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Prevalence of Associated Seed Borne Fungi of Jute and Allied Fiber Crops

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Abstract

Seed-borne fungi represent a significant biotic limitation in contemporary agricultural research, posing a substantial danger to seedling establishment globally. Four distinct methodologies to investigate the dissemination rate of seed-borne fungus in jute and associated fiber crops were used. The nine varieties of fiber crops were V_1 = Jute cvl-1, V_2 = BJRI deshi jute-5 (0-795), V_3 = BJRI deshi jute-6 (0-3820), V_4 = BJRI deshi jute-7 (BJC-2142), V_5 = BJRI deshi jute-8 (BJC-2197), V_6 = Kenaf (HC-2), V_7 = Kenaf (HC-95), V_8 = BJRI Kenaf-4, and V_9 = Mesta (HS-24). The experiment was conducted from June 2018 to January 2019 at the laboratory and net house of the Plant Pathology Department at Sher-e-Bangla Agricultural University, Dhaka, under a Completely Randomized Design with three replications. The blotter technique detected five fungal species across nine distinct varieties, while V_5 exhibited the maximum proportion of seed-borne fungus (7.00), according to this study. *Botryodiplodia theobromae*, *Fusarium* spp., *Aspergillus* spp., *Colletotrichum corchori* and *Curvularia lunata* comprise the genera. The water agar technique demonstrated that V_4 contained the most linked seed-borne fungus (5.67), with specific varieties containing five fungal species. *C. corchori*, *C. lunata*, *Fusarium* spp., *Aspergillus* spp., and *M. phaseolina* were the organisms that were identified. The V_2, V_3 and V_4 cultivars had the highest incidence of seed-borne fungus (2.00), with four fungal species identified by the test tube approach. The organisms identified were *C. corchori*, *Fusarium* spp., *Aspergillus* spp., and *M. phaseolina*. Among all approaches, V_5 had the greatest post-emergence mortality, followed by variety V_9, while variety V_7 displayed the least mortality. Four fungal genera were identified: *Aspergillus* species, *Fusarium* spp., *B. theobromae* and *C. corchori*. Variety V_7 had the lowest across all meth-

ods, whereas variety V_5 had the highest post-emergence mortality, followed by variety V_9. In contrast to other varieties, V_5 shown greater efficacy against seed-borne fungi associated with jute and allied fibers.

Keywords

Detection and Identification, Incubation Methods, *Colletotrichum corchori*, *Botryodiplodia theobromae, Macrophomina phaseolina*, *Curvularia lunata*

1. Introduction

After cotton, jute is the second-most important natural fiber crop. It comes from the genus *Corchorus* in the family Tiliaceae and is grown in two species: *Corchorus capsularis* L. and *C. olitorius* L. Bangladesh (80%) primarily cultivates these species in the fertile Ganges Delta to manufacture everyday items [1]. India, China, and Bangladesh are the three major producers of jute fibers [2]. Jute is the main cash crop of Bangladesh which possesses second position as a single producer and exporter among jute exporting countries and earns foreign exchange by exporting jute and jute goods. Mesta (*Hibiscus sabdariffa*) produces bast fiber and is used as a substitute for jute. It is also attracting the attention of food and beverage manufacturers and pharmaceutical companies, which believe it has exploitable potential as a natural food product and as a colouring agent to replace some synthetic dyes [3]. Bangladesh has a severe scarcity of quality of jute seeds [4]. The climatic conditions of Bangladesh are amenable to the production of high-quality jute. In Bangladesh, about 737,770 hectares of land were under jute cultivation, and 82, 46,797 bales of jute were produced with a yield rate of 11.178 bales/ha [5]. On the one hand, Mesta produces 1.9 t/ha [6], whereas Kenaf produces 0.08 to 0.09 million t/ha [7]. The BADC produces and distributes only 10% - 15% of the 5500 - 6000 tonnes of jute and kenaf seeds that Bangladesh requires annually [8]. BADC is the only public sector in the country that produces and distributes jute and very few kenaf seeds to the growers. BADC supplied only 12% - 15% of the total jute and allied fiber seeds [9].

Like all other plants, fiber crops face adverse threats from their environment and other biological organisms. Pathogens that are spread by seeds often infect the capsules or pods of growing jute plants in the field, making the plants produce infected or unhealthy seeds [10] [11]. The fungi that cause these diseases are *Macrophomina phaseolina*, *Botryodiplodia theobromae*, *Colletotrichum corchori* and *Rhizoctonia solani*. These diseases are stem rot, black band, anthracnose, foot rot, and wilt. The diseases are often spread through jute seeds and affect standing crops, resulting in a loss of yield [12]-[14] and a decline in fiber quality [15]. *Colletotrichum corchori* is a seed-borne fungus and is found only in *C. capsularis*. Other seed-borne fungal pathogens are *Fusarium oxysporum*, *Fusarium semitec-*

tum, *Fusarium moniliforme*, *Curvularia lunata*, and *Corynespora cassiicola* on jute seeds. These fungi cause seed rot and infection to young seedlings [16]. Besides, *Aspergillus* and *Penicillium* reduce the germination percentage, which is frequently associated with stored jute seeds. Another study by Ali *et al.* (2015) [10] examined how three types of fungi—*M. phaseolina*, *B. theobromae* and *C. corchori* infect jute through seeds. They found that more seed-borne infections led to more disease development in the field. There were several techniques which was used on the researcher to detect seed-borne fungi of jute. Mesta demonstrates greater adaptability to unfavorable soil and climatic conditions; however, it is susceptible to several diseases, notably foot and stem rot caused by *Phytophthora parasitica*, Sclerotinia stem rot (*Sclerotinia sclerotiorum*), leaf blight (*Phyllosticta hibiscicola*), and yellow vein mosaic. Kenaf is vulnerable to several diseases, including fungus, bacteria, nematodes, and viruses. *Rhizoctonia solani*, *Sclerotium rolfsii*, *Phytophthora parasitica* and *Ralstonia solanacearum* were pathogens previously identified in studies of kenaf disease [17].

The study's goals to find the seed-borne fungi that are associated with jute and related fiber crop seeds using different variety under lab techniques and to determine the rate of transmission of seed borne fungi from seed to seedling.

2. Materials and Methods

2.1. Experimental Site and Period

The experiment was carried out at the seed pathology laboratory and the net house of the Plant Pathology Department, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, from June 2018 to January 2019.

2.2. Sources of Seed Sample

Nine common seed samples (100 g of each) from the Bangladesh Jute Research Institute (BJRI) in Manik Mia Avenue, Dhaka-1207. They were V_1 = Jute cvl-1, V_2 = BJRI deshi jute-5 (0-795), V_3 = BJRI deshi jute-6 (0-3820), V_4 = BJRI deshi jute-7 (BJC-2142), V_5 = BJRI deshi jute-8 (BJC-2197), V_6 = Kenaf (HC-2), V_7 = Kenaf (HC-95), V_8 = BJRI Kenaf-4 and V_9 = Mesta (HS-24).

The selections were made considering their extensive cultivation and significance to the economy. The observed varieties demonstrated vulnerability to the fungal disease, presenting notable disease symptoms in field conditions. The study encompassed various varieties to identify the most resistant or highest-performing option.

2.3. Preparation of Seed Sample

The collected seed samples were kept in a plastic container labeled properly and preserved in the refrigerator at 50˚C till the samples were used for conducting respective research. Working seed samples were extracted from the preserved seed samples, as required. The entire procedure was maintained under the Rules of

ISTA [18]. Seventy-five seeds were randomly selected 75 seeds from the seed sample, which included three replications. The seeds were germinated on top of three layers of Whatman No. 1 filter paper. The filter papers were soaked in water and placed at the bottom of a 9-cm-diameter plastic petri dish; thereafter, 25 seeds were placed on top of the paper. Evaporation of water was minimized by tightly fitting the lids of the petri dishes. The Petri dishes were placed inside the incubator and maintained the temperature at 30˚C for five days. Seeds that produced both plumules and radicals after incubation as germinating seeds. Express the result as a percentage.

2.4. Detection on Seed-Borne Fungi

Various methods (Figure 1) for seed health analysis was used to detect seed-borne fungi in seed samples. The fungal pathogen growth was examined on the incubated seeds under the stereo microscope and identified it by its distinctive characteristics. Recorded the disease incidence and calculated it as a percentage. In case of complexity during identification, temporary slides were prepared to identify the fungi species level according to [19]-[22].

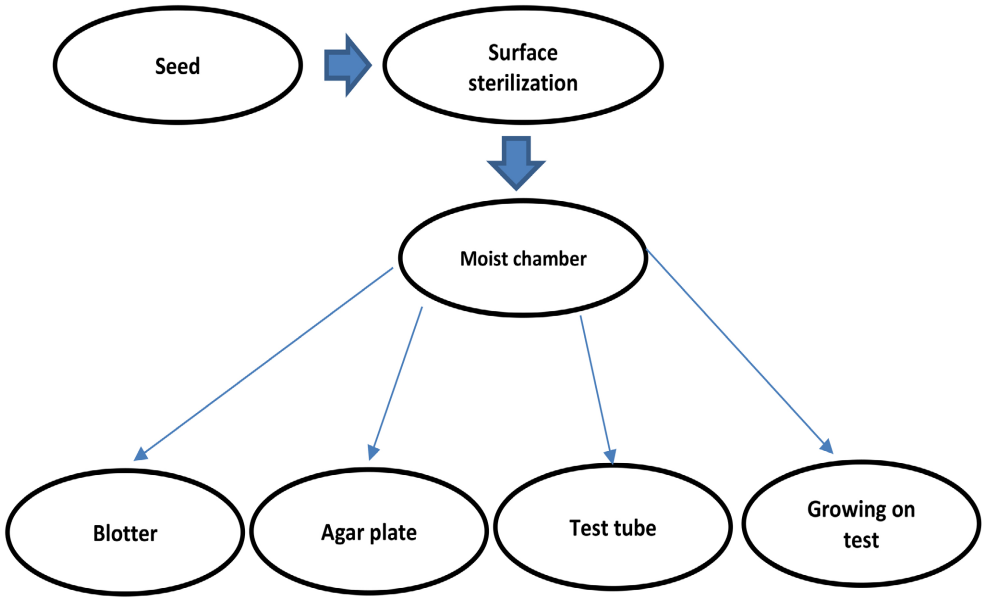


Figure 1. Schematic diagram of methodology of isolation techniques.

2.4.1. Blotter Method

The blotter method is a simple and inexpensive way to detect seed-borne fungi that respond by sporulation [23]. In this method, 75 seeds were picked at random from each sample and put on three layers of Whatman No. 1 filter paper that had been soaked in water in plastic petri dishes. The seeds were then kept at 20˚C ± 2˚C and exposed to light for 12 hours at a time. After 7 days of incubation, petri plates containing incubated seeds were observed under a stereo-binocular microscope at 20× magnification. The germination percentage of each fungal colony on

germinated seeds was recorded by using the identification key, with the assistance of a literature review and expert consultation. The results were expressed as a percentage (**Plate 1(a)**).

2.4.2. Agar Plate Method

Greater numbers of fungal colonies can be formed by Agar plate method [24]. The agar media most commonly used for incubation tests are the non-selective potato dextrose agar and malt extract agar [24]-[26]. In this method, 50 seeds were randomly taken from each sample, dipped in 3% Clorox for 1 minute, washed 3 times, and placed in glass petri dishes containing water agar media in an air laminar flow chamber. After the medium had hardened, 25 seeds of each variety were spread out evenly on two water agar plates. The plates were then kept at 20˚C ± 2˚C and exposed to light for 12 hours at a time. After being incubated for 7 days, the seeds were looked at through a stereo microscope to find pathogens carried by the seeds on the surfaces of jute and related fiber seeds. A temporary slide was prepared and examined under the compound microscope when it was difficult to identify the pathogen under the stereo microscope with the help of literature review and expert consultation. The number of germinated seeds was recorded, along with the seed-borne fungi after seven days of incubation. The results were expressed in percentage terms (**Plate 1(b)**).

2.4.3. Test Tube Method

In this method, at first, agar media was prepared and then placed in a test tube at 1/3 of this test tube's diameter in a laminar airflow chamber. One seed from each type of jute and allied fiber crop was placed in a test tube three times. The seeds were then incubated at 20˚C ± 2˚C for 12 hours with a cycle of near ultraviolet (NUV) light and darkness. After being incubated for 7 days, test tubes with seeds in them were looked at through a stereomicroscope to look for pathogens carried by the seeds on the surface of the jute seeds. In case of difficulty identifying under the stereomicroscope, a temporary slide was prepared and examined under the compound microscope. Then, the identification procedure was done with the help of a literature review and expert consultation. The number of germinated seeds was recorded, along with the seed-borne fungi, after seven days of incubation. The results were expressed in percentage terms (**Plate 1(c)**).

2.4.4. Growing on Test Method

It was tested in the net house of the Plant Pathology Department to see how fungi affect germination, the number of seedling diseases or infections, and the ability to find rotting seeds that won't sprout. The test was conducted by placing sterilized sand in plastic trays and covering them with a polythene sheet for 24 hours. The polythene sheet was removed after 24 hours and left it open for seven days to allow the formaldehyde gas to evaporate. Three trays was used for each seed sample of the deshi jute, kenaf, and mesta varieties, filling them with sterilized sand and moistening them with water. 30 seeds were extracted from each seed sample,

then sowed 10 seeds in a line in each tray for three replications. Data on germination, normal seedlings, abnormal seedlings, and diseased seedlings were recorded after 14 days of sowing following the International Rules for Seed Testing [27] with some modifications. The modification involved separating the diseased seedlings from the abnormal seedlings and counting them separately. The results were expressed in percentages (Plate 1(d)).

(a) Moist chamber (b) Ager media (c) Test tube method (d) Growing test method

Plate 1. Different methods for the isolation of seed-borne fungi and detection of seedling mortality of jute and allied fiber crops.

2.5. Seedling Incidence (%)

To estimate the percent seedling incidence using the following formula [28]:

$$\text{Seedling incidence} = \frac{\text{Number of diseased seedling}}{\text{Number of total seedlings observed}} \times 100$$

2.6. Management of Associated Seed-Borne Fungi

After observing the seed health results in different methods among fiber crops, three susceptible varieties from each fiber crop were selected for the management of seed-borne disease in the pot. Two treatments, namely *Trichoderma* sp., Autostin, with two controls (without sterilized soil and soil sterilization) at their recommended dose 2 - 3 g per kg seed for autostin and commercial bio-derma powder 5 g/10 g seed was used for *Trichoderma* sp. against the seed-borne fungal pathogens were tested. The requisite amount of each treatment and seeds from each sample was taken in a 250 ml Erlenmeyer flask and was shaken mechanically for 10 minutes for proper coating of the treatments. The Standard Blotter [19] was used to compare the treated and untreated seeds 24 hours later to see how well the seed treated ingredients worked.

2.7. Statistical Analysis

The obtained data were subjected to statistical analyses by MSTATC software, and mean comparisons were done using Duncan's Multiple Range Test (DMRT). The data were modified when necessary. The least significant differences (LSD) at the 5% level of probability were used to separate the means within the parameters [29].

3. Results

3.1. Fungi Detection by Blotter Paper Method

Significant variation was found in seed germination, seed infection, seedling infection, and post-emergence mortality depending on seed tiers, different varieties of jute, and the source of collection. V_7 (kenaf HC-95) recorded the highest percentage of seed germination (97.67%), which was identical to the V_6, V_8 and V_3 varieties (Table 1). On the other hand, variety V_9 (Mesta HS-24) recorded the lowest percentage of seed germination (81.33%). Seed infection varied significantly, while V_5 (BJRI deshi jute-8) scored the highest percentage of seed infection (46.67%) and the lowest (3.33%) was recorded in V_7 (Kenaf (HC-95)) and V_8 (BJRI Kenaf-4).

The result revealed that no seedling infection (0%) was found in fiber crop varieties V_1 (Jute cvl-1), V_3 (BJRI deshi jute-6), V_7 (Kenaf (HC-95)), and V_8 (BJRI Kenaf-4), respectively. Conversely, fiber crop variety V_5 (BJRI deshi jute-8) exhibited the highest percentage of seedling infection (36.67%). Variety V_1 (Jute cvl-1) did better; at 5, 7, and 9 DAS, no post-emergence mortality of seedlings was seen. However, variety V_5 (BJRI deshi jute-8) had the highest percentage of post-emergence mortality among seedlings (10.00%, 16.67%, and 36.67%, respectively).

Table 1. Varietal performance of jute and allied fiber crops on percent germination, seed infection, seedling infection, post emergence mortality in blotter paper method.

Varieties	Germination (%)	Seed infection (%)	Seedling infection (%)	Post emergence mortality (%)		
				5 DAS	7 DAS	9 DAS
V_1	93.00b	10.00d	0.00c	0.00c	0.00e	0.00
V_2	92.00bc	6.67e	3.33b	3.33b	3.33d	3.33d
V_3	96.67a	10.00d	0.00c	0.00c	0.00e	0.00e
V_4	81.33e	6.67e	6.67b	0.00c	6.67b	10.67c
V_5	91.00c	46.67a	36.67a	10.00a	16.67a	36.67a
V_6	96.67a	20.00c	6.67b	3.33b	6.67c	10.00b
V_7	97.67a	3.33f	0.00c	3.33b	0.00e	3.33d
V_8	96.67a	3.33f	0.00c	0.00c	3.33d	3.33d
V_9	87.33d	33.33b	3.33b	0.00c	3.33d	6.67c
CV (%)	3.48	12.53	15.43	13.23	21.43	21.33
LS	**	**	*	*	*	**

Column having common letter(s) do not different from each other as adjusted by DMRT. LS = Level of significance; CV = Coefficient of variation, *= Significant at 5% level of Probability; **= Significant at 1% level of Probability. V_1 = Jute cvl-1, V_2 = BJRI deshi jute-5, V_3 = BJRI deshi jute-6, V_4 = BJRI deshi jute-7, V_5 = BJRI deshi jute-8, V_6 = Kenaf (HC-2), V_7 = Kenaf (HC-95), V_8 = BJRI Kenaf-4 and V_9 = Mesta (HS-24).

Prevalence of Seed-Borne Fungi

Altogether, five fungi genera (*Colletotrichum corchori*, *Fusarium* spp., *Aspergillus* spp., *Botryodiplodia theobromae* and *Macrophomina phaseolina*) were identified in nine fiber crop varieties (Table 2). Of these, *Colletotrichum corchori* was the most predominant fungus recorded in V_4 (BJRI deshi jute-7), followed by V_5 (BJRI deshi jute-8), V_6 (Kenaf (HC-2)), and V_9 (Mesta (HS-24)), respectively (Plate 2). Fiber crop variety cvl-1 was found to be the most protective against fungal pathogens, and BJRI Deshi Jute-8 was found to be the most susceptible, followed by Mesta (HS-24).

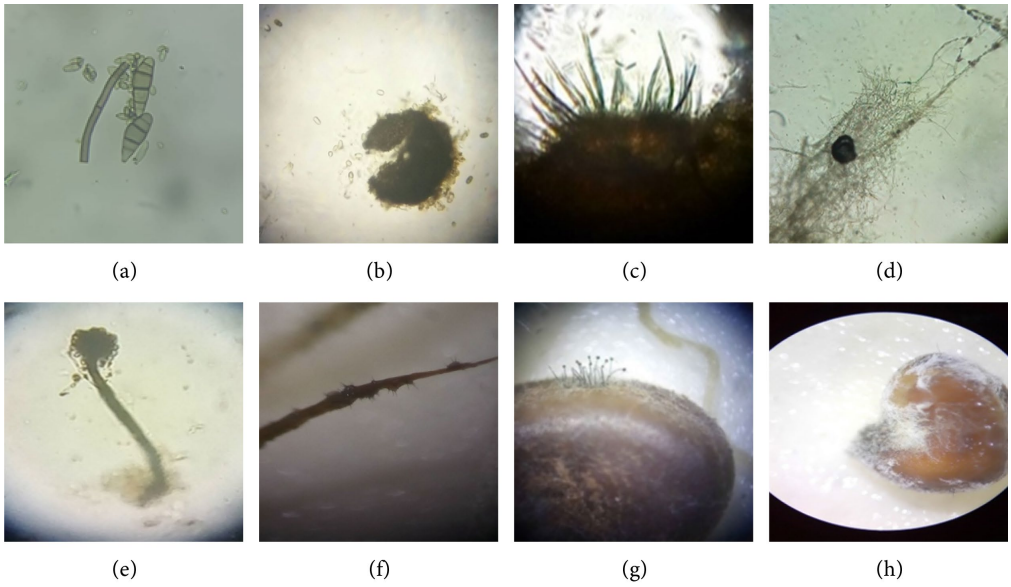


Plate 2. Compound microscopic view of (a) *Carvularia lunata*; (b) *Macrophoomina phaseolina*; (c) Seta of *Colletotrichum corchori*; (d) *Colletotrichum corchori*; (e) *Aspergillus niger* and (f) *Botryodiplodia theobromae* and Stereo microscopic view of (g) Aspergillus niger on seed; (h) *Fusarium* spp. on seed.

Table 2. Varietal performance of jute and allied fiber crops on prevalence of seed-borne fungi in blotter paper method.

Varieties	Total fungi (no.)	Mean (%)				
		Colletotrichum corchori	*Botryodiplodia theobromae*	*Macrophomina phaseolina*	*Fusarium* spp.	*Aspergillus* spp.
V_1	0.33f	0.00f	0.00b	33.33a	0.00f	0.00f
V_2	3.00d	33.33b	11.11a	0.00c	22.22d	33.33c
V_3	1.67e	16.67e	0.00b	0.00c	0.00f	83.33a
V_4	4.67c	71.67a	0.00b	13.33b	8.33e	6.67e
V_5	7.00a	28.57c	0.00b	0.00c	38.10b	33.33c
V_6	0.67f	33.33b	0.00b	0.00c	33.33c	0.00f
V_7	1.67e	0.00f	0.00b	16.67b	33.33c	50.00b
V_8	0.67f	33.33b	0.00b	0.00c	0.00f	33.33c

Continued

V_9	5.67b	23.33d	0.00b	0.00c	53.33a	23.33d
LS	**	**	*	*	**	**
CV (%)	3.48	22.53	22.43	13.33	13.43	21.29

Column having common letter(s) do not different from each other as adjusted by DMRT. LS = Level of significance; CV = Coefficient of variation, *= Significant at 5% level of Probability; **= Significant at 1% level of Probability. V_1 = Jute cvl-1, V_2 = BJRI deshi jute-5, V_3 = BJRI deshi jute-6, V_4 = BJRI deshi jute-7, V_5 = BJRI deshi jute-8, V_6 = Kenaf (HC-2), V_7 = Kenaf (HC-95), V_8 = BJRI Kenaf-4 and V_9 = Mesta (HS-24).

3.2. Fungi Detection by Agar Plate Method

Table 3 shows that the germination of seeds, seed infection, seedling infection, and post-emergence mortality were all very different depending on the type of jute used and where it was collected. The highest percentage of seed germination (92.00%) was recorded in fiber crop variety V_7 (kenaf (HC-95)), followed by V_3, whereas the lowest (77.00%) was recorded in V_6 (kenaf HC-2). V_5 (BJRI deshi jute-8) showed the highest percentage of seed infection (33.33%), followed by V_2 and V_6, while the lowest (6.67%) was recorded in the fiber crop variety V_7 (kenaf HC-95). Zero (0.00%) seedling infections were recorded in fiber crop variety V_7 (kenaf (HC-95)) and V_8 (BJRI Kenaf-4) and the highest seedling infection (16.67%) was recorded in fiber crop variety V_2 (BJRI deshi jute-5) accompanied by V_9.

Table 3. Varietal performance of jute and allied fiber crops on percent germination, seed infection, seedling infection, post post-emergence mortality in agar plate method.

Varieties	Germination (%)	Seed infection (%)	Seedling infection (%)	Post emergence mortality (%)		
				5 DAS	7 DAS	9 DAS
V_1	86.33b	16.67c	0.00e	6.67b	6.67c	6.67d
V_2	87.00b	30.00a	16.67a	3.33c	6.67c	10.00c
V_3	90.33a	6.67d	10.00bc	3.33c	6.67c	10.00c
V_4	80.33c	26.67ab	3.33de	0.00d	6.67c	6.67d
V_5	86.33b	33.33a	10.00bc	10.00a	16.67a	16.67a
V_6	77.00d	30.00a	6.67cd	0.00d	6.67c	10.00c
V_7	92.00a	6.67d	0.00e	0.00d	0.00d	3.33e
V_8	85.67b	20.00bc	0.00e	0.00d	6.67c	6.67d
V_9	86.67b	16.67c	13.33ab	3.33c	10.00b	13.33b
LS	*	**	**	**	**	**
CV (%)	7.86	12.54	17.53	21.54	12.54	21.43

Column having common letter(s) do not different from each other as adjusted by DMRT. LS = Level of significance; CV = Coefficient of variation, *= Significant at 5% level of Probability; **= Significant at 1% level of Probability. V_1 = Jute cvl-1, V_2 = BJRI deshi jute-5, V_3 = BJRI deshi jute-6, V_4 = BJRI deshi jute-7, V_5 = BJRI deshi jute-8, V_6 = Kenaf (HC-2), V_7 = Kenaf (HC-95), V_8 = BJRI Kenaf-4 and V_9 = Mesta (HS-24).

No post-emergence mortality of seedlings (0.00%, 0.00%) at 5 and 7 DAS was recorded in fiber crop V_7 (Kenaf (HC-95)), whereas only 3.33% at 9 DAS. BJRI deshi jute-8 variety showed the highest percentage of post-emergence mortality of seedlings (10.00%, 16.67%, and 16.67%) at 5, 7, and 9 DAS.

Prevalence of Seed-Borne Fungi

Six fungi genera were found in nine different types of fiber crops. These are *Colletotrichum corchori*, *Curvularia lunata*, *Fusarium* spp., *Aspergillus* spp., *Macrophomina phaseolina*, and *Botryodiplodia theobromae*. The variety V_5 (BJRI deshi jute-8) revealed *Colletotrichum corchori* as the most prevalent fungus species (Plate 3). Kenaf (HC-95) showed the most protection against fungal pathogens and found the lowest total fungi (1.00) (Table 4). The result revealed that variety V_2 (BJRI deshi jute-5) was the most susceptible variety against the fungal pathogen, with V_4 (BJRI deshi jute-7) and V_5 (BJRI deshi jute-8).

Table 4. Varietal reaction of jute and allied fiber crops on prevalence of seed-borne fungi in agar plate method.

Varieties	Total fungi (no.)	Mean (%)				
		Colletotrichum corchori	*Curvularia lunata*	*Macrophomina phaseolina*	*Fusarium* spp.	*Aspergillus* spp.
V_1	3.33c	8.33d	0.00b	0.00b	72.22a	19.44f
V_2	5.67a	34.44b	0.00b	0.00b	35.56d	30.00e
V_3	2.33d	27.78c	0.00b	0.00b	27.78e	44.44c
V_4	5.67a	35.56b	0.00b	5.56a	28.89e	30.00e
V_5	5.33a	43.33a	0.00b	0.00b	51.11c	5.56h
V_6	4.33b	8.33d	6.67a	0.00b	46.67c	38.33d
V_7	1.00e	0.00e	0.00b	0.00b	33.33d	66.67a
V_8	2.67cd	0.00e	0.00b	0.00b	50.00c	50.00b
V_9	2.67cd	22.22c	0.00b	0.00b	66.67b	11.11g
LS	**	**	*	*	**	**
CV (%)	14.23	24.40	42.35	13.54	35.45	32.34

Column having common letter(s) do not different from each other as adjusted by DMRT. LS = Level of significance; CV = Coefficient of variation, *= Significant at 5% level of Probability; **= Significant at 1% level of Probability. V_1 = Jute cvl-1, V_2 = BJRI deshi jute-5, V_3 = BJRI deshi jute-6, V_4 = BJRI deshi jute-7, V_5 = BJRI deshi jute-8, V_6 = Kenaf (HC-2), V_7 = Kenaf (HC-95), V_8 = BJRI Kenaf-4 and V_9 = Mesta (HS-24).

(a) (b) (c) (d) (e)

Plate 3. Stereo microscopic view of (a) *Colletotrichum corchori* in seedling and compound microscopic view of setae of (b) *C. corchori*; (c) *Aspergillus niger*; (d) *Macrophomina phaseolina*; (e) *Curvularia lunata.*

3.3. Fungi Detection by Test Tube Method

Significant differences were discovered as a result of post-emergence mortality, seed infection, seedling infection, and variances in seed germination (Table 5). Germination of seeds varied significantly while the highest percentage of seed germination (100%) was recorded in fiber crop variety V_1 (Jute cvl-1), V_3 (BJRI deshi jute-6) and V_4 (BJRI deshi jute-7), respectively and the lowest percentage of seed germination (86.67%) was recorded in fiber crop variety V_5 (BJRI deshi jute-8). The highest percentage of seed infection (93.33 %) was recorded in fiber crop variety V_5 (BJRI deshi jute-8) and V_6 (Kenaf (HC-2)), respectively conversely, V_3 (BJRI deshi jute-6) and V_4 (BJRI deshi jute-7) showed the lowest percentage of seed infection (0%). Result revealed that the highest percentage of seedling infection (100%) was found on V_4 (BJRI jute-7) and V_5 (BJRI deshi jute-8), respectively. On the contrary, the lowest percentage of seedling infection (86.67%) was recorded on V_3 (BJRI deshi jute-6).

The fiber crop variety V_5 (BJRI deshi jute-8) had the highest percentage of post-emergence mortality in seedlings (90%, 93.33%, and 100%) at 5, 7, and 9 DAS, respectively. The fiber crop variety V_7 (Kenaf (HC-95)) had the lowest percentage of post-emergence mortality among seedlings (73.33%, 83.33%, and 86.67%) at the same DAS.

Table 5. Varietal reaction of jute and allied fiber crops on germination, seed infection, seedling infection, post emergence mortality (%) on test tube method.

Varieties	Germination (%)	Seed infection (%)	Seedling infection (%)	Post emergence mortality (%)		
				5 DAS	7 DAS	9 DAS
V_1	100.00a	60.00c	93.33b	83.33c	96.67a	96.67b
V_2	93.33c	40.00d	93.33b	80.00d	93.33a	93.33c
V_3	100.00a	0.00e	86.67c	80.00d	90.00b	90.00d
V_4	100.00a	0.00e	100.00a	83.67b	86.33c	100.00a
V_5	86.67d	93.33a	100.00a	90.00a	93.33a	100.00a
V_6	93.33c	93.33a	93.33b	80.00d	86.67b	93.33c
V_7	93.33c	83.33b	93.33b	73.33f	83.33c	86.67e
V_8	96.67b	86.67b	93.33b	66.67g	86.67b	86.67e
V_9	96.67b	86.67b	90.00b	76.67e	93.33a	96.67b
LS	*	**	*	*	*	*
CV (%)	6.98	11.93	11.80	20.36	16.43	13.54

Column having common letter(s) do not different from each other as adjusted by DMRT. LS = Level of significance; CV = Coefficient of variation. *= Significant at 5% level of Probability; **= Significant at 1% level of Probability. V_1 = Jute cvl-1, V_2 = BJRI deshi jute-5, V_3 = BJRI deshi jute-6, V_4 = BJRI deshi jute-7, V_5 = BJRI deshi jute-8, V_6 = Kenaf (HC-2), V_7 = Kenaf (HC-95), V_8 = BJRI Kenaf-4 and V_9 = Mesta (HS-24).

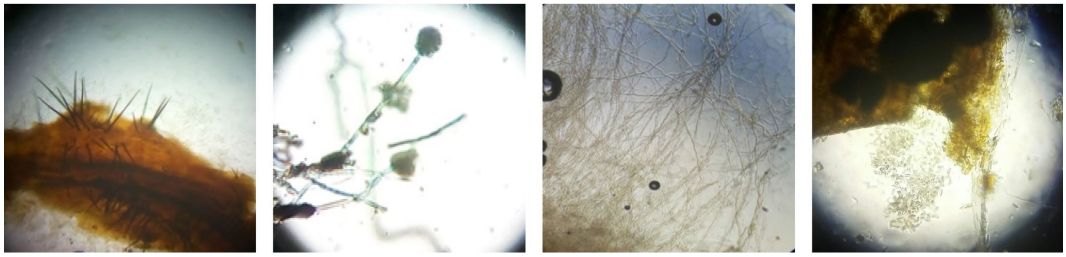
Prevalence of Seed-Borne Fungi

Some of the seeds with the fewest seed-borne fungi were from V_2 (BJRI deshi jute-5), V_3 (BJRI deshi jute-6) and V_4 (BJRI deshi jute-7). Seeds from V_7 (Kenaf HC-95) and V_8 (BJRI Kenaf-4) had the fewest (1.33% and 1.33 percent, respectively) (Table 6). Identified four fungi genera (*Colletotrichum corchori*, *Fusarium* spp., *Aspergillus* spp., and *Macrophomina phaseolina*) in nine fiber crop varieties. Of these, *Colletotrichum corchori* was the most predominant fungus recorded in variety V_5 (BJRI deshi jute-8) (Plate 4).

Table 6. Varietal reaction of jute and allied fiber crops on the prevalence of seed-borne fungi on test tube method.

Varieties	Total fungi (no.)	Mean (%)			
		Colletotrichum corchori	*Macrophomina phaseolina*	*Fusarium* spp.	*Aspergillus* spp.
V_1	1.67b	16.67d	0.00c	33.33c	50.00b
V_2	2.00a	16.67dd	33.33b	50.00b	0.00d
V_3	2.00a	16.67d	0.00c	33.33c	50.00b
V_4	2.00a	33.33c	16.67a	33.33c	16.67c
V_5	1.67b	83.33a	0.00c	33.33c	0.00d
V_6	1.67b	0.00e	0.00c	33.33c	66.67a
V_7	1.33c	0.00e	0.00c	83.33a	16.67c
V_8	1.33c	0.00e	16.67a	83.33a	0.00d
V_9	1.67b	50.00b	0.00c	33.33c	16.67c
LS	*	**	*	**	**
CV (%)	6.12	31.23	22.54	22.32	21.56

Column having common letter(s) do not different from each other as adjusted by DMRT. LS = Level of significance; CV = Coefficient of variation, *= Significant at 5% level of Probability; **= Significant at 1% level of Probability. V_1 = Jute cvl-1, V_2 = BJRI deshi jute-5, V_3 = BJRI deshi jute-6, V_4 = BJRI deshi jute-7, V_5 = BJRI deshi jute-8, V_6 = Kenaf (HC-2), V_7 = Kenaf (HC-95), V_8 = BJRI Kenaf-4 and V_9 = Mesta (HS-24).



(a) (b) (c) (d)

Plate 4. Compound microscopic view of (a) setae of *Colletotrichum corchori*; (b) *Aspergillus niger*; (c) *Fusarium* spp. and (d) *Macrophomina phaseolina* in test tube method.

3.4. Fungi Detection by Growing on Test Method

This approach revealed significant differences in seed germination, seed infection, seedling infection, and post-emergence mortality, as shown in Table 7. The highest percentage of seed germination (84%) was recorded in fiber crop variety V_7 (Kenaf (HC-95)), and the lowest percentage of seed germination (24%) was recorded in V_9 (Mesta (HS-24)). Fiber crop variety V_5 (BJRI deshi jute-8) was performed with the highest percentage of seed infection (66.67%), while the lowest percentage of seed infection (6.67%) was recorded in fiber crop variety V_7 (Kenaf (HC-95)). The results showed that fiber crop variety V_5 (BJRI deshi jute-8) recorded the highest percentage of seedling infection (40%). On the other hand, the V_8 (BJRI Kenaf-4) variety showed the lowest percentage of seedling infection (20%).

It was found that at 5, 7, and 9 DAS, the V_5 (BJRI deshi jute-8) variety had the highest percentage of seedlings dying after they sprouted (20%, 23.33%, and 40%), while the V_8 (BJRI Kenaf-4) cultivar had the lowest percentage of seedlings dying after sprouting (0%, 13.33%, and 20%).

Table 7. The varietal reaction of jute and allied fiber crops on percent germination, seed infection, seedling infection, post emergence mortality on growing on test method.

Varieties	Germination (%)	Seed infection (%)	Seedling infection (%)	Post emergence mortality (%)		
				5 DAS	7 DAS	9 DAS
V_1	75.00c	20.00b	33.33b	13.33b	23.33a	36.67b
V_2	68.67d	20.00b	23.33d	6.67d	20.00b	23.33e
V_3	81.00ab	10.00cd	23.33d	10.00c	13.33d	16.67g
V_4	66.33d	16.67bc	26.67c	6.67d	20.00b	26.67d
V_5	77.33bc	66.67a	40.00a	20.00a	23.33a	40.00a
V_6	67.33d	23.33b	33.33b	10.00c	23.33a	33.33c
V_7	84.00a	6.67d	26.67c	3.33e	20.00b	26.67d
V_8	75.33c	16.67bc	20.00e	0.00f	13.33d	20.00f
V_9	24.00e	10.00cd	23.33d	10.00c	16.67c	23.33e
LS	*	**	**	**	**	*
CV (%)	4.53	20.38	18.23	68.47	45.45	22.54

Column having common letter(s) do not different from each other as adjusted by DMRT. LS = Level of significance; CV = Coefficient of variation, *= Significant at 5% level of Probability; **= Significant at 1% level of Probability. V_1 = Jute cvl-1, V_2 = BJRI deshi jute-5, V_3 = BJRI deshi jute-6, V_4 = BJRI deshi jute-7, V_5 = BJRI deshi jute-8, V_6 = Kenaf (HC-2), V_7 = Kenaf (HC-95), V_8 = BJRI Kenaf-4 and V_9 = Mesta (HS-24).

Prevalence of Seed-Borne Fungi

The prevalence of total seed-borne fungi detection varied significantly depending on the seeds of jute and allied fiber crop varieties. The highest total number of seed-borne fungi (3.67) was recorded in V_5 (BJRI deshi jute-8), while the lowest total seed-borne fungi (1.67) was recorded in seeds obtained from V_4 (BJRI deshi jute-7) (Table 8). Four fungi genera (Colletotrichum corchori, *Fusarium* spp., *Aspergillus* spp., and *Botryodiplodia theobromae*) were identified in nine fiber crop varieties. *Colletotrichum corchori* emerged as the most prevalent fungus in variety V_5 (BJRI deshi jute-8).

Table 8. Varietal reaction of jute and allied fiber crops on prevalence of seed-borne fungi on growing on test method.

Varieties	Total fungi (no.)	Mean (%)		
		Botryodiplodia theobromae	*Colletotrichum corchori*	*Fusarium* spp.
V_1	2.67d	0.00b	44.44b	50.00b
V_2	3.33b	0.00b	33.33d	50.00b
V_3	2.33e	0.00b	50.00b	50.00b
V_4	1.67f	11.11a	11.11f	77.78a
V_5	3.67a	0.00b	63.89a	19.44e
V_6	2.67d	0.00b	38.89c	27.78d
V_7	2.67d	0.00b	11.11f	50.00b
V_8	2.67d	0.00b	0.00g	38.89c
V_9	3.00c	0.00b	16.67e	27.78d
LS	*	*	**	**
CV (%)	3.54	6.43	60.43	21.33

Column having common letter(s) do not different from each other as adjusted by DMRT. LS= Level of significance; CV= Coefficient of variation, *= Significant at 5% level of Probability; **= Significant at 1% level of Probability. V_1 = Jute cvl-1, V_2 = BJRI deshi jute-5, V_3 = BJRI deshi jute-6, V_4 = BJRI deshi jute-7, V_5 = BJRI deshi jute-8, V_6 = Kenaf (HC-2), V_7 = Kenaf (HC-95), V_8 = BJRI Kenaf-4 and V_9 = Mesta (HS-24).

However, there were six different types of fungi found in jute and its fiber seeds. They were *Aspergillus* sp., *Botryodiplodia theobromae*, *Fusarium oxysporum*, *Macrophomina phaseolina* and *Curvularia lunata*. Of these, *Curvularia lunata* was the least common (only found on agar plates), while *C. corchori* was the most common (found in all methods). Most fungi, seed infections and post-emergence deaths happened in Variety V_5 (Plate 4(a), Plate 4(c), Plate 4(d)). Variety V_9 followed this, while variety V_7 experienced the least fungi, seed infections and post-emergence mortality across all tests (Figure 2).

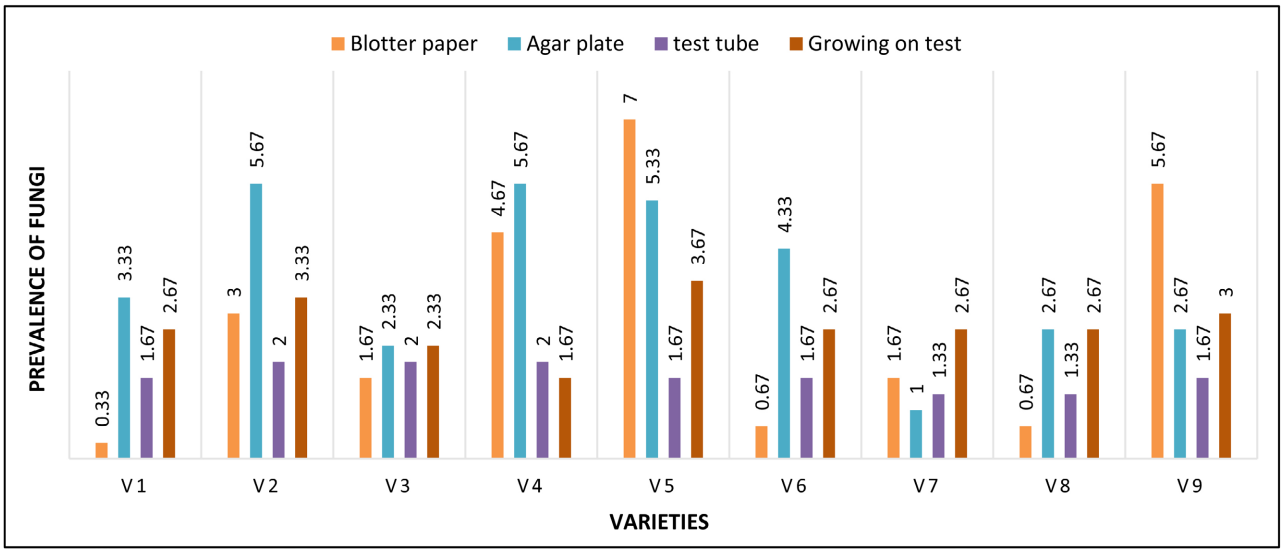


Figure 2. Prevalence of fungi against all fiber varieties in different methods.

3.5. Management of Associated Seed-Borne Fungi by Different Treatments in Pot

Table 9 displays the percent seedling incidence of fiber crops for controlling associated seed borne fungi in pot. The highest, 82.30%, 80%, and 65.67% seedling incidence was found in control (without sterilized soil) in varieties V_5, V_6 and V_9 respectively. Whereas the lowest incidence (24.14%, 21.29%, and 42.19%) was found in the Autostin treated seed in pot among all selected varieties. On the other hand, control (with sterilized soil) and Trichoderma treated seed resulted in statistically similar seedling infection.

Table 9. Effect on different seed treatments on seedling incidence (%) among three selected varieties of fiber crops.

Treatments	% Seedling incidence		
	V_5	V_6	V_9
Trichoderma sp.	52.17b	56.20c	61.00b
Autostin	24.14c	21.29d	42.19c
Control (sterilized soil)	50.33b	76.00b	61.00b
Control (without sterilized soil)	82.30a	80.00a	65.67a
LS	**	**	**
CV (%)	4.08	0.91	2.01

3.6. Percent Prevalence of Fungal Isolate, Seed Infection, Seedling and Post Emergence Mortality in Jute and Allied Fiber Crops

Percent prevalence of fungal isolate, seed infection, seedling and post emergence mortality in jute and allied fiber crops among all methods (Blotter paper method,

Agar plate method, Test tube method and Growing on test method) showed variations which are presented in Figure 3.

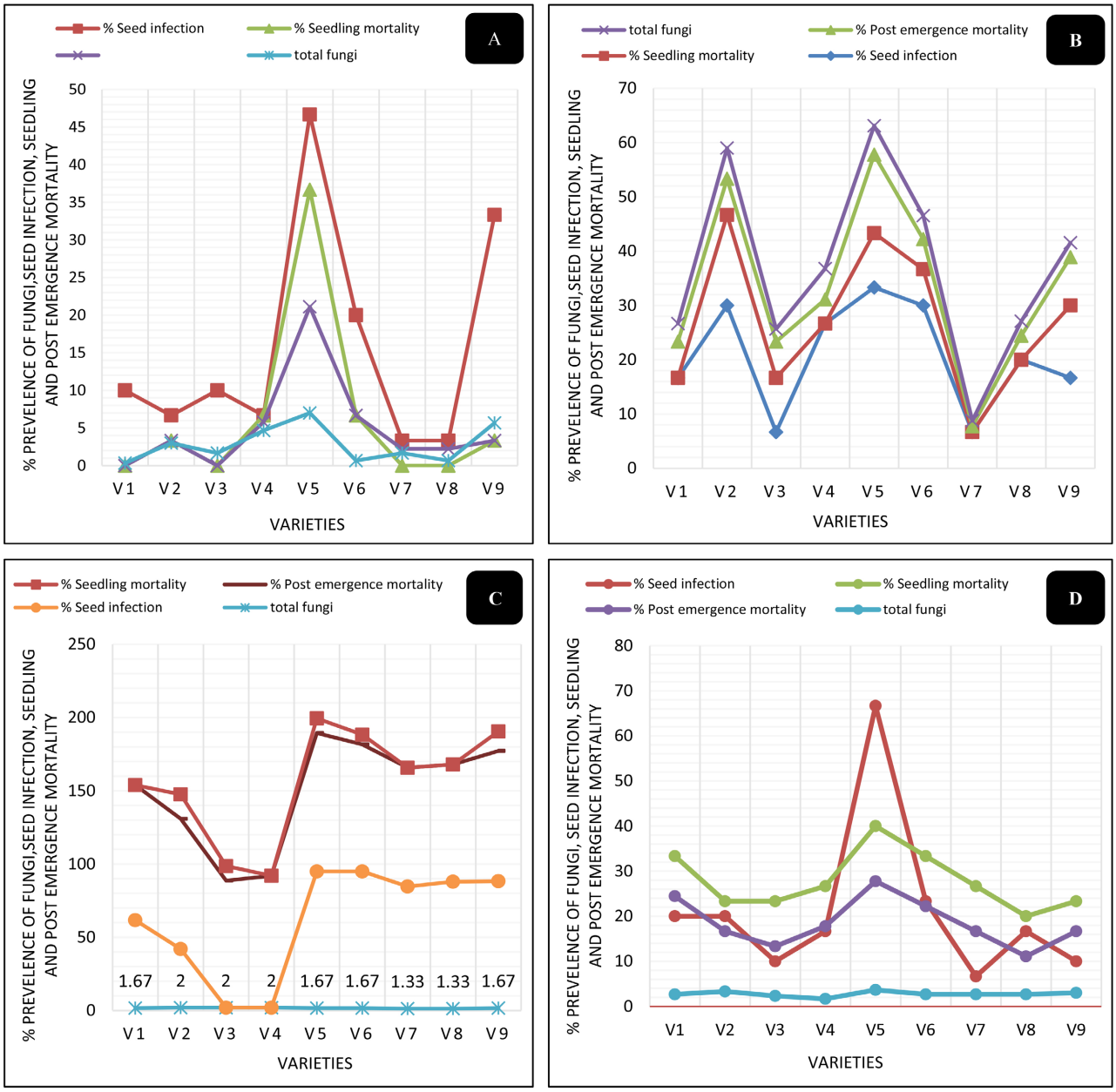


Figure 3. Percent prevalence of fungal isolate, seed infection, seedling and post emergence mortality in jute and allied fiber varieties among all methods. (A) Blotter paper method, (B) Agar plate method, (C) Test tube method, (D) Growing on test method.

4. Discussion

Jute, commonly known as the golden fiber of Bangladesh, has a great influence on socio-economic importance. Bangladesh supplies about 70% of jute and fiber crops, which are related products to the global market [30]. Despite its importance, it is infected severely by many seed-borne pathogens, which can have a detrimental influence on jute and fiber production. Seed-borne diseases are cru-

cial for jute and fiber crops. Stem rot, black band, and anthracnose are all fungal diseases that are often spread through jute seeds. They were caused by *Macrophomina phaseolina*, *Botryodiplodia theobromae* and *Colletotrichum corchori,* respectively.

Nine varieties of different jute and allied fiber crops were used in this research work. The blotter paper method revealed that V_5 (BJRI deshi jute-8) had the highest number of seed-borne fungi (7.00). Five fungal genera: *Colletotrichum corchori*, *Botryodiplodia theobromae*, *Macrophomina phaseolina*, *Fusarium* spp. and *Aspergillus* spp. were found in this study. These identified fungal genera were from nine different fiber crop varieties. The most common fungus found in these varieties was *Colletotrichum corchori* in V_4 (BJRI deshi jute-7), V_5 (BJRI deshi jute-8), V_6 (Kenaf HC-2) and V_9 (Mesta HS-24). Similar work was done in Haider *et al.* [31] (1992) and found 12 genera of fungi in jute seed, where C*olletotrichum corchori* and *Sclerotium rolfsii* were the most common.

In the agar plate method, the highest total number of seed-borne fungi (5.67) was recorded in the V_4 (BJRI deshi jute-7) variety and again, five fungal genera, viz. *Colletotrichum corchori*, *Macrophomina phaseolina*, *Curvularia lunata*, *Fusarium* spp. and *Aspergillus* spp. were identified. Among these, *Colletotrichum corchori* was the most prime fungus recorded in varieties V_5 (BJRI deshi jute-8) and V_6 (Kenaf HC-2), respectively. It is similar to [32] where the highest (96.00%) and the lowest germination (73.00%) were recorded in case of 0% and 25% initial seed-borne infection of *C. corchori*, respectively. Corresponding results were found at [13] [33] and [34].

In test tube method, the highest total number of seed borne fungi (2.00) were recorded in V_2 (BJRI deshi jute-5), V_3 (BJRI deshi jute-6) and V_4 (BJRI deshi jute-7), respectively while the lowest total seed borne fungi (1.33) were recorded in seeds obtained from V_7 (Kenaf HC-95) and V_8 (BJRI kenaf-4), respectively. Entirely four fungi genus (*Colletotrichum corchori*, *Fusarium* spp., *Aspergillus* spp., *Macrophomina phaseolina*) were identified among these; *Colletotrichum corchori* was the most prevalent fungus recorded in variety V_5 (BJRI deshi jute-8). Similarly, a researcher conducted on health quality of jute seeds and the transformation behavior of *Colletotrichum corchori* from seed to plant to seed in which *Colletotrichum corchori* was found predominant and revealed that % germination, % post-emergence infection, % germination failure and % seedling infection varied significantly [35].

In growing on test method, V_5 (BJRI deshi jute-8) variety showed the highest total number of seed borne fungi (3.67) whereas the lowest total seed borne fungi (1.67) were found on V4 (BJRI deshi jute-7) variety. Again four fungi genus (*Colletotrichum corchori*, *Fusarium* spp., *Aspergillus* spp. and *Botryodiplodia theobromae*) were identified in this method among these, *Colletotrichum corchori* was the most predominant fungus recorded in variety V_5 (BJRI deshi jute-8). Fakir *et al.* (1993) [36] reported that *Botryodiplodia theobromae*, *Colletotrichum corchori* and *Macrophomina phaseolina* were responsible for causing black band, anthrac-

nose and stem rot, respectively and most widely distributed in the country. Transmission of the major seed-borne diseases including stem rot caused by *Macrophomina phaseolina*, black band caused by *Botryodiplodia theobromae* and anthracnose caused by *Colletotrichum corchori* from seed to seedlings, revealed that germination of the seeds was found to decrease with the increase of the seed borne infection and resulted significantly higher amount of disease development [36].

The highest percentage of post-emergence mortality of seedling (20.00%, 23.33% and 40.00%) was recorded on variety V_5 (BJRI deshi jute-8) and the lowest (0%, 13.33% and 20%) was found on variety V_8 (BJRI Kenaf-4) at noted down at 5, 7 and 9 DAS. Begum *et al.* (2025) also conducted the same experiment on nemic and viral disease of jute and allied fiber crops and found that BJRI Kenaf-3 and BJRI deshi jute-7 perform the best against this disease [37]. An integrated control of seedling mortality of lentil caused by *Sclerotium rolfsii* in BSMRAU, Gazipur, was conducted by [38].

5. Conclusions

There were six types of fungi found in fiber seed. They were *Colletotrichum corchori*, *Fusarium oxysporum*, *Botryodiplodia theobromae*, *Macrophomina phaseolina*, *Curvularia lunata*, and *Aspergillus* sp. All methods found *C. corchori* as the most common type. In all methods, V_5 had the highest rate of percent fungi, seed infection, seedling infection, and post-emergence mortality of all the fiber crop varieties. V_9 had the lowest rate of all of these things. V_7 Kenaf (HC-95) was the best variety that had a high germination percentage and low seed mortality, among others, whereas V_5 and V_9 had the lowest germination and high mortality. Autistin-treated selected fiber crops showed the best result for controlling percent seedling infection in pots.

Overall findings: the V_7 variety outperformed the others in all infection percentages. Therefore, we recommend the V_7 variety for cultivation. Further study will be needed to evaluate a greater variety of fiber crop seeds and their appropriate management practices.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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