Research Article

Bangladesh Journal of Plant Pathology, 39, 68-73
ISSN : 1012-9279 (Print)
ISSN : 2412-7558 (Online)

FACTORS AFFECTING THE DETERIORATION OF ONION IN STORAGE CONDITIONS

A. Bahrain[1,2], M. S. M. Chowdhury[2*], M. R. Islam[2], F. M. Aminuzzaman[2] and M. R. Ali[3]

[1]Department of Agricultural Extension, Khamarbari, Dhaka-1215, Bangladesh
[2]Department of Plant Pathology, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh
[3]Department of Entomology, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh
***Corresponding author**: smc_1968@yahoo.com

How to cite this article
Bahrain, A., Chowdhury, M. S. M., Islam, M. R., Aminuzzaman, F. M. and Ali, M. R, Factors Affecting The Deterioration of Onion in Storage Conditions, Bangladesh J. Plant Pathol. 39(1&2): 68-73

ABSTRACT

The experiment investigated the storage performance of eight varieties of onion viz Tahirpuri, Tahirpuri King, Faridpuri, Zitka, Lal Tir King, Lal Tir Hybrid, BARI Piaz 1, and BARI Piaz 4 over a seven-month storage period (April to October) in Bangladesh. Out of seven months surveyed to see the effects of storage room temperature (25-30^{0}C) and RH (75-80%) on disease incidence and weight loss, each was significant in each month weight loss due to farmer's storage condition. Bangladesh Agricultural Development Corporation (BADC) cold storage facilities, which maintain temperatures between 0-2°C and RH at 65-70% using to control excess temperature and humidity to reduce onion diseases. The analysis aims to identify potential correlations between the storage environment and the rate of deterioration, providing valuable insights for optimizing storage practices. BARI Piaz-4 displayed the lowest overall weight loss (150g) after seven months of storage. Conversely, Lal Tir Hybrid exhibited the highest weight loss (343g). The lowest disease incidence was found in BARI Piaz 1 variety (9%) whereas the highest was in the Faridpur and Zitka variety (14%). A significant and positive correlation was found (R^2 = 0.0159) between temperature (^{o}C) and disease incidence during storage conditions. On the other hand, a significant and negative correlation was found (R^2 = 0.1993) between relative humidity (%) and disease incidence during storage conditions.

Keywords: Disease incidence, Relative humidity, Storage condition, Temperature, Weight loss.

INTRODUCTION

Onion (*Allium cepa* L.) belonging to the family Alliaceae, is an important and familiar spice crop throughout the world. It is also the most common favourable spice throughout Bangladesh and it is grown all over the country. However, the major onion-growing districts are Faridpur, Comilla, Manikganj, Dinajpur, Jessore, Pabna, Rajshahi, Mymensingh, and Rangpur (BBS, 2006). It is used as condiments for flavoring several foods and medicines (Vohora *et al.*, 1974). The primary purpose of storage is to arrest metabolic breakdown and microbial deterioration. The onion is low perishable crop, yet considerable deterioration may occur during storage due to rotting, sprouting, and physiological weight loss and storage losses could be as high as 66%. The onion crop is associated with various diseases (Meah and Khan, 1987).

Among them, 45 different fungal and 5 bacterial diseases were reported to cause damage to onion in the field and storage. The most destructive diseases in storage are black mold (*Aspergillus niger),* blue mold (*Penicillium* spp.), Fusarium rot (*Fusarium* spp.), bacterial soft rot, etc. Among these diseases, mold disease is more severe in storage. *A. niger* and *Penicillium* spp. are the predominant fungal pathogens associated with storage disease of onion observed by Raju and Nail (2006). The disease incidence increased with the increase in duration of storage irrespective of the temperature. *A. niger* and *A. flavus* infect bulbs at high temperatures with high relative humidity while *Penicillium* spp. may destroy bulbs even at low temperatures. Infections by *Penicillium* spp. may produce mycotoxin Penitrem A, which has been recently identified as the cause of tremorgenic toxicosis in man and animals (Overy *et al.*, 2005). The present study was undertaken to assess the causes and losses in the storage of onion bulbs especially by fungi and its relation to weight loss. Under storage conditions, onion bulbs lose their weight due to continuous loss of water and dry matter. Mostly serious loss arises in store due

to various bulb rotting microorganisms. The loss due to the storage disease is considerable but may go up to 40% (Ara, 2008).

Considerable loss due to the disease failing in crop production is common. Recently, the storage diseases of onion are becoming an increasing threat to onion production. Many factors influence the storage life of onion bulbs: the extent of storage losses; varietal response; temperature and RH; grading and bulb size; effect of pre-harvest treatments; effect of postharvest treatments; modification of storage structure; time of harvesting; effect of cultural practices; pathogen causing storage decay and correlation studies.

MATERIALS AND METHODS

The experiment was conducted to the storage performance of eight varieties of onion viz Tahirpuri, Tahirpuri King, Faridpuri, Zitka, Lal Tir King, Lal Tir Hybrid, BARI Piaz 1, and BARI Piaz 4. Data were collected from 16 upazilas and 2 BADC cold storage under 7 major onion growing districts. Lab experiments were conducted in the Central Laboratory of the Department of Plant Pathology, Sher-e-Bangla Agricultural University (SAU), Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh from April to October 2022.

Experimental site

In this experiment temperature and relative humidity parameters were considered as environmental factors which trigger the storage onion disease. Monthly metrological data on temperature and relative humidity were collected from 10 recognized farmer storages and temperature and relative humidity data were collected from 2 cold storages at Pabna and Faridpur during the data recording time (Table 1 and 2).

Data recording time

Assessment of the incidence of onion storage disease was observed during the period of April 2022 to October 2022.

Determination of weight loss (g)

Sample nets weighed before positioning in the storage and at the end of seven months of storage sample nets, collected from natural and ventilated storage, weighed for determining weight loss weight was taken every month.

Percent weight loss

Percent weight loss was calculated by the following formula: (Mahmud et al., 2015)

$$\text{Weight loss (\%)} = \frac{\text{(Initial weight of onion bulbs- Final weight of onion bulbs)}}{\text{Initial weight of stored onion bulbs}} \times 100$$

Assessment of disease incidence

The incidence of onion storage disease was assessed as a percentage of onion affected by visible or symptoms. Assessment of the incidence of onion was determined by the following formula: (Muntala *et al.,* 2020)

$$\text{Disease incidence (\%)} = \frac{\text{No. of infected onion}}{\text{Total no. of onion observed}} \times 100$$

Analysis of weather parameters

Generalized environmental variables were selected for their effect on the incidence of onion disease of the selected onion samples. Day by Day metrological data on temperature, relative humidity (RH) collected from BADC Cold storage and weather station located at Pabna and Faridpur and and farmers storage data collected from 4 district at Pabna, Faridpur, Manikganj and Bogra. The data were analyzed and calculated for monthly mean of minimum and maximum temperature, mean of minimum and maximum relative humidity in the study period at respective location.

Data analysis

The recorded data on various parameters under the present study were statistically analyzed using Microsoft Excel program. Selected onion samples were analyzed for correlation and regression to find out the effects of different climate factors, e.g., temperature, relative humidity.

RESULTS AND DISCUSSION

Experiment of this study identified the BARI Piaz-4 onion variety as exhibiting a lower disease incidence during storage compared to other studied varieties. Building on this finding, Experiment focused exclusively on BARI Piaz-4 onions to investigate the factors influencing their deterioration in storage conditions. This experiment monitored temperature and relative humidity (RH) within storage facilities throughout the storage period (April 2022 to October 2022) and analyzed their potential impact on BARI Piaz-4 onion spoilage.

This section discusses the collected temperature and RH data in the context of observed spoilage patterns in BARI Piaz-4 onions. The analysis aims to identify potential correlations between the storage environment and the rate of deterioration, providing valuable insights for optimizing storage practices specifically for the BARI Piaz-4 variety and minimizing post-harvest losses.

Weight loss (g) of different varieties of onion after seven months of storage

The result showcases (Table 3) the weight loss patterns of eight onion varieties (Tahirpuri, Tahirpuri King, Faridpuri, Zitka, Lal Tir King, Lal Tir Hybrid, BARI Piaz 1, and BARI Piaz 4.) over a seven-month storage period (April to October). All varieties exhibited a gradual decrease in weight throughout storage, with the most significant losses occurring in the initial months (April-May). This initial weight loss likely represented moisture evaporation and respiration processes occurring within the bulbs. Dabhi and Patel (2017)

observed a significant reduction in weight loss under forced ventilated storage compared to natural storage.

Table 1 List of onion farmer and their storage location

Sl. No.	Farmer's name	Address		Storage area (Sq.ft)	Amount of storage onion (m. ton)
		Upazila	District		
01.	Azizul Haque	Horirampur	Manikganj	360	8
02.	Badsha Mia	Horirampur	Manikganj	375	2.5
03.	Jahangir Molla	Horirampur	Manikganj	252	2.5
04.	Abdur Ranman	Atgharia	Pabna	225	3
05.	Md. Alim	Sathia	Pabna	400	10
06.	Sujoy Mahmud	Saltha	Faridpur	340	9
07.	Asraful Alam	Saltha	Faridpur	280	4
08.	Sree Asim Dutta	Shibganj	Bogra	192	2
09.	Md.Aminur Rahman	Shibganj	Bogra	200	2.5
10.	Abdul Mannan	Chandpur Sadar	Chandpur	225	2.5

Table 2 List of cold storage and their storage location

Sl. No.	Cold storage name	Address (District)	Storage area (Sq.ft)	Amount of storage onion (m. ton)
1	Pabna cold storage	Pabna	2000	200
2	Faridpur cold storage	Faridpur	2000	200

Table 3 Weight loss (g) according to onion variety after six months of storage

Month	**Name of variety**							
	Tahirpuri	**Tahirpuri King**	**Faridpuri**	**Zitka**	**LalTir King**	**LalTir Hybrid**	**BARI PIAZ 1**	**BARI PIAZ 4**
April (Start of storage)	1000	1000	1000	1000	1000	1000	1000	1000
May (weight lost in g)	160	180	155	155	170	180	100	100
June (additional weight lost in g)	50	70	50	50	55	65	50	30
July (additional weight lost in g)	25	35	25	20	30	45	20	10
August (additional weight lost in g)	15	22	10	08	20	30	10	05
September (additional weight lost in g)	08	11	5	05	10	15	09	05
October (additional weight lost in g)	05	05	04	03	05	08	05	00
Weight loss (g)	**263**	**323**	**249**	**241**	**290**	**343**	**194**	**150**
% of weight loss	**26.3**	**32.3**	**24.9**	**24.1**	**29.0**	**34.3**	**19.4**	**15.0**
Appox %	**26%**	**32%**	**25%**	**24%**	**29%**	**34%**	**19%**	**15%**

Table 4 Percent disease incidence according to the variety after six months of Storage

Onion varieties	**Initial no. of bulb**	**Infected onion bulb (no.)**	**Disease incidence (%)**			**SD**
			Minimum	Maximum	Mean	
Faridpuri	100	14	9.00	16.00	14.00	4.65
Tahirpuri	450	53	8.00	14.00	11.78	2.11
Zitka	100	14	10.00	16.00	14.00	3.44
Tahirpuri King	250	26	10.00	12.00	10.40	0.90
Lal Tir King	250	25	9.00	12.00	10.00	1.11
Lal Tir Hybrid	100	12	11.00	13.00	12.00	1.00
BARI Piaz 1	100	9	8.00	10.00	9.00	1.41
BARI Piaz 4	150	16	8.00	12.00	10.67	2.31

Varietal differences in weight loss

The data revealed variations in weight loss patterns between the varieties. BARI Piaz-4 displayed the lowest overall weight loss (150 g) after seven months of storage, followed by BARI Piaz-1 (194 g) and Zitka (241 g) (Table 3). This suggested that these varieties possessed superior storage qualities, potentially due to thicker skins or inherent resistance to moisture loss. Conversely, Lal Tir Hybrid exhibited the highest weight loss (343 g), followed by Tahirpuri King (323 g) and Lal Tir King (290 g).

Weight loss percentages

While the weight loss values (g) provided a clear picture, expressing weight loss as a percentage of the initial weight (15.0% - 34.3%) allowed for a clearer comparison between varieties (Table 3). This highlighted Lal Tir Hybrid as the most susceptible to weight loss (34.3%), while BARI Piaz-4 demonstrated exceptional storage potential with a minimal loss of only 15.0%. Ahsanuzzaman *et al.* (2017) also reported weight loss variations among onion varieties, with Zitka exhibiting the lowest loss and Pusa Red showing the highest.

Disease incidence

The data revealed a clear trend in disease incidence across the varieties after seven months of storage (Table 4). Each variety is listed along with the total number of onion bulbs tested, the number of infected bulbs, and the calculated disease incidence percentage. Faridpuri and Zitka exhibited the highest disease incidence rates, both recording 14.00%. Lal Tir Hybrid, Tahirpuri and Tahirpuri King followed closely, with disease incidence rates of 12.00%, 11.78% and 10.40%, respectively. Lal Tir King and BARI Piaz 4 showed similar disease incidence rates of 10.00% and 10.67%, respectively, while BARI Piaz 1 had the lowest incidence rate at 9.00%. Analyzing the trends, it is evident that Faridpuri, Zitka, and Lal Tir Hybrid displayed higher disease incidence rates compared to the others, suggesting potential susceptibility to storage-related diseases. Conversely, Tahirpuri, Tahirpuri King, Lal Tir King, BARI Piaz 1, and BARI Piaz 4 exhibited relatively lower disease incidence rates, indicating a higher resistance or tolerance to storage-related diseases.

Effect of temperature and RH on total disease incidence during the storage

Effect of temperature

Experiment investigated the influence of temperature on disease incidence and weight of infected bulbs in BARI Piaz-4 onions stored under typical farmer storage conditions. Temperature and relative humidity data were collected monthly throughout the storage period (April 2022 to October 2022), along with measurements of disease incidence and weight of infected bulbs (Table 5). A clear trend emerged, suggesting a potential relationship between storage temperature and relative humidity and the extent of disease development in BARI Piaz-4 onions. Here's a breakdown of the key observations.

Disease incidence and temperature

Overall disease incidence exhibited a decreasing trend as temperatures dropped throughout the storage period. The highest disease incidence (31.35%) was observed in April. Similar to Ara *et al.* (2008), disease was highest during warmer months (April) and coincided with the highest storage temperature (30.70°C) in our experiment. As temperatures steadily decreased until October (29.55°C), disease incidence followed suit, reaching a low of 7.63% in October.

Weight of infected bulbs and temperature

The weight of infected bulbs displayed a similar pattern to disease incidence. The highest weight of infected bulbs (68.33 g/kg) was recorded in April, again coinciding with the warmest temperature. As temperatures decreased, the weight of infected bulbs also decreased, reaching a minimum of 30.33 g/kg in October.

Effect of relative humidity

Disease incidence and relative humidity

Disease incidence generally exhibited increasing trend throughout the storage period, similar to the pattern observed with temperature. However, the decrease was not as linear in relation to RH compared to temperature. The highest disease incidence (31.35%) occurred in April with a relatively low RH (55%). However, disease incidence remained low even at higher RH levels in September (78%) and October (72%).

Weight of infected bulbs and relative humidity

Similar to disease incidence, the weight of infected bulbs displayed a general downward trend throughout storage. However, the correlation with RH appeared weaker compared to temperature. The highest weight of infected bulbs (68.33 g/kg) again coincided with the lowest RH (55%) in October. The weight of infected bulbs decreased as RH increased. The most significant decrease in weight of infected bulbs occurred in September and October, coinciding with the highest RH values.

The observed trend of decreasing disease incidence and weight of infected bulbs throughout the storage period may be due to several reasons. Firstly, regular cleaning of storage rooms by farmers likely reduced the build-up of pathogens and spores, minimizing the initial disease load. Secondly, the practice of monthly sorting and removal of diseased and deformed onions prevented the spread of infections, thereby lowering the overall disease incidence. Effective temperature management also played a crucial role, as lower

temperatures slow down the metabolic rate of onions and the growth rate of many pathogens, leading to reduced disease incidence. Additionally, the cumulative effect of these storage practices likely resulted in a decreased pathogen load over time, contributing to the observed decline in disease incidence and weight of infected bulbs.

Correlation matrix between disease incidence and storage factors

Relationship of temperature (^{o}C) with total disease incidence (%) during storage

Correlation study was done to establish the relationship between temperatures (^{o}C) with total disease incidence (%) during onion storage. From the study it was revealed that significant correlation was observed between the temperatures (^{o}C) with total disease incidence (%) during storage (Figure 1). It was evident from the Figure 2 that the regression equation y = -0.618x + 3.1819 gave a good fit to the data, and the co-efficient of determination (R^2 = 0.0159) showed that, fitted regression line had a significant regression co-efficient. From this regression analysis, it was evident that there was a positive relationship between temperatures (^{o}C) with total disease incidence (%) during storage, i.e., the disease incidence increased with the increase of temperature. Mahmud and Monjil (2015) who observed the lowest disease incidence in onions stored at cooler temperatures (6°C).

Relationship of relative humidity (%) with total disease incidence (%) during storage

Correlation study was done to establish the relationship between relative humidity (%) with total disease incidence (%) during onion storage. From the study it was revealed that significant correlation was observed between the relative humidity (%) with total disease incidence (%) during storage (Figure 2). It was evident from the Figure 2 that the regression equation y = -0.4314x + 52.977 gave a good fit to the data, and the co-efficient of determination (R^2 = 0.1993) showed that, fitted regression line had a significant regression co-efficient. From this regression analysis, it was evident that there was a negative relationship between relative humidity (%) with Total Disease incidence (%) during storage, i.e., the disease incidence increased with the decrease of relative humidity.

Table 5 Effect of temperature and relative humidity on total disease incidence and weight of infected bulbs

Month	Mean of monthly temperature (^{o}C)	Mean of monthly humidity (%)	Weight of infected bulbs (g)/(kg)	Total disease incidence (%)
April, 22	30.70	55	68.33	31.35
May, 22	30.50	72	60.66	29.57
June, 22	29.10	79	57.67	24.44
July, 22	25.75	79	51.33	21.82
August, 22	30.00	78	49.33	20.56
September, 22	30.25	78	34.67	14.17
October, 22	29.55	72	30.33	7.63

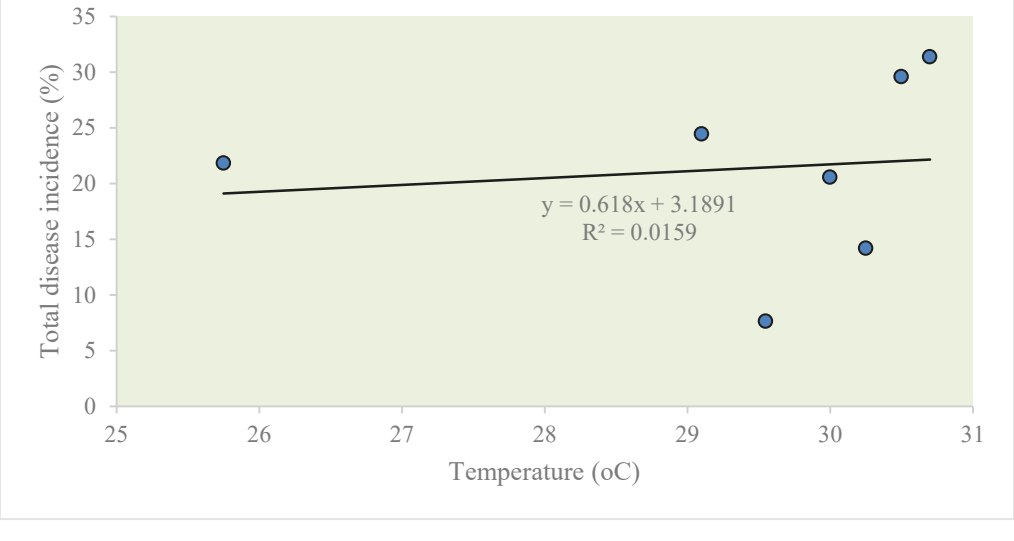

Figure 1 Relationship between temperature and disease incidence of onion during storage

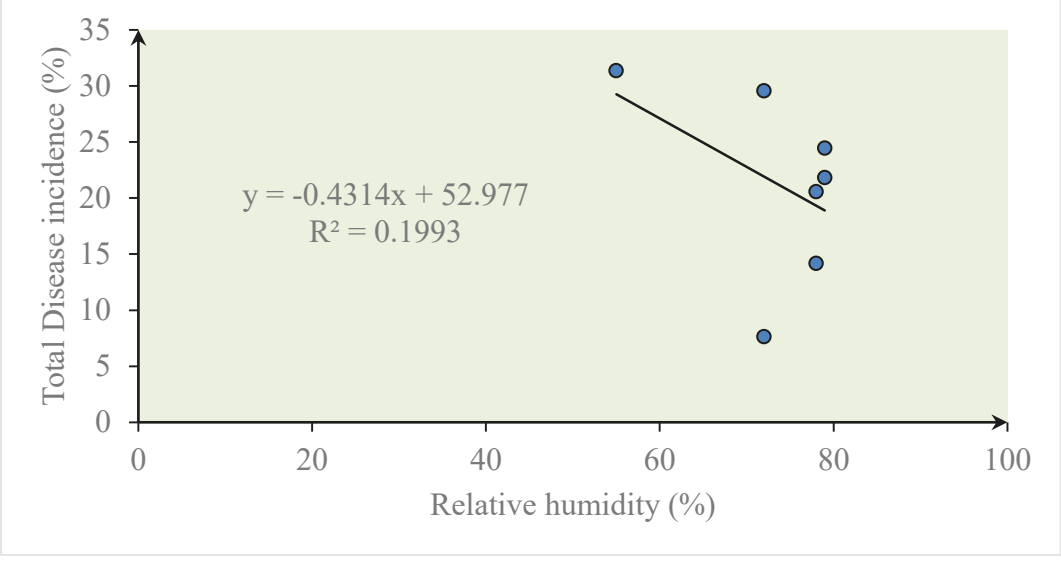

Figure 2 Relationship between relative humidity and disease incidence of onion during storage

CONCLUSION

These findings underscore the importance of selecting onion varieties with optimal storage qualities to mitigate weight loss and disease incidence, thereby maximizing post-harvest quality and marketability. Result delved into the impact of temperature and relative humidity (RH) on disease incidence and the weight of infected bulbs in BARI Piaz-4 onions stored under typical farmer conditions. A correlation analysis confirmed these observations. A positive correlation between temperature and disease incidence indicated that disease increased with higher storage temperatures. Conversely, a negative correlation between RH and disease incidence suggested disease decreased with higher relative humidity.

ACKNOWLEDGEMENT

The authors were thankful to all concerned Professors and staff of the Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka for their kind help, cooperation, and suggestions that assisted in conducting the experiment successfully.

REFERENCES

Ahsanuzzaman, M., Sarker, M. M., Hasan, R., Muqit, A. and Doullah, M. A. U. year Assessment of weight loss of onion in storage due to fungi. J. Sylhet Agril. Univ. 4(1):95-100.

Ara, A M, Doullah M. A. and Ashrafuzzaman, M. 2008. Isolation and identification of storage fungi from onion. Int. J. Sustain. Crop Prod. 9(3):41-46.

Ara A M, Khatun M L, Ashrafuzzaman M 2008. Fungi causing rots in onions at storage and market. J. Bangladesh Agril. Univ., 6(2): 245– 251.

BBS.2006. Bangladesh Bureau of Statistics, Ministry of Planning, Govt. of People's Republic of Bangladesh. Dhaka. p. 49.

Dabhi, M and Patel, N. 2017. Physical and Mechanical Properties of Talaja Red Onion Cultivar. Bioprocess Engineering.Vol. 1, No. 4, 2017, pp. 110-114.

Mahmud, M.S. and Monjil, M.S. 2015. Storage diseases of onion under variable conditions. Progressive Agriculture 26:45-50.

Meah, M. B. and Khan, A. A. 1987. Check list of fruit and vegetable diseases in Bangladesh. Department of Plant Pathology, BAU, Myrnensingh. p.: 23.

Muntala, A., Norshie, P. M., Santo, K. G. and Saba, C. K. S. 2020. *Colletotrichum gloeosporioides* species complex: Pathogen causing anthracnose, gummosis and die-back diseases of cashew (*Anacardium Occidentale* L.) in Ghana. European Journal of Agriculture and Food Sciences, 2(6), 1–10.

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

Overy, D.P., Frisvad, J.C., Steinmeier, U. and Thrane, U. 2005. Clarification of the agents causing blue mold storage rot upon various flower and vegetable bulbs: implications for mycotoxin contamination. Postharvest Biology and Technology., 35 (2):217-221.

Vohora, S. B., Rizman, M. and Khan, J. A. 1974. Medicinal uses of common Indian Vegetables. Plant Medica. 23(4): 381-393.