Original Research Article

Evaluation of Seed Health Status of Some Selected Podded and Root Vegetables in Bangladesh

Abstract

The seed health status of podded vegetable crops, such as yard long beans and country beans, and root vegetables, including bottle gourds, sweet gourds, and sponge gourds, was examined in 2015 at the Seed Health Laboratory (SHL) of Sher-e-Bangla Agricultural University. Loose seeds from each crop were collected from various wholesale seed markets in Dhaka. Two seed health assessment methods recommended by ISTA were employed: dry seed examination and the blotter method. The prevalence of seed-borne fungi varied significantly across different vegetable seeds, depending on the seed category and source. Six seed-borne fungi were identified in the examined seeds of three vegetable crop groups: *Rhizopus* spp., *Aspergillus niger*, *Aspergillus flavus*, *Fusarium* sp., *Chaetomium* sp., and *Alternaria* spp. All six fungi were detected in the seeds of podded vegetables, while five were found in the seeds of leafy vegetables. Using the blotter method, seeds from Alo Bij Vander exhibited the highest level of fungal infection, whereas seeds from Bismillah Seed Store showed the lowest level. Among the crops, radish seeds displayed the highest frequency of seed-borne fungi, while yard long beans had the lowest. Based on the findings, it was evident that the health condition of loose vegetable seeds was substandard. However, further research with more representative seed samples from various markets across Bangladesh is necessary to provide a comprehensive understanding of seed health in relation to different seed sources.

Keywords: *Seed health, podded vegetables, and root vegetables,* Bangladesh

1. Introduction

In Bangladesh, vegetables represent a promising and vital category of crops due to their quick production cycle, high nutritional value, and low production costs. Among agricultural inputs, seeds are the most critical factor influencing crop yield. Ensuring the

availability of healthy, high-quality seeds is therefore of paramount importance. Pathogen-free or healthy seeds are considered essential for optimal plant growth and maximum yield. The health of seeds can be affected by pathogens in several ways: through direct infection, contamination with pathogenic propagules on or within the seeds, or concurrent contamination [1]. Pathogenic propagules can hinder seed germination, leading to seedling infections and subsequent disease development in later plant stages. This makes the presence of pathogens in seed lots a significant concern. As a result, high-quality, disease-free seeds are deemed indispensable for successful crop production. Vegetable seeds, in particular, are prone to rapid degradation during storage and are highly susceptible to disease attacks. For a crop to be healthy, the seeds must meet critical quality criteria: they should be pure, viable, and in excellent condition. Studies suggest that under consistent production conditions, using high-quality seeds can increase vegetable yields by as much as 30% [2].

In Bangladesh, only about 10% of the seeds used for agricultural production are supplied by government or semi-government organizations. The remaining 90% of the nation's seed requirements are met by farmers' own seed stocks, which often fail to meet necessary quality and health standards. One of the most significant challenges to achieving sustainable agricultural production is the widespread use of unhealthy, low-quality seeds, coupled with the effects of seed-borne diseases [3]. It is estimated that in Bangladesh, 2–3% of the total seeds stored annually are lost to rot caused by bacteria and fungi, leading to an economic loss of approximately Taka 430 million [4]. Currently, over 100 different crops are cultivated in the country, and these are susceptible to more than 500 diseases. Many of these major diseases—affecting key crops such as rice, wheat, maize, jute, sugarcane, cotton, potato, tomato, okra, mustard, beans, peanuts, sesame, black gram, and chickpeas—are predominantly seed-borne and seed-transmitted. These diseases result in an annual yield loss valued at approximately $250 million USD [5]. To assess seed health, a variety of techniques are employed, including dry seed examination, blotter testing under incubation, agar plate testing, water agar plate testing, deep-freezing blotter testing, and symptom-based seedling testing. Additional methods include microscopic observation of suspensions (e.g., washing tests), whole

embryo count techniques, growing-on tests, indicator plant tests, and serological tests, among others. The present study aims to evaluate the quality and health status of loose podded and root vegetable seeds collected from the wholesale markets in Dhaka, Bangladesh. Specifically, the objectives are to identify the prevalence of seed-borne fungi associated with loose seeds of selected vegetables and to assess the overall seed health status of various vegetable crops.

2. Materials and Methods

2.1. Experiment site

Loose seeds of each crop were collected from various sources within the wholesale seed markets in Dhaka. The experiments were carried out at the Seed Health Laboratory of the Department of Plant Pathology, Sher-e-Bangla Agricultural University (SAU), located in Sher-e-Bangla Nagar, Dhaka-1207. The study was conducted over a period spanning from November 2014 to April 2015.

2.2. Collection of seeds

Loose seeds from two different categories of vegetables (podded and root) were collected from three shops located in Siddik Bazar, Dhaka. The seeds for each crop were sourced from Mithila Seed Enterprise, Alo Bij Vander, and Bismillah Seed Store.

2.3. Vegetable Categories

Seeds from two different categories of vegetables were analyzed to assess their health and quality. The categories included:

i) Podded vegetables**:** Country bean and yard long bean

ii) Root vegetable**:** Radish

2.4. Detection and identification of seed borne pathogens

Two seed health testing methods, namely **dry seed inspection** and the **blotter method**, were employed to detect seed-borne pathogens in the selected vegetable seeds.

2.4.1. Inspection of dry seeds

The seeds were visually inspected, and the sample was divided into three components: pure seed**,** seeds of other crops,i and inert matter**.** According to the International Rules for Seed Testing ~~(1999)~~, [xxx] inert matter includes soil, sand, stones, various types of plant debris, sclerotia, and smut or bunt balls of fungi. Although categorized as “inert” in

these rules, such materials often carry viable and infective fungal structures that are pathologically significant.

2.4. 2. Blotter method

A working sample of 400 seeds was subjected to the blotter test to detect seed-borne fungi, following the International Rules for Seed Testing [6]. In this method, sterilized plastic Petri dishes (9 cm in diameter) and Whatman No. 1 filter paper were used. The Petri dishes containing treated seeds were incubated in the laboratory at a temperature of 22°C for 7 days. During incubation, the seeds were exposed to an alternating cycle of 12 hours of near-ultraviolet (NUV) light and 12 hours of fluorescent daylight.

2.5. Design of experiments and Statistical Analysis

A Completely Randomized Design (CRD) was used for this experiment with four replications. Data were analyzed using the MSTAT-C computer package program. The level of significance and analysis of variance (ANOVA) were performed following the methods outlined by Gomez and Gomez [7], and treatment means were compared using Duncan's Multiple Range Test (DMRT).

3. Results and Discussion

3.1. Seed health status of podded vegetables

Fungi were detected in the podded vegetable seeds collected from various seed shops in Siddik Bazar, Dhaka, and the results are presented in tables, plates, and figures. The podded vegetables studied include country bean and yard long bean. The prevalence of seed-borne fungal infections varied depending on the vegetable seeds, with different levels of fungal presence observed in each type of seed.

3.1.1. Seed health study of Country bean (*Phaseolus vulgaris* L.)

3.1.1.1 Health status of Country bean seed by inspection of dry seed

Hollow and discoloration of seeds were observed in seeds collected from Mithila Seed Enterprise, while shriveling was noted in seeds from Alo Bij Vander. Reduced seed size was observed in seeds from Bismillah Seed Store (Table 1). Black dots were present on the seeds collected from Mithila Seed Enterprise and Alo Bij Vander, but fruiting structures were absent on the seeds collected from Bismillah Seed Store (Table 1).

For purity analysis, 40.0 grams of seeds from each sample were visually inspected. In the case of seeds from Mithila Seed Enterprise, out of 40.0 grams, 36.0 grams (90.0%) were pure seeds, while 4.0 grams (10.0%) were inert matter, and no other seeds were present (0%). From Bismillah Seed Store, the pure seeds accounted for 38.0 grams (95.0%), inert matter was 2.0 grams (5.0%), and no other seeds were detected (0%). Similarly, seeds collected from Alo Bij Vander contained 34.0 grams (95.0%) of pure seeds, 2.0 grams (5.0%) of inert matter, and no other seeds were present (Table 1).

Table 1. Health status of country bean seed by inspection of dry seed

Name of seed sources	Total weight (g)	Pure seeds (g)	Pure seeds (%)	Inert materials (g)	Inert materials (%)	Other seeds (g)	Other seeds (%)	Fruiting structures	Physical Abnormalities of seed
Mithila Seed Enterprise	40	36	90	4	10	0	0	Black dots	Hollow and discoloration of seeds
Alo Bij Vander	40	34	85	6	15	0	0	Black dots	Shrivelling of seeds
Bismillah Seed Store	40	38	95	2	5	0	0	-	Reduction of seeds

3.1.1.2. Prevalence of seed-borne fungi of country bean identified by blotter method

The incidence of *Alternaria* sp. ranged from 2.0% to 3.0%. The highest incidence (3.0%) was observed in seeds collected from Alo Bij Vander, which was similar to the incidence in seeds from Mithila Seed Enterprise. The lowest incidence (2.0%) was observed in seeds collected from Bismillah Seed Store (Table 2). The incidence of ~~Aspergillus niger~~ *Aspergillus niger* ranged from 6.0% to 7.0%. The highest incidence (7.0%) was observed in seeds collected from Bismillah Seed Store, which was similar to seeds collected from Mithila Seed Enterprise. The lowest incidence (6.0%) was found in seeds collected from Alo Bij Vander (Table 2). The incidence of ~~Aspergillus flavus~~ *Aspergillus flavus* ranged from 7.5% to 8.5%. The highest incidence (8.5%) was observed in seeds from Alo Bij Vander, which was identical to seeds from Mithila Seed Enterprise. The lowest incidence (7.5%) was observed in seeds from Bismillah Seed Store (Table 2). Among the sources,

no statistically significant differences were observed for seed-borne infections of *Chaetomium* sp., *Fusarium* sp., and *Rhizopus* spp.

Table 2. Prevalence of seed-borne fungi of country bean identified by blotter method.

Seed sources	Seed borne infection (%)							Total seed borne fungal infections (%)
	Rhizopus spp.	***Aspergillus niger***	***Aspergillus flavus***	***Fusarium sp.***	***Chaetomium spp.***	***Alternaria spp.***	***Unidentified bacterium***	
Mithila Seed Enterprise	2.5	6.5ab	8.0a	2.0	1.0	2.5a	2.0	24.5
Alo Bij Vander	2.5	6.0b	8.5a	2.0	1.0	3.0a	2.0	25.0
Bismillah Seed Store	2.5	7.0a	7.5b	2.0	1.0	2.0b	2.0	24.0
LSD 0.5	-	0.923		-	-	0.385	-	-
Level of significant	NS	*	*	NS	NS	*	NS	-
CV%	-	11.79	14.45	-	-	6.28		

*, **Significant at 5% and 1% level of significance respectively; NS = non- significant

3.1.2. Yard long bean (~~*Vigna ungulculata*~~ *Vigna unguiculata* L. (Walp.))

3.1.2.1 Health status of Yard long bean seed by inspection of dry seed method

Deformed seeds were observed in seeds collected from Mithila Seed Enterprise, while wounds were noted on seeds collected from both Alo Bij Vander and Bismillah Seed Store (Table 3). Black dots were present on seeds from Mithila Seed Enterprise, cottony structures were found on seeds from Alo Bij Vander, and no fruiting structures were observed on seeds from Bismillah Seed Store (Table 3). For purity analysis, 40.0 grams of seeds from each sample were visually inspected. In the case of seeds from Mithila Seed Enterprise, 37.0 grams (92.5%) were pure seeds, 2.7 grams (6.75%) were inert matter, and 0.3 grams (0.75%) were other seeds. For seeds from Bismillah Seed Store, the pure seeds accounted for 38.0 grams (95.0%), inert matter was 1.7 grams (4.25%), and 0.3 grams (0.75%) were other seeds. Similarly, seeds from Alo Bij Vander contained

36.0 grams (90.0%) of pure seeds, 3.7 grams (9.25%) of inert matter, and 0.3 grams (0.5%) of other seeds (Table 3).

Table 3. Health status of yard long bean seed by inspection of dry seed

Seed sources	Total weight (g)	Pure seeds (g)	Pure seeds (%)	Inert materials (g)	Inert materials (%)	Other seeds (g)	Other seeds (%)	Fruiting structures	Physical Abnormalities of seed
Mithila Seed Enterprise	40	37	92.5	2.7	6.75	0.3	0.75	Black dots	Deformed seed
Alo Bij Vander	40	36	90	3.7	9.25	0.3	0.75	Cottony structure	Wounded seed
Bismillah Seed Store	40	38	95	1.7	4.25	0.3	0.75	-	Wounded seed

3.1.2.2 Prevalence of seed-borne fungi of yard long bean identified by Blotter method

The incidence of Aspergillus flavus ranged from 8.0% to 9.0% (Table 4). The highest incidence (8.5%) was observed in seeds collected from Alo Bij Vander, which was similar to the incidence in seeds from Mithila Seed Enterprise. The lowest incidence (7.5%) was observed in seeds collected from Bismillah Seed Store. Among the samples, no statistically significant differences were observed for seed-borne infections of *Chaetomium* spp., *Fusarium* sp., *Rhizopus* spp., and *Aspergillus flavus.*

Table 4. Prevalence of seed-borne fungi of yard long bean identified by Blotter method.

Sources name	Seed borne infection (%)					Total seed borne fungal infections (%)
	Rhizopus spp.	*Aspergillus niger*	*Aspergillus flavus*	*Fusarium sp.*	*Chaetomium spp.*	
Mithila Seed Enterprise	3.0	4.0	8.5ab	3.5	4.0	23%
Alo Bij Vander	2.5	4.0	9.0a	3.5	4.0	23%
Mithila Seed Enterprise	3.5	4.0	8.0b	3.5	4.0	23%
LSD 0.5	0.923	-	0.753	-	-	
Level of significance	NS	NS	*	NS	NS	
CV%	19.20	-	5.55	-	-	

*, **Significant at 5% and 1% level of significance respectively; NS = non- significant

3.1.2.3. Total seed borne fungal infections (%) of podded vegetables of different seed sources

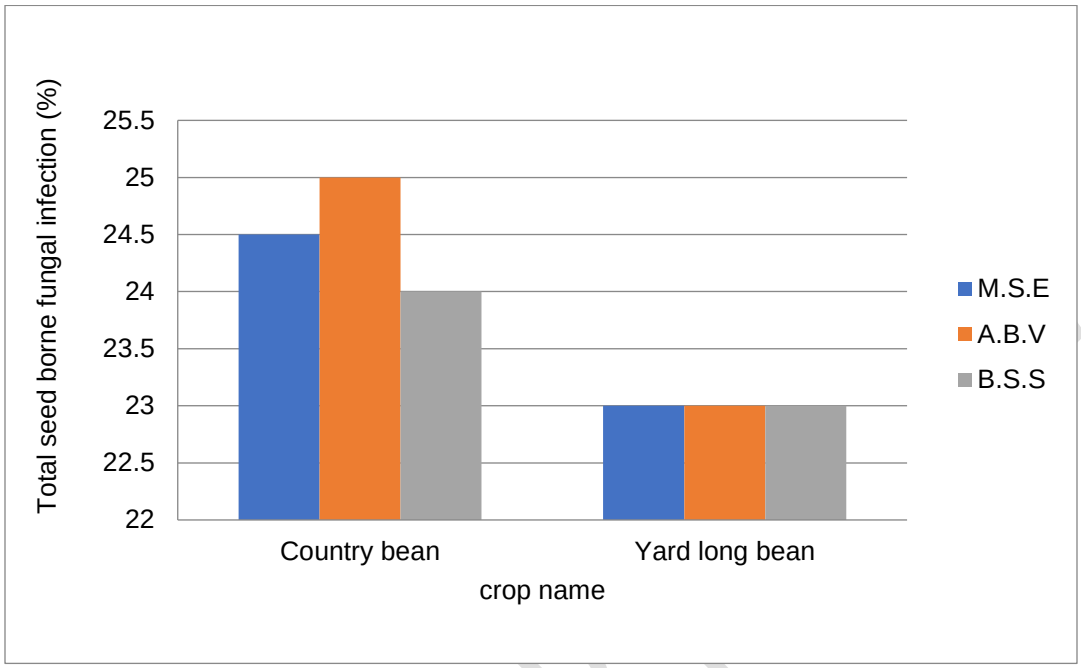

Figure 1. Total seed borne fungal infections (%) of podded vegetables of different seed sources

Here, M.S.E- Seed collected from Mithila Seed Enterprise, A.B.V- Seed collected from Alo Bij Vander, B.S.S- Seed collected from Bismillah Seed Store

The present study indicated that, in all cases, seeds from Alo Bij Vander exhibited the highest level of seed-borne fungal infection for country bean (25%). Bismillah Seed Store showed the lowest level of seed-borne fungal infection for both country bean and yard long beans. Seeds from Mithila Seed Enterprise exhibited a medium level of seed-borne fungal infection for country bean. For yard long beans, all seed sources showed similar results (Figure 1).

3.2. Seed health status of root vegetables

3.2.1. Radish (*Raphanus sativus* L.)

3.2.1.1. Health status of bottle gourd seed by inspection of dry seed

Wounded seeds were observed in seeds collected from Mithila Seed Enterprise, while both wounded and deformed seeds were found in seeds collected from Alo Bij Vander. Broken seeds were also observed in seeds collected from Bismillah Seed Store (Table

5). Bacterial ooze was noted in seeds collected from Mithila Seed Enterprise, cottony structures were found in seeds collected from Alo Bij Vander, and black dots were observed in seeds collected from Bismillah Seed Store (Table 5). For purity analysis, 40.0 grams of seeds from each sample were visually inspected. In the case of seeds from Mithila Seed Enterprise, 39.2 grams (98%) were pure seeds, 0.6 grams (1.5%) were inert matter, and 0.2 grams (0.5%) were other seeds. For seeds from Bismillah Seed Store, the pure seeds accounted for 39.4 grams (98.5%), inert matter was 0.4 grams (2.5%), and 0.2 grams (0.5%) were other seeds. Similarly, seeds from Alo Bij Vander contained 39.0 grams (97.5%) of pure seeds, 0.4 grams (1%) of inert matter, and 0.2 grams (0.5%) of other seeds (Table 5).

Table 5. Health status of radish seed by inspection of dry seed

Seed sources	Total weight (g)	Pure seeds (g)	Pure seeds (%)	Inert materials (g)	Inert materials (%)	Other seeds (g)	Other seeds (%)	Fruiting structures	Physical Abnormalities of seed
Mithila Seed Enterprise	40	39.2	98	0.6	1.5	0.2	0.5	Bacterial ooze	Wounded and shirked of seed
Alo Bij Vander	40	39.0	97.5	0.8	2	0.2	0.5	Cottony struck	Wounded and deformed of seeds
Bismillah Seed Store	40	39.4	98.5	0.4	1	0.2	0.5	Black dots	Broken seed

3.2.1.2 Prevalence of seed-borne fungi of radish identified by Blotter method

The incidence of ~~Aspergillus niger~~ *Aspergillus niger* ranged from 4.5% to 5.5% (Table 6). The highest incidence (5.5%) was observed in seeds collected from Alo Bij Vander, which was similar to the seeds collected from Mithila Seed Enterprise. The lowest incidence (4.5%) was observed in seeds collected from Bismillah Seed Store. The incidence of *Rhizopus* spp. ranged from 3.5% to 4.5% (Table 6). The highest incidence (4.5%) was observed in seeds collected from Alo Bij Vander, which was similar to the incidence in

seeds from Mithila Seed Enterprise. The lowest incidence (3.5%) was observed in seeds collected from Bismillah Seed Store. Among the samples, there was no significant difference observed for seed-borne infections of *Chaetomium* spp., *Fusarium* sp., and *Aspergillus flavus.*

Table 6. Prevalance of seed-borne fungi of radish identified by blotter method

Seed sources	Seed borne infection (%)					Total seed borne fungal infections (%)
	~~*Rhizopus spp.*~~ *Rhizopus* spp.	*Aspergillus niger*	*Aspergillus flavus*	*Fusarium sp.*	*Chaetomium sp.*	
Mithila Seed Enterprise	4.0ab	5.0ab	9.5	4.5	5.0	28.00
Alo Bij Vander	4.5a	5.5a	9.5	4.5	5.0	29.00
Bismillah Seed Store	3.5b	4.5b	9.5	4.5	5.0	27.00
LSD 0.05	0.923	0.653	-	-	-	
Level of Significance	**	*	NS	NS	NS	
CV%	14.43	8.16	-	-	-	

*, **Significant at 5% and 1% level of significance respectively; NS = non- significant

Researchers worldwide have observed similar types of pathogen infestations in seeds. For example, studies on the major seed-borne fungi associated with common bean (*Phaseolus vulgaris* L.) seeds were conducted in several bean-growing regions of Ethiopia by [8]. The primary seed-borne fungi identified were *Ascochyta phaseolorum*, *Phaeoisariopsis griseola*, and *Colletotrichum lindemuthianum*. Contaminated seeds were identified as the main source of bean anthracnose infection in the field, as the disease only survived in infected seeds and not in the soil. Furthermore, Alves et al. [9] isolated *Colletotrichum gossypii* var. *cephalosporioides*, *Colletotrichum truncatum*, and *Colletotrichum lindemuthianum* from common bean seeds (*Phaseolus vulgaris* L.) using the water restriction technique. The blotter test results also revealed the presence of *Fusarium* spp.~~*spp*~~., *C. gossypii* var. *cephalosporioides*, *C. truncatum*, and *C. lindemuthianum* on the surface of inoculated seeds. In the current investigation, similar

seed-borne fungal infections were observed in podded vegetable seeds, including cabbage, Indian cabbage, spinach, Indian spinach, and red amaranth. Seeds from different seed shops in Mymensingh tested positive for various fungal species such as *Alternaria spp.*, *Curvularia spp.*, *Fusarium spp.*, *Aspergillus niger*, *Phoma spp.*, *Penicillium spp.*, and *Rhizopus spp.* (Khanom, 2011).

Conclusion

Six different types of seed-borne fungi were identified from the seeds of three vegetable crops: *Rhizopus spp.*, *Aspergillus niger*, *Aspergillus flavus, Fusarium sp.*, *Chaetomium sp.*, and *Alternaria spp.* Of these, six fungi were found in the seeds of pod vegetables, while only five were detected in the seeds of root vegetables, specifically radish. According to the results of the blotter test, the seeds collected from Alo Bij Vander exhibited the highest frequency of seed-borne fungal infections, while those from Bismillah Seed Store had the lowest. Radish seeds showed the highest frequency of seed-borne fungi, whereas yard long beans had the lowest. Further studies with a broader range of seed samples from various markets in Dhaka are needed to fully understand the impact of different seed sources on seed health.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

The author(s) hereby declare that no generative AI technologies, including but not limited to Large Language Models, were used during the writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

References

1. Martín I, Gálvez L, Guasch L, Palmero D. Fungal pathogens and seed storage in the dry state. Plants (Basel). 2022;11(22):3167. https://doi.org/10.3390/plants11223167
2. Khanom D. Assessment of health and quality of some vegetable seeds of Mymensingh. M.Sc. Thesis, Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh; 2011. 28 p.
3. Rashid BAQM, Fakir GA. Seed pathology laboratory research report on the survey of Bipolaris leaf blight epidemic in Bangladesh. Seed Pathology Center, Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh-2202; 2000.
4. Fakir GA, Khan AL, Neergaard P, Mathur SB. Transmission of *Drechslera* spp. through wheat seed in Bangladesh. Bangladesh J Agric. 1977;1:113–118.
5. Rashid BAQM, Fakir GA. Seed pathology laboratory research report on the survey of Bipolaris leaf blight epidemic in Bangladesh. Seed Pathology Center, Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh-2202; 2000.
6. ISTA (2001) (International Rules for Seed Testing Association) International Rules for Seed Testing. Rules Amendments. Seed Science and Technology, 29, 1-127.
7. Gomez KA, Gomez AA. Statistical procedures for agricultural research. 2nd ed. International Research Institute, Manila, Philippines; 1983. 139–207 p.
8. Yesuf M, Sangchote S. Survival and transmission of *Colletotrichum lindemuthianum* from naturally infected common bean seeds to the seedlings. Tropical Science. 2007;47(2):96–103.
9. Alves MdeC, Rozza EA. Scanning electron microscopy applied to seed borne fungi examination. Microscopy Res Tech. 2009;72(7):482–488.