[*N. N. Tonu* et al., 4(9): September, 2017*] ISSN: 234-5197
Impact Factor: 2.715

INTERNATIONAL JOURNAL OF RESEARCH SCIENCE & MANAGEMENT

QUALITY AND HEALTH STATUS OF FARMER SAVED WHEAT SEED IN BANGLADESH

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DOI: 10.5281/zenodo.886909

Keywords: Wheat seed, Seed Quality, Seed health, Black pointed seed

Abstract

Quality and health status of farmer saved wheat seed of cv Kanchan was determined by seed health and quality analysis. One hundred seed samples collected from 100 farmers representing ten upazilas under nine major wheat growing districts of Bangladesh were included. Seed health and quality analysis revealed that moisture content of farmer saved seed ranged between 12.04-13.30%. Six type's seed contaminants– weed seeds, insects, varietal mixture, seed with husk, other crop seed and inert matter; and five types of abnormal seeds - black pointed seed, discoloured seed, undersized seed, shriveled seed and insect damaged seed, recorded in Farmer saved seed. On an average, 58.48% 'clean' or 'best' seed was recovered from farmer saved wheat seed by removing the seed contaminants and abnormal seeds through manual seed cleaning. Clean seed had the highest weight, while the undersized and black point Grade 5 seeds were lighter than all other categories of wheat seed. Of the 13 fungi encountered in farmers' seeds, five target pathogenic fungi identified, in order of prevalence, were - *Bipolaris sorokiniana, Alternaria tenuis, Curvularia lunata, Fusarium oxysporum* and *Aspergillus flavus.* Incidence of these target fungi in both unclean and clean seeds varied significantly with respect to location of seed collection. All the five target fungal pathogens were more prevalent in farmers saved seed compared to clean seed. 'Clean' or 'best' seed significantly gave higher counts of normal seedlings and lesser percentage of abnormal seedlings and dead seeds over unclean farmers' seed and abnormal seeds like black pointed, undersized, discoloured and shriveled seeds. Similarly clean seed resulted higher germination and seedling vigour index over unclean and abnormal seeds.

Introduction

Wheat (*Triticum aestivum* L.) is the second most important staple food crop next to rice in Bangladesh. The average yield of wheat is only 3000 kg/ha. in Bangladesh, which is too low as compared to the developing countries of the world like Egypt, Zambia, U.K. Denmark, Ireland and Netherlands producing 6150, 6452, 7778, 7832, 7862, 9110 kg/ha., respectively [19]. Thus the yield of wheat in the country is relatively low. Among the various factors responsible for low yield of the crop, diseases and low seed quality play a vital role. Wheat suffers from as many as 120 different diseases, out of which 42 are seed-borne [33, 42]. Coincidentally, seed-borne diseases of wheat are more devastating in nature and have worldwide occurrence. In Bangladesh, 16 different diseases are known to occur on wheat. Of these, 12 are seed borne [12, 13]. Seed is the most important input for crop production and quality healthy seed is the crying need of the day. Good or quality healthy seed means good crop. This truth is also applicable for wheat seed. In Bangladesh, of the total wheat seed requirement, only 10% seed produced by BADC, NGOs and seed companies are of good quality to some extent. Traditionally, our farmers grow (rest 90%) wheat for consumption purpose. From this produce, they save a portion and keep them as seed. These farmer-saved seeds are never tested for quality. Obviously, these seeds are of poor quality and often infected by pathogens.

Infected wheat seeds fail to germinate or the young seedlings emerging from the infected seeds die resulting germination failure, post emergence damping off and seedling blight. The pathogens present in the infected seeds will remain alive in dormant condition as long as the seed remains viable [36]. As these pathogens are very small and microscopic in nature their presence in or on the seed cannot be seen from outside with naked eyes. However, sometimes infected wheat seeds may be recognized by observing various kinds of lesions/spots, discoloration, deformation and other abnormalities. Propagules of different pathogens present in dusts, soil

particles or infected crop debris (inert matter) may also be mixed with seeds in a given seed lot during the process of harvesting, winnowing and storage. Presence of insects, weed seeds, seeds of other wheat varieties as well as other crop seeds are not also hygienic for the seed lot. Thus, wheat seeds can be infected by seed-borne pathogens or it can carry pathogens as contamination or concomitant contamination. There are also evidences that undersized wheat seeds are poor as regard to seed health quality [1, 21, and 40]. Such infected seeds and seed lots having contaminants and abnormal seeds signify the poor health and quality of wheat seeds.
From the foregoing deliberations, it appears that seed-borne diseases are responsible for low yield and production of poor quality wheat seeds in Bangladesh. But the health status of wheat seeds produced by the farmers in the country is not precisely known. But successful wheat cultivation largely depends on the use of quality healthy seeds. In view of the above facts, the present investigation has been undertaken to determine the quality and health status of wheat seeds produced by the farmers in Bangladesh.

Materials and Methods

Locations of Seed Collection

The seed quality analysis and the laboratory experiments were conducted in the Departments of Plant Pathology, Sher-e-Bangla Agricultural University (SAU), Sher-e-Bangla Nagar, Dhaka, and Seed Pathology Centre (SPC), Bangladesh Agricultural University (BAU), Mymensingh. Ten locations under 10 upazilas representing nine major wheat growing districts of Bangladesh were selected as sources of seed collection. A popular and widely cultivated wheat cultivar Kanchan was used for the study. The ten selected upazilas/locations are as follows:

1. Atghoria, Pabna
2. Dinajpur, Sadar
3. Faridpur, Sadar
4. Ishurdi, Pabna
5. Jhikargasa, Jessore
6. Koshba, Brahmanbaria
7. Mymensingh, Sadar
8. Rajbari, Sadar
9. Sherpur, Bogra
10. Ulipur, Kurigram

Collection and Preservation of Seed Samples

One hundred wheat seed samples representing 10 farmers under 10 Upazilas belonging to nine different districts were included for the present study. 500g wheat seeds were obtained from each farmer. Seed samples were collected from farmer's seed store by removing top 15cm seed following the International Rules for Seed Testing [25] .The collected seed samples were kept in cloth bag and stored immediately in a well-ventilated room of the Department of Plant Pathology, SAU, under ambient condition for a short period. The seed samples were then registered. After registration the samples were preserved in a refrigerator in the laboratory.

Seed Quality and Health Analysis

Determination of moisture content

Moisture content of the seed samples was determined prior to temporary storage by a digital electric moisture meter and the results were expressed in percentage on wet weight basis.

Sorting of 'Best' or apparently healthy seeds

Cleaning of seed by manual seed sorting was done on a clean laboratory table in order to separate out the 'Best' (Apparently healthy) seeds from the original farmer saved seeds. In doing so, seed contaminants and abnormal seeds (seed conditions) present in a 250g working sample of farmer saved seeds were looked for and separated out from each working sample. Seed contaminants separated and recorded from each sample were as follows:

- Weed seeds
- Insects
- Varietal mixture
- Seed with husk
- Other crop seeds

- Inert matter

Abnormal seeds sorted out and recorded were as follows:

- Undersized seeds
- Black pointed seeds
- Discolored seeds
- Shriveled seeds
- Insect damaged seeds

Apparently healthy seeds obtained from a seed sample by cleaning or removing seed contaminants and abnormal seeds are considered as 'Clean seed'. Inert matter were included, crop residues (broken seeds, husk, awns, etc.), stones, soil and sand particles etc. Undersized seeds were considered those seeds which had diameter below 2.25mm. Insect damaged seeds were identified by observing the circular hole made by the invading insects. The separation of contaminants and abnormal looking seeds were done with unaided eyes. Occurrence of weed seeds and insects were counted species-wise in number. The rest of the seed contaminants and abnormal seed conditions were recorded and expressed in percentage of seed weight.

Determination of seed weight

Weight of 1000 seeds of different seed categories of wheat *viz.* Farmer saved seed, Black pointed seed, Undersized seed, Shriveled seed and Best seed was measured by a digital balance. Similarly, 1000 seed weight of the six Black point Grades (0-5) were also measured. The results were expressed in gram (g).

Detection of seed- borne fungi

Two hundred seeds randomly taken from each working sample were used for detection of seed-borne fungi prevalent in the test seed samples. The fungi were detected by the Blotter method [25]. After incubation, the seeds were examined for the presence of seed borne fungal infections. The fungi were recorded by observing their growth characters on the incubated seeds under stereomicroscope at 25X magnification. The fungi thus recorded were identified following the keys of [7, 11, 32, 34 and 41]. Fungi thus recorded and identified were expressed in percentage. Of all the fungi detected in wheat seed samples analysed, five fungi *viz. Bipolaris sorokiniana, Alternaria tenuis, Curvularia lunata, Fusaruim oxysporum* and *Aspergillus flavus* were established seed borne pathogens of wheat. As such, they were considered as the target pathogenic fungi for the study.

Determination of germination

Germination of original farmer saved seed, best or 'clean seed', black pointed seed, undersized seed and shrivelled seed were determined in clean sand. Plastic trays were used for this purpose. Four hundred seeds in four replicates taken randomly from each seed lot mentioned above were used for germination test. Hundred seeds were sown in each tray and the trays were then kept on the Laboratory table at room temperature for 14 days. Germination was recorded up to 14 days at an interval of 2 days. Normal seedlings, abnormal seedlings and dead seeds were recorded separately following the International Rules for Seed Testing [25] with some modifications. The modifications included- seedlings with slight defects and seedlings with secondary infection were placed under the abnormal seedling category instead of normal seedlings. The results were expressed in percentages. The number of seeds that produced normal seedlings, abnormal seedlings and dead or decayed seeds were counted and recorded the percentage data.

Determination of seedling vigour

Seedling vigour was determined by recording the speed of germination, which was done by taking data on seed germination at 2 days interval. For determination of seedling vigour after two weeks of germination, 25 seedlings were randomly selected and the individual root and shoot length for the selected seed categories viz.- farmers saved seed, black pointed seed, undersized seed, shriveled seed and best seed were measured. Shoot and root were separated from the seedlings and length of shoot was measured from the base of the stem upto the growing point of the youngest leaf. Similarly, length of the root was measured from the starting point of root to the largest available lateral root apex. Seedling vigour was determined by the following formula[3].

Vigour index = (Mean of root length + Mean of shoot length) x seed germination (%)

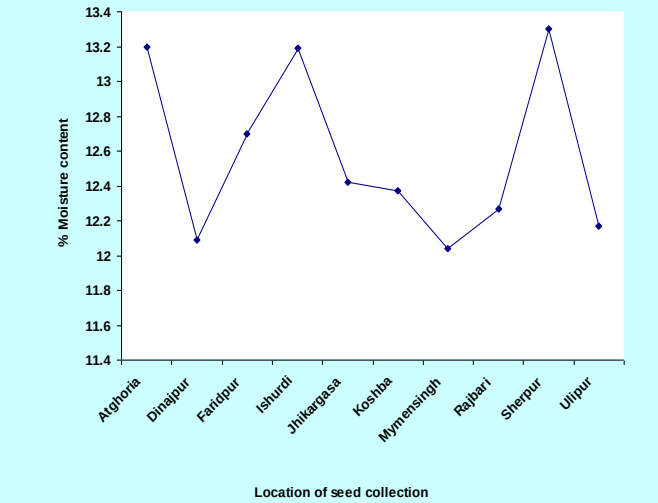
Statistical Analysis

The recorded data were analysed using MSTAT-C computer package program. The mean differences for efficiency of the treatments were judged by Least Significant Difference (LSD).

Results and discussion

Moisture Content

The average moisture content of farmers saved wheat seed obtained from 10 different locations of Bangladesh varied significantly from 12.04 – 13.30% (Fig. 2). The maximum moisture content (13.30%) was found in seeds collected from Sherpur, followed by Atghoria (13.20%) and Ishurdi (13.19%), whereas the minimum moisture content (12.04%) was recorded at Mymensingh followed by Dinajpur (12.09%) and Ulipur (12.17%).



Figrue. 1. Moisture content of farmer saved wheat seed collected from 10 different locations of Bangladesh

Variation in moisture content of seeds of the individual farmers observed was probably due to the differences in the degree of drying of seeds. Again, this difference could be due to the ignorance of the farmers about the deleterious effect of high moisture content in seeds. Or, it could be due to the exposure of seeds to wet weather during pre-monsoon days when wheat crop is harvested and processed. The national standard for moisture content of wheat seed is 12.00%. But, moisture content data obtained in the present study showed that all the hundred seed samples had higher moisture content than the national standard. High moisture content in seed prior to storage is not safe for health of stored seeds. Because, wheat seeds stored with higher moisture content is vulnerable to the attack of storage fungi and stored grain insects, which often cause considerable losses through reduction in germination [9, 12].

Seed contaminants

Seed contaminants and its frequency of occurrence in the farmers saved seeds are presented in Table 1. Six different types of seed contaminants *viz*., weed seed, insects, varietal mixture, seed with husk , other crop seeds and inert matter , were recorded in the farmers saved wheat seeds. The seed contaminants varied significantly with respect to location of seed collection (Table 1).

Six different species of weed seeds (*Brassica kaber*, *Chenopodium album*, *Cyperus* sp., *Echinochloa crusgalli*, *Solanum nigrum*, *Polygonum hydropiper* and *Vicia sativa*) were found as seed contaminants in farmer saved seed. Weed seeds were recorded in farmer saved seeds at all the locations. The highest number (3.00) of weed seeds was observed at Jhikargasa while the lowest (1.30) was encountered at Ulipur (Table 1).

Three species of insects *viz*, red flour beetle (*Tribolium casteneum*), rice moth (*Corcyra cephalonica*) and weevil (*Sitophillus oryza*) were observed in farmer's saved seed during seed quality analysis. The three insects were recorded in seeds collected at all the locations. Maximum number (2.80) of insects was found at Dinajpur (2.60), while the minimum number (0.70) was recorded at Rajbari (Table 1).

The prevalence of varietal mixture in farmer saved seed varied significantly from 0.06 – 3.90% with respect to source of seed collection. The average mixture of other varieties with the collected seed samples was the highest at Ulipur (3.90%) ,while the lowest (0.04%) was recorded at Mymensingh (Table 1).

The occurrence of seed with husk, other crop seed and inert matter as seed contaminants in farmers' seed was found in low quality at all the locations with some exceptions. Seed with husk was present at all the locations of seed collection. It varied from 0.09 – 0.35% depending on the seed sources. Other crop seed also occurred at all the locations ranging from 0.05 – 1.68%. Maximum association of other crop seeds were found at Ishurdi (1.68%) and the minimum was encountered at Koshba (0.05%). The percentage of inert matter ranged from 0.24 (Mymensingh) to 2.65% (Jhikargasa) (Table 1).

Table 1. Seed contaminants recorded in farmers' saved wheat seed collected from different locations of Bangladesh

Location	Seed contaminants					
	Weed seed (No.)	Insect (No.)	Varietal mixture (%)	Seed with husk (%)	Other crop seed (%)	Inert matter (%)
Atghoria	1.80 b	1.60 b	2.56 c	0.35 a	0.22 ef	0.60 d
Dinajpur	2.50 a	2.80 a	3.86 a	0.16 bcd	0.29 de	0.38 ef
Faridpur	2.60 a	2.60 a	1.79 d	0.17 bcd	0.71 c	0.96 c
Ishurdi	1.70 b	1.70 b	3.89 a	0.09 d	1.68 a	0.45 e
Jhikargasa	3.00 a	1.90 b	0.12 e	0.16 bcd	0.21 ef	2.65 a
Koshba	1.70 b	1.60 b	3.23 b	0.25 abc	0.05 g	0.44 e
Mymensingh	2.70 a	2.60 a	0.06 e	0.18 bcd	0.07 g	0.24 f
Rajbari	1.60 b	0.70 c	2.36 c	0.11 cd	0.12 fg	1.19 b
Sherpur	1.70 b	1.60 b	1.61 d	0.29 ab	0.91 b	0.36 ef
Ulipur	1.30 b	0.80 c	3.90 a	0.12 cd	0.34 d	0.90 c
LSD (P≥0.01)	0.63	0.57	0.35	0.14	0.12	0.15
CV (%)	25.84	26.92	12.72	61.59	20.33	15.34

** = 1% level of significance

Analysis was performed after square root transformation of the % data.

These contaminants occurred in trace to appreciable extent depending on the type of contaminant and site of seed collection. This situation indicates that farmer saved wheat seed is not of good quality. Because, seeds of weed species may carry inocula of fungal pathogen like *B. sorokiniana*. Although no study has been made on the role of weeds grown in the wheat field in harbouring pathogens as alternate host, seeds of certain weed species found in farmer saved rice seed, which have been reported to serve as alternate hosts of *Bipolaris oryzae* and *Pyricularia oryzae* (15). Occurrence of as high as 7.35% insect damaged seed at certain location as seed contaminant (Table 2) further bears the testimony of deleterious effect of stored insects on the quality of farmer saved wheat seed.Presence of inert matters has not been investigated in wheat earlier or in the present study. But there is evidence that inert matter present in rice seed produced by the farmers' of Bangladesh can carry viable propagules of *B. oryzae*, *A. padwickii*; *Fusarium* spp, *Aspergillus* spp. and *Penicillium* sp. (31). Thus, the presence of inert matter in farmer saved seed poses risk as regard to contamination of seed lot by the propagules of pathogenic fungi. Therefore, studies need to be undertaken on the role of inert matter present in farmers' saved wheat seed in carrying pathogenic fungi.

Varietal mixture indicates that farmers are not much careful about the varietal mixture in their saved seeds. Presence of seeds of other wheat varieties as well as seeds of other crops in a given seed lot may affect the health of the seed lot through mixture of seeds of susceptible varieties/crops with the saved seeds of a resistant variety.

Abnormal seeds

Data on five different types of abnormal seeds recorded in farmer saved wheat seed collected from ten selected locations are presented in Table 2. Five types of abnormal seeds encountered were undersized seed black pointed seed, discoloured seed, shriveled seed and insect damaged seed. The prevalence of abnormal seeds varied significantly depending on the types of abnormal seeds and location of seed collection (Table 2). Among the different types of abnormal seeds, undersized seed was the predominant, followed by black pointed seed.
The highest occurrence of undersized seed was recorded in Sherpur (33.01%) while the lowest record of undersized seed was found in Jhikargasa (16.52%).
Prevalence of black point in farmers' saved seed varied significantly from 3.38% – 28.53% depending on the location of seed collection. The highest count of black point was observed at Sherpur (28.53%), while the lowest was encountered at Faridpur (3.38%).Highest percent of discolored seeds were noted at Dinajpur (3.82 while the lowest was encountered at Rajbari (0.37%).The prevalence of shriveled seed and insect damaged seed ranged from 0.90 – 4.80% at Rajbari and Ishurdi, and 0.02%–7.35% at Rajbari and Atghoria, respectively.

Table 2. Abnormal seeds recorded in farmers' saved wheat seed collected from different locations of Bangladesh

Location	Undersized seed (%)	Black pointed seed (%)	Discoloured seed (%)	Shriveled seed (%)	Insect damaged seed (%)
Atghoria	17.64 ef	5.98 f	0.92 g	1.06 g	7.35 a
Dinajpur	19.22 de	10.71 c	3.82 a	3.55 b	1.59 cd
Faridpur	19.48 d	3.38 g	1.59 d	2.24 de	1.27 de
Ishurdi	17.49 f	8.07 d	2.58 c	4.80 a	1.02 e
Jhikargasa	16.52 g	25.12 b	1.36 f	1.68 f	0.51 f
Koshba	24.38 c	6.04 f	1.47 e	3.05 c	3.20 b
Mymensingh	31.61 ab	3.44 g	3.37 b	2.27 de	3.30 b
Rajbari	18.50 h	10.62 c	0.37 h	0.90 g	0.02 g
Sherpur	33.01 a	28.53 a	3.27 b	3.27 d	1.96 c
Ulipur	29.55 b	7.09 e	2.55 c	2.03 e	0.42 f
LSD (P≥0.01)	0.23	0.15	0.04	0.12	0.15
CV (%)	4.62	4.18	2.69	6.64	9.70

** = 1% level of significance
Analysis was performed after square root transformation of the % data.
Presence of five types of abnormal seeds *viz.* undersized seed, black pointed seed, discoloured seed, shriveled seed and insect damaged seed in the farmer saved seed further proves that the quality of our farmers' wheat seed is poor. Occurrence of abnormal seeds like black pointed, discoloured, undersized and shriveled seeds, poses threat of carrying leaf blight pathogen, *B. sorokiniana* and black point pathogens like *B. sorokiniana, A. tenuis, C. lunata* and *Fusarium* spp., which might be responsible for causing leaf blight disease in the field and discoloration and black point symptom to wheat seed. It has been demonstrated that creamy to pink coloured shriveled wheat seeds were infected by *Fusarium* spp. [2]. Different study [28] also demonstrated that seedling vigour, especially root length and seedling growth was found to decrease with the decrease in seed size of wheat.

'Clean' or 'Best' (Apparently healthy) Seed

Average percentage of 'Clean' or 'Best' (Apparently healthy) seed (Plate 1) recovered from farmers' saved seed ranged from 27.64 – 83.80% with respect to location of seed collection. Out of the ten locations, four had more than 60.00% 'Clean' or 'Best' seed. The four locations were – Dinajpur (83.80%), Ishurdi (69.96%), Mymensingh (68.62%) and Sherpur (63.03%), while the lowest quantity of 'Best' or 'Clean' seed was recovered from Ulipur (27.64%). The 'Clean' seed sorted out from the rest five locations ranged from 51.76 – 57.41%. On an average, 58.48% Best seed was recovered from farmer saved seed by manual seed cleaning (Fig. 2).

Plate 1. 'Clean' or 'Best' seed sorted out from farmers' saved wheat seed.

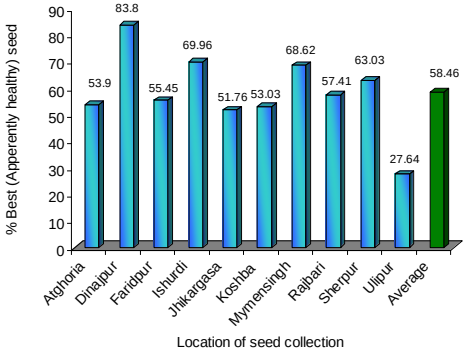


Figure. 2 'Best' or apparently healthy wheat seed recovered from farmers saved wheat seed collected from ten different locations of Bangladesh

This study shows that more than 40% of the wheat seed produced by the farmers is discarded due to presence of abnormal seeds. This is an alarming situation in wheat seed production for Bangladesh. The situation demands more careful attention to seed crop management and processing of seeds after harvest specially during cleaning operations.

1000 Seed Weight

Weight of 1000 seeds of the five selected wheat seed categories recorded in the present study are presented in Fig. 4. Of the five seed categories, 1000 'Best seed' had the highest weight (40.63g), followed by farmer saved seed (34.01g), black pointed seed (31.38g) and shriveled seed (21.54g). Of the five categories, undersized seed was the lightest; 1000 seeds of this category weighed 19.99g only. Thousand seed weight of the six categories of black pointed seed decreased with the increase in black point severity (Fig. 5). The highest weight of 1000 seeds was recorded in Grades 0 i.e. wheat seed without black point; while the lowest weight was observed in Grade 5. It was also observed from the Figure that 1000 seed weight decreased progressively from Grade 1 to Grade 5.

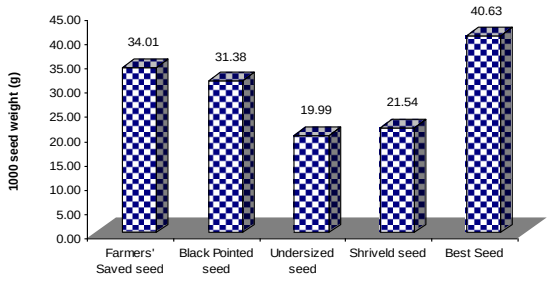


Figure. 3. Thousand seed weight of different categories of wheat seed

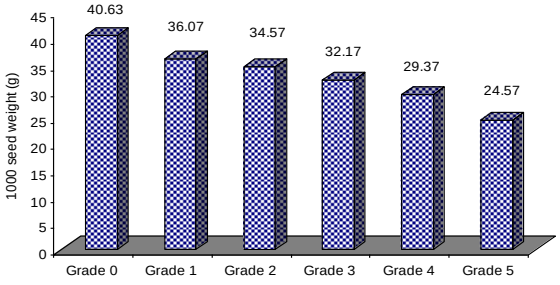


Figure. 4. Thousand seed weight of different categories of black pointed wheat seed

The present study revealed that among the five different seed categories, 1000 clean or best seeds had the maximum weight, while the small undersized and shriveled seeds were lighter than seeds of other categories. Again, of the five categories of black point, Grade 5 (i.e. seeds most severely affected by black point) seeds were lighter in weight. Similar results had been found [6] while grading black pointed wheat grains. He reported that black pointed wheat grains were usually lighter in weight than normal best grains.

Prevalence of fungi

Thirteen species of fungi representing 11 genera recorded by blotter method from unclean (farmers' saved seed) and clean wheat seed obtained from 10 different locations of Bangladesh. The 13 fungi encountered were *Alternaria tenuis, Alternaria longissima, Aspergillus flavus, Aspergillus niger, Bipolaris sorokiniana, Chaetomium globosum, Cladosporium cladosporoides, Curvularia lunata, Fusarium oxysporum, Penicillium sp., Phoma sp., Rhizopus nigricans* and *Trichothecium roseum.* All the 13 fungal species were found in unclean seed, while in clean seed 10 fungal species (except *A. longissima, C. cladosporoides* and *Phoma* sp.,) were encountered.

Prevalence of target pathogenic fungi

Out of the total 13 fungal species recorded in the present study five fungi- *B. sorokiniana, A. tenuis, C. lunata, F. oxysporum* and *A. flavus* were designated as the target pathogenic fungi as they are the established pathogens of wheat. The average percent seed borne infection of the five target pathogenic fungi encountered in unclean and clean wheat seeds are shown in Fig. 5. Unclean seed yielded higher percent of seed borne infection of all the five selected pathogens compared to clean seed. In case of all the five test pathogens more than 30.00% reduced seed-borne infection was recorded in clean seed compared to unclean. Of the five selected pathogens, *B. sorokiniana* had the highest percent of seed borne infection both in unclean and clean seed, followed by *A. tenuis, C. lunata,* and *F. oxysporum,* while *A. flavus* had the lowest incidence. It can also be seen from the Fig. 5 that occurrence of *B. sorokiniana* was three to six times higher than *A. tenuis, C. lunata* or *F. oxysporum* and about 15 times higher than *A. flavus*.

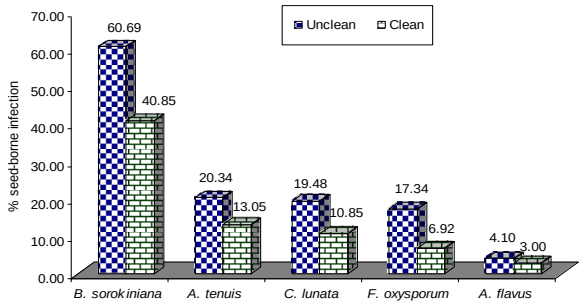


Figure. 5. Average percent seed-borne infection of the five target pathogenic fungi encountered in unclean and clean seeds (Average of 10 locations)

The prevalence of the individual target fungal pathogens varied with respect to location of seed collection and seed cleanliness. Occurrence of all the five target fungi was always higher in unclean seed compared to clean seed at all the locations. Of the five target pathogens, *B sorokiniana* was the most predominant fungus, followed by *A. tenuis, C. lunata, F. oxysporum* and *A. flavus* in both unclean and clean seeds. The incidence of the fungus ranged between 37.75-84.88% and 30.00-66.00% in unclean and clean seed, respectively. The highest as well as the lowest occurrence of *B. sorokiniana* both in unclean and clean seed were recorded at Sherpur (84.88% and 66.00%) and at Faridpur (37.75 and 27.50%) (Table 3 and 4).

In unclean seed, the highest count of *A. tenuis* was recorded at Dinajpur (25.50%), followed by Sherpur (23.63%), Jhikargasa (22.88%), Atghoria (22.38%) and Koshba (19.50%), while the lowest was encountered at Faridpur (15.50%), whereas the highest and the lowest record of the fungus in clean seed was noted in Dinajpur (20.25%) and Rajbari (7.30%), respectively (Table 3 and 4).

The highest and the lowest prevalence of *C. lunata* in unclean seed was observed at Ulipur (36.25%) and Koshba (8.88%), respectively (Table 3). Similarly, the maximum incidence of the pathogen in clean seed was recorded at Ulipur (22.88%) and the minimum (4.00%) at Koshba (Table 4).

In unclean seed, the highest seed-borne infection of *F. oxysporum* was found at Koshba (30.25%), while the lowest (4.75%) was detected at Ishurdi (Table 3). In case of clean seed, the highest and the lowest occurrence of the target pathogen was encountered at Dinajpur (13.88%) and Ishurdi (2.87%), respectively (Table 4).

The occurrence of *A. flavus* in unclean seed ranged from 1.62% at Rajbari to 26.38% at Ulipur (Table 3), while in clean seed the lowest percent (0.62%) of infection was observed at Rajbari and the highest (17.75%) at Ulipur (Table 4).

Table 3. Prevalence of five target pathogenic fungi in unclean farmers' saved wheat seed collected from 10 different locations of Bangladesh.

Location	% seed borne infection of				
	B. sorokiniana	*A. tenuis*	*C. lunata*	*F.oxysporum*	*A. flavus*
Atghoria	47.38 ef	22.38 abc	35.88 a	18.75 cd	16.2 b
Dinajpur	66.75 bc	25.50 a	20.75 bc	22.00 bc	2.87 e
Faridpur	37.75 g	15.50 d	11.50 cd	13.88 de	3.50 e
Ishurdi	67.63 b	19.38 abcd	13.50 bcd	4.75 f	1.87 e
Jhikargasa	80.75 a	22.88 abc	20.25 bc	15.25 cde	10.00 c
Koshba	54.38 de	19.50 abcd	8.875 d	30.25 a	3.12 e
Mymensingh	39.50 fg	16.50 cd	11.13 cd	10.75 ef	4.87 de
Rajbari	68.88 b	18.75 bcd	13.75 bcd	11.50 ef	1.62 e
Sherpur	84.88 a	23.63 ab	22.88 b	17.13 cde	8.62 cd
Ulipur	59.00 cd	19.38 abcd	36.25 a	29.13 ab	26.38 a
LSD (p≥0.01)	8.26	6.49	10.48	7.22	5.11
CV (%)	6.94	16.29	27.46	21.26	32.94

Table 4. Prevalence of five target pathogenic fungi in clean farmers' saved wheat seed collected from 10 different locations of Bangladesh

Location	% seed borne infection of				
	B. sorokiniana	*A. tenuis*	*C. lunata*	*F.oxysporum*	*A. flavus*
Atghoria	30.00 c	15.50 ab	15.38 bc	8.87 b	4.62 b
Dinajpur	37.63 bc	20.25 a	10.13 cd	13.88 a	1.50 bc
Faridpur	27.50 c	10.50 bc	4.12 e	7.87 b	2.00 bc
Ishurdi	39.13 bc	13.75 abc	7.25 de	2.87 c	1.12 bc
Jhikargasa	63.00 a	14.25 abc	16.13 b	9.50 ab	4.75 b
Koshba	32.50 bc	7.750 c	4.00 e	10.00 ab	1.00 bc
Mymensingh	33.75 bc	11.75 bc	6.00 de	6.00 bc	2.87 bc
Rajbari	49.38 ab	7.625 c	4.75 de	6.37 bc	0.62 c
Sherpur	66.00 a	16.88 ab	17.88 ab	8.87 b	4.75 b
Ulipur	29.63 c	12.25 bc	22.88 a	10.25 ab	17.75 a
LSD (p≥0.01)	17.97	7.09	5.45	4.69	3.98
CV (%)	22.45	27.73	25.87	28.36	49.59

The cause of absence of the three fungi in clean seed was probably due to the fact that seed cleaning processes might have eliminated them from the original farmer saved seed.

Variation in the prevalence of seed-borne fungal pathogens with regard to geographic locations has been demonstrated earlier in a number of crops like rice, kaon, mustard, black gram, wheat, jute, chilli, zinnia, maize, barley, sorghum and cheena by different research workers in Bangladesh [4,10,15,16,23,26,29 and 45]. More than 30% population of each of the five target fungi was found to be reduced in clean seed in comparison with unclean seed at all the locations. This indicates that manual seed cleaning has significant impact on the reduction of the pathogenic fungi in farmer saved wheat seed. Such reduction in population of pathogenic fungi through manual seed cleaning has been observed in rice [20, 27 and 31], eggplant [23, 35], mustard [8] and jute [13]. Reduced population of pathogenic fungi has also been encountered in apparently healthy wheat seed obtained through sieving [43]. Thus, quite high occurrence of the pathogen even in clean seed (30.00-66.00%) demands routine health test of wheat seeds prior to sowing.

Presence of seed-borne infection of the five target pathogenic fungi in the test seed samples depict that in no way the health status of wheat seed samples tested is satisfactory. Original saved wheat seeds carrying even the amount of inocula of the four pathogenic field fungi - *B. sorokiniana*, *A. tenuis*, *C. lunata* and *F. oxysporum* detected in the present analysis, if transmitted to the field, may create alarming disease outbreaks in the fields resulting heavy yield losses to the crop as well as hampering quality healthy seed production. Occurrence of the dangerous storage fungus, *A. flavus* in the test seed samples also questions the keeping quality of farmer saved wheat seed in storage as the pathogen is known to cause germination loss in many crops [9,15,18,23 and39]. The above mentioned facts can be supported from the germination test record in the present study, where original farmer saved seed had always poor germination, produced much lesser number of normal seedlings and resulted higher number of dead seed, abnormal or diseased seedlings and low seedling vigour [46] . On the contrary, best seeds obtained from farmer saved original seed through physical cleaning by separation or removal of seed contaminants and abnormal seeds, had low seed borne infections of pathogenic fungi (Fig. 6) Best seeds in the germination test in natural soil resulted markedly higher percentage of normal seedlings, lesser percentage dead seeds, abnormal seedlings including diseased seedlings and high seedling vigour [46]. Similar benefits of manual seed cleaning have been obtained in jute [13], mustard [8], rice [15] and egg plant [23].

Germination

Percentage of normal seedling, abnormal seedling and dead seed recorded in unclean and clean seeds in the germination test varied significantly depending on the locations and cleanliness of seed. In general, higher percentage of normal seedlings and lower percentage of abnormal seedlings and dead seeds were recorded in clean seed compared to unclean farmer saved seed at all the sites of seed collection (Figs. 6-8). The highest count of normal seedlings was obtained in unclean seed at Faridpur (84.38%) followed by Atghoria (81.13%), whereas the lowest incidence of normal seedlings was observed in clean seed at Ulipur (49.25%). On other hand, the highest count of normal seedlings in clean seed was recorded at Atghoria (93.50%), followed by Faridpur (91.88%), while, the lowest count (80.00%) of normal seedlings was observed at Jhikargasa (Fig. 6).
In unclean seed, the highest count of abnormal seedlings was found at Ulipur (13.70%), followed by Koshba (9.75%) and Dinajpur (8.37%), whereas the lowest incidence of abnormal seedlings was observed at Jhikargasa (5.37%). In case of clean seed, the highest count of abnormal seedlings was obtained at Koshba (9.75%), followed by Jhikargasa (7.50%), while the lowest incidence (2.87%) of abnormal seedlings was recorded at Ulipur (Fig. 7).
In unclean seed' the highest count of dead seed was found at Rajbari (19.00%) followed by Ishurdi (18.25%), while the lowest incidence of dead seeds was encountered at Faridpur (8.75%). In case of clean seed, the maximum percentage of dead seed was obtained at Sherpur (12.75%), followed by Jhikargasa (12.50%) and Ishurdi (11.75%), while the minimum percentage of dead seed (2.37%) was recorded at Faridpur and Atghoria (Fig. 8).

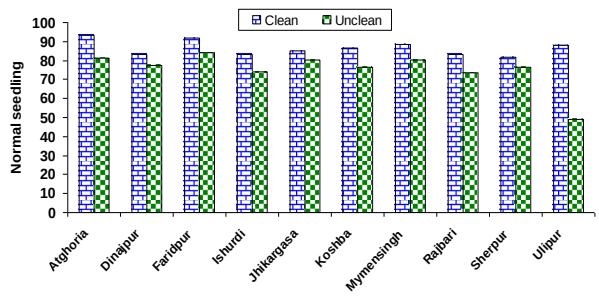


Fig.6. Percentage of normal seedling in clean and unclean wheat seeds collected from 10 different locations of Bangladesh

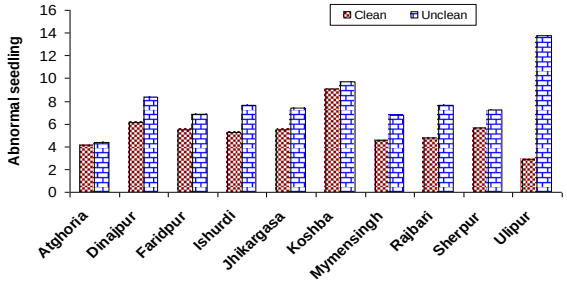


Fig.7. Percentage of abnormal seedling in clean and unclean wheat seeds collected from 10 different locations of Bangladesh

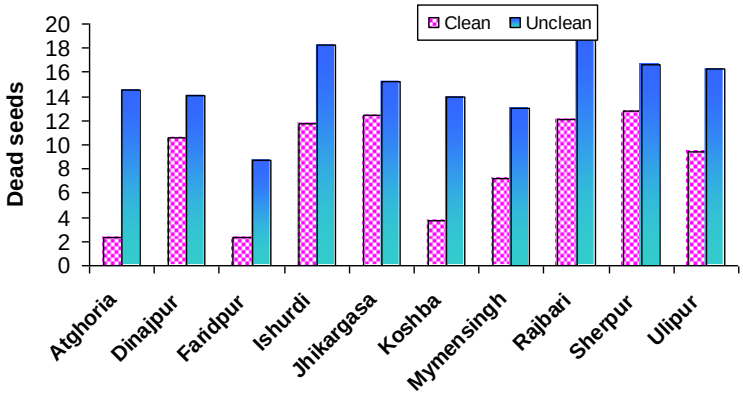


Figure.8. Percentage of dead seeds in clean and unclean wheat seeds collected from 10 different locations of Bangladesh

Seedling vigour observed in different categories of wheat seeds

The root length, shoot length, germination and seedling vigour index recorded in five different categories of wheat seeds are presented in Table 5. Root length, shoot length and germination varied significantly among the categories of seeds. 'Best' or 'Clean'seed always gave the highest root length, shoot length, germination and vigour index and the lowest root length, shoot length, germination and vigour index were recorded in undersized seed. It was also observed from the Table that farmer saved seed produced less root length, shoot length, germination and vigour index than the best seed. The root length and shoot length of black pointed seed and undersized seed did not differ significantly but the germination and vigour index showed wide variation. Shriveled seed produced higher root length, shoot length, germination and vigour index compared to undersized seed.

In the present study, it was found that size and weight of wheat seeds had profound effect on germination and seedling vigour. Undersized smaller seeds and Grade 5 black point affected seeds showed lower germination and seedling vigour compared to bigger and heavier clean or best seeds (Table 5). These results are consistent with the findings of other workers [28, 30, 38 and 43].

Table 5. Seedling vigour recorded in different categories of wheat seed

Seed categories	Root length (cm)	Shoot length (cm)	Germination (%)	Vigour index (VI)
Farmer saved seed	16.06 ab	11.77 a	79.17 a	2195.0
Black pointed seed	11.55 b	8.61 b	56.08 b	1132.0
Undersized seed	11.44 b	7.707 b	24.08 c	463.7
Shriveled seed	16.97 ab	7.723 b	36.17 bc	884.8
Best seed	20.39 a	12.40 a	95.25 a	3124.0
LSD (P≥0.01)	6.10	3.13	20.75	-
CV (%)	14.17	11.85	13.02	-

From the foregoing discussions, it is clearly evident that the health status of farmer saved seed is poor. It is, therefore, suggested to provide proper training to the farmers for better seed crop management and proper storage of wheat seed. This will help to improve the seed health quality of wheat seed at farmer's level and contribute for higher yield per unit area.

Conclusion

Health and quality status of farmer saved wheat seed was determined by seed health and quality analysis. One hundred seed samples of the wheat variety Kanchan were collected from 100 different farmers representing 10 villages under 10 upazilas located in nine major wheat growing districts. The ten locations were – 1) Atghoria,

Pabna; 2) Dinajpur, Sadar; 3); Faridpur, Sadar 4); Ishurdi, Pabna 5) Jhikargasa, Jessore; 6) Koshba, Brahmanbaria; 7) Mymensingh, Sadar; 8) Rajbari, Sadar; 9) Sherpur, Bogra and 10) Ulipur, Kurigram.

The seed samples were analyzed in the Departments of Plant Pathology, Sher-e-Bangladesh Agricultural University (SAU), Dhaka and Seed Pathology Centre (SPC), Bangladesh Agricultural University (BAU), Mymensingh. Seed samples were tested for moisture content by electronic digital moisture meter. Best or clean (Apparently healthy) seed was sorted out from the original farmer saved seed through elimination of seed contaminants and abnormal seeds by manual seed cleaning. Germination test was conducted in plastic trays with clean sand to record the normal seedlings, abnormal seedlings and dead seeds following the International Rules for Seed Testing. Seedling vigour was determined following the formula of [3]. Health analysis was carried out to detect seed borne fungal infections by Blotter method.

Seed quality analysis revealed that the average moisture content of the farmer saved wheat seed varied from 12.04 – 13.30% with respect to location of the seed collection. Six types of seed contaminants recorded in farmer saved seeds were - weed seeds, insects, varietal mixture, seed with husk, other crop seeds and inert matter. The seed contaminants varied significantly depending on the location of seed collection. Six species of weed seeds observed were - *Brassica kaber, Chenopodium album, Cyperus* sp., *Echinochloa crusgalli, Solanum nigrum, Polygonum hydropiper* and *Vicia sativa*, while the three species of insects encountered were *Tribolium casteneum, Corcyra cephalonica* and *Sitophillus oryza*.

Five types of abnormal seeds viz. black pointed seed, discoloured seed, undersized seed, shriveled seed and insect damaged seed recorded in this study varied in prevalence significantly with respect to location of seed collection. Among the different types of abnormal seeds, undersized seed was the most predominant followed by black pointed seed.

Average percentage of 'clean' or 'Best' seed recovered from farmers' saved seed ranged from 27.64 – 83.80% depending on the location of seed collection. Out of the ten locations, four had more than 60.00% 'Best' or 'clean' seed. On an average, 58.48% 'Best' seed was recovered from farmer saved seed by manual seed cleaning.

Out of five the seed categories, weight of 1000 'Best seed' had the highest weight followed by farmer saved seed, black pointed seed and shriveled seed, while undersized seed had the lowest weight. Thousand seed weight of the six categories of black pointed seed (0-5 scale) decreased with the increase in black point severity. The highest weight of 1000 seeds was recorded in Grade 0, while the lowest weight was observed in Grade 5.

Thirteen fungi namely *Alternaria longissima, A. tenuis, Aspergillus flavus, A. niger, Bipolaris sorokiniana, Chaetomium globosum, Cladosporium cladosporoides, Curvularia lunata, Fusarium oxysporum, Penicellium sp, Phoma sp, Rhizopus nigricans, Trichothecium roseum* were detected in farmer saved wheat seed collected from 10 different locations of Bangladesh. Of the 13 fungi, five target pathogenic fungi viz. *B. sorokiniana, A. tenuis, C. lunata, F. oxysporum* and *A. flavus* detected in the present study, varied in prevalence with respect to location of seed collection. Occurrence of all the five target pathogenic fungi was found always higher in unclean seed compared to clean seed at all the locations. Among the target fungi, *B. sorokiniana* was the most predominant fungus, followed by *A. tenuis, C. lunata, F. oxysporum* and *A. flavus* in both unclean and clean seeds. Normal seedlings, abnormal seedlings and dead seeds recorded in the germination test varied significantly depending on the location and cleanliness of seed. Higher percentage of normal seedlings and lower percentages of abnormal seedlings and dead seeds were always observed in clean seed compared to unclean seed at all locations. 'Clean' or 'best' seed resulted the highest germination (95.25%) and vigour index (3124.0), while the lowest germination (24.08%) and vigour index (463.7) were recorded in undersized seed. Among the different black point categories, Grade 0 i.e. seed without black point gave the highest germination (90.08%) and vigour index (2012.0), while the lowest germination (2.25%) and vigour index (27.9) were encountered in Grade 5. Based on the present study the following conclusions may be drawn:

- Quality and health status of farmer saved wheat seed in Bangladesh is poor. Farmers' seed contains more moisture content, appreciable quantity of seed contaminants, considerable amount of abnormal seeds and seed-borne infection of dangerous pathogenic fungi.
- About 60% 'Best' or clean (apparently healthy) wheat seed can be recovered from farmer saved seed through manual seed cleaning.
- Clean or best seed gives higher counts of normal seedlings and lesser percentage of abnormal seedlings and dead seeds over abnormal seeds like black pointed, undersized, discoloured and shriveled seeds. Clean seed also results higher seedling vigour index.

- Health and quality of farmer saved wheat seed can be improved markedly by manual seed cleaning.

Acknowledgements

Author would like to express deep gratitude to late Prof. Dr. Golam Ali Fakir, for his valuable and constructive suggestion during the planning and development of this research work, and also endless support and encouragement throughout the study.

References

[1] Adlakha, K.L. and L.M. Joshi, Black point of wheat. Indian PhytoPath. 27: 41-44. 1974.
[2] Agarwal. P. C., K. Anitha, U. Dev, R. Dev, B. Singh and R. Nath. *Alternaria alternata*, real causes of black point and differentiating of two other pathogens associated with wheat *(Triticum aestivum* L.) Indian Phytopath. 4:37-42. 1993.
[3] Baki AA. And JD Anderson, Physiological and biological deterioration of seeds, Seed biology, Vol. II, Academic Press, New York, pp. 283-315. 1972.
[4] Barma, A.C. and G.A. Fakir. Prevalence and pathogenicity of fungi associated with the seeds of kaon (*Setaria italica*). Bangladesh J. Agrl. Vol. 6 (2&3):6-14, 1981.
[5] Basak, A.B., G.A. Fakir and M.A.U. Mridha. Mycoflora of chili seeds obtained from different types of fruit rots. Chittagong Univ. Studies Part II. 15 (2):11-17, 1991.
[6] Bolley, H. L. Wheat soil troubles and seed deterioration. N. Dak. Agri. Expt. Sta. USA. 13 July. pp. 107, 1913.
[7] Booth, C. The genus *Fusarium.* Commonwelth Mycol. Inst. Kew, Surrey, England. pp. 236. 1971.
[8] Chowdhury, R.H. Production of *Alternaria* infection free seeds of Mustard through integrated crop management. An M.S. thesis submitted to the Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh. pp. 89, 1999.
[9] Christensen, C.M. and H.H. Kaufman. Deterioration of stored grains by fungi. Ann. Rev. Paytopath. Vol. 3: 69-89, 1965.
[10] Dey, T.K. and G.A. Fakir. Prevalence of fungi in mustard seeds in Bangladesh. Bangladesh J. Pl. Pathol.. 4:87-93, 1988.
[11] Ellis, M.B. Dematiaceous Hypomycetes. CMI, Kew Surrey, England. pp. 608, 1960.
[12] Fakir, G. A. List of seed-borne diseases of important crops occurring in Bangladesh. Seed Pathology Laboratory, Department of Plant Pathology, BAU, Mymensingh. pp. 20, 2001.
[13] Fakir, G. A., M.A. Sarder, M.A. Gaffer and M.U. Ahmad. An Annotated list of important disorders of important crop plants of Bangladesh. DANIDA, Royal Danish Embassy, Dhaka pp. 105, 1990.
[14] Fakir, G.A. and M.R. Islam, Survey on the health status of jute and rice seeds of farmers of sadar Upazila, Mymensingh. BAURES. Progress 7:42-47, 1990.
[15] Fakir, G.A. and Mia, M.A.T, 2004. Report on Quality of Farmer Saved Rice seed in Bangladesh. Seed Pathology Center (SPC), BAU, Mymensingh. pp. 53, 2004.
[16] Fakir, G.A. and N. Halder, Seed-borne fungi of chili. Bangladesh J. Pl. Pathol. 7:34-37, 1993.
[17] Fakir, G.A., M.H. Rahman and G.M.M. Rahman, Effect of black point fungi on germinating seed and emerged seedling of wheat. Proc. 6th National Botical Conc. Chittagong (Bangladesh). BBS. pp. 7-8, 1989.
[18] Fakir, G.A., R.E. Welty and E.B. Cowling, Prevalence and pathogenicity of fungi associated with achene's (seeds) of sycamore in the field and in storage. Phaytopathology 61: 660-668, 1971.
[19] FAO, Production year Book. Food and Agricultural Organization of the United Nations, Rome, Italy. pp. 12-15, 2016.
[20] Hossain, I. and Asad-ud-doulllah, M., Pilot Project Research. Paper presented at the DGISP Workshop II "Future strategies for Research, Training and Development of Seed Pathology in Bangladesh" held on 10 December, 1998 at BARC, Dhaka. Bangladesh. pp. 35-45, 1998.
[21] Huguelet, J. E. and R. L. Kiesling, Influence of inoculum composition on the black point disease of durum wheat. Phyto-pathology. 63: 1220-1225, 1973.

[22] Islam, H., Prevalence and pathogenicity of fungi in maize seeds. M.S. Thesis. Department of Plant Pathology. Bangladesh Agricultural University. Mymensingh. pp. 76, 2005.
[23] Islam, M.R., An integrated approach for management of Phomopsis blight and Fruit rot of egg plant. A Ph. D. thesis submitted to the Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh. pp 167, 2005.
[24] Islam, M.R., G.A. Fakir and G.M.M. Rahman, Prevalence of black point fungi in stored wheat seeds. Bangladesh J. Crop Sci. 2(10):11-20, 1991.
[25] ISTA (International Rules for Seed Testing Association), International Rules for Seed Testing. Rules Amendments. Seed Science and Technology. 29: 1-127, 2001.
[26] Kabir, A.K.M. and G.A. Fakir, Seed-borne fungi of black gram and their effect on germination of seeds and seedlings. Bangladesh J. Pl. Pathol. 4:43-61, 1988.
[27] Kabir, M.H., G.A. Fakir, M.A. Malek, M.E. Hossain and M.K. Islam, Effect of seed treatment on seed yield, Yield Contributing Characters. and Seed Quality of Boro Rice. J. Science Foundation. 3(1):51-58, 2005.
[28] Kalaknnavar, R. M. and S. A. Shashidhaa and G. N. Kulkarni, Effect of grading on quality of wheat seeds. Seed Res. 17(2): 182-185, 1989.
[29] Karim, M.M., Prevalence and of fungi associated with seeds of some minor cereals. M.S. Thesis. Department of Plant Pathology. Bangladesh Agricultural University. Mymensingh. pp. 97, 2005.
[30] Khare, L. and R.G. Satpute, Influnce on Days to Maturity and Seed Size on Germination and Seedling Vigour in Pigeonpea. Seed Res. 27(2):170-173, 1999.
[31] Khokon, M.A.R., M.B. Meah and G.A. Fakir, Inert matter with rice and wheat seeds is source of inoculum of plant pathogens. Seed Sci. and Technol. 33:127-140, 2005.
[32] Malone, J.P. and A.E. Muskett, Seed-borne fungi: Description of 77 fungus species. Proc. Int. Seed. Testing Assoc. 29: 179-384, 1964.
[33] Mathur, S.B. and B.M. Cunfer, Seed borne diseases and seed health testing of wheat. Danish Govt. Institute of Seed Pathology for Developing Countries, Copenhagen, Denmark. pp. 168, 1993.
[34] Mathur, S.B. and O. Kongsdal, Common Laboratory Seed Health Testing Methods for Detecting Fungi. Danish Govt. Institute of Seed Pathology for Developing Countries, Copenhagen, Denmark. ISTA, Switzerland. pp. 425, 2003.
[35] Meah. M.B., Development of an integrated approach for management of *Phomopsis* blight/fruit rot of eggplant in Bangladesh. BAU Res. Prog. 12:33-35, 2002.
[36] Neergaard, P., Seed Pathology. Vol 1. The Macmillan Press Ltd. 1: pp. 839, 1977.
[37] Rahman, H.M., G.A. Fakir, G.M.M. Rahman and M.R. Islam, Survey on the prevalence of black point of wheat in Bangladesh. Bangladesh J. Pl. Pathol. 4:35-42, 1988.
[38] Rahman, G. M. M. and M. R. Islam, Effect of black point of wheat on some qualitative characters of its grain and seed vigour. Bangladesh J. Agril. Res. 23(2): 283-287, 1998.
[39] Rahman, M. and M.A.T. Mia, Studies on the health status of farmers' stored seed of rice. Bangladesh J. Pl. Pathol. 14 (1&2):37-40, 1998.
[40] Ram, B. and L. M. Joshi, Effect of artificial inoculation of *Alternaria triticina* on yield components of wheat. Zeitschriftful Pfinzenrankheiten and Pflanzenschutz. 86 (12): 741-744, 1979.
[41] Raper, K.B. and D.I. Fennel, The genus *Aspergillus.* The Williams and Wilikins Co., Baltimore, pp. 686, 1965.
[42] Richardson, M.J., An annotated list of seed borne diseases. CAB Publications, CMI, Kew Surrey, U.K. pp. 529, 1990.
[43] Siddique, M.A., Effect of clearing by sieving on germination and health of wheat seeds. M.S. Thesis, Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh, Bangladesh. pp. 74-76, 2003.
[44] Sultana, K. Biswas, A.C., Begum, H.A., Hoque, M.S. and H. Banu, Effect of stem rot and anthracnose disease on the infection of fruit and seed of jute *(Corchorus capsularis).* Bangladesh J. Jute Fib. Res. 17(1&2): 99-102, 1992.
[45] Sultana, S., Prevalence and pathogenicity of fungi associated with the seeds of some selected flowering plants. M.S. Thesis. Department of Plant Pathology. Bangladesh Agricultural University. Mymensingh. 2004.

[46] Tonu N.N., Fakir G.A. and Islam M.R., Health quality of black pointed wheat seeds. Journal of Science Foundation, Vol. 4, No. 2, December, pp 111-119, 2006.
[47] Weise, M.V., Compendium of wheat diseases. 2nd ed. American Phytopathological Society. St. Paul. Minnesota, USA. pp. 112, 1991.