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Epidemiological Studies on Various Weather Parameters for Development of Brown Spot Disease in Sugarcane

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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

Availability of susceptible host and prevalence of favorable weather condition play important role in the process of disease development, dissemination of diseases and favour epidemics. Epidemiological studies on brown spot disease of sugarcane will gave an idea about the time of occurrence, development, survival of the pathogen in nature and intensity of particular disease on specific location based on various weather parameters which may help us to formulate the management strategy. A field trial on epidemiological studies was conducted during *Suru*-2023 at Central Sugarcane Research Station, Padegaon farm, Tal. Phaltan Dist. Satara on highly

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susceptible cv. CoM 0265 in natural condition. Different weather parameters were explored by correlation and regression analysis to find out their contribution to infection and development of the brown spot disease of sugarcane. Epidemiological studies under field conditions revealed that, the first appearance of brown spot disease of sugarcane on susceptible cultivar CoM 0265 was recorded during third week of July. During 2023, correlation matrix showed that, maximum temperature, relative humidity (morning), and bright sunshine were the three significant factors that showed a significantly positive correlation. Rainfall also showed a positive correlation. However, minimum temperature, relative humidity (evening) and wind speed showed significantly negative correlation with correlation coefficient.

Keywords: Sugarcane; epidemiological studies; Per cent disease intensity (PDI) and weather.

1. INTRODUCTION

Sugarcane is a major commercial crop grown in tropical and subtropical regions of the country. Climate is most crucial and dependent factor for proper growth and yield of sugarcane. The sugarcane plant is subjected to a wide variety of climatic variables, including humidity, temperature, sunshine, and rainfall, over a duration of 12 to 24 months. Each of these elements has an impact on the quality, plant's growth and yield of sugar. Certain meteorological conditions with the right parameters are necessary for the robust growth and abundant output of plants. The sugarcane industry confronts numerous hurdles for decreasing productivity of sugarcane includes floods, drought, water logging, weed, diseases and pests, etc. Among them, diseases of sugarcane have been found the most devastating and widespread yield reducing factors that tremendously depreciate the crop qualitatively and quantitatively. During the last centenary, the country has witnessed epidemics of various stalk infecting fungal, viral and bacterial diseases. Each epidemic has a different impact on sugarcane based on the kind of diseases present and the distribution of the afflicted cultivars (Gopi et al., 2021; Chaulagain et al., 2020). Several sugarcane cultivars were removed from cultivation and replaced because they were liable to get an unfamiliar disease or pathogenic strain. In contrast to diseases that infect the stalk, foliar diseases are primarily specific to a certain variety and are seasonal, occurring during the monsoon and post-monsoon seasons. It has been discovered that certain foliar diseases, such as eye spot, brown spot, rust, and others, only affect sugarcane in high humidity regions or at particular seasons of the year. However, the severity of the disease is increased when vulnerable types are planted in areas where it is prevalent. In recent years, we have seen a serious brown spot outbreak brought on by *Cercospora longipes*. The fungus *Cercospora longipes* E. Butler, which causes brown spot, was once thought to be a minor harm but has recently become a major one (Gopi et al., 2023; Ganapathy & Jayakumar, 2023; Ganapathy et al., 2024). It sporadically becomes a major disease that occurs in a particular season of the year or is limited to areas with high rainfall and humidity, such as Maharashtra's main sugarcane growing areas (Viswanathan & Ashwin, 2020).

Availability of susceptible host and prevalence of favorable weather condition play important role in the process of disease development. Over the past three to four years, the brown spot (*Cercospora longipes*) which was previously negligible in sugarcane, has grown significantly, resulting in a reported loss of 12 to 20% in sugar quality and recovery and significant reduction in sugar yield in areas where the brown spot disease was pervasive (Viswanathan & Ashwin, 2020).Review of pertinent literature indicates that very meager work was done on this disease in Maharashtra state, where disease is changing its status from minor to major. The fact that foliar diseases in sugarcane cause less economic damage than stalk diseases may be the reason for the paucity of scientific studies on the subject. This was made to draw attention of sugarcane scientists to initiate some work. Hence, there is a scope for initiate the fascinating field of research with a prime objective to Epidemiological studies on brown spot will give an idea about the relationship of weather parameters for disease occurrence, development, survival of the pathogen in nature and developed technology for pathogen management. Early disease detection and treatment are necessary to minimize the spread of the disease across the whole sugarcane crop (Ratnasari et al., 2014).

2. MATERIALS AND METHODS

A field trial on epidemiological studies was conducted during *Suru*-2023 at Central

Sugarcane Research Station, Padegaon farm, Tal. Phaltan Dist. Satara on highly susceptible cv. CoM 0265. All the recommended agronomical package of practices were adopted for raising the crop. No plant protection measures were taken in this plot. The meteorological data were recorded from meteorological observatory of CSRS, Padegaon. The weekly observations on weather parameters *viz.,* maximum temperature (°C), minimum temperature (°C), morning relative humidity (%), evening relative humidity (%), and sunshine hours per day, total rainfall in mm and wind speed km/hr were recorded. The 20 randomly selected plants on which the brown spot appeared were tagged for further periodical observation. Likewise, the observations were made for brown spot disease intensity from the first appearance of disease till the harvesting of the crop at weekly interval. PDI of brown spot disease of sugarcane was recorded by using following formula. Correlation matrix studies were carried out to determine the relationships between weather parameters with progressive per cent disease intensity of brown spot disease of sugarcane. The data was again subjected to stepwise regression equations by eliminating the non-significant factors and including only significant factors and regression equations were used to develop forewarning model for predicting disease incidence in advance.

2.1 Per cent Disease Intensity (PDI)

The disease intensity was measured by adopting 0-9 scale using standard evaluation system (SES) for brown spot disease of paddy developed by International Rice Research Institute (Anonymous, 2002). Further, the disease intensity was calculated using the following formula. Subsequently, the data on disease intensity was collected and subjected to statistical analysis.

$$\text{Disease intensity (\%)} = \frac{\text{Sum of the individual disease ratings}}{\text{Total no. of leaves observed} \times \text{Maximum grade}} \times 100$$

List 1. Disease intensity scale for evaluation of brown spot of sugarcane (Anonymous, 2002)

Score	Disease Intensity%	Disease reaction
0	No incidence	Immune
1	Less than 1%	Resistant
2	1-3%	
3	4-5%	
4	6-10%	Moderately resistant
5	11-15%	
6	16-25%	
7	26-50%	Moderately susceptible
8	51-75%	Susceptible
9	76-100%	Highly susceptible

3. RESULTS AND DISCUSSION

The experimental data on influence of epidemiological factors *viz.,* maximum and minimum temperature, morning and evening relative humidity, total rain fall, rainy days, bright sunshine hours and wind speed on the intensity of brown spot disease of sugarcane were studied at weekly interval that is presented in Table 1. First symptoms of brown spot disease incidence recorded on 16th July 2023 i.e., 29th standard meteorological week (1.96%) on susceptible variety CoM 0265 which was planted on 11th January, 2023. It was observed that intensity was continuously increasing from 29th SMW to the maximum in 42nd SMW. Brown spot disease intensity (17.65% to 40.98%) reached at its peak period during 34th SMW to 42nd SMW, hence this period was considered as window period for brown spot disease.

Table 1. Effect of different weather parameters on intensity of brown spot disease of sugarcane during 2023-24

SMW	PDI	Temperature (°C)		Humidity (%)		Bright sunshine (Hrs.)	Rainfall (mm)	Wind speed (km/hr)
		Maximum	Minimum	Morning	Evening			
28	0	30.83	23.14	98.00	86.71	3.54	0	5.67
29	1.96	28.54	22.86	96.22	93	1.14	1.21	5.77
30	3.95	26.87	22.37	97.33	90.43	0.14	3.34	5.21
31	7.96	28.63	22.91	97.14	88.14	3.6	0	6.49
32	10.35	30.01	22.4	96.88	85	4.57	0.14	4.44
33	15.63	29.66	22.14	97.45	85.57	4.9	0	4.41

SMW	PDI	Temperature (°C)		Humidity (%)		Bright sunshine (Hrs.)	Rainfall (mm)	Wind speed (km/hr)
		Maximum	Minimum	Morning	Evening			
34	17.65	29.86	21.46	97.44	87.43	4.84	0.14	4.43
35	19.64	31.19	22.03	98.00	89.29	6.36	1.43	3.83
36	21.36	29.54	22.77	98.00	84.43	3.67	0	6.13
37	25.68	30.33	22.06	98.00	88.14	7.77	0	4.97
38	29.65	30.4	22.11	98.00	85.71	3.14	2.66	2.93
39	33.48	28.34	22.51	97.86	90.57	2.7	9.71	2.33
40	36.12	30.07	21.6	97.95	87.43	4.93	6.11	4.03
41	38.18	33.37	21.31	97.99	84.29	7.64	0	1.4
42	40.98	33.29	21.74	98.03	85.57	6.26	0	1.8

SMW= Standard Meteorological Week PDI=Per cent Disease Intensity

When the correlation was worked out between seven independent variables (average of the previous seven days) and the dependent variable, which is disease, four weather parameters showed a positive correlation and the remaining showed a negative correlation. Independent variables like maximum temperature, relative humidity (morning), and bright sunshine were the three significant factors that showed a significantly positive correlation of 0.586, 0.647 and 0.580, respectively. Rainfall also showed a positive correlation with a correlation coefficient of 0.320. However, minimum temperature, relative humidity (evening) and wind speed showed significantly negative correlation with correlation coefficient of -0.705, -0.379 and -0.806 respectively (Table 2). It is evident that no single weather factor may influence how severe brown spots are. As a result, the results of the regression analysis will provide further light on the ways in which various meteorological factors affect sugarcane brown spot. In this study, the regression models were adjusted to include weather variables to forecast the rise in the per cent of brown spot, as follows:

Y (Brown spot PDI) =

-80.649+1.287 MaxT-5.333 MinT+2.691 RH-I-0.966 RH-II+1.508

Sunshine+2.225 Rainfall-1.828 windspeed

Thus, weather parameters played a major role in brown spot disease incidence. Correlation matrix and step wise regression equation model established may be most reliable and useful for forecasting of the brown spot disease of sugarcane. The loss caused by the brown spot disease can be saved by forewarning to the farmers and thereby controlling the same at the proper time.

The above shown results are in line with the findings of Viswanathan (2018) who reported that the intensity of disease is felt during hot summer with humid conditions and monsoon period. Viswanathan and Ashwin (2020) reported that high humidity and rainfall favours the brown spot disease development. Barnwal et al., (2013) reported that stronger epidemics were encouraged by seasons with little rainfall but a lot of dew, whereas brown spot was not seen in years with consistent rainfall. The effect of temperature and humidity on infection efficiency was seen in leaf wetness. This might help to explain why more severe epidemics were caused by lowering daily minimum temperatures.

Table 2. Correlation coefficient of PDI of brown spot with weather parameters (2023-24)

Sr. No.	Weather parameters	Correlation coefficient
1	Maximum temperature (°C)	0.586*
2	Minimum temperature (°C)	-0.705**
3	Relative Humidity (morning) %	0.647**
4	Relative Humidity (evening) %	-0.379
5	Bright sunshine (Hrs.)	0.580*
6	Rainfall (mm)	0.320
7	Wind speed (kmph)	-0.806**
	r value at 1%**	0.641
	r value at 5%*	0.514

***Note**: **-Significant at 1%; *-Significant at 5%*

4. CONCLUSION

Epidemiological studies under field conditions found that, the first appearance of brown spot disease of sugarcane on susceptible cultivar CoM 0265 was recorded during third week of July. The maximum PDI (40.98%) occurred when favorable weather conditions *viz.,* maximum temperature in range of 26.87 to 33.37oC,

minimum temperature in range of 21.31 to 22.91oC, bright sunshine hours in range of 0.14 to 7.77 per day, whereas morning relative humidity in range of 96.22 to 98.03 per cent and rainfall in range of 0.14 to 9.71 mm. PDI reached at its peak period during 34th SMW to 42nd SMW, hence this period was considered as window period for brown spot disease.

Correlation matrix worked out showed that, significantly highly positive correlation recorded with maximum temperature (0.586**), relative humidity (morning) (0.647**) and bright sunshine (0.580**) at 5% level. However, significantly highly negative correlation with minimum temperature (-0.705**) and wind speed (-0.806**). Rainfall (0.320) was noticed to be positively correlated and relative humidity (evening) (-0.379) was noticed to be negatively correlated.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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