SEED QUALITY ASSESSMENT OF ELEVEN MAIZE VARIETIES OF BANGLADESH

Ummay Sadia[1] and Shamim Shamsi[*]

[1]M. Phil student, Department of Botany University of Dhaka
** Corresponding author: prof.shamsi@gmail.com*

ABSTRACT

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Analysis of seed quality status was performed in eleven selected maize varieties namely Khai Bhutta, Mohor, Barnali, BARI misty Bhutta, BHM-3, BHM-5, BM-5, BHM-6, BHM-7, BM-7 and BHM-9. The percentage of pure seed varied from 68.8 to 95.1%. The occurrence of inert matter was 3.75% and found only in the variety Mohor. The highest amount of abnormal seeds (27.45%) was also recorded in Mohor whereas the lowest (4.90%) was observed in BHM-9. The highest occurrence of spotted seed (14.2%) was recorded in Mohor while the lowest (2.6%) was found in BHM-9. Among the varieties, BHM-5 showed the highest germination percentage (95.67%) whereas the lowest germination capacity (21%) was recorded in Mohor. The highest seedling mortality (39%) was found in BM-7 whereas BHM-7 showed the lowest (14%) seedling mortality. The highest average shoot length was 36 mm in BHM-5 and the lowest shoot height was 7.25 mm in Mohor. On the other hand, the highest average root length was 38.33 mm in Barnali and the lowest root length of 12 mm recorded in Mohor. A total of seven different fungi were isolated from the seeds of maize in storage. The isolated fungi were *Aspergillus flavus*, *A. fumigatus*, *A. nig*er, *Curvularia lunata*, *Fusarium* sp., *Penicillium* sp. and *Rhizopus stolonifer*. The frequency percentage of association of *R. stolonifer* and *A. niger* isolated from maize seeds was higher than any other fungi.

Keywords: Quality assessment, maize seeds, Bangladesh

INTRODUCTION

Maize (*Zea mays* L.) is a member of the grass family Poaceae. It was first grown by the people in ancient Central America. It is now the third most important cereal crop in the world. However, little of maize is eaten directly by humans. Most of them is used to make corn ethanol, animal feed and other maize products, such as corn starch and corn syrup (Anon. 2020). Maize has long been used as a staple food by many people in Mexico, Central and South America and parts of Africa. In Europe and North America, maize is grown mostly for use as animal feed. In Canada and the United States, maize is commonly referred to as "corn". Maize was first domesticated by the native people in southern Mexico about 10,000 years ago. The plant was originally domesticated in Mesoamerica, and appears to be related to species of wild grass which still exists in Central America (Roney 2009). The US is ranked first in the world in corn production and approximately 13% of its annual yield is exported. Other top maize producing countries include China, Brazil, Mexico, Indonesia, India, France and Argentina.

In Bangladesh maize has been cultivated in 2.02 lakh hectares with a production of 13.17 lakh metric tons in 2010 (BBS 2011). It grows well in Dinajpur, Thakurgaon, Rangpur, Chuadanga, Meherpur, Dhaka, Tangail, Khagrachori, Chittagong and Mymensingh districts. Humid tropical climate (21-27°C) and high rainfall (635-1015 mm per year) are favorable for the production of maize. Loam soil is suitable for the growth of maize. It is cultivated in two seasons *viz.*, Rabi and Kharif (Rahman 2011) Maize was introduced as a relatively new crop in the rice-based agriculture in Bangladesh, especially in the northern region. Currently, maize is considered as an important cash crop for its growers. Maize (*Zea mays*) has emerged as the most important cereal crop for its food and feed values after rice in Bangladesh (Alam *et al.* 2014). The area under maize cultivation is increasing steadily due to its ready market, remunerative price, lower cost of production, and overall higher profitability compared to rice and wheat (Moniruzzaman *et al.* 2009). Presently, maize is a potential cereal crop in Bangladesh for its low cost of production, wide adaptability and diversified use.

In Bangladesh, 17 maize diseases with 30 causal organisms were identified based on field survey, focus group discussion and laboratory analysis. The diseases are Fusarium rot, Pythium rot, Rhizoctonia rot, Pythium stalk rot, Fusarium stalk rot, leaf blight, brown spot, Curvularia leaf spot, Cercospora leaf spot, Phyllosticta leaf spot, downy mildew, rust, smut, anthracnose, cob rot, grain rot, bacterial wilt, bacterial stalk rot, maize mosaic, maize dwarf mosaic, maize leaf streak, root lesion and root knot. (Alam *et al.* 2014).

A number of pathogens are likely to be associated with maize seed (Bari and Alam 2004). Six different diseases viz., leaf blight, yellow spot, stalk rot, stem rot, cob sheath rot/cob blight and mosaic were also reported to occur on three varieties of maize named Barnali, Mohor and Shuvra (Siddique 1996). Fakir (2001) listed 11 seed-borne diseases on this crop.

In Bangladesh, most of the farmers use hybrid seeds imported from abroad under quarantine rules. Therefore, disease frequency is generally very low in the field in our country (Bari and Alam 2004). But maize seeds as well as grains are infected with different fungi in storage condition that causes significant losses in both quality and quantity (Alam *et al*. 2014). This also imparts an adverse effect on poultry industry as well as human consumption. In Bangladesh, insufficient report is available on storage disease of maize grain and its fungal infestation. The present study was undertaken to assess the health status, quality and fungal incidence of maize seeds of selected varieties developed in Bangladesh.

MATERIALS AND METHODS

Seed samples of eleven selected maize varieties were collected from Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur to record the seed qualities, fungal incidence and also to detect the pathogenic fungi associated with maize seeds during 2011 to 2015. The selected varieties were Khai Bhutta, Mohor, Barnali, BARI Misty Bhutta, BHM-3, BHM-5, BM-5, BHM-6, BHM-7, BM-7 and BHM-9. Collected samples were placed in clean brown paper bags and labeled properly. All samples were preserved at 4ºC in refrigerator for subsequent uses.

Seed quality analysis

The seeds were subjected to visual observation and examined under stereoscopic microscope. One hundred seeds per sample were examined with four replicates. To analyze the seed quality, the pure seeds, abnormal seeds and inert matter were taken into consideration. Seeds that showed distinct symptoms and abnormalities were categorized into different groups. Seed contaminants and abnormal seeds separated and recorded from each sample. Abnormal seeds categorized into spotted, broken, undersized and wrinkled seeds. Purity percentage of seeds was determined with the following formula:

$$\text{Purity precentage of seed} = \frac{\text{Weight of pure seed}}{\text{Total weight of seed}} \times 100$$

The fungi were isolated from the samples following the Tissue Planting method on PDA medium (CAB 1968) and Blotter method as recommended by ISTA (Anon. 1976, 1998, 2014). The seeds of each variety were washed with sterile water and then surface sterilized by dipping in 10% Clorox solution for 5 min. Four hundred seeds of each sample were placed on three layers of moist blotting paper (Whatman No. 1) in Petri plates. Ten Seeds were placed in each plate and incubated at 25 ± 2°C. Identification of the isolates were determined following the standard literatures (Barnett and Hunter 2000, Booth 1971, Ellis 1971, 1976, Thom and Raper 1945, Raper *et al*. 1949).

All the isolated fungi were selected for pathogenicity test. Pathogenicity tests were done following seed inoculation technique (Chowdhury *et al.* 2015). Apparently healthy seeds were selected to detect the pathogenic potentiality of particular fungus. Two hundred healthy seeds for each variety were soaked in distilled water in a beaker for one hour and then surface sterilized with 10% Chlorox solution for 10 min. One hundred milliliter of spore suspension of the test fungus at 10^4 conidia/ml water was prepared in a 250 ml sterilized beaker. Seeds were inoculated by dipping into spore suspension and then air-dried for 30 min. Seeds were then placed in sterilized 8-inch cotton plugged test tubes each containing 5 ml of 2% water agar medium. Healthy seeds without inoculation served as control. Observation was made for four weeks. After 10 days of inoculation pathogenic fungi were re-isolated from the seeds. Germination percentage of seeds, development of disease symptoms, seedling mortality and root-shoot ratio were recorded on healthy and inoculated seeds.

RESULTS AND DISCUSSION

Seed quality analysis

Quality analysis showed that seeds of BHM-9 was 95.10% pure followed by BHM-5 91.10%. Mohor showed lowest 68.80% pure seeds. Highest Abnormal seeds were recorded 27.45% in Mohor followed by BHM -7 (24.75%) and lowest count was 8.9% in BHM-5. Seed contaminants and its occurrence in different varieties are presented in Table 1. Only one type of contaminant was found in the present study.

The contaminant was inert matter. The occurrence of inert matter was 3.75% in variety Mohor only.

Table 2 showed the four types of abnormal seeds recorded in the present study. The abnormal seeds were spotted seed, broken seed, undersized seed and wrinkled seed. The highest occurrence of spotted seed (14.2%) was recorded in variety Mohor while the lowest (2.6%) in variety BHM-9. The highest occurrence of broken seed (5.45%) was found in variety BHM-7 and the lowest (1.02%) in variety Khai Bhutta. The highest occurrence of undersized seed (11%) was found in Barnali and the lowest (2.3%) in variety BHM-9. The occurrence of wrinkled seed was 3.75% which was found only in variety Mohor.

Germination and mortality percentage of seeds of different maize varieties

Seeds of maize varieties Khai Bhuta showed 96 percent germination followed by BHM- 95.67% and BHM-6. 94.67%. Whereas seeds of Mohor showed 21 percent germination. The highest mortality percentage of maize seedling (39%) was found in variety BM-7 whereas BHM-7 showed the lowest mortality percentage of seedling (14%) (Table 3). The standard germination percentage was between 92-98% as recommended by Anonymous (1993). However, the differences in germination status might also be due to differences in storage and handling. The prevalence of seed-borne infection is also responsible for lower germination (Fakir *et al.*1990).

Table 1. Purity status of the maize seeds collected from BARI, Joydebpur, Gazipur.

Sl. No.	Name of varieties	Percent weight		
		Pure seed	Abnormal seeds	Inert matter
1.	Khai Bhutta	89.40	10.6	-
2.	Mohor	68.8	27.45	3.75
3.	Barnali	78.5	21.5	-
4.	Bari misty Bhutta	85.5	14.5	-
5.	BHM-3	87.85	12.25	-
6.	BHM-5	91.1	8.9	-
7.	BM-5	88.65	16.35	-
8.	BHM-6	79.3	20.7	-
9.	BHM-7	75.25	24.75	-
10.	BM-7	83.9	16.1	-
11.	BHM-9	95.1	4.9	-

"-" indicates no inner matter found.

Table 2. Different types of abnormal seeds detected in eleven different varieties of maize seeds collected from BARI, Joydebpur, Gazipur.

Sl. No.	Name of varieties	Total abnormal seeds (% by weight)				
		Spotted	Broken	Undersized	wrinkled	Total
1.	Khai Bhutta	5.03	1.02	4.55	-	10.60
2.	Mohor	14.2	4.2	5.3	3.75	27.45
3.	Barnali	10.5	-	11	-	21.5
4.	BARI misti Bhutta	04.1	-	6.45	-	14.50
5.	BHM-3	05	-	7.25	-	12.25
6.	BHM-5	-	-	8.9	-	8.90
7.	BM-5	8.9	-	5.85	-	16.35
8.	BHM-6	9.85	4.25	6.6	-	20.70
9.	BHM-7	10.35	5.45	8.95	-	24.75
10.	BM-7	10.1	-	06	-	16.10
11.	BHM-9	2.6	-	2.3	-	4.90

"-" indicates no broken and wrinkled seed found.

Table 3. Germination percentage and seedling mortality of different varieties of maize seeds.

Name of varieties	Germination percentage	Percentage of seedling mortality
Khai Bhutta	96	22
Mohor	21	24
Barnali	58.33	30
Bari misty Bhutta	57.67	24
BHM-3	80.67	26
BHM-5	95.67	27
BM-5	84	19
BHM-6	94.67	19
BHM-7	86.33	14
BM-7	73.33	39
BHM-9	92	19

Length of root and shoot of maize varieties

Among the 11 varieties of maize the highest average shoot length was 36 mm in BHM-5 and the lowest shoot height was 7.25 mm in Mohor. On the other hand, the highest average root length was 38.33 mm in Barnali and the lowest root length was 12 mm in Mohor (Table 4). A total of seven species of fungi *viz.*, *Aspergillus flavus* (Link), *A. fumigatsu* (Fresenius), *A. niger* (Van Tiegh), *Curvularia lunata* (Wakker Boedijn) *Fusarium* (Link), *Penicillium* (Link) and *Rhizopus stolonifer* (Ehrenb Vuill) were isolated from the different maize varieties. The frequency percentage of *R. stolonifer* was highest (43%) in Bornali followed by *A. niger* (42%) in BHM-5. Lowest fungal count (1%) in BARI misty Bhutta (Table 5).

Table 4. Length of root and shoot of different varieties of maize seedling at 7th day.

Name of varieties	Root length (mm)			Shoot length (mm)		
	Highest value	Lowest value	Average value	Highest value	Lowest value	Average value
Khai Bhutta	20	5	13.25	22	5.5	13.12
Mohor	22.3	3	12	9	7	7.25
Barnali	50	25	38.33	45	25	35.2
BARI Misti Bhutta	33	9	20.5	50	24.5	33.25
BHM-3	35	10	23	32	15	22.37
BHM-5	45	25	35.72	40	30	36
BM-5	45	20	35	56	5	28.6
BHM-6	32	18.5	25.11	28	15	21.5
BHM-7	52	13	33.25	35	17	25
BM-7	47	9.9	29.01	33	15	26
BHM-9	40	0	21	25	13	18.5

Table 5. Frequency percentage of association of fungi with maize seeds.

Name of varieties	Per cent frequency of isolated fungi						
	Aspergillus flavus	*A. fumigatus*	*A. niger*	*Curvularia* sp.	*Fusarium* sp.	*Penicillium* sp.	*Rhizopus stolonifer*
Khai Bhutta	20	7	-	-	-	-	7
Mohor	4	-	17	21	-	-	19
Barnali	4	-	6	-	7	-	43
Bari misty Bhutta	-	1	23	-	-	-	20
BHM-3	4	5	-	-	-	-	-
BHM-5	-	-	42	-	-	15	-
BM-5	-	-	3	-	22	12	-
BHM-6	3	-	8	-	-	-	20
BHM-7	-	4	-	-	-	-	30
BM-7	-	7	-	-	-	-	28
BHM-9	-	-	11	-	-	16	-

"-" = No fungal growth

Seeds inoculated with *C. lunata* and *Fusarium* sp. failed to germinate and produced spots on seeds similar to those observed in nature. Both the fungi were successfully re-isolated from the artificially inoculated seeds. Out of 7 fungi isolated, only *Curvularia lunata* and *Fusarium* sp. were found to be pathogenic to maize seedlings (Plate 1).

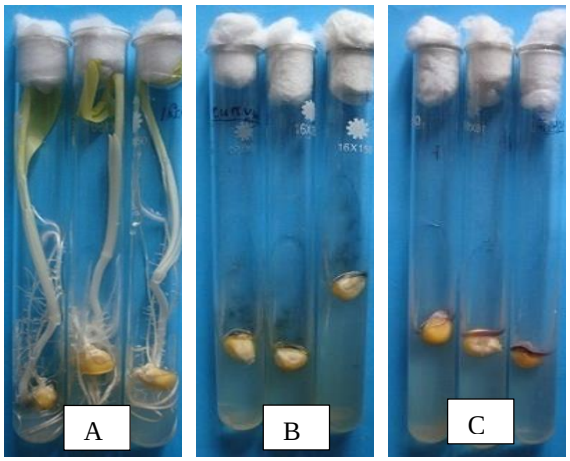

Plate I. A. Healthy maize seeds (Uninoculated ontrol), B. Seeds inoculated with *Curvularia lunata* and C. Seeds inoculated with *Fusarium* sp.

From Bangladesh, Khalequzzaman *et al*. (1998) reported 31-41% infection of maize seed due to the fungus *Helminthosporium turcicum*. During storage, several kinds of fungi can remain associated with corn seeds either causing their deterioration or simply remain viable to infect germinating seedling. The fungal genera typically associated with stored grains include *Aspergillus*, *Penicillium* and *Fusarium* (Orsi *et al*. 2000, Castlellarie *et al*. 2010). Development of fungi in grains is influenced by temperature, humidity and period of storage. Several fungi such as *Alternaria alternata*, *Aspergillus* spp., *Bipolaris maydis*, *Fusarium moniliforme*, *Fusarium* spp. and *Cephalosporium* spp. were identified in grains depending on storage conditions (Fakir 2001). Some researchers reported *Helminthosporium* spp., *Mucor* sp. and *Penicillium* spp. from maize seeds in storage (Hafiz 1986, Ahmad *et al*. 1993, Anne *et al*. 2000, Fakir *et al*. 2001, Tulin and Askun 2006).

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