Reprint **ISSN 1991-3036 (Web Version)**

International Journal of Sustainable Crop Production (IJSCP)

(*Int. J. Sustain. Crop Prod.*)

Volume: 9 **Issue: 3** **November 2014**

Int. J. Sustain. Crop Prod. 9(3): 41-46 (November 2014)

ISOLATION AND IDENTIFICATION OF STORAGE FUNGI FROM ONION

M.A.U. DOULLAH, A.M. ARA AND M. ASHRAFUZZAMAN

An International Scientific Research Publisher

Green Global Foundation©

Web address: http://ggfjournals.com/e-journals archive
E-mails: editor@ggfjournals.com and editor.int.correspondence@ggfjournals.com

ISSN-1991-3036 (Online)
Int. J. Sustain. Crop Prod. 9(3):41-46(November 2014)

ISOLATION AND IDENTIFICATION OF STORAGE FUNGI FROM ONION

M.A.U. DOULLAH[1]*, A.M. ARA[2] AND M. ASHRAFUZZAMAN[2]

[1]Associate Professor, Department of Plant Pathology and Seed Science, Sylhet Agricultural University, Sylhet-3100; [2]Student, Department of Plant Pathology, Bangladesh Agricultural University (BAU), Mymensingh-2202, Bangladesh; [2]Professor, Department of Plant Pathology, BAU, Mymensingh-2202, Bangladesh.

*Corresponding author & address: Dr. Md. Asad-ud-doullah, E-mail: asadmeli@gmail.com
Accepted for publication on 29 October 2014

ABSTRACT

Doullah MAU, Ara AM, Ashrafuzzaman M (2014) Isolation and identification of storage fungi from onion. *Int. J. Sustain. Crop Prod.* 9(3), 41-46.

A survey was conducted on diseases of five onion varieties which included four local varieties namely Taherpuri, Faridpuri, Kalashnagari and Zitka, and one Indian variety namely Pusa red in four different markets in Mymensingh during 2007. These varieties were used as test samples to isolate and identify the associated fungi in storage condition. Five different fungal species belonging to three genera were isolated and their population increased proportionately with the duration of storage period. The fungi isolated were *Aspergillus niger, Aspergillus flavus, Penicillium* spp., *Fusarium oxysporum* and *Fusarium moniliforme*. Healthy onion bulbs were inoculated (with injury and without injury) by these fungi. Individual fungi produced distinct symptom of disease in inoculation chamber at 22-23°C temperature. Comparatively lower amount of disease was found at15 days of inoculation. Maximum diseases were found in the variety Pusa Red (with injury). Disease development increased with increasing storage duration and the lowest was found in variety Zitka (without injury).

Key words: *storage fungi, pathogenicity, disease incidence, isolation, inoculation, onion*

INTRODUCTION

Onion is one of the most important and familiar spices around the world specially in Asia. It has many medicinal values like diabetes, cancer and asthma (Vohora *et al*. 1974). In Bangladesh, commercial cultivation of onion is increasing and ranks first in terms of annual production (BBS 2006). However, average production is low compared to other countries because of a number of diseases are involved with onion production (Munoz and Martinez Perez, 1984; Ahmed and Hossain, 1985; Meah and Khan, 1987). Besides, there are several factors for the deterioration of onion bulbs in storage. Under storage conditions, onion bulbs lose its weight due to continuous loss of water and dry matter. But the most serious loss arises from storage rots due to various diseases and from unwanted sprouting and rotting (Jones and Mann, 1963). About 15 different fungal species are responsible for the onion diseases in the storage and transit all over the world. The loss due to these diseases is considerable and may go up to 40% (Aiyer 1980).

Presently, the storage diseases of the onion are putting increasing threat. In storage, various diseases namely black mould rot (*Aspergillus niger*), blue mould rot (*Penicillium* spp.), Fusarium bulb rot (*Fusarium* spp.), basal rot (*Fusarium monillifome*) and Aspergillus rot (*Aspergillus* spp.) etc. where black mould rot (*A. niger*) is more severe in storage (Velez *et al*. 2004). *Aspergillus* spp. infects the bulbs at high temperature and high relative humidity. On the other hand, *Penicillium* spp. destroys the bulbs at low temperature. Sometimes, *Penicillium* spp. produces the mycotoxin Penitrem A, which has been previously implicated in tremorgenic toxicosis (Overy *et al.* 2005). *Aspergillus* spp., *Penicillium* spp. and *Fusarium* spp. are the predominant pathogens of storage onion (Surviliene 2003; Raju and Nail, 2006). Few works have been done on isolation and identification of fungi associated with degradation of stored onion bulbs. Information regarding the causes and loss due to fungal deterioration of onion bulbs in storage is not available in Bangladesh conditions which is highly congenial to such diseases and losses caused thereby. Considering the above facts and circumstances, the present study was undertaken to find out the association of various fungi and their identification from naturally infected onion bulbs from different markets of Mymensingh.

MATERIALS AND METHODS

Experimental Site

A survey was conducted in four different markets namely Kamal Ranjit market (BAU), Kewatkhali bazaar, Shesh mor market (BAU) and Natun bazaar in Mymensingh district. The clinical experiment was carried out in the Mycology lab of Seed Pathology Centre (SPC), Bangladesh Agricultural University (BAU), Mymensingh during July to December 2007.

Survey on the storage loss of marketed onion due to the diseases

A preliminary survey was done on the stored onion bulbs in above four markets. Four local varieties of onion namely Taherpuri, Faridpuri, Kalashnagari, Zitka and one Indian variety Pusa red were selected for the study. There was no systemic record of the actual storage loss. The losses were mainly due to black mould rot, Fusarium bulb rot and blue mould rot in the markets. To calculate loss, the vendors were motivated to keep purchase and sale records of onion separately.

Three kilogram (3 kg) of variety Pusa red and 2 Kg of Taherpuri, Faridpuri, Kalashnagari & Zitka were collected from 4 different markets in Mymensingh town. The samples were drawn at random and placed in

separate labeled jute bag. The composite samples were brought to Mycology lab of the Seed Pathology Centre (SPC), BAU, Mymensingh and stored for one week at room temperature (20-29°C).

After one week of storage, sample was spread on a working table and the onion bulbs were sorted out into five categories *viz*. i. Healthy looking bulb (no any symptom/sign on the bulb) ii. Black mould rot symptom bearing bulb iii. Blue mould rot symptom bearing bulbs iv. Fusarium rot symptom bearing bulbs and v. others (having other symptoms/sign). The total number of onion and the number of onion in each category were counted and weighed. All these exercise were done on the basis of direct dry inspection without or with the aid of a 5x hand lens. The difference between the sum of weights of the sorted onions after a week of storage and the weight of the onion bulb sample during collection was loss in weight of onion bulbs. The percent disease incidence was calculated using following equation:

$$\%\ Disease\ incidence = \frac{No.\ of\ diseased\ onion}{Total\ no.\ of\ onion} \times 100$$

Isolation technique

Tissue plating method was used for isolation of associated microorganisms. Diseased onion bulbs were selected for isolation. The selected diseased onion bulb was washed thoroughly to remove soil and sand particles. The infected onion bulb was cut pieces into 5mm in length containing diseased area along with healthy tissues. These inocula were then washed with sterile water for 3-4 times and then placed on the filter paper to remove excess water. Half of the inocula pieces were subjected to surface sterilization by dipping for 5 seconds in 1:1000 $HgCl_2$ solutions. Surface sterilized inocula were then thoroughly (3 times) washed with sterile water and dried on sterile filter paper.

Acidified Potato Dextrose Agar (PDA) was used for isolation of associated mycoflora of onion. Two drops of 50% lactic acid was used for 15-20 ml PDA in each 9 cm diameter petridish for acidifying the PDA media to get rid of bacterial contamination. Five cut pieces were placed at equal distances in each of the petridish. Then the plates were incubated in an incubator at 25°C for 3-10 days to allow the pathogen to grow out of the diseased tissues on the medium. Different fungi appearing from the incubated tissues were aseptically transferred to fresh plates containing PDA aiming at culturing one fungal species in separate petridish. Pure culture of individual fungus was prepared through repeated transfer of hyphal tips or single spores. Stock cultures of the isolates were maintained on slants of PDA in test tubes. Most of the associated microorganisms were detected by observing their growth characters on the incubated diseased onion on PDA following the keys of Barnet (1965). Temporary slides were prepared from the fungal colony and observed under compound microscope and identified with the help of keys suggested by Booth (1971) and Ellis (1971).

Pathogenicity test

Inoculation of bulbs with injury

Healthy and disease free onion bulbs of all varieties were selected for inoculation. The bulbs were pricked just near the stem with a sterilized needle. The inocula were placed in to the pricked part of the bulbs. Ten healthy bulbs were inoculated where every 2 bulbs were inoculated with *Aspergillus niger*, *A. flavus*, *Penicillium* spp., *Fusarium moniliforme* and *F. oxysporum*, respectively maintaining 4 replications with appropriate controls. The test onion was then incubated at 22-23°C for up to 90 days.

Inoculation of bulbs without injury

The same inoculation process (described above) was followed. In this case healthy and disease free onion bulbs were not pricked, just inoculum was placed on to the surface of the necked bulbs. After that test onions were then incubated at 22-23°C for up to 90 days. Disease development was recorded by eye estimation at 15 days intervals.

Experimental design and statistical analysis

The experiment was laid out in a Completely Randomized Design (CRD) with four replications. The data were analyzed using MSTAT statistical package programme. The level of significance and analysis of variance along with the Least Significance Difference (LSD) were done following Gomez and Gomez (1984). Mean separation was done by Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Survey on onion samples

Frequency, occurrence of diseased onion bulbs collected from 4 markets of Mymensingh

The results of the sorting on onion sample drawn from different market from different groups on the basis of presence of symptom and causal agents are presented in Table 1. A total of 2,784 onions belongs to different varieties were collected from different markets namely Kamal Ranjit market, Shesh mor market, Natun bazaar market and Kewatkhali bazaar market where 496,544, 560, 632 and 552 were Taherpuri, Faridpuri, Kalashnagari, Zitka and Pusa red, respectively. Diseased bulbs varied with respect to variety and storage in the markets. In Taherpuri variety, disease incidence (%) was 10.47 where 4.44 was black mould, 0.60 was blue

mould, 1.41 was Fusarium bulb rot and 4.26 was other diseases. In case of Faridpuri was 11.75 where 4.59, 1.10, 1.47, were black mould, blue mould and Fusarium bulb rot, respectively. In Kalashnagari variety, it was 12.14 where in Zitka and Pusa red variety, it was 5.06 and 13.76. The lowest disease incidence was found in Zitka variety and the highest was in Pusa red variety (Table 1).

Table 1. Frequency, disease incidence and percentage loss of onion bulb collected from four different markets in Mymensingh

Variety	No. of onion bulb	No. of infected bulb	Disease incidence (%)					Loss(%) in one week
			Black mould	Blue mould	Fusarium bulb rot	Others	Total	
Taherpuri	496	52	4.44	0.60	1.41	4.26	10.71	0.34
Faridpuri	544	64	4.59	1.10	1.47	4.59	11.75	0.40
Kalashnagari	560	68	4.64	0.89	1.07	5.54	12.14	0.44
Zitka	632	32	1.58	0.47	0.32	2.68	5.06	0.21
Pusa red	552	76	3.44	1.27	2.17	6.88	13.76	0.47
Total	2,784	292						

Detection and identification of fungi associated with stored onion bulbs

Five different fungi *viz*. *Aspergillus niger*, *A. flavus*, *Penicillium* spp., *Fusarium oxysporum* and *F. moniliforme* were repeatedly isolated and identified by PDA plate methods from four local and one Indian varieties.

Pathogenicity of Aspergillus niger, A. flavus and Penicillium* spp.*, Fusarium oxysporum and F. moniliforme

On artificial inoculation (with and without injury) all the three fungi produced characteristics mould symptoms in onion bulbs where control did not show any disease symptom. Two species of *Fusarium- F. oxysporum* and *F. moniliforme* were found pathogenic to the onion bulbs. They also produced characteristic rot in onion bulbs. Control bulb did not develop any symptom.

Disease development by Aspergillus niger in onion bulbs at different storage duration after inoculation

Aspergillus niger was infectious in all varieties of test onion bulbs. In case of inoculation with injury, the highest (15.33%) disease development was observed in Pusa red variety at 15 days after inoculation and the lowest (4.58%) in Zitka variety. There was no significant difference in disease development among Taherpuri, Faridpuri and Kalashnagari variety. In case of inoculation without injury at 15 days after inoculation, the highest (6.42%) disease development was found in Pusa red variety and the lowest (0.92%) in Zitka variety (Table 2). Same trend of disease development with different disease severity was found with and without injury inoculation with increasing storage duration. After 90 days of inoculation, disease development was the highest (44.17% with injury and 13.83% without injury) in Pusa red variety. The lowest 14.58% (with injury) and 4.00% (without injury) amount of disease was observed in the variety Zitka. The results of the pathogenicity test with *Aspergillus niger* with injury indicated susceptibility of the test varieties at 90 days after inoculation were (high to low): Pusa red> Taherpury> Faridpuri> Kalashnagari > Zitka (Table 2).

Table 2. Percentage disease development by *Aspergillus niger* after different days of inoculation in the infectivity test

Variety	*Aspergillus niger*											
	15 days		30 days		45 days		60 days		75 days		90 days	
	With injury	Without injury	With injury	Without injury	With injury	Without injury	With injury	Without injury	With injury	Without injury	With injury	Without injury
Taherpuri	10.50b	3.33b	18.17b	6.00b	24.08b	9.00b	26.08b	10.08a	30.58b	11.25a	33.50b	12.83b
Faridpuri	10.33b	2.17c	13.00c	3.41c	15.42b	4.67c	18.50c	5.58b	22.16c	7.50b	25.00bc	8.50c
Kalashnagari	8.41b	2.33c	11.92c	3.41c	14.58c	4.33c	17.25d	5.33b	19.92d	6.17c	22.67bc	7.58d
Zitka	4.58c	0.92d	7.58d	1.08d	9.42d	1.41d	10.92e	2.08c	12.58e	3.08d	14.58c	4.00e
Pusa red	15.33a	6.42a	22.25a	8.08a	32.58a	9.58a	36.00a	10.58a	40.75a	11.25a	44.17a	13.83a
LSD	**0.346**	**0.229**	**0.598**	**0.250**	**0.483**	**0.271**	**0.375**	**0.251**	**0.433**	**0.275**	**4.494**	**0.296**
CV(%)	**12.36**	**13.52**	**15.63**	**12.36**	**12.33**	**13.54**	**10.23**	**11.58**	**10.25**	**10.52**	**29.36**	**10.23**
Level of Sig.	**	**	**	**	**	**	**	**	**	**	**	**

In a column figures with similar letter(s) did not vary significantly. ** = Significant at 1% level, NS += Not significant

Disease development by Aspergillus flavus in onion bulbs at different storage duration after inoculation

Disease was found in all the varieties caused by *Aspergillus flavus* after different days of inoculation (Table 3). In case of inoculation with injury at 15 days,the highest (11.33%) disease incidence was found in Pusa red variety and the lowest (4.50%) in Zitka variety. There was no significant difference between Taherpuri and Faridpuri variety in disease development. In case of inoculation without injury, Pusa red was also highest (3.83%) of disease development whereas no significant difference between Faridpuri and Zitka variety. Disease incidence in Faridpuri and Zitka variety were 0.17% and 0.08%, respectively. There was no significant difference between Taherpuri and Kalashnagari variety. Same trend of disease development was found in different storage durations. On the basis of susceptibility with injury (high to low) the cultivars tested at 90 days after inoculation were arranged in the followed order: Pusa red> Taherpuri> Faridpuri> Kalashnagari > Zitka (Table 3).

Table 3. Disease development by *Aspergillus flavus* after different days of inoculation in the infectivity test

Variety	*Aspergillus flavus*											
	15 days		30 days		45 days		60 days		75 days		90 days	
	With injury	Without injury	With injury	Without injury	With injury	Without injury	With injury	Without injury	With injury	Without injury	With injury	Without injury
Taherpuri	9.00b	1.00b	11.58b	1.58b	13.42b	2.17b	15.08b	3.00b	18.66b	4.00b	21.58b	5.00c
Faridpuri	8.67b	0.17c	10.66c	0.58c	12.83b	1.00	15.08b	1.83c	16.75c	2.33c	19.00c	3.33d
Kalashnagari	6.75c	1.08b	9.00d	1.83b	11.42c	2.50b	13.50c	3.41b	15.08d	4.08b	16.58d	5.66b
Zitka	4.50d	0.08c	6.42e	0.41c	7.67d	0.75c	9.91d	1.08d	11.83e	1.75c	13.16e	2.58e
Pusa red	11.33a	3.83a	12.33a	5.00a	15.67a	6.08a	18.58a	7.00a	21.83a	8.00a	26.75a	8.58a
LSD	0.329	0.199	0.340	0.218	0.358	0.375	0.233	0.183	0.370	0.280	0.331	0.347
CV(%)	13.25	22.41	12.45	17.54	11.58	25.48	15.44	16.00	11.30	11.00	9.52	16.54
Level of Sig.	**	**	**	**	**	**	**	**	**	**	**	**

In a column figures with similar letter(s) did not vary significantly. ** = Significant at 1% level, NS + = Not significant

Disease development by Penicillium* spp. *with stored onion bulbs at different storage duration after inoculation

Disease was found to be developed in all the varieties of onion when bulbs were inoculated with *Penicillium* spp. In case of inoculation with injury after 15 days Pusa red was the most susceptible (11.58%) variety and Kalashnagari was the least susceptible (4.00%) variety to storage disease. In case of inoculation without injury, the highest (2.17%) disease development was found in Taherpuri variety and the lowest (0.08%) in Zitka variety. After 30 days of inoculation, the highest (15.33%) disease development was found in Pusa red and the lowest (5.83%) in Zitka variety (with injury). Same trend of disease development with different disease severity was found with and without injury inoculation with increasing storage duration like 45, 60, 75 and 90 days after inoculation. On the basis of infectivity test results without injury inoculations, the test varieties may be arranged on the basis of shown susceptibile to *Penicillium* spp. at 90 day of inoculation as follows: > Taherpuri> Kalashnagari, Faridpuri, and Pusa red > Zitka (Table 4).

Table 4. Disease development by *Penicillium* spp. after different days of inoculation in the infectivity test

Variety	*Penicillium* spp.											
	15 days		30 days		45 days		60 days		75 days		90 days	
	With injury	Without injury	With injury	Without injury	With injury	Without injury	With injury	Without injury	With injury	Without injury	With injury	Without injury
Taherpuri	4.83c	2.17a	10.50b	4.33a	16.16b	6.42a	19.16b	7.25a	24.75b	8.17a	28.66b	9.33a
Faridpuri	7.08b	0.33c	10.33b	1.17c	13.50c	2.08b	15.83c	4.00b	18.08b	4.83b	22.00c	6.25b
Kalashnagari	4.00d	1.25b	9.58c	2.00b	11.75d	2.92b	14.00d	4.00b	15.50c	5.00b	17.83d	6.41b
Zitka	4.50cd	0.08c	5.83d	0.33d	8.42e	0.75c	9.50e	0.75d	10.50d	1.17c	12.58e	1.83c
Pusa red	11.58a	1.41b	15.33a	2.17b	19.75a	2.50ab	22.00a	3.41c	25.42a	5.08b	31.91a	6.41b
LSD	0.386	0.195	0.335	0.259	0.345	0.225	0.215	0.210	0.200	0.192	0.344	0.217
CV(%)	16.54	25.36	12.55	19.65	10.52	12.47	9.58	12.47	5.68	11.40	8.52	10.47
Level of Sig.	**	**	**	**	**	**	**	**	**	**	**	**

In a column figures with similar letter(s) did not vary significantly. ** = Significant at 1% level, NS + = Not significant

Disease development by Fusarium oxysporum with stored onion bulbs at different storage duration after inoculation

Significant disease development was found in onion bulb in case of inoculation with injury. At 15 days of inoculation, the highest (0.66%) disease development was found in Taherpuri variety but there was no significant difference among Taherpuri, Faridpuri and Pusa red variety (Table 5). The lowest amount of disease development (0.17%) was found in Kalashnagari and Zitka variety. In case of inoculation without injury, there was no disease development in other varieties except in Taherpuri (0.08%).

After 30 days, 45 days, 60 days, 75 days and 90 days after inoculation with injury the highest percentage of disease development was found in Faridpuri variety (1.25%, 2.33%, 2.75%, 3.17% and 3.66%, respectively) whereas the lowest was in Zitka variety (0.41%, 0.58%, 0.83%, 1.17% and 1.50%). In case of inoculation without injury, a negligible amount of disease development was found in all the varieties after different days of inoculation.

Table 5. Disease development by *Fusarium oxysporum* after different days of inoculation in the infectivity test

Variety	*Fusarium oxysporum*											
	15 days		30 days		45 days		60 days		75 days		90 days	
	With injury	Without injury	With injury	Without injury	With injury	Without injury	With injury	Without injury	With injury	Without injury	With injury	Without injury
Taherpuri	0.66a	0.08	1.08a	0.17	1.41ab	0.41a	1.92b	0.58	2.25c	0.92	2.42b	1.00
Faridpuri	0.58a	0.00	1.25a	0.08	2.33a	0.25ab	2.75a	0.50	3.17a	0.75	3.66a	0.83
Kalashnagari	0.17b	0.00	0.50b	0.17	1.17b	0.50a	1.75b	0.58	2.08c	0.75	3.25a	1.08
Zitka	0.17b	0.00	0.41b	0.00	0.58c	0.08b	0.83c	0.33	1.17d	0.41	1.50c	0.50
Pusa red	0.50	0.00	1.17a	0.33	1.66b	0.41a	2.00b	0.50	2.75b	0.75	3.25a	0.83
LSD	0.154	0.053	0.206	0.139	0.188	0.128	0.180	0.132	0.175	0.149	0.227	0.192
CV(%)	27.58	32.56	20.36	29.33	22.36	28.55	16.38	22.65	13.40	19.54	12.65	22.36
Level of Sig.	**	NS	**	NS	**	**	**	NS	**	NS	**	NS

In a column figures with similar letter(s) did not vary significantly. ** = Significant at 1% level, NS + = Not significant

Disease development by Fusarium moniliforme with stored onion bulbs at different storage duration after inoculation

Considerable amount of disease development was found when bulbs were inoculated by *F. moniliforme* in case of inoculation with injury (Table 6). After 15 days , 30 days, 45 days, 60 days, 75 days and 90 days after inoculation, the highest amount of disease was found in Taherpuri (1.08%), Taherpuri and Pusa red (1.33%), Pusa red (2.50%, 2.50%), Faridpuri (3.25% and 3.75%) whereas the lowest disease development was found in Zitka variety (0.08%, 0.17%, 0.50%, 0.75%, 1.41% and 1.75%, respectively). In case of without injury, a negligible amount of disease development was found in all the varieties at different days of inoculation but in case of 90 days after inoculation highest amount of disease development (1.41%) was found in Kalashnagari variety and the lowest (0.66%) in Zitka variety. There was no significant difference among Taherpuri, Faridpuri and Zitka variety in disease development.

Table 6. Disease development by *Fusarium moniliforme* after different days of inoculation in the infectivity test

Variety	*Fusarium moniliforme*											
	15 days		30 days		45 days		60 days		75 days		90 days	
	With injury	Without injury	With injury	Without injury	With injury	Without injury	With injury	Without injury	With injury	Without injury	With injury	Without injury
Taherpuri	1.08a	0.08	1.33a	0.17	1.66ab	0.33	2.08a	0.58b	2.41b	0.75bc	2.50c	0.92bc
Faridpuri	0.83a	0.08	1.17ab	0.17	1.41ab	0.25	1.66b	0.50b	3.25a	0.58bc	3.75a	0.83c
Kalashnagari	0.41b	0.08	0.83b	0.41	1.41ab	0.58	2.00ab	1.08a	2.58b	1.17a	3.08b	1.41a
Zitka	0.08c	0.00	0.17c	0.00	0.50b	0.08	0.75c	0.17c	1.41c	0.50c	1.75d	0.66c
Pusa red	0.83a	0.00	1.33a	0.17	2.50a	0.41	2.50a	0.66b	2.50b	0.92ab	2.83bc	1.17ab
LSD	0.135	0.095	0.170	0.154	0.600	0.194	0.190	0.201	0.230	0.205	0.270	0.198
CV(%)	20.14	25.33	20.58	4.25	22.36	4.56	18.00	28.65	17.51	22.36	18.56	20.33
Level of Sig.	**	NS	**	NS	**	NS	**	**	**	**	**	**

In a column figures with similar letter(s) did not vary significantly. ** = Significant at 1% level, NS + = Not significant

Sample survey from different markets indicated that the average disease incidence was the highest in Pusa red variety (14.13%) followed by Kalashnagari (12.14%), Faridpuri (11.75%), Taherpuri (10.47%) and Zitka (5.06%) variety. The higher infection in Pusa red may be due to higher injury in the bulb during transportation from India through the long rough route. The other reason might be due to the exposure of Indian onion bulbs to a changed environment in Bangladesh. Among the varieties Zitka showed the lowest disease development because it was small in size with dry skin and these small bulbs usually have good storability (Ko-SweeSuak *et al*. 2002).

Several fungi were isolated and identified from different onion bulbs in the present investigation. In Bangladesh such reports are available. However, various seed borne fungi were identified by number of workers from onion seeds (Fakir 2001; Hossain 1999 and Ali *et al*. 2002).

Storage loss was maximum in Pusa red (0.47%) and minimum in Zitka (0.21%). Prevalence of black mould rot (*Aspergillus niger*) was more in all the varieties than blue mould and Fusarium bulb rot. Market survey for assessment of spoilage caused by *A. niger* reported a loss of 2.9% to 12.09% (Srinivasan *et al*. 2002). Storage losses were significantly influenced by storage duration, cultivar and interaction between storage duration and cultivar (Ko-SweeSuak *et al.* 2002). Sprout loss and disease losses were the major storage losses of onion bulbs during storage (Satish *et al*. 2002).

Five species belonging to the 3 genera of fungi were isolated and identified from collected diseased onion bulbs. The fungi were *A. niger, A. flavus, Penicillium* spp., *Fusarium oxysporum* and *Fusarium moniliforme*. Among these fungi: *A. niger, A. flavus* and *Penicillium* spp. were more predominant in stored onion bulbs, whereas *F. oxysporum* and *F. moniliforme* was occasionally found in stored onion bulbs. *Fusarium* spp. was found in storage if the bulbs were infected by *Fusarium* spp. in the field condition.

Disease development was significantly different in different varieties. From the results, Pusa red variety was found more susceptible to disease development at different duration and Zitka was comparatively less susceptible to disease. The populations of storage fungi were increased periodically after inoculation and for these reasons which caused greater damage in the stored inoculated bulbs.

The limitation of the present investigation is that, the survey was made only in 4 different markets in Mymensingh town, but not in a broader spectrum in Bangladesh. Other limitation is that many other factors have not been considered for disease development like harvesting, curing, bagging and transported except causal agents. Curing is a process which reduces the chance of infection by disease causing organisms in storage (Thompson *et al*. 1972). Onion growers and traders can reduce the rotting and fungal infection by pre-harvest treatment and maintaining low temperature and adequate ventilation in storage condition. The result indicated that the fungal diseases are serious problem of onion bulb in Bangladesh.

CONCLUSION

Five fungal species namely *Aspergillus niger, A. flavus, Penicillium* spp., *Fusarium oxysporum* and *F. moniliforme* were identified from storage onion. They caused black mould rot, blue mould rot and Fusarium

bulb rot diseases which are serious problem of onion bulb in Bangladesh. Maximum diseases were found in Pusa red variety and the lowest was found in Zitka. Disease development increased with increasing storage duration.

REFERENCES

Ahmed HU, Hossain MM (1985) Final report of the project crops diseases, survey and establishment of herbarium at BARI. Plant Pathology Div. BARI, Gazipur, 170 pp.

Aiyer AKN (1980) Field crops of India with special reference to Karnatak, (7th ed.). Banglore. BAPPCO.

Ali MA, Fakir GA, Sarker AK (2002) Research on seed-borne fungal diseases of spices in Bangladesh Agricultural University. *Bangladesh J. of Training and Development*, 15(1/2), 245-250.

Barnet HL (1965) Illustrated Genera of Imperfect fungi. Bugress Publishing Co. 225p.

BBS (2006) Monthly (October) Statistically Bulletin. Bangladesh Bureau of Statistics. Statistics Division, Ministry of Planning, Govt. of the Peoples Republic of Bangladesh, Dhaka.

Booth C (1971) The Fusarium commonwealth Mycol. Inst. Kew, Survey, England. 236p.Barnett, H.L. 1965. Illustrated genera of imperfect fungi. Bugress Publishing Co., 225p.

Ellis MB (1971) Dematiaceous Hypomycetes. CMI, Kew survey, English, 507p.

Fakir GA (2001) List of seed bone diseases of important crops occurring in Bangladesh. Seed Pathology Laboratory, Dept. of Plant Pathology, BAU, Mymensingh, 20p.

Gomez KA, Gomez AA (1984) Statistical procedures for Agricultural Research. 2nd Edn. John Wiley and Sons. New York, 68p.

Hossain R (1999) Studies on seed borne fungi of onion and their control. MS thesis, Dept. of Plant Pathology, BAU, Mymensingh, pp. 4-7.

Jones HA, Mann LK (1963) Onions and their allies. Interscience publishers, Inc. New York.

Ko-SweeSuak J, Huang W, Wang JF, Shanmugasundaram S, Chang WN (2002) Evaluation of onion cultivars for resistance to *Aspergillus niger*, the causal agent of black mould: *Journal of the American Society for Hort. Sci.*, 127(4), 697-702.

Meah B, Khan AA (1987) Checklist of vegetables and fruit disease in Bangladesh. Dept. of Plant Pathology, Bangladesh Agricultural University, Mymensingh. 22pp.

Munoz DCL, Martinez Perez AP (1984) Onion seed production under tropical conditions. Humbaldt Inst. Fund. *Res. Trop. Agric. Acad. Sci*., 10(2), 42-45.

Overy DP, Frisvad JC, Steinmeier U, Thrane U (2005) Clarification of the agents causing blue mold storage rot upon various flower and vegetable bulbs: implications for mycotoxin contamination. Postharvest Bio and Tech., 35, 217-221.

Raju K, Nail MK (2006) Effect of pre-harvest spray of fungicides and botanicals on storage diseases of onion. Indian Phytopath., 59(2), 133-141.

Satish SV, Rangganna B, Ramakumar MV (2002) Influence of storage conditions on onion losses in ambient storage. *Mysore J. of Agril. Sci*., 36(3), 260-265.

Srinivasan R, Shanmugam V, Kamalakannan A, Surendran M (2002) Influence of fertilizer, host factors and storage conditions in relation to disease severity: a case study of black mould rot of onion. Acta Phytopath. et Entom. Hungarica, 37(1/3), 119-135.

Surviliene E (2003) Influence of bulb rot on onion storage. Vagos, (57), 54-59.

Thompson AK, Booth RH, Proctor FJ (1972) Onion storage in the tropics. Trop. Sci., 14, 19-34.

Velez L, Rivera LI, Rodriguez RP, Cabrera I (2004) Fungi associated with onion (*Allium cepa* L.) field in southern Puerto Rico. *Journal of Agriculture University of Puerto Rico*., 88(1/2), 55-72.

Vohora SB, Rizman M, Khan JA (1974) Medicinal uses of common Indian vegetables planta medica, 23(4), 381-393.