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Status of maize diseases in southern and western parts of West Bengal

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Abstract
Maize is an important cereal crop after rice and wheat and in West Bengal importance and area of maize is increasing day by day. 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 2016, 2017 and 2018 in seven 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. The leaf blight diseases are very much common in maize crop in this state specially turcicum leaf blight or northern corn leaf blight and maydis leaf blight or southern corn 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, rust of maize (both common and Polysora rust) diseases are also found in some areas of these parts of West Bengal.

Keywords: Biotic stress, northern corn leaf blight, southern corn leaf blight, Polysora rust, roving survey

Introduction
Maize (*Zea mays* L.) is called queen of cereals for its high yield potential and was first domesticated by the indigenous people of southern Mexico about 10,000 years ago. It is now the third most important cereal crop in the world after rice and wheat. Maize grain and corn meal is a staple food in many regions of the world and it is also a major source of both feed and fodder for livestock.

United States is the largest producer of maize. Brazil, Ukraine and Argentina are the other key maize producing countries behind USA. In India nine states – Karnataka, Andhra Pradesh, Tamil Nadu, Rajasthan, Maharastra, Bihar, Uttar Pradesh, Madhya Pradesh and Gujrat account for 85% of total maize production and 80% of area under cultivation. Andhra Pradesh has the highest yield followed by Tamil Nadu because of using single cross hybrids.

In India the yield is half of the global average because –

- Climatic conditions resulting in drought / excess water associated with increased pressure of diseases / pests
- Cultivation of maize in kharif season under rainfed conditions
- Only 30% of the maize area is under single cross hybrid
- Limited adoption of improved production – protection technology
- Unavailability of quality seeds
- Small farm holdings and limited resource availability with farmers.

In India most of the maize is used in the poultry feed industry and livestock feed. In West Bengal rice is the main cereal crop and before 2010 area under maize was very low. But due to erratic and irregular rainfall during kharif season and high water requirement for paddy during rabi season maize is getting importance in this state and specially as a rabi crop. Area, production and productivity of maize in this state are in increasing trend since2010.

Disease incidence is one of the important constraints in maize production. Among the foliar diseases Turcicum leaf blight (TLB) and Maydis leaf blight (MLB) are having world wide importance.

TLB is caused by *Exserohilum turcicum* (Pass) Leonard and Suggs and this disease was first described by Passerini (1976) [13] from Italy. Turcicum leaf blight is causing reduction in grain yield of more than 50% (Raynundo and Hooker 1981) [15]. Pant *et al* (2001) [12] reported about 91% reduction in the photosynthesis due to more than 50% severity of TLB.

Maydis leaf blight is a serious fungal disease of maize throughout the world where maize is grown under warm and humid conditions (White, 1999) [17]. Yield loss upto 40% has been reported in artificially inoculated field trials by Byrnes *et al.,* 1989 [5].

Curvularia leaf spot (CLS), banded leaf and sheath blight (BLSB) of maize, post flowering stalk rot (PFSR) and rust disease are other important diseases of maize causing loss in production. CLS was first reported in Karnataka in India in 2008 (Anonymous, 2008) [3]. The occurrence of the disease and causal organism was reported by Harlapur *et al*., (2012) [7].

In West Bengal considering the increasing importance of maize survey programme on diseases of maize is very much necessary to get the comprehensive information on disease distribution, level of severity, extent of spread and to locate hot spots of genotypes in disease resistance programme.

Materials and Methods

Seven maize growing districts of southern and western part of West Bengal were selected for conducting roving survey on maize diseases. A predesigned questionnaire was used to collect information on level of knowledge on diseases of maize aspects of farmers. A good number of maize fields in seven districts of West Bengal [Nadia, Murshidabad, Burdwan, Midnapore, Birbhum, Bankura and 24 PGS (N)] were surveyed to find out the incidence and severity of maize diseases. The maize fields were visited during kharif season of 2016-17, 2017-18 and 2018-19.

The incidence and severity of leaf spot, leaf blight, rust, post flowering stalk rot were assessed in the farmer's field. The farmers of the visited fields interacted with us and we have collected so many informations about maize crop and disease infections.

The way of interaction was as follows

1. Their experience in maize cultivation and production
2. Awareness of the farmers about leaf spot, leaf blight, rust, PFSR and BLSB diseases through symptoms or otherwise
3. Time of first appearance of diseases or disease symptoms in their fields
4. Degree of disease infection and severity during kharif season
5. Suspected causes of the diseases
6. Varieties of maize planted by the farmers
7. Sources of their seeds
8. Effect of the diseases on their production and yield of crop
9. Measures taken for management of the diseases
10. Readiness of the farmers to plant resistant varieties if introduced
11. Changes in the market value of the produce due to disease infection
12. Their suggestions on possible remedies against the diseases
13. Intervention of government or government agencies / extension agents on reduction of diseases in maize.

The above interaction procedure was followed from Akinbode *et al.,* (2014) [1].

Other informations gathered were – location of the field, weather condition, vulnerability of the plants to disease infection, plant growth stage, size of the field and cultural practices such as weed infestation, plant density and estimated date of planting. Data were collected on incidence and severity of all the diseases found on maize in farmer's field by scoring and counting the number of affected plants per unit area and expressed as percentages.

Severity was determined by screening selected plants and giving an overall note for the symptom severity of each disease. Disease severity scales for individual disease were used to assess the extent of disease in a particular field. Identification of the diseases was based on visual symptoms and rated as follows:

The severity of leaf blight diseases was recorded using 1-9 disease rating scale (Mitiku *et al*. 2014) [11]. Further these values were converted into Percent Disease Index (PDI) as per the formula given below (Wheeler, 1969) [16].

$$\text{Percent Disease Index (PDI)} = \frac{\text{Sum of all the individual disease ratings}}{\text{Total number of plants observed}} \times \frac{100}{\text{Maximum disease grade}}$$

Disease scoring of TLB and MLB was done by following this scale

Table 1: Scale (1-9) for disease scoring of Turcicum leaf blight (TLB) &Maydis leaf blight**.**

Rating scale	Degree of infection (% Diseased leaf area)	PDI	Disease reaction
1.0	Nil to very slight infection (≤10%).	≤11.11	Resistant (R) (Score: ≤ 3.0) (PDI: ≤ 33.33)
2.0	Slight infection, a few lesions scattered on two lower leaves (10.1-20%).	22.22	
3.0	Light infection, moderate number of lesions scattered on four lower leaves (20.1-30%).	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) (Score: 3.1–5.0) (PDI: 33.34-55.55)
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	
6.0	Heavy infection, abundant number of lesions scatteredon 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) (Score: 5.1-7.0) (PDI: 55.56-77.77)
7.0	Heavy infection, abundant number of lesions scatteredon lower and middle leaves and moderate number of lesions on two to four leaves above the cob (60.1- 70%).	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) (PDI:>77.77)
9.0	Very heavy infection, lesions abundant scattered on almost all the leaves, plant prematurely dried and killed (>80%).	99.99	

Balint-Kurti *et al*., (2006) [4].

Disease scoring of Curvularia leaf spot (CLS) was done by following this scale

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

Hou *et al.*, (2013) [8].

Disease scoring and severity of rust disease of maize was estimated by following this scale.

Table 3: Disease Scoring scale (1-9) of Maize Rust.

Rating scale	Degree of infection (% Diseased leaf area)	PDI	Disease reaction
1.0	No uredia or hypersensitive flecks (<1%).	<11.11	Immune/HR (Score: <1.0) (PDI: < 11.11)
2.0	Very slight infection, one or two pustules on lower leaves only (1.0%).	22.22	Resistant (R) (Score: 1.1-2.0) (PDI: 11.12-22.22)
3.0	Very slight to slight infection, few scattered pustules on lower leaves only (1.1-10%).	33.33	Moderately resistant (MR) (Score: 2.1-4.0) (PDI: 22.23-44.44)
4.0	Light infection, few scattered pustules on lower leaves only (10.1-20.0%)	44.44	
5.0	Moderate infection, moderate number of pustules on lower leaves only (20.1-30%)	55.55	Moderately susceptible (MS) (Score: 4.1-6.0) (PDI: 44.45-66.66)
6.0	Moderate infection, abundant pustules on lower leaves; few on middle leaves (30.1- 40%)	66.66	
7.0	Severe infection (40.1-60%)	77.77	Susceptible (S) (Score: >6.0) (PDI: >66.66)
8.0	Severe infection, abundant pustules onlower and middle leaves; extending to upperleaves (heavy infection) (60.1-80%)	88.88	
9.0	Severe infection, abundant pustules on all leaves, plant may dry prematurely or killed by the disease (very heavy infection) (>80%)	99.99	

Lubberstedt *et al*., (1998) [10].
Paterniani *et al*., (2000) [14].

Result and Discussion

A thorough survey of seven districts in southern and western part of West Bengal was done during 2016, 2017 and 2018 and the districts under this survey programme were – Nadia, Murshidabad, Burdwan, Bankura, Birbhum, North 24 PGS and Midnapore (East).

The result of this survey programme explains that, two types of leaf blight diseases (TLB & MLB) are present in all the locations of all the districts.

During 2016 three districts were covered under this survey programme – Nadia, Burdwan and Birbhum. Presence of Turcicum leaf blight and maydis leaf blight was found in all the locations In Burdwan district severity of both MLB (PDI – 23.6 to 24.44) and TLB (PDI – 18.5 to23.3) was low (Table – 1). In Nadia district the crop was in soft dough stage, severity of MLB was medium (44.44 to 45.55) and that of TLB was also medium (PDI = 38.88 to 39.99) In Birbhum the crop was in physiological maturity stage and severity of MLB was high (PDI = 71.10) and that of TLB was medium (PDI = 53.33)

Survey on maize diseases was done in five locations of three districts of West Bengal. Mainly two diseases (MLB & TLB) were found in all the locations. Highest intensity of both the diseases was found in Shekhampur of Birbhum district (MLB – 71.10 and TLB – 53.33) and lowest was observed in Kalinagar of Burdwan District (TLB – 18.5 and MLB – 23.60).

During 2017 under survey programme two districts were covered namely Birbhum and Bankura. Two locations in Birbhum and three locations in Bankura district were covered. Mainly MLB and TLB were found. Disease severity of MLB was high in Birbhum that of TLB was medium (Table – 2).

In Bankura at one location (Garkata) MLB severity was high and at other two locations it was low. Overall this can be said that disease severity was more in Birbhum District in comparison to Bankura.

During 2018 four districts namely Murshidabad, Purba Medinipur, 24PGS(N) and Nadia were covered under survey programme. In Murshidabad MLB, TLB and CLS diseases were found. Severity of MLB was medium, TLB was high and CLS was high (Table – 3).

In Purba Medinipur also MLB, TLB and CLS diseases were observed with high MLB, low TLB and low CLS severity.

In 24 PGS(N) MLB, TLB, CLS and rust diseases were found with low MLB, low TLB, low CLS but high rust severity.

In baby corn fields of Nadia district only MLB and CLS symptoms were found with medium MLB and low CLS severity.

In contrast to this, Halugappa *et al.* [9], also reported a similar result of severity of Mlb during Kharif and rabi (2011) survey from different districts of Northern Karnataka that maximum disease severity was during Kharif seasons and severity percentage greatly varies from one district to other.

The findings of the present studies are in agreement with the Geeta *et al.,* (2018) [6] who reported the disease severity of TLB from Eastern Karnataka during kharif (2016) survey from different districts of Karnataka that the cropping seasons is prime factor for the increase and decrease of the severity of disease of TLB.

The same trend was also observed by the *Akindobe et al.,*(2014) [1] during survey of resurgence of maize diseases in south western and Kwara states of Nigeria stated that the incidence of 80% by Rust disease where whole farm was completely infected and resurgence of Curvularia leaf spot disease with a potiential threat to maize production due to loss of photosynthetic potentials.

Table 4: Severity of different diseases inthree maize growing districts of North Eastern parts of West Bengal during kharif season of 2016

Sl. No.	Place / District	Crop stage	Variety	Maydis leaf blight severity (PDI)	Turcicum leaf blight severity (PDI)
1	Kalinagar / Burdwan	Silking	Hybrid	23.60 (Low)	18.5 (Low)
2	Samudragarh / Burdwan	Baby Corn	Hybrid	24.44(Low)	23.30 (Low)
3	Nabadweep / Nadia	Soft Dough	Hybrid	44.44(Medium)	38.88(Medium)
4	Krishnagar / Nadia	Soft Dough	Hybrid	45.55(Medium)	39.99 (Medium)
5	Shekhampur / Birbhum	Physiological maturity sage	Hybrid	71.10 (High)	53.33(High)

Table 5: Severity of different diseases in two locations of Birbhum and three locations of Bankura District during kharif season of 2017

Sl. No.	Place / District	Crop Stage	Variety	Maydis leaf blight severity (PDI)& Reaction	Turcicum leaf blight severity (PDI) and Reaction
1	Shekhampur / Birbhum	Hard Dough stage	Hybrid	67.43 (High)	56.21(High)
2	Birbhum	Hard Dough	Hybrid	60.66 (High)	46.77 (Medium)
3	Garkata / Bankura	Maturity	Hybrid	62.88(High)	65.10 (High)
4	Sampur / Bankura	Tasselling	Hybrid	17.77 (Low)	21.88(Low)
5	Manjua / Bankura	Tasselling	Hybrid	13.33 (Low)	13.33(Low)

Table 6: Severity of different diseases in four Districts of North Eastern part of West Bengal during kharif season of 2018

Sl. No.	Place / District	Crop Stage	Variety	Maydis leaf blight severity (PDI) & Reaction	Turcicum leaf blight severity (PDI) & Reaction	Curvularia leaf spot severity (PDI) & Reaction	Severity (PDI)of other diseases& Reaction
1	Lalgola / Murshidabad	Physiological maturity	Kaveri 50	55.55 (Medium)	68.88 (High)	73.32(High)	-
2	Anandapur / PurbaMidnapur	Physiological maturity	P 3505	75.54 (High)	32.21(Low)	35.55(Medium)	-
3	Singha / 24PGS(N)	Harvesting	Sugar 75 (Sweet Corn)	28.88(Low)	19.99(Low)	11.11 (Low)	Rust infection-77.77(High)
4	Bholadanga / Nadia	Tasselling	Baby Corn	52.21(Medium)	-	33.33(Low)	-

Conclusion

West Bengal is in the North Eastern Plain Zone of India and this zone is prone to leaf blight and leaf spot diseases of all crops. This roving survey work covering seven districts of southern &western parts of West Bengal also explaining the same fact. In all the locations under survey programme both Turcicum leaf blight and Maydis leaf blight diseases were observed with low to high severity during three years, Curvularia leaf spot was found in few locations during 2018. Besides, rust disease incidence was also found in sweet corn in one location during Kharif 2018 for the first time but with high severity.

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