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Status of Maize Diseases in Bankura District of West Bengal

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ABSTRACT

Background: Maize is an important cereal crop after rice and wheat and in West Bengal importance and area of maize is increasing day by day.

Methods: For studying the biotic stresses of maize crop in southern and western part of West Bengal a roving survey work was conducted during *kharif* season of 2022, 2023 and 2024 in bankura districts. West Bengal is under North Eastern Plain zone of India and this zone is prone to blight diseases of any crop as well as maize also.

Result: The leaf blight diseases are very much common in maize crop in this state specially Northern leaf blight and Southern leaf blight. Both diseases are found in *kharif* and *rabi* seasons but the intensity is more during kharif season in comparison to *rabi*. Besides Curvularia leaf spot, stalk rot/post flowering stalk rot, Brown spot of maize diseases are also found in some areas of these parts of West Bengal.

Key words: Biotic stress, Brown spot, Curvularia leaf spot, Northern leaf blight, Southern leaf blight.

INTRODUCTION

Maize, scientifically known as *Zea mays* L., has rightfully earned the esteemed title of the “queen of cereals” owing to its exceptional potential for high yields, solidifying its place as the third most vital cereal crop worldwide after rice and wheat. This fascinating history of maize can be traced back around 10,000 years to its cultivation by the indigenous communities of southern Mexico. Over millennia, maize has become an indispensable staple food globally, playing a crucial role in sustaining communities across the world. Its versatility extends beyond human consumption, with maize grain and cornmeal serving as essential sources of nutrition for livestock, supporting the global livestock industry.

Notably, the United States stands out as the largest contributor to global maize production, with countries like Brazil, Ukraine and Argentina also playing significant roles in the maize market. In India, maize cultivation prominently thrives in nine key states, collectively accounting for a substantial percentage of both total maize production and cultivation area in the country.

India showcases innovative agricultural practices in maximizing maize yields, with Andhra Pradesh and Tamil Nadu leading in high maize yield, attributed in part to the adoption of single cross hybrids. Despite these successes, India faces challenges in achieving high maize yields due to factors like limited access to advanced farming techniques, inadequate irrigation infrastructure and erratic weather patterns. Addressing these challenges necessitates concerted efforts from the government and agricultural stakeholders to enhance sustainable farming practices and provide necessary support to farmers. Moreover, the significance of maize in India’s agricultural landscape is expanding, notably in West Bengal, where a shift towards maize cultivation has been observed since 2010, driven by climatic factors and water demand for paddy during the rabi season. Disease outbreaks, including notable foliar diseases like Northern leaf blight, southern leaf blight, gray leaf spot, brown spot and curvularia leaf spot, pose significant challenges that demand effective management strategies for sustainable maize production in the region.

Northern leaf blight, a devastating plant disease caused by the fungus *Exserohilum turcicum* (Pass) Leonard and Suggs, was first documented by Passerini in 1876 in Italy. Kiran *et al*., 2023 also reported that the pathogen is easily wind disseminated and apparently most consistent in their occurrence and severity across the diverse sorghum growing environments also. This pathogen has proven to be a significant threat to maize crops, leading to a drastic reduction in grain yield of over 50% as highlighted by Raynundo and Hooker, (1981). Moreover, studies conducted by Pant *et al.* (2001) revealed that fields with more than 50% severity of Northern leaf blight experienced a staggering 91% decrease in photosynthesis. The impact of this disease extends beyond mere yield lose. it disrupts the crucial process of photosynthesis,

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a fundamental mechanism for plant growth and development. Farmers worldwide have grappled with the challenges posed by Northern leaf blight, which not only reduces productivity but also jeopardizes food security and economic stability. Efforts to manage and mitigate the spread of this fungal disease have become paramount in safeguarding maize production and ensuring agricultural sustainability. As scientists and researchers continue to study the complex interactions between *Exserohilum turcicum* and maize plants, advancements in disease resistance and control strategies offer hope for the protection of vulnerable crops against the destructive forces of Northern leaf blight. The use of organic materials and biological agents is one of the solutions in increasing disease resistance and corn productivity (Handrid *et al.,* 2020). In bankura district's soil there is lack of organic matter, so, this soil is most prone to various diseases.

Brown spot, a severe fungal disease that affects maize, poses a significant threat to crops globally, particularly in regions characterized by warm and humid climates where maize cultivation is prevalent, as highlighted by White in 1999. The impact of this disease on maize yields is substantial, with reports by Byrnes *et al.* (1989) indicating potential losses of up to 40% in field trials artificially inoculated with the pathogen. The widespread occurrence of brown spot underscores the importance of effective management strategies to mitigate its detrimental effects on maize production, emphasizing the critical role of early detection and control measures to safeguard crop yields and food security. Researchers and agricultural experts continue to explore innovative solutions to combat this fungal disease, striving to enhance resilience against brown spot and ensure the sustainable productivity of maize cultivation worldwide.

Curvularia leaf spot (CLS) and gray leaf spot disease are significant plant diseases that have detrimental effects on maize production, resulting in decreased yields. These fungal colonies are brownish black in the middle and grayish black at the edges (Ni *et al.*, 2020). In 2008, CLS was initially identified in the state of Karnataka, India, marking its presence in the maize cultivation landscape (Anonymous, 2008). Subsequent studies conducted by Harlapur and colleagues provided more insights into the occurrence of the disease and its causal organism. The emergence of CLS and gray leaf spot disease underscores the importance of implementing effective disease management strategies to mitigate the impact on maize productivity and ensure sustainable agricultural practices. Efforts to enhance disease resistance in maize cultivars through breeding programs and the adoption of integrated pest management practices play a crucial role in safeguarding maize crops from the damaging effects of these diseases. Continuous monitoring, early detection and prompt action are essential components of an integrated approach to disease control in maize cultivation. By staying vigilant and proactive in addressing the challenges posed by CLS and gray leaf spot disease, farmers can protect their maize crops and optimize production outcomes. Collaboration among researchers, extension services and farmers is key to fostering a holistic approach to disease management and enhancing the resilience of maize cultivation systems against these prevalent pathogens.

In West Bengal, given the growing significance of maize as a staple crop and in recognition of the impact of diseases on maize cultivation, it is imperative to conduct a thorough survey program to gather comprehensive data. This survey will play a crucial role in providing detailed insights into the distribution of diseases affecting maize, the severity levels of these diseases, the extent to which they have spread across different regions and identifying specific areas that are hotspots for certain genotypes in the disease resistance program. Such detailed information will be valuable for developing effective strategies to combat these diseases, preserving the health and productivity of maize crops and ultimately contributing to sustainable agriculture practices in the region.

MATERIALS AND METHODS

In the maize-growing regions of bankura district in West Bengal, a comprehensive roving survey was carried out to investigate the prevalence of diseases affecting maize crops. Specifically chosen areas such as chhatna, susunia, jhantipahari, ranibandh, simlapal and raipur were analyzed using a structured questionnaire designed to gauge farmers' knowledge about maize diseases. Extensive field visits were conducted during the *kharif* seasons of 2021-22, 2022-23 and 2023-24 to ascertain the incidence and severity of various maize diseases, including northern leaf spot, southern leaf spot, brown spot, gray leaf spot and curvularia leaf spot. Farmers actively participated in these interactions, providing valuable insights and data on maize cultivation practices and the impact of disease infections on their crops. The collaborative efforts between researchers and farmers yielded a wealth of information that contributes to a deeper understanding of maize disease dynamics in the region and facilitates the development of effective management strategies.

The way of interaction was as follows

A. Their significant expertise in cultivating and producing maize, showcasing their deep knowledge and skills in this particular field.
B. Farmers are made aware of northern leaf spot, southern leaf spot, brown spot, gray leaf spot and curvularia leaf spot diseases through recognizable symptoms and informative sessions.
C. The time when diseases or disease symptoms first manifest in the specific environment they arise in is of critical importance in the field of epidemiology.
D. During the *kharif* season, monitoring the degree of disease infection and assessing its severity are crucial components for effective disease management strategies.

E. Possible suspected causes of the diseases are being investigated by researchers.
F. The farmers planted various varieties of maize in the field to ensure a diverse and healthy crop that could withstand different environmental conditions and pests.
G. The sources of their seeds include local farmers, seed banks and trusted suppliers.
H. The impact of diseases on the production and yield of crops can have significant consequences on their overall output.
I. Various measures have been implemented to effectively manage the diseases and improve overall plant health outcomes.
J. The farmers demonstrate a high level of readiness to promptly begin planting resistant varieties in their fields if they are officially introduced as an option for cultivation.
K. Fluctuations in market value can occur when produce is affected by disease, leading to changes in pricing and demand.
L. They provided insightful recommendations on potential solutions and treatments for combating the diseases.
M. The intervention of government or government agencies, along with the support of extension agents, plays a crucial role in implementing effective strategies for reducing diseases in maize crops.

The above interaction procedure, as outlined by Akinbode *et al.* (2014), was meticulously adhered to.

In addition to the details mentioned earlier, the collected data also encompassed various factors essential for analyzing the agricultural landscape. This included insights into the geographical positioning of the fields, prevalent weather patterns, the susceptibility of plants to diseases, the growth phase of the plants, the overall size of the field and the cultural practices being employed, such as levels of weed infestation, plant density and the estimated date of planting. Data acquisition further involved meticulous observation of disease occurrences in maize plants within farmers' fields, utilizing scoring techniques to quantify the number of affected plants per unit area and expressing the data as percentages. Assessment of disease severity was conducted by closely examining selected plants and assigning a comprehensive grade based on the intensity of symptoms displayed by each disease. Specific disease severity scales were employed to accurately gauge the magnitude of disease impact in individual fields. Identification of the diseases was primarily reliant on visual symptom observation, with each disease being categorized and rated according to established guidelines.

The severity of leaf blight diseases was meticulously assessed by employing a standardized 1-9 disease rating scale, as outlined in the study by Mitiku *et al.* (2014) (Table 1 and 2). This comprehensive evaluation technique allowed for accurate measurement and classification of the diseases based on their severity levels. Subsequently, the obtained ratings were meticulously transformed into the widely recognized per cent disease index (PDI) by applying the prescribed formula developed by Wheeler in 1969. This conversion process facilitated a more precise and quantitative representation of the disease severity, enabling researchers to compare, analyze and interpret the data with greater clarity and accuracy. By utilizing these established measurement and calculation methods, researchers were able to delve deeper into the nuances of leaf blight diseases, enhancing the understanding of their impact and progression within the specific context of the

Table 1: Scale (1-9) for disease scoring of northern leaf spot, southern leaf spot and brown spot disease.

Rating scale	Degree of infection (% Diseased leaf area)	PDI	Disease reaction
1.0	Nil to very slight infection (≤10%).	≤11.11	Resistant (R)
2.0	Slight infection, a few lesions scattered on two lower leaves (10.1-20%).	22.22	(Score: ≤3.0)
3.0	Light infection, moderate number of lesions scattered on four lower leaves (20.1-30%).	33.33	(PDI: ≤33.33)
4.0	Light infection, moderate number of lesions scattered on lower leaves, a few lesions scattered on middle leaves below the cob (30.1-40%).	44.44	Moderately resistant (MR)
5.0	Moderate infection, abundant number of lesions scattered on lower leaves, moderate number of lesions scattered on middle leaves below the cob (40.1-50%).	55.55	(Score: 3.1-5.0) 5.0 (PDI: 33.34-55.55
6.0	Heavy infection, abundant number of lesions scattered on lower leaves, moderate infection on middle leaves and a few lesions on two leaves above the cob (50.1- 60%).	66.66	Mod. susceptible (MS)
7.0	Heavy infection, abundant number of lesions scattered on lower and middle leaves and moderate number of lesions on two to four leaves above the cob (60.1- 70%).	77.77	(Score: 5.1-7.0) 7.0 (PDI: 55.56-77.77)
8.0	Very heavy infection, lesions abundant scattered on lower and middle leaves and spreading up to the lag leaf (70.1-80%).	88.88	Susceptible (S) (Score: >7.0)
9.0	Very heavy infection, lesions abundant scattered on almost all the leaves, plant prematurely dried and killed (>80%).	99.99	(PDI:>77.77)

Balint-Kurti *et al.* (2006).

study. This systematic approach not only provided a robust foundation for the assessment of disease severity but also laid the groundwork for potential future investigations and advancements in the field of plant pathology.

Per cent disease index (PDI) =

$$\frac{\text{Sum of all disease ratings} \times 100}{\text{Total number of leaf observed} \times \text{Maximum disease rating}}$$

Disease scoring of Northern leaf spot, southern leaf spot and brown spot was done by following this scale.

Disease scoring of Curvularia leaf spot (CLS) was done by following this scale Hou *et al.* (2013).

RESULTS AND DISCUSSION

In 2021-22, 2022-23 and 2023-24, a comprehensive survey was conducted in Bankura district of West Bengal, focusing on six specific areas. The areas examined under this survey initiative included Chhatna, Susunia, Jhantipahari, Ranibandh, Simlapal and Raipur. The findings from this rigorous survey program highlighted the presence of two distinct types of leaf blight diseases, namely Northern leaf blight and Southern leaf blight, across all the locations within Bankura district. This significant discovery sheds light on the widespread nature of these leaf blight diseases, emphasizing the importance of diligently monitoring and managing them to safeguard the agricultural interests of the region. It is evident from the results that these diseases pose a common threat to the crops in Bankura district, urging for proactive measures to mitigate their impact and preserve the agricultural productivity in the area. The dedicated efforts carried out during the survey years underscore the need for continued vigilance and research to develop effective strategies for combating these prevalent leaf blight diseases. The comprehensive nature of the survey underscores the thoroughness and commitment of the researchers in uncovering vital insights that can inform future agricultural practices and disease management protocols in Bankura district and beyond.

During the survey programme conducted in 2021-22, a total of six locations were included, namely chhatna, susunia, jhantipahari, ranibandh, simlapal and raipur. Analysis revealed the presence of Northern leaf blight and brown spot across all these locations. Notably, in chhatna and susunia, the severity of both Northern leaf blight and brown spot was relatively low, with recorded percentages of 25.4 and 19.6 and 27.8 and 21.4 respectively (Table 3). It was observed that the crop in chhatna had reached the maturity stage, while in susunia, it was still in the silking stage. Here, the severity of Northern leaf blight was deemed moderate, at 48.72 and 50.44 respectively, alongside a similar trend for brown spot, with a Plant Disease Index (PDI) of 32.66 and 40.68. On the other hand, in jhantipahari and ranibandh, where the crop had progressed to the dough stage, the severity of Northern leaf blight was notably high, with a PDI recorded at 60.70 and 72.34, while brown spot followed a similar pattern, registering high PDIs of 44.34 and 50.66, respectively. Lastly, in simlapal and raipur, where the crop was at the silking stage, the levels of severity for both diseases were still notable.

During 2022-23 under survey programme same locations were covered namely Chhatna, Susunia, Jhantipahari, Ranibandh, Simlapal and Raipur.

Presence of Northern leaf blight and southern leaf blight was found in all the locations. In chhatna and susunia severity of both Northern leaf blight and southern leaf spot -(35.4 and 22.6) and (50.7 and 62.5) was high (Table 4). In Chhatna and Susunia, the crop was in maturity stage, severity of Northern leaf blight was medium (22.56 and 28.40) and that of Southern leaf spot was also medium (PDI = 27.44 and 34.72) In jhantipahari and ranibandh and the crop was in silking stage and severity of Northern leaf blight was low (PDI = 16.36 and 24.72) and that of Southern leaf blight was low (PDI = 20.4 and 28.92) in simlapal and raipur and crop was in mature stage.

During 2023-24 under survey programme same locations were covered namely Chhatna, Susunia, Jhantipahari, Ranibandh, Simlapal and Raipur and all the crops were at mature stage. In the study conducted across

Table 2: Scale for disease scoring (1-9) of Curvularia leaf spot.

Rating scale	Degree of infection (% Diseased leaf area)	PDI	Disease reaction
1.0	≤10% area of leaf infected	≤11.11	Resistant (R)
2.0	10.1-20% area of leaf infected	22.22	(Score: ≤3.0)
3.0	20.1-30% area of leaf infected	33.33	(PDI: ≤33.33)
4.0	30.1-40% area of leaf infected	44.44	Moderately resistant (MR)
5.0	40.1-50% area of leaf infected	55.55	(Score: 3.1-5.0)
			(PDI: 33.34-55.55)
6.0	50.1-60% area of leaf infected	66.66	Mod. susceptible (MS)
7.0	60.1-70% area of leaf infected	77.77	(Score: 5.1-7.0)
			(PDI: 55.56-77.77)
8.0	70.1-80% area of leaf infected	88.88	Susceptible (S)
9.0	>80%% area of leaf infected	99.99	(Score: >7.0)
			(PDI:>77.77)

Table 3: Severity of different diseases in five maize growing areas of bankura district of West Bengal during *kharif* season of 2021-22.

Place/District	Variety	Crop stage	Northern leaf spot severity (PDI)	Brown spot severity (PDI)
Chhatna	Hybrid	Maturity	25.4	19.6
Susunia	Hybrid	Silking	27.8	21.24
Jhantipahari	Hybrid	Dough	48.72	32.66
Ranibandh	Hybrid	Dough	50.44	40.68
Simlapal	Hybrid	Silking	60.70	44.34
Raipur	Hybrid	Silking	72.34	50.66

Table 4: Severity of different diseases in five maize growing areas of bankura district of West Bengal during *kharif* season of 2022-23.

Place/District	Variety	Crop stage	Northern leaf spot severity (PDI)	Brown spot severity (PDI)
Chhatna	Hybrid	Maturity	35.4	22.6
Susunia	Hybrid	Maturity	50.7	62.5
Jhantipahari	Hybrid	Silking	22.56	27.44
Ranibandh	Hybrid	Silking	28.40	34.72
Simlapal	Hybrid	Maturity	16.36	20.4
Raipur	Hybrid	Maturity	24.72	28.92

Table 5: Severity of different diseases in five maize growing areas of bankura district of West Bengal during *kharif* season of 2023-24.

Place/District	Variety	Crop stage	Northern leaf spot severity (PDI)	Southern leaf spot severity (PDI)	Brown spot severity (PDI)	Gray leaf spot severity (PDI)	Curvularia leaf spot severity (PDI)
Chhatna	Hybrid	Maturity	65.5	34.2	70.4	30.6	20.6
Susunia	Hybrid	Maturity	70.8	28.4	65.0	-	-
Jhantipahari	Hybrid	Silking	50.4	60.8	48.4	-	-
Ranibandh	Hybrid	Silking	40.4	38.6	26.4	30.52	36.6
Simlapal	Hybrid	Maturity	48.52	30.6	24.8	28.6	-
Raipur	Hybrid	Maturity	62.4	40.4	30.8	27.8	30.6

various regions, distinct patterns of fungal diseases affecting the crops were observed. In Chhatna, the presence of diseases such as Northern leaf spot, Southern leaf spot, Brown spot, Gray leaf spot and Curvularia leaf spot was documented. Notably, the severity of Brown spot was notably high at 70.4, while for Northern leaf spot disease, it was recorded at a medium level of 65.52. Moving on to susunia, it was found that the severity of Northern leaf spot was notably high at 70.8, while the severity of Brown spot disease was at a medium level of 65.0. Interestingly, there were no instances of Curvularia leaf spot disease or Gray leaf spot disease in this region. In jhantipahari, the incidence of Southern leaf spot disease reached a high level of 60.80, whereas the incidence of Northern leaf spot disease was at a medium level of 50.4. Notably, Gray leaf spot and Curvularia leaf spot diseases were absent in this area. Shifting focus to ranibandh, simlapal and raipur, it was observed that the severity of Northern leaf spot disease was notably high at 40.4, 48.52 and 62.4, respectively, with the severity of Southern leaf spot disease recorded at a medium level of 38.6, 30.6 and 40.4, respectively Table 5. It is worth mentioning that in the Simlapal area, there were no reported incidences of Curvularia leaf spot disease.

CONCLUSION

West Bengal, located in the North Eastern Plain Zone of India, is particularly susceptible to leaf blight and leaf spot diseases affecting a wide range of crops in the region. A comprehensive survey conducted across six areas of the Bankura district in West Bengal further reinforces this susceptibility and highlights the prevalence of these diseases. Over the course of three years, observations from the survey program revealed varying degrees of severity in the occurrence of Northern leaf blight, southern leaf blight and brown spot diseases across all surveyed locations. Additionally, during the monitoring period in 2024, instances of Curvularia leaf spot and gray leaf spot were also documented in specific areas, shedding more light on the diverse array of diseases that pose a threat to crops in West Bengal. These findings underscore the urgent need for targeted interventions and strategies to manage and mitigate the impact of these plant diseases, ensuring the agricultural sustainability and productivity of the region.

Conflict of interest

All authors declared that there is no conflict of interest.

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