

Study on Quality of Okra (*Abelmoschus esculentus* L.) Seed Collected from Different Sources and Locations of Bangladesh

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Abstract: A study was conducted at Sher-e-Bangla Agricultural University, Dhaka during September 2009 to March 2010 to determine the quality and health status of okra seed collected from different sources and locations of Bangladesh. Different sources were government organization, namely BARI, Gazipur and BADC, Dhaka, eight seed companies and ten farmers of different districts. Seed collection and quality analysis exposed that moisture content of seed samples ranged from 8.37-14.95% and 9.97-13.71% in terms of source and group of seed collection. Germination percentage of government organization seeds, seed companies' seeds and farmers saved seeds was 86.52, 82.71 and 53.74%, respectively. Purity percentage varied from 87.86 to 99.70% in different sources. Purity percentage of government organization seeds, seed company's seeds and farmers saved seeds were 94.57%, 99.41% and 92.45%, respectively. In government organization seeds, both vigor index (2273.0) and 1000-seed weight (59.59g) were found higher than the Seed companies and farmers saved seeds. In seed health study, seven fungi, namely *Fusarium* spp., *Colletotrichum dematium*, *Aspergillus flavus*, *A. niger*, *Rhizopus stolonifer*, *Bipolaris* spp., and *Curvularia* spp. were found in the seed samples. The highest mean incidence of fungi in okra seeds was recorded from farmer seeds (16.31%) followed by seed companies (13.33%) and the lowest from government organizations (11.81%).

Keywords: Okra, Germination, Purity, Seed Health Status, *Fusarium* spp., *Aspergillus flavus*

1. Introduction

Okra [*Abelmoschus esculentus* (L.)] is a member of the family malvaceae and native of South Africa and Asia. It is an annual summer vegetable crop grown in tropical and subtropical parts of the world. Although okra is primarily a rainfed crop, it also comes up well under irrigated conditions during kharif and summer seasons. In Bangladesh, the total vegetable production (summer and winter) is 30,68,000 metric tons with an average yield of 3,378 kg/acre under the total vegetable cultivation area of 9,08,000 acres while

26,000 acres was used for okra cultivation with an average yield of 1,680 kg/acre and the total production is 43,000 metric tons during 2010-2011 growing season [1]. The yield of okra though is not quite high compared to other okra growing countries.

Quality seed is the basis of successful crop production. It is a most vital input for crop production [2]. By using quality seed, production can be increased up to 25-50% [3]. In Bangladesh, the estimated annual requirement of okra seed

for 7,595 ha land and 1, 78, 28,000 homesteads (assuming 20g seed per homestead) is about 300 tons [4, 5]. Bangladesh Agricultural Development Corporation (BADC) and private seed companies produce about 25% of the okra seed. Another 25% is seed is imported. The rest 50% seed is used from farmer's seed every year. The farmer's seeds are in most cases, of inferior quality and use of poor quality seeds is responsible for low yield in Bangladesh [6]. Hence, for increasing the production of okra and for reducing the import of seeds, more attention is to be given to increase the production of quality okra seed in Bangladesh.

Since seed is a living entity, it is subjected to various environmental stresses which affect the quality. In storage, the viability and vigour of the seeds not only vary from genera to genera and variety to variety, but it is also regulated by many physico-chemical factors like moisture content, atmospheric relative humidity, temperature, initial seed quality, physical and chemical composition of seed, gaseous exchange, storage structure, packaging materials etc.[7]. The major factors affecting the seed quality during storage are temperature and relative humidity, which results in drastic deterioration of seed. Apart from this, fungi associated with stored seeds are mainly responsible for deterioration of quality and reduction in germination potential [8]. Available information on the stated subject under Bangladesh conditions is inadequate. Therefore, the present study was conducted to determine the quality and health status of okra seed collected from different sources (government organization, seed companies and farmers) and locations of Bangladesh.

2. Materials and Methods

2.1. Experiment Set-up

The experiment was conducted at the Seed Pathology Laboratory, Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka during September 2009 to March 2010.

2.2. Seed Sample

Sixty samples of okra seeds were collected. Among them 2 samples from government organization (BARI, BADC), 8 samples from private seed companies (code names are SC-1, SC-2, SC-3, SC-4, SC-5, SC-6, SC-7 and SC-8) and 50 samples were collected from farmer of most okra growing 10 districts (Chittagong, Noakhali, Dhaka, Tangail, Jessore, Khulna, Kushtia, Dinajpur, Rajshahi and Rangpur) of Bangladesh. 5 samples were collected from different farmer of each district and were mixed thoroughly to make a composite farmers seed sample of a district. Quality attributes and health status of the seed samples were determined taking sub-samples from each of the samples according to ISTA [9] rules.

2.3. Treatment and Layout

The experiment was laid out in completely randomized

design (CRD) and was replicated four times. Moisture content, purity, 1000-seed weight, germination, shoot length, root length, seedling vigor index, grading and health status (seed-borne fungi) were determined.

Working samples 140 g were drawn from each seed samples of okra seed. They were sorted out as pure seed, other seed and inert matter and the results were expressed as Percentage.

Moisture content of seeds was measured following high constant temperature oven method [9]. Two independent working samples of seeds were drawn from each sub-samples and ground in a grinder. Five grams of ground seeds of each working samples were dried in an oven at 130-133°C for one hour. Percentage of moisture content was calculated using following formula:

$$\% \text{ Moisture content} = (M_2 - M_3) / (M_2 - M_1) \times 100$$

Where,

M_1 = weight in grams of container and its cover,

M_2 = weight in grams of the container, its cover and ground seed before drying,

M_3 = weight in grams of the container, cover and ground seed after drying.

Four hundred pure seeds were randomly selected from each sample which was sown in plastic pot filled with moist sand in the laboratory under adequate light and moisture condition. The sand was sterilized through sunburn before using in germination test. The seeds were soaked 12 hours in water for quick germination before sowing. First, second and last counting were made after 4, 8 and 12 days, respectively. Only the normal seedlings were included in the computation of germination percentage. Percentage of germination was determined by using the following formula:

$$\% \text{ Germination} = (\text{Number of normal seedlings} / \text{Number of seeds sown}) \times 100$$

To determine 1000-seed weight sub-samples were drawn from each seed samples. A total 3000 pure seeds, free from other seeds and inert matter, were sorted out. They were divided into 3 working samples. Weights of 1000 seeds were measured and an average weight of 3 working samples were computed and recorded as 1000-seed weight [10].

After 14 days of setting germination test, 10 seedlings were randomly selected for seedling vigor index test. Altogether 40 seedlings were selected from each sub-sample. Shoot length (cm) and root length (cm) of the seedlings were recorded and mean values of the two parameters were computed. Vigor index was computed following a standard formula as suggested by Abdul-Baki and Anderson [11],

Where,

$$\text{Vigor index} = [\text{Mean shoot length (cm)} + \text{Mean root length (cm)}] \times \text{Germination (\%)}.$$

To detect the seed borne pathogens associated with the seeds in seed samples the Blotter method was used by following international rules for seed testing [12]. In this

method four hundred seed of each sample was used for this purpose. Three layers of well-moistened blotter (filter paper) were placed at the bottom of the plastic Petri dish. In each plate 10 seeds were placed depending on seed size. The plated seeds were incubated at $25 \pm 1^{\circ}$ C under 12 hr. cycles of alternate Near Ultra Violet light and darkness. Observation on the presence of fungi was made after 7 days of incubation.

Seeds from each district were categorized in four grades based on their physical conditions observed under a hand lens. A total of 400 seeds were taken randomly from each of the selected samples. The grades were as follows:

Grade-I: Apparently healthy seeds,

Grade-II: Discolored seeds,

Grade-III: Spotted seeds,

Grade-IV: Shriveled and broken seeds.

The recorded data were statistically analyzed following the analysis of variance for the Completely Randomized Design (CRD). Comparison among means was done using the Duncan's multiple range Test (DMRT) to determine the level of significance among treatment means [13].

3. Result

3.1. Moisture Content

Moisture content of seed samples showed significant difference among the group, sources and location of seed sample (Table 1). Among the seed companies the lowest moisture content (8.37%) was found in the seed of SC-7 company followed by SC-6 (8.73%) and the highest (11.73%) was in SC-1. In government organizations, the lowest (11.57%) moisture content was in BADC seed and highest (12.40%) in BARI seed. Among the farmer's seeds the lowest moisture seed content (13.22%) in Kushtia district followed by Rajshahi district (13.38%) and the highest moisture content (14.95%) was found from the seed of farmers of Rangpur (Table 1). Among the groups it ranged from 9.97 to 13.71%. The lowest moisture content (9.97%) was found in the seeds collected from seed companies, which was followed by government organizations (11.90%) and the highest (13.71%) was in farmers seeds (Table 2).

3.2. Purity

The percentage of seed purity varied significantly among different groups, sources and locations. Among the government organization BADC seeds contained more pure seeds (97.20%) than that of BARI seed (96.28%). In Seed Company, the highest pure seed (99.70%) was found in SC-7 company followed by SC-5 company (99.50%) and the lowest was in BARC Seed Company (90.23%). Among the farmer's seed, the highest pure seed was found in Jessore (94.55%) district followed by Kushtia (93.38%) district and the lowest was in Rangpur and Dinajpur (92.16%) district (Table 1). In case of group, it was ranged from 99.41% to 92.45%. The highest pure seeds (99.41%) were found from seed companies followed by government organizations (94.57%) and then farmer's seeds (92.45%) (Table 2).

3.3. 1000-Seed Weight

Among the samples there was a significant difference in respect of 1000-seed weight (Table 1). The seeds of BARI had higher 1000-seed weight (60.19 g) than those of BADC (59.46 g). The maximum 1000-seed weight (61.42 g) was found in seeds of SC-5 company and minimum (48.38 g) in seeds of SC-4 company. There was mark able difference in 1000-seed among the farmer's seed. The maximum 1000-seed weight (55.95 g) was found from the farmers of Rajshahi district followed by Kushtia (54.90 g) district and the lowest (47.94 g) was from the farmers of Noakhali district (Table 1). Similar trend was found in the seeds of different groups. It was ranged from 59.59 g to 51.38 g (Table 2). The maximum 1000-seed weight was found in the samples collected from government organization (59.59 g), which was followed by seed company farmer (58.03 g) (Table 2).

3.4. Germination

The germination percentage of all okra seed samples varied with groups, sources and locations (Table 1). Among the government organization, the highest germination percentage (92.39%) was found in seeds of BADC and the lowest (91.41%) in the seeds of BARI seed. The seeds of SC-5 company were highest in germination percentage (86.27%), which was followed by seeds of SC-3 seed company (85.66%) and the seeds of SC-4 company was lowest (74.65%). Among the farmers, the highest germination (78.76%) was found from the farmers seeds of Chittagong district and the lowest seed germination (29.87%) was found from the farmers seeds of Tangail district (Table 1). Among different group, the highest germination percentage (86.52%) was found in seed samples from government organization, which was followed by Seed Company (82.71%) and farmers seed (53.73%) (Table 2).

3.5. Seedling Vigor Index

Similar trend as found in germination rate was found in seedling vigor index for different sources of seed sample (Table 1). The maximum seedling vigor index (2472) was found from the seeds of BADC and the lowest (2380) from the seeds of BARI of government organization. Among the seed companies, maximum seedling vigor index (2251) was found from the seeds of SC-5 company followed by SC-3 company (2237) and the lowest (1734) was from seeds of SC-4 company. Farmers of Chittagong district produced seeds of the highest seedling vigor index (1958), while the farmers of Noakhali district produced seeds of the lowest seedling vigor (905.6) index and the farmers of Jessore district produced seeds of the second highest seedling vigor index (1808). Significant difference was also found among the groups. It was varied from 2273 to 1269. Government organization produced significantly highest seedling vigor index (2273) followed by Seed company (2043) and Farmer produced the lowest (1269) seedling vigor index seed (Table 2).

Table 1. Quality attributes of okra seeds collected from different group and source of Bangladesh.

Group	Source	Moisture (%)	Purity (%)	1000-seed wt. (g)	Germination (%)	Seedling vigor index
Government organization	BARI, Gazipur	12.40 gh	96.28 abcd	60.19 b	91.42 b	2380 ab
	BADC, Dhaka	11.57 j	97.20 abc	59.46 c	92.39 a	2472 a
Seed companies	SC-1	11.73 ij	90.23 ef	59.13 cd	75.73 h	1968ef
	SC-2	11.63 ij	98.89 ab	58.74 de	78.66 g	2050 cde
	SC-3	9.50 l	99.67 a	60.35 b	85.66 d	2237 bcd
	SC-4	9.17 lm	99.53 a	48.38 kl	74.65 i	1734 g
	SC-5	10.23k	99.50 a	61.42 a	86.27 c	2251 bc
	SC-6	8.73 mn	99.20 ab	59.39 c	85.43 d	2047 cde
	SC-7	8.37 n	99.70 a	59.55 c	84.24 e	2027 de
	SC-8	12.13 hi	99.40 a	58.39 e	84.07 e	1953 ef
Farmers	Farmer, Chittagong	13.49 cde	92.83 cde	52.22 i	78.76 g	1958 ef
	Farmer, Noakhali	14.16 b	87.86 f	47.94 l	40.58 m	905.6 ij
	Farmer, Dhaka	12.74 fg	93.29 cde	50.64 j	57.05 j	1321h
	Farmer, Tangail	13.87 bcd	92.76 cde	53.19 h	29.87 n	735.0 j
	Farmer, Jessore	13.68 bcde	94.55bcde	48.29 kl	81.60 f	1808 fg
	Farmer, Khulna	14.01 bc	92.18 def	51.76 i	40.53 m	1007 i
	Farmer, Kushtia	13.22 ef	93.38 cde	54.90 g	54.57 k	1371h
	Farmer, Dinajpur	13.58 cde	92.16 def	50.14 j	54.28 k	1246h
	Farmer, Rajshahi	13.38 de	93.30 cde	55.95 f	54.87 k	1414h
	Farmer, Rangpur	14.95 a	92.16 def	48.76 k	45.25 l	922.8ij
LSD	**	**	**	**	**	
CV (%)	1.97	2.02	1.60	3.39	3.66	

In a column, the figures having similar letter(s) do not differ significantly at 0.05 level

**= Significant at 0.01 level; *= Significant at 0.05 level; NS= Non significant

Table 2. Average quality of okra seed collected from different Groups.

Group	Moisture (%)	Purity (%)	1000-seed wt. (g)	Germination (%)	Seedling vigor index
Government organization	11.90b	94.57b	59.59a	86.52 a	2273 a
Seed companies	9.97c	99.41a	58.03b	82.71b	2043 a
Farmers	13.71a	92.45c	51.38c	53.74c	1269b
LSD	**	**	**	**	**
CV (%)	1.32	2.57	3.41	2.12	2.19

In a column, the figures having similar letter(s) do not differ significantly at 0.05 level

**= Significant at 0.01 level; *= Significant at 0.05 level; NS= Non significant

3.6. Grading

There were four grades of seeds collected from different sources and groups (Table 3). The grades were Grade-I (apparently healthy seeds), Grade-II (discolored seeds), Grade-III (spotted seeds) and Grade-IV (shriveled and broken seeds). Percentage of different graded seeds was significantly varied in samples of different sources and groups. The highest percentage of grade-I seed (96.20%) was found in BADC, while the lowest percentage (83.97%) was in farmers of Tangail district and the second highest percentage of grade-I seed (96.13%) was noticed in the seeds of BARI and SC-5. Maximum percentage of grade-II seed (6.19%) was found in farmer's seed of Tangail followed by farmers of Khulna district (5.88%), SC-1 (5.60%) of Seed Company and the lowest from BADC (1.75%) of government organizations. In case of grade-III the highest percentage (4.61%) was found in farmers seed from the district of Tangail, followed by farmers of Khulna district

(4.27%), SC-6 (3.70%) and lowest (1.10%) from BARI and BADC of government organizations. Farmers of Tangail district produced maximum percentage (5.13%) of grade-IV seed and lowest percentage (0.77%) was from BARI and second lowest (0.85%) from BADC and SC-7 (Table 3).

In case of group, there were highest mean percentages of grade-I seed (91.69%), followed by grade-II (3.51%), grade-IV (2.44%) and the lowest percentage of grade-III (2.32%) was found in the seed samples (Table 4). In government organizations, there was maximum percentage of grade-I seed (93.91%), which was followed by grade-II (3.11%), grade-III (1.53%) and lowest grade-IV (1.40%). In seed companies, the highest percentage of seed was grade-I (91.98%), followed by grade-II (3.30%), grade-III (2.49%) and then grade-IV (2.23%). The highest percentage of seed was found grade-I (89.19%) followed by grade-II (4.12%), grade-IV (3.68%) and the lowest was found grade-III (2.93%) in the farmers seed.

Table 3. Percentage of different grades of okra seeds collected from different groups and sources of Bangladesh.

Group	Source	Grade-I (%)	Grade-II (%)	Grade-III (%)	Grade-IV (%)
Government organization	BARI, Gazipur	96.13a	2.00 ij	1.10 k	0.77 i
	BADC, Dhaka	96.20a	1.75j	1.10 k	0.85 i
	BARC, Dhaka	89.41g	5.60 abc	2.40 fgh	2.59 efg
	SC-2	88.80g	4.80 cde	3.20 bc	3.20 cde
	SC-3	92.00 de	3.00 gh	2.50 efg	2.50 fgh
Seed companies	SC-4	90.00fg	5.11 bcd	2.00 ghij	2.89 def
	SC-5	96.13a	0.870 k	2.00 ghij	1.00i
	SC-6	89.66 g	3.40 fg	3.70 b	3.24 cd
	SC-7	93.85bc	3.20 gh	2.10 ghi	0.85i
	SC-8	93.45 bcd	2.70 ghi	1.90 hij	1.95h
	Farmer, Chittagong	93.99b	2.41 hij	1.50jk	2.09 gh
	Farmer, Noakhali	86.39 h	4.45 de	3.67 b	4.75 a
	Farmer, Dhaka	89.43 g	4.14 ef	2.69 cdef	3.74 bc
Farmers	Farmer, Tangail	83.97i	6.19 a	4.61 a	5.13 a
	Farmer, Jessore	92.20 cde	2.64 ghi	1.75ij	3.41 bcd
	Farmer, Khulna	85.90 h	5.88 ab	4.27 a	3.97 b
	Farmer, Kushtia	91.53 ef	3.37 fg	2.17 fghi	2.93 def
	Farmer, Dinajpur	88.95 g	4.57de	2.97 cde	3.51 bcd
	Farmer, Rajshahi	90.47 efg	3.12 gh	2.65 def	3.76bc
	Farmer, Rangpur	89.08g	4.45 de	3.04 cd	3.48 bcd
LSD	**	**	**	**	
CV (%)	2.81	3.64	4.08	2.06	

In a column, the figures having similar letter(s) do not differ significantly at 0.05 level. Grade-I: Apparently healthy seeds, Grade-II: Discolored seeds, Grade-III: Spotted seeds, Grade-IV: Shriveled and broken seeds, **= Significant at 0.01 level, *= Significant at 0.05 level, NS= Non significant

Table 4. Quality attributes of okra seed of different Groups.

Group	Grade-I (%)	Grade-II (%)	Grade-III (%)	Grade-IV (%)
Government organization	93.91 a	3.12 b	1.53 c	1.40c
Seed companies	91.98b	3.30 b	2.49b	2.23b
Farmers	89.19c	4.12 a	2.93 a	3.68 a
Mean	91.69	3.51	2.32	2.44
LSD	**	**	**	**
CV (%)	2.21	3.06	1.58	2.04

In a column, the figures having similar letter(s) do not differ significantly at 0.05 level. Grade-I: Apparently healthy seeds, Grade-II: Discolored seeds, Grade-III: Spotted seeds, Grade-IV: Shriveled and broken seeds, **= Significant at 0.01 level, *= Significant at 0.05 level, NS= Non significant

3.7. Seed Health Status (Seed-Borne Fungi) of Collected Okra Seeds

Altogether seven fungal species belong to six genera were found to be associated with the seed samples. The identified fungal species were *Fusarium* spp., *Aspergillus flavus*, *A. niger*, *Colletotrichum dematium*, *Rhizopus stolonifer*, *Bipolaris* spp., and *Curvularia* spp. The percentage of total seed-borne infection of various fungi in different location ranged from 8.88 to 22.77%. Among the farmers seed maximum fungi incidence was found from the farmers of Rangpur district (22.77%), which was followed by farmers of Tangail district (17.66%), farmers of Dhaka district (16.05%), farmers of Noakhali district, Dinajpur district (15.81%) and the lowest was from farmers of Khulna district (12.72%). In case of seed company the highest fungi incidence was recorded from SC-8 (15.96%) followed by BRAC (15.78%), SC-2 seed (15.36%) and the lowest from

SC-6 (9.23%). BARI seed had more fungi incidences (11.85%) than BADC seed (8.88%) (Table 5). Marked variation was observed in the prevalence of fungi among the government organization, seed companies and farmers saved seeds. Among seven fungi, *Fusarium* spp., *Aspergillus flavus* and *Aspergillus niger* was most prevalent in all government organization, seed companies and farmers saved seeds. The highest infection of *Fusarium* spp., (5.01%) and *Aspergillus niger* (2.03%) was found in farmers saved seeds, whereas the highest infection of *Aspergillus flavus* (3.69%) was observed in seed companies (Table 6).

Occurrence of the seven fungi varied independently each other with respect to the location of seed collection. The incidence of *Fusarium* spp. had a very high range of 3.24-5.01%, where *Aspergillus flavus* had 2.46-3.69% and *Aspergillus niger* had 0.94-2.03%, respectively.

Table 5. Percentage of different seed born fungi on okra seeds collected from different sources of Bangladesh.

Group	Source	Location	<i>Fusarium spp.</i> (%)	<i>Colletotrichum dematium</i> (%)	<i>Aspergillus flavus</i> (%)	<i>Aspergillus niger</i> (%)	<i>Rhizopus stolonifera</i> (%)	<i>Bipolaris spp.</i> (%)	<i>Carvularis spp.</i> (%)	Total (%)	
Government organization	BARI	Gazipur	3.84h	0.71 n	4.24 c	0.94ij	0.71k	0.71l	0.71j	11.85	
	BADC	Dhaka	2.24 o	0.71 n	2.73 g	1.07hi	0.71k	0.71l	0.71j	8.88	
Seed companies	SC-1	Dhaka	5.60 a	1.72i	4.11 d	0.78 j	1.32gh	0.71l	1.54ef	15.78	
	SC-2	Dhaka	2.83 l	1.04 m	4.75b	1.06 hi	2.08c	0.71l	2.89a	15.36	
	SC-3	Dhaka	3.51i	1.52jk	2.15j	1.49 fg	0.71k	2.2c	1.63e	13.21	
	SC-4	Dhaka	3.02k	0.71 n	3.06f	1.86e	1.28ghi	0.71l	0.71j	11.35	
	SC-5	Dhaka	3.30j	1.40k	2.49h	1.13 h	0.71k	0.71l	1.34g	11.08	
	SC-6	Dhaka	2.72 m	0.71n	2.05k	1.62f	0.71k	0.71l	0.71j	9.23	
	SC-7	Dhaka	2.57 n	0.71n	0.71q	3.08ab	0.71k	2.88a	2.67b	13.33	
	SC-8	Dhaka	4.36 g	3.40b	0.71q	1.91 e	0.71k	2.65b	2.22c	15.96	
Farmers	Farmer	Chittagong	4.67 f	2.74 e	1.33 mn	2.23 d	1.16i	1.58h	1.12h	14.83	
	Farmer	Noakhali	5.42 b	3.08 c	1.29no	0.51 k	2.21b	1.85f	1.45f	15.81	
	Farmer	Dhaka	4.98 d	3.38b	2.23i	2.16 d	1.41fg	1.00k	0.89i	16.05	
	Farmer	Tangail	5.21 c	2.93 d	2.27i	1.17 h	2.89 a	2.07d	1.12h	17.66	
	Farmer	Jessore	4.88 de	2.14 g	1.26o	1.55 fg	1.21 hi	1.45i	1.95d	9.56	
	Farmer	Khulna	4.91 d	1.57j	1.60l	1.42 g	1.33 gh	0.98k	0.91 i	12.72	
	Farmer	Kushtia	4.96 d	1.90h	1.08 p	2.46 c	1.51 ef	1.94e	2.14c	15.99	
	Farmer	Dinajpur	5.34 b	2.56 f	3.41 e	0.91 ij	1.55 e	1.14j	0.91i	15.82	
	Farmer	Rajshahi	4.79 e	1.22 l	1.39 m	3.20 a	1.02 j	1.78g	1.33g	14.73	
	Farmer	Rangpur	4.88 de	4.11 a	5.76a	2.92b	1.73 d	2.27c	1.10h	22.77	
	LSD			**	**	**	**	**	**	**	
	CV (%)			1.11%	3.18%	1.67%	4.78%	3.22%	2.83%	3.33%	

In a column, the figures having similar letter(s) do not differ significantly at 0.05 level. Grade-I: Apparently healthy seeds, Grade-II: Discolored seeds, Grade-III: Spotted seeds, Grade-IV: Shriveled and broken seeds, **= Significant at 0.01 level, *= Significant at 0.05 level, NS= Non significant

Table 6. Percentage of different seed born fungi on okra seeds collected from different groups.

Group	<i>Fusarium spp.</i> (%)	<i>Colletotrichum dematium</i> (%)	<i>Aspergillus flavus</i> (%)	<i>Aspergillus niger</i> (%)	<i>Rhizopus stolonifera</i> (%)	<i>Bipolaris spp.</i> (%)	<i>Carvularis spp.</i> (%)	Total (%)
Government organization	4.12b	0.91c	3.69 a	0.94c	0.64b	0.71c	0.79c	11.81
Seed companies	3.24c	1.46b	2.52b	1.84b	0.84b	1.63a	1.79a	13.33
Farmers	5.01 a	2.60a	2.46 b	2.03a	1.53a	1.51b	1.16b	16.31
LSD	**	**	**	**	**	**	**	
CV (%)	1.08	3.32	1.44	3.11	4	2.41	2.35	

In a column, the figures having similar letter(s) do not differ significantly at 0.05 level. Grade-I: Apparently healthy seeds, Grade-II: Discolored seeds, Grade-III: Spotted seeds, Grade-IV: Shriveled and broken seeds, **= Significant at 0.01 level, *= Significant at 0.05 level, NS= Non significant

4. Discussion

Farmers used ordinary containers which contain thousand of small pores due to its nature of preparation that results in absorption of moisture. Razzaque [14] and Rahman *et al.* [15] reported that the seeds absorbed moisture when they were stored in ordinary containers. Threshing floor may be considered as the main source of seed contamination. The use of kacha (non cemented) floor during seed processing at farmers level resulted in higher accumulation of inert matter in the farmer's seeds. Due to proper plant nutrition at the time of crop production 100 seed weight may be varied among the seed samples. Abduhu [16] reported that 1000-seed weight varied among the locations, sources and variety and it ranged from 44 to 70g. Due to proper production technology and seed storage seed germination percentage may be poor, Seedling vigour index was different among the sources may be due to different germination percentage of the samples from different sources. Gurumitsingh and Harisingh [17] reported that germination percentage differed significantly among the locations, source and variety of 39 samples of okra seed that ranged from 46 to 87%. Sarkar *et al.* [18] reported similar results on quality of okra seed

collected from different sources and groups. Lower grade seeds were found high percentage in the farmers seeds may be due to lack of careful attention to seed crop management and processing of seeds after harvesting specially during cleaning operations.

The presence of these fungi in the seed samples depicted that in no way the health status of okra seed samples was satisfactory. This fungus might create alarming disease outbreaks in the fields resulting in low quality seed production. These fungi were also reported to be seed-borne in okra by Fakir [19], Gupta *et al.* [20] and Fernandes *et al.* [21]. Findings of the investigation suggested that percentage of fungal infection varied in seeds with places of collection and this variation might be due to the variation in climatic and environmental condition at different locations.

5. Conclusion

From the above mentioned findings of the present study, it may be concluded that the highest percentage of quality okra seeds (on the basis of moisture content, purity, 1000-seed weight, germination, seedling vigor index and grading) were found from the seeds of government organizations than seed

companies and the lowest percentage were found from of farmers seeds In seed health study, seven fungi, namely *Fusarium* spp., *Colletotrichum dematium*, *Aspergillus flavus*, *A. niger*, *Rhizopus stolonifer*, *Bipolaris* spp., and *Curvularia* spp. were found in the seed samples. The highest mean incidence of fungi in okra seeds was recorded from farmer seeds followed by seed companies and the lowest was recorded from the seeds of government organizations.

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