative humidity and rainfall favoured the development of disease from September to December (Fig-1). The disease assumed serious proportions in crops sown between 10^{th} July and 25^{th}July.

On 25^{th} June sown crop, rainfall of 35 mm and temperature of 34.2^{o}C with a relative humidity varies from of (87-75%) favoured the TLB (Fig.2, Table-2). On July 10^{th} s own crop (Fig. 3, Table-3) maximum temperature of 29.9^{o}C with daylight duration of 13.2 h recorded the maximum disease. On 25^{th}July sown crop (Fig-4, Table-4) daylight duration played a positive role in disease progress. Similarly, on 10^{th} and 25^{th}August sown crop, sunshine, wind speed and relative humidity during morning respectively favoured the TLB development.

In this cropping season, maximum cumulative rainfall was recorded during October along with higher average relative humidity of more than 75 percent with the diurnal temperature of 21.8 to 30°C, which helped in the occurrence and progress of disease. (Table 2, 3 and 4). Factors play a significant role in epidemiology of TLB of maize.

The present findings are supported by the research work of Harlapur *et al.*, *(*2000) who reported that high rainfall coupled with low temperature during September increased the incidence of TLB and caused significant yield loss. Pandurangegowda *et al.*, *(*1994) also observed that the incidence of TLB of maize increased from June to October. Meteorological factors like temperature (22-38°C), relative humidity (72-98%) and rainfall (134-165 mm) have shown highly significant correlation with disease intensity.

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4. Conclusion

Effect of weather factors on TLB, the minimum temperature (16.10-20.70°C), maximum temperature (29.9-30.50°C) and relative humidity (76.00-84.00%); rainfall (46mm), Sunshine (6.2-13.2) h. and wind speed (4.3-7.2 km/h) were found to be highly TLB of favourable for disease development.

Acknowledgement
The author would like to thank Dr. Syed Aasif Hussain Andrabi, Associate Professor in Glocal University, Saharanpur, UP. and Dr. Virendra Kumar, Assistant Director (PP), Locust Warning Organisation, Jodhpur for their constant support, valuable time and innovative ideas for this research work.

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Plate 2: General view of the experimental plot of different dates of sowing

A. Highest severity of TLB on 25th July sown maize

B. Lowest severity of TLB on 25th August sown maize

Plate 3: Severity of TLB of maize on different dates of sowing

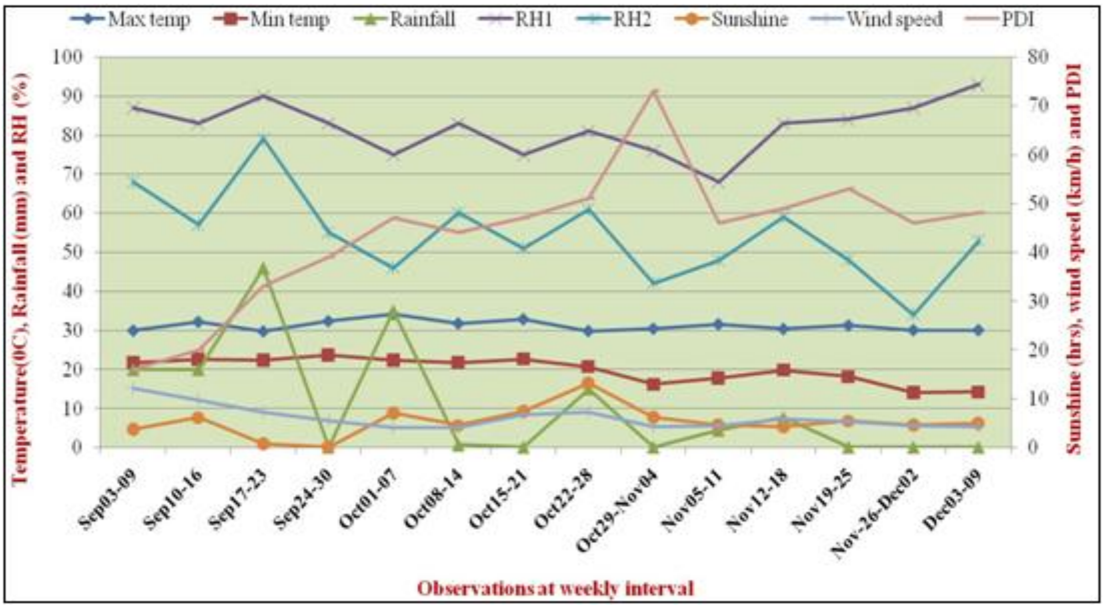

Figure 1: Influence of weather parameters on severity of TLBat different dates of sowing during 2020

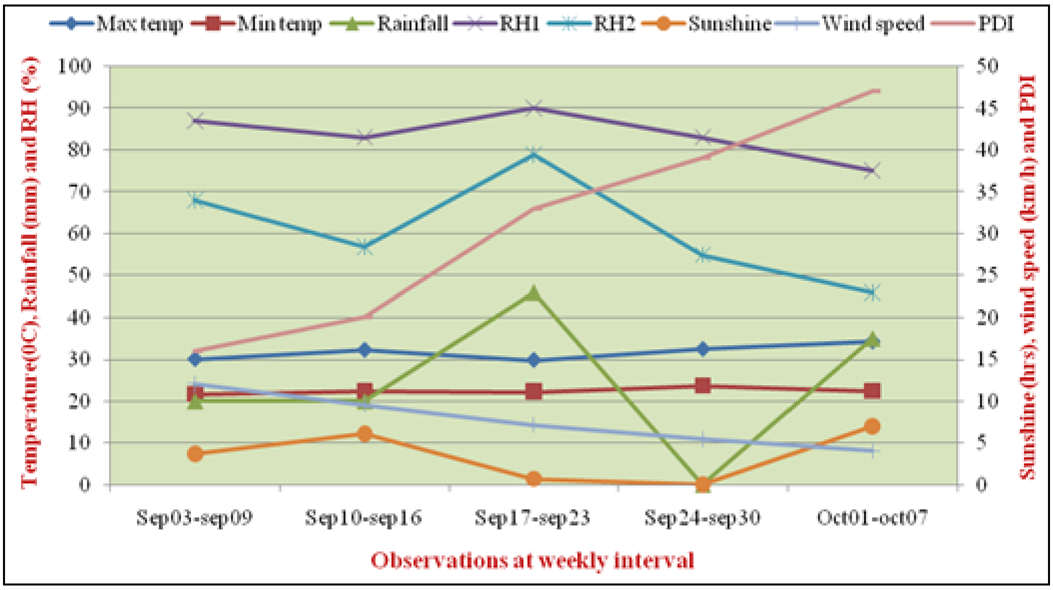

Figure 2: Influence of weather parameters on severity of TLBof maize sown during 25th June, 2020

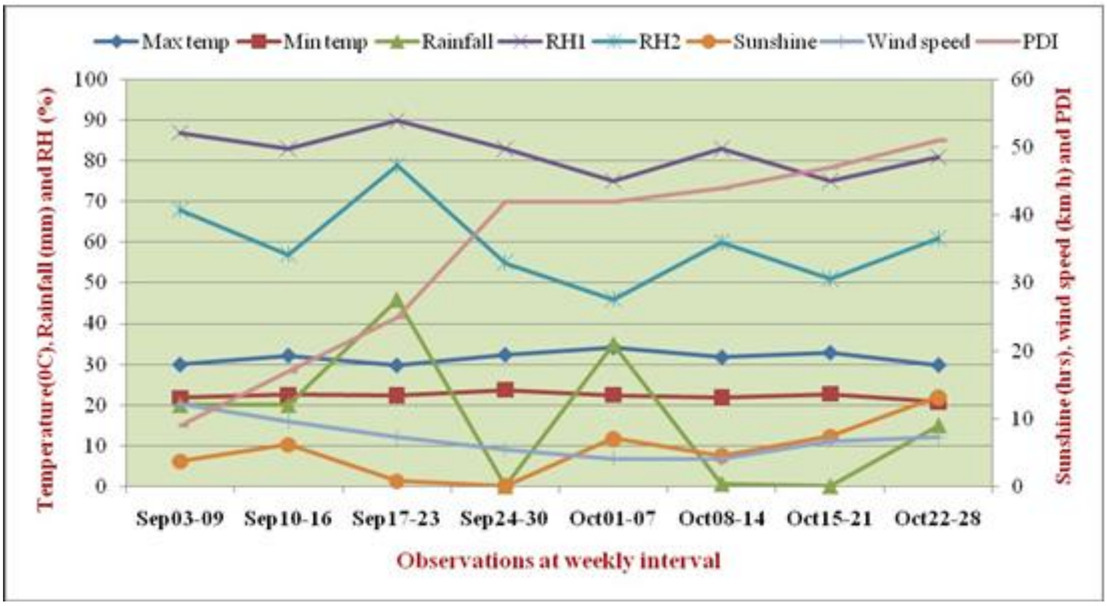

Figure 3: Influence of weather parameters on severity of TLB of maize sown during 10th July, 2020

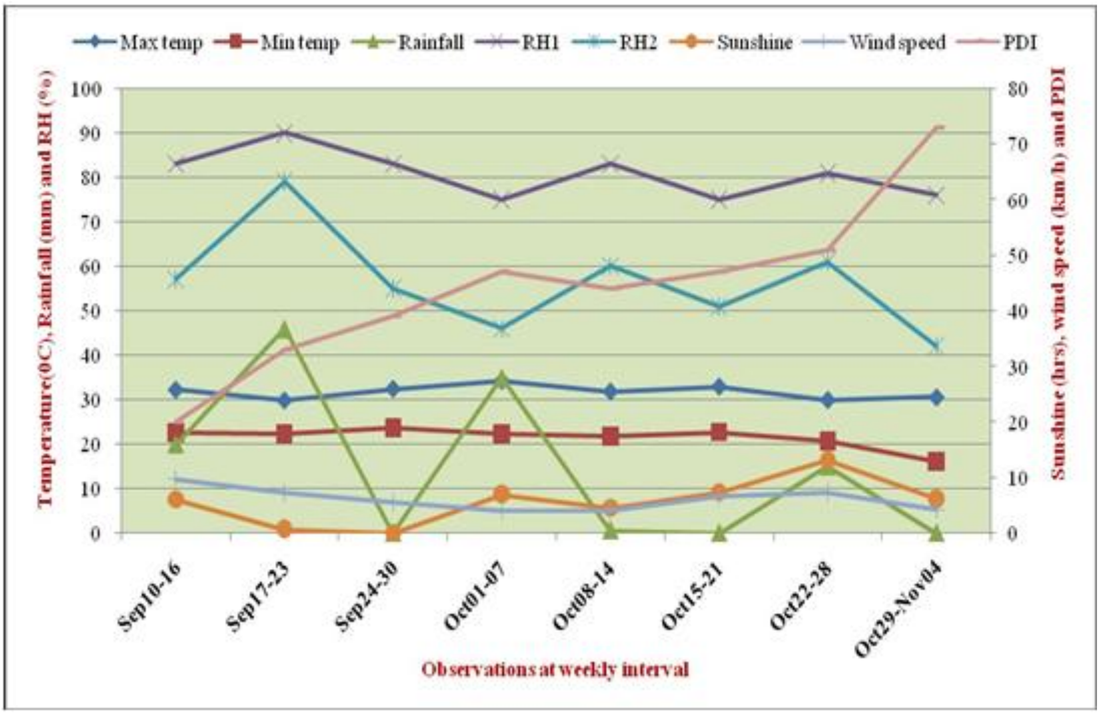

Figure 4: Influence of weather parameters on severity of TLB of maize sown during 25th July, 2020

Table 2: The data of weather parameters and percent disease index of TLB of maize during the crop sown on June 25th, 2020

Standard week	Dates	Temperature (^{o}C)		Rainfall (mm)	Relative humidity (%)		Sunshine (h)	Wind speed (km/h)	PDI
		Max	Min		RH 1	RH 2			
36	Sep 03-09	30.00	21.70	20.00	87.00	68.00	3.70	12.10	16.00
37	Sep 10-16	32.20	22.50	20.00	83.00	57.00	6.10	9.60	20.00
38	Sep 17-23	29.80	22.30	46.00	90.00	79.00	0.70	7.20	33.00
39	Sep 24-30	32.40	23.70	0.00	83.00	55.00	0.00	5.50	39.00
40	Oct 01-07	34.20	22.40	35.00	75.00	46.00	7.00	4.10	47.00

Table 3: The data of weather parameters and percent disease index of TLB of maize during the crop sown on July 10th, 2020

Dates	Temperature (^{o}C)		Rainfall (mm)	Relative humidity (%)		Sunshine (h)	Wind speed (km/h)	PDI
	Max	Min		RH 1	RH 2			
Sep 03-09	30.00	21.70	20.00	87.00	68.00	3.70	12.10	9.00
Sep 10-16	32.20	22.50	20.00	83.00	57.00	6.10	9.60	17.00
Sep 17-23	29.80	22.30	46.00	90.00	79.00	0.70	7.20	25.00
Sep 24-30	32.40	23.70	0.00	83.00	55.00	0.00	5.50	42.00
Oct 01-07	34.20	22.40	35.00	75.00	46.00	7.00	4.10	42.00
Oct 08-14	31.80	21.80	0.60	83.00	60.00	4.50	4.10	44.00
Oct 15-21	32.90	22.70	0.00	75.00	51.00	7.40	6.70	47.00
Oct 22-28	29.90	20.70	15.00	81.00	61.00	13.20	7.20	51.00

Table 4: The data of weather parameters and percent disease index of TLB of maize during the crop sown on July 25th, 2020

Standard week	Dates	Temperature (^{o}C)		Rainfall (mm)	Relative humidity (%)		Sunshine (h)	Wind speed (km/h)	PDI
		Max	Min		RH 1	RH 2			
37	Sep 10-16	32.2 0	22.50	20.00	83.00	57.00	6.10	9.60	20.00
38	Sep 17-23	29.80	22.30	46.00	90.00	79.00	0.70	7.20	33.00
39	Sep 24-30	32.40	23.70	0.00	83.00	55.00	0.00	5.50	39.00
40	Oct 01-07	34.20	22.40	35.00	75.00	46.00	7.00	4.10	47.00
41	Oct 08-14	31.80	21.80	0.60	83.00	60.00	4.50	4.10	44.00
42	Oct 15-21	32.90	22.70	0.00	75.00	51.00	7.40	6.70	47.00
43	Oct 22-28	29.90	20.70	15.00	81.00	61.00	13.20	7.20	51.00
44	Oct 29-Nov 04	30.50	16.10	0.00	76.00	42.00	6.20	4.30	73.00