INNSPUB

International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print), 2222-5234 (Online)
http://www.innspub.net
Vol. 7, No. 6, p. 111-117, 2015

RESEARCH PAPER OPEN ACCESS

Study on etiology, incidence and severity of Southern corn leaf blight, curvularia leaf spot, sheath blight and damping off of maize

Md. Moshiur Rahman Akonda*[1], Monira Yasmin[2], Ismail Hossain[1]

[1]*Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh, Bangladesh*

[2]*Dept. of Agricultural Chemistry, Bangladesh Agricultural University, Mymensingh, Bangladesh*

Key words: Etiology, Disease, Incidence, Severity, Maize.

http://dx.doi.org/10.12692/ijb/7.6.111-117 Article published on December 24, 2015

Abstract

An experiment was conducted to determine the incidence and severity of different fungal diseases of maize occurred in the major maize growing regions (Bogra, Gaibandha, Mymensingh and Rangpur) of Bangladesh during January 2007 to March 2008. Incidence and severity of the diseases *viz.* southern corn leaf blight (*Bipolaris maydis*), curvularia leaf spot (*Curvularia lunata*), sheath blight (*Rhizoctonia solani*) and damping off of seedlings (*Aspergillus* spp., *Fusarium* spp. and *Penicillium* spp.) were recorded from a hybrid variety Pacific-984 and a high yielding variety Khai Vutta at seedling stage (30 DAS-Days After Sowing), vegetative growth stage (60 DAS) and silking stage (90 DAS) of the plant. The etiology of the diseases was also studied. Considering all growth stages of plant, the comparative analysis revealed that incidence and severity of the diseases varied from one district to another, but almost minimum levels of infection were observed in Rangpur followed by Bogra, Gaibandha and Mymensingh. The results also depicted that southern corn leaf blight and curvularia leaf spot were found at all the growth stages of plants, sheath blight was found at vegetative stage and silking stage, where as damping off symptoms were recorded only at seedling stage of maize plants. As the pathogens have negative influence on plant health as well as yield so, special attention should be given by the growers to minimize the fungal infections by promoting good agricultural practices in the maize growing districts of the country.

* **Corresponding Author:** Md. Moshiur Rahman Akonda ✉ moshiur.ado@gmail.com

Introduction

Maize (*zea mays* L.) is one of the most important cereal crops in the world and ranks third next to wheat and rice (Aldrich *et al.*, 1975). In Bangladesh, it has a good potential as a cereal crop due to its low cost of production, wide adaptability and diversified use. There has been continuous increase in the consumption of corn mainly owning to increase in the demand from meat and starch sector. There is growing requirement of maize from poultry sector where it is being used as feed. It is also fractionated by either dry or wet milling into food and industrial ingredients. Starch, the major constituent of the corn kernel, is used in its native form or after chemical or enzymatic modification, in foods and industrial products. Starch is also converted into glucose or fructose for use as food sweetener. Glucose can be fermented into ethanol for beverages or into many other chemicals. Recently, it has been discovered that corn can also be used in the production of biofuel (Deepavali and Nilima, 2013). However, maize kernels have high nutritive value containing 66.2% starch, 11.1% protein, 7.1% oil and 1.5% minerals. Besides, it contains 90mg carotene, 1.8mg niacin, 0.8mg thiamin and 0.1mg riboflavin per 100g grains (Chowdhury and Islam, 1993).

The average yield of corn in the world is 4.31 ton/ha (FAO, 1999). In Bangladesh corn was cultivated in 66,801 ha of land and production was 35,600 ton having the average yield 5.33 ton /ha during the year 2005 (BBS, 2006). Recently, government of Bangladesh has given special emphasis on its extensive cultivation, especially in the *char* areas where the land remains almost fallow during the winter.

Many factors such as environmental conditions, yield potential, soil fertility, genetics of particular hybrids, and the synergistic action of different diseases and insects all impact yield loss and cannot be evaluated with any precision, especially over a large geographic area (White, 1999). As many as 112 diseases are known to occur on corn in the corn growing countries.

Of all the diseases, more than 70s are seed borne (USDA, 1960). Among the diseases, southern corn leaf blight (*Bipolaris maydis*), curvularia leaf spot (*Curvularia lunata*), stalk rot (*Zibberella zeae*), sheath blight (*Rhizoctonia solani*), damping off of seedlings (*Aspergillus* spp., *Fusarium* spp., *Penicillium* spp.), bacterial leaf blight (*Pseudomonas avenae*), bacterial leaf streak (*Xanthomonas campestris* pv. *Zeae*) and maize dwarf mosaic of maize are common in Bangladesh. Seasonal yield loss is significantly correlated with disease incidence and severity of maize (Zhang *et al.*, 1999). Though it is a food crop of economic significance so, by knowing the causes of disease and damaging effects of a disease at particular growth stage of plant will provide basic information to the growers to initiate appropriate management strategies on time to minimize the yield loss. In view of above-mentioned facts, the present research has been undertaken to study the etiology of the diseases and to record the incidence and severity of maize diseases at specific growth stages of plants in the existing maize fields of the farmer.

Materials and methods

The field experiment was conducted in four maize growing districts of Bangladesh during January 2007-March 2008. A detailed description of the experimental site is presented in the table 1. The experiment was laid out in Randomized Complete Block Design (RCBD) with five replications. Four districts i.e. Rangpur, Gaibandha, Bogra and Mymensingh under different Agro ecological Zones (AEZ) were considered as treatment of the experiment. Maize was grown during Rabi season in the surveyed regions within the period of last week of November to first week of December 2007. The line to line and plant to plant spacing were as Rangpur-58 × 22 cm^2, Gaibandha-60 × 20 cm^2, Bogra-60 × 17cm^2 and Mymensingh-75×20 cm^2. No pesticide was applied during the growing season of maize. In case of Mymensingh, weeding and thinning were done only at seedling stage of the plants, but no weeding was done in other regions.

Table 1. Description of the experimental site.

Districts	Thanas	Village/ Location	AEZ No.	Name of the AEZ
Rangpur	Mithapukur	Fateepur	3	Tista Meander Floodplain
Gaibandha	Sadullapur	Birahimpur	7	Active Brahmaputra & Jamuna Floodplain
Bogra	Bogra Sadar	Fulbari	4	Karatoa-Bangali Floodplain
Mymensingh	Mymensinh Sadar	GPB field laboratory	9	Old Brahmaputra Floodplain

AEZ means Agro Ecological Zone.

Data collection

Data on disease incidence and severity were recorded at seedling stage (30 DAS), vegetative growth stage (60 DAS) and silking stage (90 DAS) from a hybrid variety Pacific-984 and a high yielding variety Khai Vutta those were cultivated in Bogra, Gaibandha, Rangpur and Mymensingh respectively. To record incidence and severity, one village/location from each Thana's of each District was selected. From each village/location, five farmer's fields were selected at random. Actual disease assessment was made on five unit areas of each randomly selected farmer's field. The size of each unit area was 2m × 2m. For determining disease incidence, total number of infected plants from each unit area were counted and finally expressed as percentage. The following formula is used in case of disease incidence:

$$\text{Disease incidence (\%)} = \frac{\text{Number of infected plants per plot}}{\text{Total number of plants}} \times 100$$

To record the disease severity, ten infected leaves for each disease were selected at random from a unit area and finally per cent diseased area was measured bases on eye estimation. In case of sheath blight severity, the relative lesion height was calculated as per the formula given below (Ansari, 1995):

$$\text{Relative lesion height (\%)} = \frac{\text{Lesion height (cm)}}{\text{Plant height (cm)}} \times 100$$

The mean values of the individual treatment were compared with least significant difference (LSD) and analysis of variance was done using MSTAT program.

Isolation of the pathogen from infected plant materials

The symptoms bearing leaves and sheath for each disease were collected from the selected farmers' fields and carried to the MS laboratory, Dept. of Plant Pathology, Bangladesh Agricultural University, Mymensingh, Bangladesh. After cleaning and washing, diseased samples with typical symptoms were selected and cut into 1.5-2 mm pieces containing both healthy and diseased parts. The inocula were then surface-sterilized by using 30% ethanol for 2 minutes and washed three times with consecutive changes of sterile water. Excess water remained onto the inocula was removed by sterilized blotting papers. Four inocula were plated in each of three petridishes containing PDA media. The whole operation was done in a laminar air flow cabinet. The petridishes were then incubated at room temperature for seven days in case of fast growing fungi, and twenty one days in case of slow growing fungi. After the required time, each petridish was observed individually under Stereomicroscope and temporary after that permanent slides were prepared for taking pathogenic structure. The photograph of the distinct pathogenic structure was taken from the permanent slides at 20X magnification using Olympus Microscope (Field Fertility Clinic, Faculty of Veterinary Science, BAU, Mymensingh).

Results

Southern corn leaf blight of maize

Southern corn leaf blight symptoms produced by the pathogen on maize leaf were primarily spindle shaped with initial size of 2-6mm and chocolate-colored lesions on maturing plants were 2.5-20cm in length. More elongated and elliptical blighted areas were concentrated along with the margins and mid rib regions of the mature leaves (Fig. 1A & 1B). The observed conidia under compound microscope were typically olivaceous brown, curved, spindle shaped with tapering to rounded ends and 10-11 septation (Fig. 1C). Disease incidence and severity of maize were progressed with time.

The highest southern corn leaf blight incidence was observed 30 DAS (seedlin stage) in Mymensingh (5.64%) and the lowest in Gaibandha (3.46%) where the severity levels were 0.85% and 0.65% respectively (Table 2). The same result was found 60 DAS (vegetative growth stage) where the highest incidence value was 17.80% and the lowest value was 9.42%, but the severity levels were 2.27% in Mymensingh and 1.63% in Rangpur and Bogra. Disease severity was insignificant among Rangpur, Gaibandha and Bogra where the hybrid variety Pacific-984 was cultivated (Table 2).

At reproductive stage i.e. 90 DAS, higher southern corn leaf blight incidence was observed in Mymensingh (30.47%) followed by Rangpur (21.53%), Bogra (20.57%) and Gaibandha (18%), and the severity levels were 2.92%, 2.50%, 2.72% and 2.97% respectively. In case of incidence, significant differences were observed among the districts but difference was insignificance between Bogra and Rangpur. Southern corn leaf blight severity was insignificant between Bogra and Gaibandha but significantly different from Rangpur and Mymensingh (Table 2).

Table 2. Incidence and severity of southern corn leaf blight of maize.

Variety	Districts	Disease incidence (%)			Disease severity (%)		
		30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
Pacific-984	Rangpur	4.68b	12.30b	21.53b	0.69b	1.63b	2.50b
	Gaibandha	3.46c	9.42d	18.00c	0.65b	1.65b	2.79 ab
	Bogra	3.76c	11.30c	20.57b	0.73b	1.63b	2.72 ab
Khai vutta	Mymensingh	5.64a	17.80a	30.47a	0.85a	2.27a	2.92a
CV (%)		6.07	1.98	2.75	6.69	6.12	6.01
LSD (0.05)		0.53	0.50	1.24	0.09	0.22	0.33

In a column, figures having common letter (s) do not differ significantly at 5% level by LSD. DAS represents days after sowing.

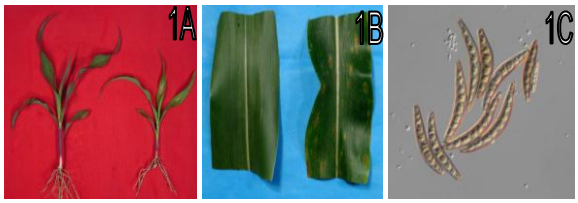

Fig. 1. Southern corn leaf blight symptoms on seedling (1A) & mature leaf (1B) caused by *Bipolaris maydis* (1C).

Curvularia Leaf spot of maize

This disease was recorded in the field at all the growth stages of maize plants. The observed spots were small (1-2mm), straw colored, and circular to oval; have reddish brown to dark brown margins surrounded by straw colored or chlorotic halos. Secondary infection to cob and other floral parts were also observed (Fig. 2A& 2B). The observed conidia under compound microscope were pale brown and straight or slightly curved, tapered at both ends, and were usually 4 septation (Fig. 2C).

Higher leaf spot incidence was observed 30 DAS (seedling stage) in Mymensingh (4.98%) and the lowest in Rangpur (3.54%) where the severity levels were 0.85% and 0.83% respectively. At seedling stage, per cent disease incidence was insignificant among Rangpur, Gaibandha and Bogra but disease severity was significantly different from Rangpur to Gaibandha and Bogra (Table 3). At vegetative growth stage, disease incidence was insignificant between Rangpur and Gaibandha but significantly different from Bogra and Mymensingh where the highest value was 15.43% and the lowest value was 11.87% in Mymensingh and Gaibandha respectively. Higher disease severity was recorded in Mymensingh (2.26%) that significantly different to rest of the districts (Table 3). At reproductive stage i.e. 90 DAS, the regular disease progression was found in Mymensingh where the disease incidence was 27.03% and severity was 3.81%, and the lowest incidence value was 18.40% and severity level was 2.56% in Bogra and Rangpur respectively (Table 3).

Table 3. Incidence and severity of leaf spot of maize.

Variety	Districts	Disease incidence (%)			Disease severity (%)		
		30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
Pacific-984	Rangpur	3.54b	12.40c	20.33b	0.83a	1.86b	2.56b
	Gaibandha	3.70b	11.87c	19.13c	0.62b	1.77bc	2.83b
	Bogra	3.71b	13.27b	18.40d	0.69b	1.72c	2.73b
Khai vutta	Mymensingh	4.98a	15.43a	27.03a	0.85a	2.26a	3.81a
CV (%)		2.54	2.36	1.58	7.29	3.21	5.66
LSD (0.05)		0.19	0.62	0.67	0.11	0.13	0.34

In a column, figures having common letter (s) do not differ significantly at 5% level by LSD.

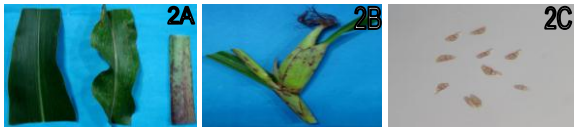

Fig. 2. Leaf spot symptoms on leaf (2A) & cob (2B) caused by *Curvularia lunata* (2C).

Sheath blight of maize

This disease was recorded in the field at vegetative growth stage and reproductive stage of maize plants. The observed lesions were large, gray, tan or brown discolored areas alternate with dark bands on infected leaves and sheaths (Fig. 3A). Sheath blight symptoms appeared more in medium low land compared to medium high land and high land. Upon microscopic examination, the observed mycelia were cottony white, hyaline and septate. Constriction present at the basal cell of daughter hypha (Fig. 3B). The incidence of sheath blight of maize was not found at seedling stage. At vegetative growth stage i.e., 60 DAS, higher sheath blight incidence was observed in Gaibandha (13.53%) and the lowest in Mymensingh (5.39%), where the severity levels were 18.20% and 5.91% respectively. Disease incidence was insignificant between Rangpur (10.10%) and Bogra (9.40%) but severity levels were insignificant among the districts (Table 4). At silking stage i.e., 90 DAS, sheath blight incidence and severity were significantly different from one district to another. Again, the highest incidence was observed in Gaibandha (61.60%) and the lowest in Mymensingh (19.37%), where the severity levels were 40.30% and 12.13% respectively (Table 4).

Table 4. Incidence and severity of sheath blight of maize.

Variety	Districts	Disease incidence (%)		Disease severity (%)	
		60 DAS	90 DAS	60 DAS	90 DAS
Pacific-984	Rangpur	10.10b	41.00b	11.23c	20.57c
	Gaibandha	13.53a	61.60a	18.20a	40.30a
	Bogra	9.40b	38.03c	11.97b	21.30b
Khai vutta	Mymensingh	5.39c	19.37d	5.917d	12.13d
CV (%)		3.65	2.11	1.70	1.12
LSD (0.05)		0.70	1.68	0.39	0.56

In a column, figures having common letter (s) do not differ significantly at 5% level by LSD.

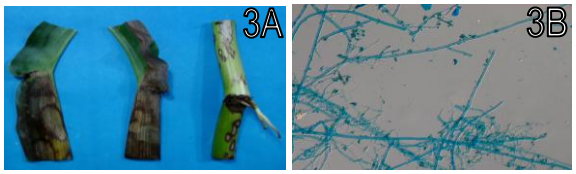

Fig. 3. Sheath blight symptoms (3A) caused by *Rhizoctonia solani* (3B).

Damping off of seedlings of maize

Post emergence damping off of seedlings was observed in the farmers' field of the surveyed regions. The symptoms appeared as blighted of young leaves leading to rapid death of the seedlings and the plants that survived were often stunted and yellow. In the laboratory, both pre and post emergence damping off symptoms were observed. Germination test followed by blotter method revealed profusely growth of pathogens at the embryonic zone of maize seeds that suppressed the germination of seeds. The same symptoms were observed in case of post emergence damping off as seen in the fields (Fig. 4A).

The pathogens causing damping off symptoms were observed under stereomicroscope and isolated from damaged maize seeds, and finally confirmed as *Aspergillus* spp., *Fusarium* spp. *and Penicillium* spp. (Fig. 4B, 4C, 4D, 4E & 4F). The incidence of these pathogens was higher at embryonic areas compared to the other parts of the infected kernels. This disease was found only at seedling stage i.e., 30 DAS. Damping off incidence of maize was higher in Mymensingh (5.85%) and lower in Rangpur (2.76%), but Incidences were more or less similar among Rangpur, Gaibandha and Bogra. Disease severity was recorded as 100% from all the surveyed districts (Table 5). The pathogen isolated from respective disease symptoms and further confirmations were made following the literature "Compendium of Corn Diseases" (White, 1999).

Table 5. Incidence and severity of damping off of maize.

Variety	Districts	Disease incidence (%)	Disease severity (%)
		30 DAS	30 DAS
Pacific-984	Rangpur	2.76 b	100
	Gaibandha	2.84 b	100
	Bogra	3.21 b	100
Khai vutta	Mymensingh	5.85 a	100
CV (%)		13.39	0
LSD (0.05)		0.98	-

In a column, figures having common letter (s) do not differ significantly at 5% level by LSD.

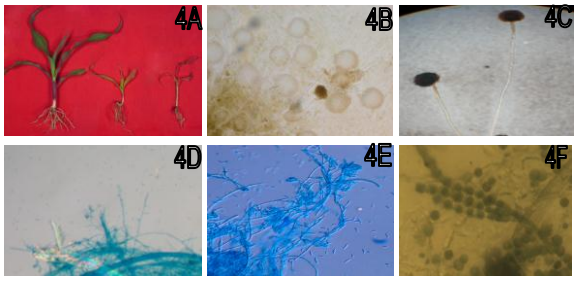

Fig. 4. Damping off symptoms (4A) caused by *A. flavus* (4B), *A. niger* (4C), *F. moniliforme* (4D), *F. oxysporum* (4E) and *Penicillium* spp. (4F).

Discussion

The etiology and incidence and severity of four fungal diseases viz. southern corn Leaf blight, curvularia leaf spot, sheath blight and damping off of maize prevailed in major maize growing districts namely Rangpur, Bogra, Gaibandha and Mymensingh of Bangladesh were investigated in the present work. Southern corn leaf blight, a fungal disease caused by *Bipolaris maydis* was found to be a major disease occurred at seedling stage, vegetative growth stage and silking stage of plant. *Curvularia lunata* cause of curvularia leaf spot has been reported in the recent study and was found at all the growth stages of maize plants. This is because of soilborne or seedborne fungal inocula present in soil or seed capable of infecting seedlings and then to mature plants by airborne conidia.

In the present study, like other cereal crops, the infection cycle of *Rhizoctonia solani* causing sheath blight has also been noted in maize. This disease was not found at seedling stage during monitoring but other stages were susceptible to sheath blight. The present study also revealed that the incidence and severity of sheath blight of maize is high in medium low land rather than high land. The possible reason is due to the presence of free moisture in the low land compared to high land. Adequate moisture promotes fungal infection at collar region of the plant resulting sheath blight in severe case. A seedling disease namely damping off of seedlings of maize has been found all over the surveyed districts. This disease is due to the complex interactions of several species of soilborne fungi and is proved by laboratory test. Based on the findings of the present study, it is reported that the incidence and severity of different maize diseases significantly varied from one district to another. The probable reasons of the variation may be due to differences of regional conditions, cultivars, inoculum potential of the pathogens etc. Earlier investigation conducted by Atac (1984), Esteves (1984), Brekalo *et al.* (1991) in Croatia, White (1999) in America, Harlapur *et al.* (2000) in north Karnataka (India), Tang *et al.* (2000) in China, Egein and Arinze (2001) in Nigeria and Kar (2006) in Orissa (India) found comparatively similar results for different fungal diseases of maize conformed with the present outcome.

Conclusion

Among the diseases, southern corn leaf blight and curvularia leaf spot were found at all the growth stages of the plant. Sheath blight was observed at vegetative and reproductive stage but damping off was recorded at seedling stage only. The damaging indicators of these diseases varied from one location to another, probably due to differences in cultivars, the growth phase of the plant and agro ecological zones. The results revealed that the incidence and severity of these diseases were comparatively at minimum in Rangpur, followed by Bogra, Gaibandha and Mymensingh. As the pathogens have negative influence on plant health as well as yield so, special attention should be given by the growers to minimize the fungal infections by promoting good agricultural practices in the maize growing districts of the country. Further research should be focused on developing high yielding, disease resistant maize cultivars by exploitation of molecular techniques to maximize the production.

References

Aldrich SR, Scott WO, Leng ER. 1975. Modern corn production. 2nd edition, United States of America pp. 1-5.

Atac. 1984. Survey of fungus disease of second crop maize in the Mediterranean region. Bitki Koruma Bulteni **24(3),** 137-147.

BBS. 2006. Monthly Statistical Bulletin. Bangladesh Bureau of Statistics, Ministry of Planning, Govt. of Bangladesh 54.

Brekalo J, Palaversic JB, Rojic M. 1991. Monitoring the occurrence and severity of maize disease in Croatia from 1985 to 1989. Zastita Bilja **42 (1)** 51-60.

Chowdhury MK, Isalm MA. 1993. Production and uses of maize (in Bengali). Published by On-Farm Res. Div. Bangladesh Agril. Res. Inst., Joydebpur, Gazipur 1-189.

Deepavali S, Nilima WK. 2013. Incidence of Seedborne Mycoflora on Maize and its Effect on Seed Germination, Int. J. Current Research **5(12)**, 4151-4155.

Egein MI, Arinze AE. 2001. A new fusarial disease of maize in Nigeria. Whurr Publishers, London, UK. Tropical Science **41(3),** 133-136.

Esteves A. 1984. Incidence of diseases under field conditions on maize *(Zea mays)* cultivars in Dourados. Fitopatologia Brasileira **9(1),** 155-160.

FAO. 1999. Production Year Book. Food and Agriculture Organization, Rome **53,** 70-79.

Harlapur SI, Mruthunjaya CW, Anahosur KH, Muralikrishna S. 2000. A report survey and surveillance of maize diseases in north Karnataka. All India Co-ordinated Maize Improvement project, Agricultural Research Station, Arabhavi-591318, India. Karnataka Journal of Agricultural Sciences **13(3),** 75.

Kar AK. 2006. Assessment of losses due to maydis leaf blight disease of maize in Orissa. Bhubaneswar, India. Society for Plant Protection and Environment. Journal of Plant Protection and Environment **3(2)**, 120-121.

Tang CR, Jie C, Shan JM, Dao ZQ, Gang S. 2000. The etiology of corn sheath blight in Liaoning Province. Chinese Society for Plant Pathology, Beijing, China. Acta Phytopathologica Sinica **30(4)**, 319-326.

USDA. 1960. Index of Plant Disease in the United States. Agricultural Hand Book. No **165**, 531.

White DG. 1999. Compendium of Corn Diseases. APS Press, The American Phytopathological Society. 3 rd edition 1-54.

Zhang DF, He-Pei X, Xiu WY, Ting MJ. 1999. Damage and control index of maize leaf spot (*Curvularia lunata*). Henan Vocation-Technical Normal College, Xinxiang, Henan Province, China. Plant protection **25(4)**, 12-15.