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PREVALENCE OF SEED BORNE FUNGI ASSOCIATED WITH JHUM MORICH (JHUM CHILLI) SEEDS

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ABSTRACT

Karim MM, Momotaz R, Arifunnahar M, Islam MN, Rahman MME (2017) Prevalence of seed borne fungi associated with jhum morich (jhum chilli) seeds. *Int. J. Sustain. Crop Prod.* 12(3), 7-12.

Fungi associated with the seeds of jhum chilli which is locally known as "jhum morich" collected from three different upazilla of Khagrachari hill district of Bangladesh were recorded. Nine different fungi encountered in jhum morich seeds, in order of prevalence, were- *Penicillium* sp., *Fusarium* sp., *Alternaria alternata*, *Colletotrichum capsici*, *Doratomyces* sp., *Curvularia lunata*, *Alternaria solani*, *Aspergillus candidus*, *Cercospora capsici*. Prevalence of the total as well as the individual seed-borne fungal infections recorded in jhum morich varied significantly with respect to sources of seed collection. Seed germination also varied significantly depending on the seed sources. No definite relationship between germination and seed-borne fungal infections was observed.

Key words: *seed-borne fungi, jhum chilli, seed*

INTRODUCTION

Seed is the most important input for crop production. In modern agriculture seed health is a well recognized factor for increase production. Many plant pathogens are seed borne, which can cause enormous crop losses. In Bangladesh, 16% annual crop losses occur due to plant diseases, at least 10% loss is incurred due to seed borne diseases (Fakir 1983). It has also been demonstrated that seed borne fungi are responsible for poor health of seeds in many crops (Neergaard 1979). Rashid *et al*. (1995) reported that most of the devastating crop diseases in Bangladesh were seed-borne and seed transmitted and as many as 490 seed-borne diseases were known to attack 76 different important crops incurring enormous annual lost.

Chilli (*Capsicum annum* L.) is one of the most important spice crops of tropical and subtropical countries and the fourth major crop cultivated globally. Around 400 different varieties of chilies are cultivated throughout the globe. In Bangladesh, chilli is grown in almost all areas and seasons (Asaduzzaman *et al*. 2010). Globally chilli is grown over an area of 1.5 million ha with production of 7.18 million tons (Anon. 2005). The average yield of chilli in Bangladesh is 1.678 metric t ha^{-1} which is very low compared to the yield of other chilli growing countries (BBS 2011).

Jhum morich (Jhum chilli) one of local chilli variety is very popular spice among the indigenous people of Chittagong Hill Tracts. It is cultivated mostly in kharif season at jhum field and can also be cultivated in rabi season if moisture is available. It is usually used as green chilli and its hotness is very high. But the yield of jhum morich is very low. One of the striking reasons is disease and most of the diseases are caused by seed borne fungi. As a result seed yield and qualities are deteriorated. Ayub (2006) listed ten fungal pathogens on chilli seeds collected from BARI and farmer's field, among them fungal genera *Colletotrichum* and *Alternaria* were predominant. Fakir and Halder (1993) listed two seed-borne fungal pathogens *Colletotrichum capsici* and *Cercospora capsici* in chilli from Bangladesh. But no work has been done on seed borne fungi of jhum morich in Bangladesh. Therefore, the present study has been undertaken to study the prevalence of fungi in seeds of jhum morich grown in hilly region of Bangladesh.

MATERIALS AND METHODS

The experiment was conducted in the laboratory of Plant Pathology Division, BARI, Gazipur during 2009 cropping season using the seeds of chilli grown in hilly region which is locally known as "jhum morich". A total of 12 jhum morich seed samples were collected from three different upazilla of Khagrachari district namely- Khagrachari sadar, Dighinala and Panchari. From each upazilla four seed samples were collected at farmer's level. The jhum morich seed samples of Khagrachari sadar, Dighinala and Panchari upazilla were designated as Sadar 1, Sadar 2, Sadar 3, Sadar 4, Dighinala 1, Dighinala 2, Dighinala 3, Dighinala 4, Panchari 1, Panchari 2, Panchari 3 and Panchari 4. Each sample contain about 50 gm seeds. Seeds were collected during January to May, 2009.

Collected seed samples were kept in paper bags and stored in the refrigerator at 5±1°C for further study. Health of all the seed samples used were analyzed for detection of fungi by the Blotter Method following the International Rules for Seed Testing Association (ISTA 2001). In this method, three pieces of filter paper (Whatman No. 1) were soaked in sterilized water and placed at the bottom of 9 cm dia. glass petridish. Two hundred seeds from each sample were taken randomly and then placed on the moist filter paper in 8 replicated petridishes at the rate of 25 seeds per plate. The petridishes with seeds were then incubated at 22±°C under 12/12 hours alternating cycles of NUV and darkness in the incubation room of the laboratory for seven days. After incubation the seeds were examined under the stereo microscope for recording the seed-borne fungal infections grown on the incubated seeds.

Seed-borne infections of fungi observed under the stereo microscope were identified by observing their growth characters on the incubated jhum morich seeds in the Blotter method. The fungi were identified to species level, wherever possible, following the keys of Malone and Musket (1964); Raper and Fennel (1965); RamNath *et al.* (1970); Booth (1971); Ellis (1971); Chidambaram *et al.* (1973); Mathur and Kongsdal (2003). Germination was recorded with natural soil in plastic pot in the field laboratory. Two thousand seeds were used for germination test in 10 replicate (200 seeds/tray). Data on germination were recorded after 4, 7 and 14 days after sowing. But germination recorded on the 14th day was taken into final account. Germination was expressed in percentage. The data were analyzed following the Completely Randomized Design (CRD). The mean differences for efficiency of the treatments were judged by Least Significant Difference (LSD) test.

RESULTS AND DISCUSSION

A total of 1743 seed-borne fungal infections were recorded from 2400 seeds obtained from 12 different samples collected at three different of upazilla of Khagrachari hill district. The total seed-borne fungal infections varied in prevalence considerably depending on the sample and location of seed collection. Out of the 1743 seed-borne fungal infections recorded from 12 different samples of jhum morich seeds collected from Khagrachari sadar, Dighinala and Panchari upazilla; nine species of fungi representing eight genera were identified. The identified fungi were *Alternaria alternata*, *Alternaria solani*, *Aspergillus candidus*, *Cercospora capsici*, *Colletotrichum capsici*, *Curvularia lunata*, *Doratomyces* sp., *Fusarium* sp. and *Penicillium* sp. Of all these fungi, the predominant fungi were *Penicillium* sp. (21.1%), followed by *Fusarium* sp., *A. alternata* and *Colletotrichum capsici* which constituted 17.4%, 17.0% and 14.9% of the total seed-borne fungal infections, respectively. Other predominant fungi were *A. solani*, *C. lunata* and *Doratomyces* sp., constituting at least 5.0% of the total seed-borne infections. *Cercospora capsici* had the lowest (0.5%) occurrence. Again, as regard to percentage of seed yielding individual fungi, 15.3% of the seeds yielded *Penicillium* sp., followed by *Fusarium* sp. (12.7%), *A. alternata* (12.3%) and *Colletotrichum capsici* (10.8%). Of the 12 seed samples, all samples were infected by *A. alternata*, *A. solani*, *Colletotrichum capsici*, *C. lunata*, *Fusarium* sp. and *Penicillium* sp. while the lowest number of samples (4) was infected by *Cercospora capsici*. On the other hand, 8 samples each were found to be infected by *A. candidus* and *Doratomyces* sp. (Table 1).

Table 1. Frequency of occurrence of fungi recorded on jhum morich seeds collected from three different upazilla of Khagrachari

Name of fungi	No. of fungal infections	% of total infections [a]	% of total seed yield infections [b]	No. of infected seed sample [c]
Alternaria alternata [d]	296	17.0	12.3	12
Alternaria solani [d]	112	6.4	4.7	12
Aspergillus candidus	32	1.8	1.3	8
Cercospora capsici	8	0.5	0.3	4
Colletotrichum capsici [d]	259	14.9	10.8	12
Curvularia lunata [d]	164	9.4	6.8	12
Doratomyces sp.[d]	200	11.5	8.3	8
Fusarium sp. [d]	304	17.4	12.7	12
Penicillium sp. [d]	368	21.1	15.3	12

[a] Percentage of total infections was calculated on the basis of 1743 fungal infections.
[b] Percentage of the seed yielding of different fungi was calculated on the basis of 2400 seeds.
[c] Total no. of seed samples were 12.
[d] Predominant fungus constituted at least 5.0% of the total seed-borne infections.

Of the eight fungi identified in the jhum morich seeds collected from Khagrachari sadar upazilla. The predominant fungi, in order to prevalence, were *Fusarium* sp. (23.1%), *Penicillium* sp. (20.0%), *Colletotrichum capsici* (13.2%), *A. alternata* (11.6%), *C. lunata* (10.0%), *Doratomyces* sp. (8.3%) and *A. solani* (5.0%). At least 14.0% of the seeds yielded *Fusarium* sp., the most predominant fungus. All the four seed samples of this location were infected each by all eight fungi. In this location no seed-borne infection of *A. candidus* could be found. Seven different fungi were detected from seeds of Dighinala upazilla. The most predominant fungi encountered in the jhum morich seeds were *Colletotrichum capsici* (35.8%), *A. alternata* (20.8%), *Fusarium* sp. (18.9%), *Penicillium* sp. (13.2%) and *C. lunata* (5.7%). At least 19.0% of the seeds yielded *Colletotrichum capsici*, the most predominant fungus. In case of *Cercospora capsici* and *Doratomyces* sp., there was no seed infection was observed at this location. All the seven indentified fungi were recorded from all the four seed samples. In the jhum morich seeds collected from Panchari upazilla, the most predominant fungi in order to prevalence, were *Penicillium* sp. (25.9%), *Doratomyces* sp. (19.2%), *A. alternata* (18.2%), *Fusarium* sp. (13.4%), *A. solani* (10.0%), *C. lunata* (6.8%) and *Colletotrichum capsici* (5.1%). At least 27.0% of the seeds yielded *Penicillium* sp., the most predominant fungus. *Cercospora capsici* was absent in all the four seed samples collected from Panchari upazilla (Table 2).

Table 2. Frequency of seed-borne fungi recorded on jhum morich seeds collected from different locations of Khagrachari

Name of fungi	**No. of fungal infections**	**% of total infections [a]**	**% of total seed yield infections [b]**	**No. of infected seed sample [c]**
Fungi recorded on jhum morich seeds collected from Khagrachari Sadar upazilla				
Alternaria alternata [d]	56	11.6	7.0	4
Alternaria solani [d]	24	5.0	3.0	4
Aspergillus candidus	0	0.0	0.0	0
Cercospora capsici	8	1.7	1.0	4
Colletotrichum capsici [d]	64	13.2	8.0	4
Curvularia lunata [d]	84	10.0	10.5	4
Doratomyces sp.[d]	40	8.3	5.0	4
Fusarium sp. [d]	112	23.1	14.0	4
Penicillium sp. [d]	96	20.0	12.0	4
Fungi recorded on jhum morich seeds collected from Dighinala upazilla				
Alternaria alternata [d]	88	20.8	11.0	4
Alternaria solani	8	1.9	1.0	4
Aspergillus candidus	16	3.8	2.0	4
Cercospora capsici	0	0	0	0
Colletotrichum capsici [d]	152	35.8	19.0	4
Curvularia lunata [d]	24	5.7	3.0	4
Doratomyces sp.	0	0	0	0
Fusarium sp. [d]	80	18.9	10.0	4
Penicillium sp. [d]	56	13.2	7.0	4
Fungi recorded on jhum morich seeds collected from Panchari upazilla				
Alternaria alternata [d]	152	18.2	19.0	4
Alternaria solani [d]	80	10.0	10.0	4
Aspergillus candidus	16	2.0	2.0	4
Cercospora capsici	0	0	0	0
Colletotrichum capsici [d]	43	5.1	5.4	4
Curvularia lunata [d]	56	6.8	7.0	4
Doratomyces sp.[d]	160	19.2	20.0	4
Fusarium sp. [d]	112	13.4	14.0	4
Penicillium sp. [d]	216	25.9	27.0	4

[a] Percentage of total infections was calculated on the basis of 484 fungal infections for Khagrachari sadar, 424 fungal infections for Dighinala and 835 fungal infections for Panchari upazilla.
[b] Percentage of the seed yielding of different fungi was calculated on the basis of 800 seeds.
[c] Total no. of seed samples were 4.
[d] Predominant fungus constituted at least 5.0% of the total seed-borne infections.

The prevalence of total and the predominant individual fungi detected in jhum morich seeds of 12 different samples obtained from three different upazilla of Khagrachari hill district varied markedly depending on the location and seed sample. Form Khagrachari sadar upazilla, the highest occurrence of *A. alternata* (9.0%) and *A. solani* (5.5%) were recorded in sample Sadar 3 whereas the lowest count of *A. alternata* (4.5%) and *A. solani* (0.5%) were observed in sample Sadar 4. The maximum prevalence of *Cercospora capsici* (1.5%), *Colletotrichum capsici* (12.5%) and *C. lunata* (16.0%) were recorded in sample Sadar 2. On the other hand, the highest percent of *Doratomyces* sp. (8.0%) was recorded in sample Sadar 1 while the lowest (3.0%) in sample Sadar 3. The highest (19.5%) and lowest (9.5%) incidence of *Fusarium* sp. was observed in sample Sadar 3 and Sadar 1, respectively. On the other hand, the highest (18.0%) and lowest (6.0%) incidence of *Penicillium* sp. was counted from the seed sample of Sadar 1 and Sadar 2, respectively.

In Dighinala upazilla, the highest seed-borne infection of *A. alternata* (14.5%) and *C. lunata* (4.5%) were recorded in sample Dighinala 1. But, the lowest count of *A. alternata* (8.5%) and *C. lunata* (2.0%) were observed in sample Dighinala 4 and Dighinala 2, respectively. On the other hand, the highest occurrence of *A. solani* (1.5%) and *Fusarium* sp. (18.0%) were recorded in sample Dighinala 2 whereas the highest occurrence of *A. candidus* (3.5%), *Colletotrichum capsici* (28.0%) and *Penicillium* sp. (9.5%) were recorded in sample Dighinala 3. The lowest incidence of *A. candidus* (1.0%), *Colletotrichum capsici* (13.0%) and *C. lunata* (2.0%) were counted from the sample Dighinala 2 while the lowest seed-borne infection of *A. alternata* (8.5%), *A. solani* (0.5%), *Fusarium* sp. (3.5%) and *Penicillium* sp. (4.0%) were recorded from sample Dighinala 4.

In Panchari upazilla, the highest incidence of *A. alternata* (28.0%) and *A. solani* (17.5%) were recorded in sample Panchari 1 whereas lowest infections 9.0% and 3.5% were observed in sample Panchari 4, respectively. On the other hand, the highest seed-borne infection of *A. candidus* (3.0%) was recorded in both the samples Panchari 3 and Panchari 4. The maximum (7.5%) and minimum (3.0%) occurrence of *Colletotrichum capsici*

were recorded in sample Panchari 2 and Panchari 4, respectively while the highest (28.5%) and lowest (14.5%) seed-borne infection of *Doratomyces* sp. were counted in sample Panchari 3 and Panchari 1, respectively. The maximum seed-borne infection of *C. lunata* (11.0%), *Fusarium* sp. (18.0%) and *Penicillium* sp. (28.0%) were recorded in sample Panchari 4 (Table 3).

Table 3. Frequency of seed-borne fungi recorded on jhum morich seeds collected from different locations of Khagrachari

Sample no.	% seed-borne infection [a]								
	Alternaria alternate [d]	***Alternaria solani*** [d]	***Aspergillus candidus***	***Cercospora capsici***	***Colletotrichum capsici***	***Curvularia lunata***	***Doratomyces* sp.**	***Fusarium* sp.**	***Penicillium* sp.**
Seeds collected from Khagrachari sadar upazilla of Khagrachari hill district									
Sadar 1	8.0 a	4.5 a	-	0.5 c	4.0 c	13.0 a	8.0 a	9.5 b	18.0 a
Sadar 2	6.5 ab	1.5 b	-	1.5 a	12.5 a	16.0 a	5.5 b	13.5 b	6.0 c
Sadar 3	9.0 a	5.5 a	-	1.0 b	5.5 bc	8.0 b	3.0 c	19.5 a	11.0 b
Sadar 4	4.5 b	0.5 b	-	1.0 b	10.0 ab	5.0 b	3.5 bc	13.5 b	13.0 b
CV%	23.04	22.42	-	20.34	29.48	23.49	20.82	15.97	18.00
Seeds collected from Dighinala upazilla of Khagrachari hill district									
Dighinala 1	14.5 a	1.0 b	2.0 b	-	18.5 b	4.5 a	-	13.0 b	8.0 b
Dighinala 2	9.5 bc	1.5 a	1.0 b	-	13.0 c	2.0 b	-	18.0 a	6.5 c
Dighinala 3	11.5 b	1.0 b	3.5 a	-	28.0 a	2.5 b	-	5.5 c	9.5 a
Dighinala 4	8.5 c	0.5 c	1.5 b	-	16.5 bc	3.0 b	-	3.5 c	4.0 d
CV%	16.72	11.28	19.43	-	22.24	10.08	-	7.15	14.33
Seeds collected from Panchari upazilla of Khagrachari hill district									
Panchari 1	28.0 a	17.5 a	1.5 b	-	6.5 b	7.0 b	14.5 c	16.5 a	19.0 b
Panchari 2	21.5 b	13.5 b	0.5 c	-	7.5 a	7.0 b	15.5 c	12.0 b	21.5 b
Panchari 3	17.5 c	6.5 cd	3.0 a	-	4.5 c	3.0 c	28.5 a	9.5 b	13.5 c
Panchari 4	9.0 d	3.5 d	3.0 a	-	3.0 d	11.0 a	21.5 b	18.0 a	28.0 a
CV%	15.45	26.05	12.22	-	23.77	15.10	9.90	18.03	21.57

Means followed by the same letter (s) in a column did not differ significantly at 1% level by DMRT.
[a] Data based on 200 seeds.
[b] Predominant fungus constituted at least 5.0% of the total seed-borne infections.
CV means co-efficient of variation.

Germination of seeds of the 12 samples of jhum morich collected from three different upazilla of Khagrachari hill district varied significantly from 65.9-82.3% depending on the seed source and seed sample. Highest germination was recorded in sample Dighinala 4 (82.3%) at Dighinala upazilla, while the lowest germination (65.9%) was observed in Sadar 2 at Khagrachari sadar upazilla. On the other hand, in Khagrachari sadar the highest germination (78.5%) was observed in sample Sadar 3 and in Dighinala, the lowest germination (71.8%) was observed in sample Dighinala 3. In Panchari, maximum germination (78.6.3%) was recorded in sample Panchari 1 and the minimum (67.3%) in Panchari 4. No definite relationship between germination and seed-borne fungal infections was observed. Out of twelve samples of jhum morich, all samples showed lower germination failure than total seed-borne fungal infections (Table 4).

Table 4. Percent of germination and total seed-borne fungal infections in jhum morich seeds collected from three different upazilla of Khagrachari hill district

Name of upazilla	Sample no.	% seed germination	% germination failure	% of total seed-borne fungal infections
Khagrachari sadar	Sadar 1	73.2	26.8	65.5
	Sadar 2	65.9	34.1	63.0
	Sadar 3	78.5	21.5	62.5
	Sadar 4	68.5	31.5	51.0
Dighinala	Dighinala 1	75.4	24.6	61.5
	Dighinala 2	79.3	20.7	51.5
	Dighinala 3	71.8	28.2	61.5
	Dighinala 4	82.3	17.7	37.5
Panchari	Panchari 1	78.6	21.4	79.0
	Panchari 2	72.8	27.7	89.0
	Panchari 3	70.9	29.1	74.5
	Panchari 4	67.3	31.7	91.0

Jhum morich is one kind of chilli variety which is locally cultivated at Chittagong Hill Tract. In jhum morich nine different fungi were detected in seeds of twelve samples collected from three different upazilla of Khagrachari hill district. The identified fungi were- *Alternaria alternata*, *A. solani*, *Aspergillus candidus*, *Cercospora capsici*, *Colletotrichum capsici*, *C. lunata*, *Doratomyces* sp., *Fusarium* sp. and *Penicillium* sp. Notable works on seed-borne fungi of chilli seeds have carried out in Bangladesh as well as outside the country,

but no work have been done on fungi associated with jhum morich seeds in Bangladesh. Fakir and Halder (1993) listed two seed-borne fungal pathogens *Colletotrichum capsici* and *Cercospora capsici* in chilli from Bangladesh. *Colletotrichum capsici* is responsible for anthracnose and die-back or fruit rot chilli (Than *et al*. 2008 and Saxena *et al*. 2014) whereas cercospora leaf spot or velvet spot of chilli is caused by *Cercospora capsici* (Cerkauskas 2004). The germination of discoloured seeds of *Capsicum annuum* was considerably reduced by most commonly seed-borne fungi, *Colletotrichum*, *Cladosporium*, *Alternaria*, *Drechslera* and *Curvularia* spp. These fungi affected root elongation more adversely than shoot elongation (Adiver 1987). Ayub (2006) listed ten fungal pathogens on chilli seeds collected from BARI and farmer's field, among them fungal genera *Colletotrichum* and *Alternaria* were predominant. *Fusarium oxysporum* frequently isolated from chilli seeds in India was found to reduce seed germination and induce wilting in the transplanted crop (Vidhyasekaran and Thiagarajan, 1981). Koike *et al*. (2007) reported that damping off disease of chilli is caused by *Fusarium* spp. Anthracnose caused by *Colletotrichum capsici* and leaf spot is caused by *Alternaria solani* which are seed borne and reduce the seed germination and yield loss up to 30-60% in chilli (Thippeswamy *et al*. 2007). Alam *et al*. (2014) found five different seed borne fungi *viz. Colletotrichum capsici, Curvularia lunata, Rhizopus stolonifer, Aspergillus flavus* and *Fusarium moniliforme* were associated with the tested chili seed samples and among these *Curvularia lunata* was the most prevalent.

In the present study, the prevalence of total and individual fungal infections of jhum morich varied depending on the sources of seed collection. Such variation in the occurrence of seed-borne fungi has been demonstrated in chilli with a number of crops viz. rice, kaon, mustard, black gram, wheat, jute and maize by different research workers in Bangladesh (Hossain *et al*. 1977; Barma and Fakir, 1981; Dey and Fakir, 1988; Kabir and Fakir, 1988; Rahman *et al*. 1988; Fakir and Islam, 1990; Basak *et al*. 1991; Fakir and Halder, 1993).

CONCLUSION

In the present study, seed-borne infections and germination percentages were recorded from jhum morich seeds collected from three different upazilla of Khagrachari hill district. Seed-borne fungal infections detected, varied from 37.5-91.0% in jhum morich. Similarly, Germination of seeds of jhum morich varied significantly from 65.9-82.3%. The results show that, no definite relationship between germination and seed-borne fungal infections was observed. In this present study, pathogenicity of different species of fungi of jhum morich has not been conducted. To demonstrate the role of these fungi associated with seeds of jhum morich pathogenicity needs to be tested.

REFERENCES

Adiver K (1987) Germination of discolored seed *Capsicum annuum*. Current Research. India. 16(5), 70-72.

Alam MZ, Hamim I, Ali MA, Ashrafuzzaman M (2014) Effect of seed treatment on seedling health of chili. *J. Environ. Sci. & Natural Resources.* 7(1), 177-181.

Anonymous (2005) *FAO Statistical Year Book*, Food and Agriculture Organization of UN, Rome. 75-76 pp.

Asaduzzaman M, Alam MJ, Islam MM (2010) Effect of *Trichoderma* on seed germination and seedling parameters of chilli. *Journal of Science Foundation.* 8(1&2), 141-150.

Ayub A (2006) Prevalence of seed-borne pathogens of some spices crops. Annual Report (2004-2005). Plant Pathology Division, BARI, Joydebpur, Gazipur. 10 pp.

Barma AC, Fakir GA (1981) Prevalence and pathogenicity of fungi associated with the seeds of kaon (*Setaria italica*). *Bangladesh J. Agr.* Vol. 6(2-3), 6-14.

Basak AB, Fakir GA, Mridha MAU (1991) Mycoflora of chilli seeds obtained from different types of fruit rots. Chittagong Univ. Studies Part II. 15(2), 11-17.

BBS (Bangladesh Bureau of Statistics) (2011) Yearbook of Agricultural Statistics of Bangladesh. 38 pp.

Booth C (1971) The genus *Fusarium*. Commonwealth Mycol. Inst. Kew, Surrey, England. 236 pp.

Cerkauskas R (2004) "Cercospora leaf spot," in *AVRDC Fact Sheet: Pepper Diseases*, edK. Tom (Taiwan: AVRDC–The World Vegetable Center; AVRDC Publication), 4–575.

Chidambaram P, Mathur SB, Neergaard P (1973) Identification of Seed-borne *Drechslera* species. The Danish Government Institute of Seed Pathology for Developing Countries, Copenhagen, Denmark. FRIESIA. 10, 165-207.

Dey TK, Fakir GA (1988) Prevalence of fungi in mustard seeds in Bangladesh. *Bangladesh J. Pl. Pathol.* 4, 87-93.

Ellis MB (1971) Dematiaceous hyphomycetes. Commonwealth Mycol. Inst. Kew, Surrey, England. 608 pp.

Fakir GA (1983) Teaching, research and training activities on seed pathology in Bangladesh. Seed Sci. & Technol. 11, 1345-1352.

Fakir GA, Halder N (1993) Seed-borne fungi of chilli. *Bangladesh J. Pl. Pathol.* 7, 34-37.

Fakir GA, Islam MR (1990) Survey on the health status of jute and rice seeds of farmers of Sadar Upazila, Mymensingh. BAURES. Progress 7, 42-47.

Hossain M, Fakir GA, Momin A (1977) Distribution of some seed-borne pathogens of rice. *Bangladesh J. Agri. Sci.* 4, 179-181.

ISTA (International Rules for Seed Testing Association) (2001) International Rules for Seed Testing. Rules Amendments. Seed Sci. & Technol. 29, 1-127.

Kabir AKM, Fakir GA (1988) Seed-borne fungi of blackgram and their effect on germinating seeds and seedlings. *Bangladesh J. Pl. Pathol.* 4, 43-61.

Koike ST, Gladders P, Paulus A (2007) "*Capsicum*: pepper," in *Vegetable Diseases: A color Handbook*, edJ. Northcott (London: Manson Publishing Ltd.), 208–209.

Malone GP, Musket AE (1964) Seed-borne fungi. Description of 77 fungus species. Proc. Intl. Seed Test Ass. 29(2), 180-183.

Mathur SB, Kongsdal O (2003) Common Laboratory Seed Health Testing Methods for Detecting Fungi. Danish Govt. Institute of Seed Pathology for Developing Countries, Copenhagen, Denmark. Published by ISTA, Switzerland. 425 pp.

Neergaard P (1979) Seed Pathology. Vol. 1. The Macmillan Press Ltd. 1, 839p.

Rahman HM, Fakir GA, Rahman GMM, Islam MR (1988) Survey on the prevalence of black point of wheat in Bangladesh. *Bangladesh J. Pl. Pathol*. 4, 35-42.

RamNath P, Neergaard, Mathur SB (1970) Identification of *Fusarium* species on seeds as they occur in blotter test. Proceedings of the International Seed Testing Association. 35, 121-144.

Raper KB, Fennel DI (1965) The genus *Aspergillus*. The Williams and Wilkins Co., Baltimore, 686 p.

Rashid AQMB, Fakir GA, Mia MAT, Shafiq Uddin K (1995) Seed health studies and crop production in Bangladesh. *J. Sustainable Agric*. 6(2/3), 93-122.

Saxena A, Raghuvanshi R, Singh HB (2014) Molecular, phenotypic and pathogenic variability in *Colletotrichum* isolates of subtropical region in North Eastern India, causing fruit rot of chillies. *J. Appl. Microbiol.* 117, 1422–1434.

Than PP, Jeewon R, Hyde KD, Pongsupasamit S, Mongkolporn O, Taylor PWJ (2008) Characterization and pathogenicity of *Colletotrichum* species associated with anthracnose disease on chilli (*Capsicum* spp.) in Thailand. *Plant Pathol.* 57, 562–572.

Thippeswamy B, Krishnappa M, Chakravarthy CN, Sathisha AM, Jyothi SU, Vasantha Kumar K (2007) Pathogenicity and management of anthracnose and alternaria leaf spot of chilli. Internat. *J. Plant Sci.* 2(1), 39-43.

Vidhyasekaran P, Thiagarajan CP (1981) Seed-borne transmission of *Fusarium oxysporum* in chilli. Indian Phytopathol. 34(2), 211-213.