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Research Article

EFFECTS OF SEED-BORNE FUNGI ON GERMINATION AND SEEDLING VIGOR OF AROMATIC RICE VARIETIES

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ABSTRACT
A seed technological investigation was conducted on forty-rice varieties comprising thirty-seven aromatic and three non-aromatics to investigate seed health status, germination and seedling vigor. Twelve seed borne fungi were isolated and identified. Among these six important pathogenic fungi namely *Bipolaris oryzae*, *Curvularia lunata*, *Fusarium moniliforme*, *Microdochium oryzae*, *Pyricularia oryzae* and *Sarocladium oryzae* showed average incidence ranges of 2.5-24.5%, 6.5-42.5%, 2.5-25%, 0.0-5%, 0.5-5.5% and 0.5-12% respectively as detected by standard blotter method. False smut of rice was found in 14 varieties with a range of 0.5-3.5% seed infection. The lower and higher limits of germination were 38.67% and 97.33% in var. Khazar and var. BRRI dhan 28 for which the corresponding vigor indexes were found 373.55 and 1472.60 respectively.

Keywords: *Aromatic Rice, Germination, Field Disease, False Smut, Seed-Borne Fungi, Seed Health, Seedling Vigor*

INTRODUCTION
In Bangladesh most of the aromatic rice are of traditional type and generally grown during *Aman* cropping season. Among the various constrains responsible for low yield of rice, diseases are considered most important. Like all rice growing areas of the world, the loss caused by seed-borne rice diseases seemed to be quite high in Bangladesh. Mycoflora associated with seeds are not only responsible for various diseases in the field, but also affect seed in storage by reducing germination, vigor, food value and yield. Germination of seed and seedling vigor are determinants for efficient crop establishment, stability and productivity of crops. Many seed-borne fungi, either singly or in combination are responsible for poor germination and diseased seedlings (Bora and Gogoi, 1993; Khair *et al.*, 1988; Mathur *et al.*, 1972). Among the seed-borne pathogens *Bipolaris oryzae* is the most predominant one, which causes 6-50% germination loss (Rath, 1974). Information on germination and seedling vigor ultimately helps developing seed certification standard for important seed-borne pathogens. The present work was undertaken to assess the impact of seed-borne pathogens on germination and seedling vigor of aromatic rice varieties cultivated in Bangladesh.

MATERIALS AND METHODS
Forty rice varieties comprising thirty-seven aromatic and three non-aromatics were used as materials for the present investigation. Seed health test was carried out following standard blotter method (ISTA, 2003) to detect the seed-borne pathogens associated with the seed samples. For proper identification of fungi temporary slides were prepared from the fungal colony and observed under compound microscope.
Top paper method (ISTA, 2003) was followed for Germination test. Four hundred seeds for each sample were tested.
One hundred seeds were placed on two layered moisture paper towels kept in transparent plastic pot. The lids of pots were closed. All pots were incubated for 14 days at 30°C and in light regime of 12 hours each day.
After 5th day and 14th day of incubation the germination was counted for normal seedlings, abnormal seedlings, fresh seeds, hard seeds and dead seeds. Above mentioned categories were expressed in percentage.

For determination of seedling vigor 25 seedlings were randomly selected from each germination pot and their individual shoot and root length were measured. The vigor of the seedlings were determined by following the formula of Baki and Anderson (1972) where,
Vigor index = (Mean of root length + Mean of shoot length) x Percentage of seed germination.

RESULTS AND DISCUSSION

The results of seed health test have been presented in Table 1. The results revealed that the seeds were infected with major disease producing fungi namely, *Bipolaris oryzae*, *Fusarium moniliforme*, *Pyricularia oryzae*, *Rhizoctonia solani* and *Sarocladium oryzae*, responsible for brown leaf spot, Bakanae, leaf blast, sheath rot and sheath blight respectively, showed seed-borne infection ranging from 2.5 - 24.5%, 2.5 - 25%, 0.5 - 5.5%, 0.0 - 2% and 0.5 - 12%, respectively. The minor pathogenic organisms recorded were *Curvularia lunata*, *Microdochium oryzae*, *Nigrospora oryzae*, *Trichoconis padwickii* and *Ustilaginoidia virens* incidences as 6.5-42.5%, 0.0-5.0%, 0.5-3.5%, 8.0-42.5%, and 0.5-3.5% respectively in forty varieties. This finding also corroborates with those reported by earlier workers (Khan *et al.*, 1999; Riaz *et al.*, 1995; Islam *et al.*, 1994; Shahjahan *et al.*, 1988; Soave *et al.*, 1983). *Trichoconis padwickii*, responsible for stack burn disease, showed higher incidences among the seed samples. Mia and Mathur (1983) also found highest seed infection of *Trichoconis padwickii* in local varieties of rice of Bangladesh. Reports claimed this fungus to be responsible for germination loss (Sharma *et al.*, 1987; Mathur, 1972). Maximum mean percentage incidence of seed-borne fungi recorded was 24.9% for *Trichocoins padwickii*, and minimum was 1.1% for *Rhizoctonia solani*. Average total fungal association in these rice varieties was 71.7%. Maximum and minimum total fungal associations were 95.5% and 31.5% respectively, for the varieties Khazar and Basmati Tapl- 90. Both aromatic and non-aromatic varieties were found to be infested with same seed-borne diseases. Among the three non-aromatic varieties the highest total fungal association recorded in Nizersail (90.5%) and the lowest in BRRI dhan 28 (56.5%).

The results on germination and vigor index have been presented in Table 2, and table 3 respectively. Results on germination test, as recorded in forty varieties, average were 86.85% normal seedlings, 5.22% abnormal seedlings, 0.03% fresh seeds, 0.53% hard seeds and 7.29% dead seeds. Maximum counts of abnormal seedlings and dead seeds were found in the var. Khazar were 14.33% and 45.33% respectively. The lowest number of abnormal seedlings and dead seeds recorded were 0.33% and 2.33% respectively for variety BRRI dhan-28. The lower and higher limits of germination were 38.67% and 97.33% in var. Khazar and var. BRRI dhan 28 for which the corresponding vigor indexes were found 373.55 and 1472.60 respectively. Mean vigor index for forty rice varieties was 835.68. Among the aromatic varieties the highest germination recorded in var. Hatisail Tapl-25 (94.67%).

Germination of seed and seedling vigor are determinants for efficient crop establishment, stability and productivity of crops. Usually, laboratory germination tests are employed to obtain a general indication of the capacity of seeds to produce good plant stands in the field. Many seed-borne fungi, either singly or in combination are responsible for poor germination and diseased seedlings. In the present investigation germination ranged between 38.67- 97.33% and their corresponding fungal association were 95.5% and 56.5% in variety Khazar and var. BRRI dhan 28 respectively. Germination and vigor index strongly negatively correlated with fungal association in the varieties (Figure 1 & Figure 2). Thus, it proves that seed-borne fungi have inhibitory effect on rice seed germination (Ashokan *et al.*, 1979). Average germination recorded was 86.85%. It has met the minimum national seed standard limit of 80% as set by national seed board of Bangladesh (NSB). However, some varieties, such as, Sarwati (77.67%), Elai (76.33%), Niemat (73.67%) and Khazar (38.67%) failed to meet this requirements. Nevertheless, samples showing higher germination may be loaded with higher percentage of seed infection. It could be explained by the fact that these seeds might have been infested with lower level of pathogenic inoculum (Bokhary, 1991). Moreover, location of the inoculum in the seed is also determinants of the severity of the effect in respect of germination failure and establishment of infection in the seedlings. This view is supported by the fact that in the present investigation highest degrees of total fungal association always do not correlate negatively with the germination. As for example, saprophytic invasion of species of

Aspergillus and *Penicillium* has great potentiality to destroy embryos or germ of the seed in storage and thus reduce seed germination (Christensen and Kaufman, 1965). So, it is not always the pathogenic seed-borne fungi, which is responsible to reduce seed germination. Similar observations were made by Mian and Fakir (1989) and Reddy and Khare (1978). However, in the present study, no storage fungi were recorded as the seeds samples were assayed after 100 days of harvest, and the sample size was too small to allow any chance to accumulate moisture in the seed lots examined.

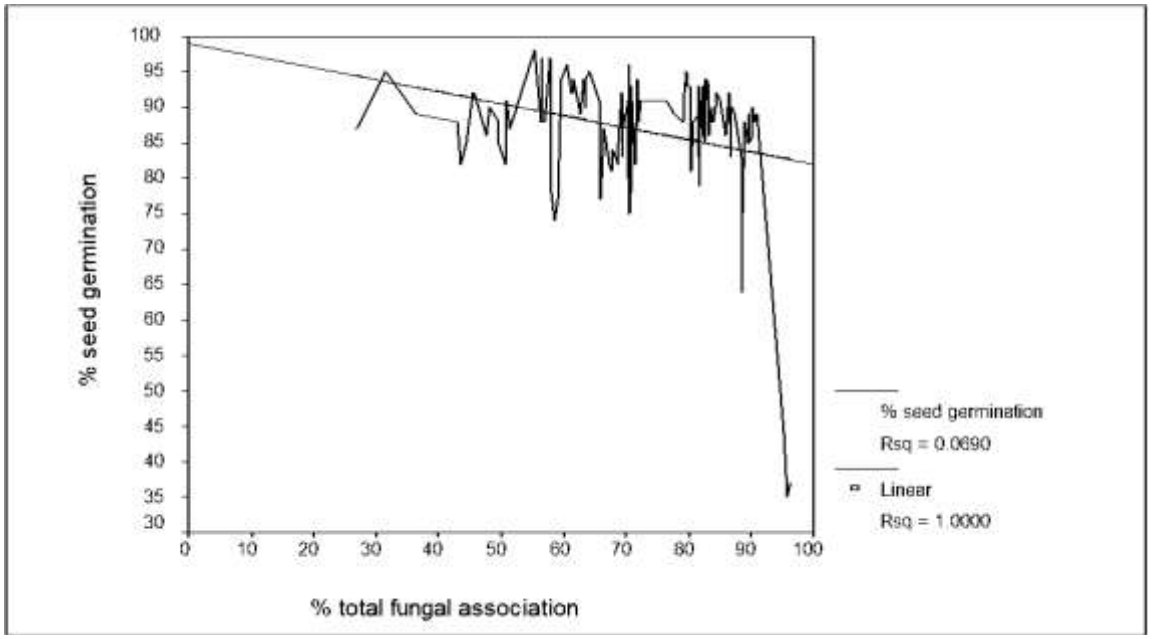

Figure 1: Relationship between Seed Germination and Total Fungal Association

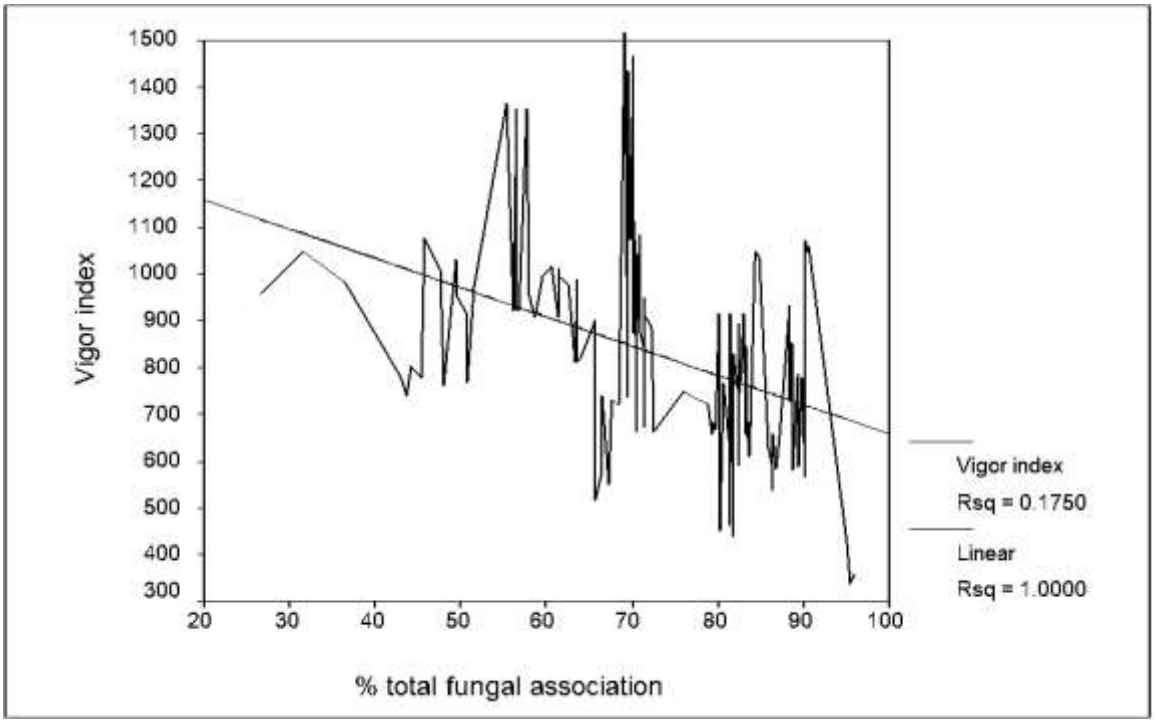

Figure 2: Relationship between Seedling Vigor Index and Total Fungal Association

Table 1: Incidence of Twelve Seed-Borne Fungi Associated with Pure Seed Samples of Aromatic Rice**

Name of the Varieties	Percentage of Seed-Borne Fungi												Total Fungal Load
	1	2	3	4	5	6	7	8	9	10	11	12	
BadshabhogTapl-63	0.5	5.5	28.5	-	11	-	-	-	-	2.5	20.5	-	68.5
Baoijhak	-	7.5	9.5	-	3.5	-	1.5	0.5	-	3	18	-	43.5
Basmati Tapl- 90	-	6.5	8.5	-	5.5	-	0.5	1	-	1	8	0.5	31.5
Basmati PNR 346	-	3	10	-	18.5	-	1	-	-	2	12.5	0.5	47.5
Begun bichi	1	9.5	14	-	4.5	1	0.5	-	-	1.5	16.5	-	48
Benapul	-	6.5	24	1	10	-	1.5	-	-	0.5	18.5	0.5	62.5
Bhogganjia	-	11	12.5	-	-	-	2.5	-	0.5	-	24	-	50.5
BRRI dhan 28*	-	3.5	18	1.5	5.5	-	2.5	-	1.5	-	24	-	56.5
BRRI dhan 38	1.5	11.5	15	-	4.5	-	0.5	1.5	-	-	35	2	71.5
BRRI dhan 39*	-	8.5	26.5	-	7.5	-	1.5	-	-	1	24	0.5	69.5
Chinigura	-	10.5	19	-	7	-	-	1.5	-	1	29	-	70
Chinikani	2.5	11.5	22	0.5	-	0.5	-	2	-	2.5	35.5	0.5	86.5
Darshal	3.5	12	27	-	8.5	-	-	-	1.5	2.5	21	3.5	79.5
Daiargura	6.5	5.5	24	-	8	0.5	1.5	1.5	2	-	30.5	2.5	82.5
Elai	2.5	2.5	6.5	1	6.5	-	2.5	-	-	2	25	-	58.5
GandhoKasturi	3.5	6	42.5	-	7.5	1.5	-	-	-	-	25	-	89.5
Gandhoraj	5.5	4.5	20	-	8	1.5	-	2	-	2.5	24.5	-	71.5
HatisailTapl- 101	-	3.5	10	-	6.5	3	-	-	-	1	36.5	-	60.5
Jamaisohagi	-	2.5	30.5	-	5.5	0	1	-	-	2.5	27.5	-	71
JataKatari	2	9.5	24.5	-	6.5	-	0.5	-	1.5	1.5	35.5	-	81.5
Jassobalam Tapl-25	0.5	15.5	20	-	4.5	-	1	-	2	1.5	37.5	1	83.5
Jira Katari	-	15	25.5	-	6	2	-	-	1	7.5	22.5	2	81.5
Kalijira	-	9.5	22.5	-	2.5	-	-	-	1	2.5	25.5	-	63.5
Kalomai	-	16	25.5	-	5.5	3	-	3.5	-	5.5	25.5	-	84.5
KaminiSoru	1	7	14.5	-	7.5	-	-	3	-	2	31.5	-	66.5
Kataribhog	-	24.5	15.5	-	4.5	0.5	2.5	-	1.5	-	32.5	3	83.5
Khazar	-	18	20.5	1	25	3.5	3	-	-	12	12.5	-	95.5

LaljiraTapl- 130	1	9	24.5	-	9.5	-	-	0.5	-	2.5	34.5	1	82.5
Niemat	1	18.5	16	5	18.5	5	1.5	1.5	1	6.5	15.5	-	88
Nizersail*	1	13.5	29.5	-	10	0.5	3.5	5.5	0.5	-	23.5	3	90.5
PhiliphineKatari	-	10.5	14.5	-	10.5	-	2.5	1	1.5	3.5	23.5	-	67.5
Premful	-	6	21.5	-	12.5	-	-	1	0	6	42.5	-	89.5
Radhuni PagalTapl77	0.5	13.5	15.5	1	10.5	-	-	-	-	5	17.5	-	63.5
Rajbhog	-	7.5	24.5	1.5	16.5	-	1.5	-	0	-	29.5	3.5	86.5
Shaibal	-	10	14.5	2.5	15.5	0.5	0.5	1.5	-	4.5	21	-	70.5
SakkorKhore	-	18.5	17.5	-	10.5	1.5	1.5	1.5	0.5	4.5	26.5	-	82.5
Sarwati	-	3.5	20.5	2.5	8.5	-	0.5	1	1.5	4	19.5	-	70.5
Sugandha- 1	-	3	38.5	-	15.5	0	2	0.5	-	5.5	15.5	-	77.5
Tilkapur	-	4	12	-	12.5	2	-	-	-	1.5	24.5	-	56.5
Uknimadhu	-	12.5	25.5	-	12.5	0	-	3.5	-	2.5	25.5	-	81.5
$\bar{x}$	2.1	9.4	20.3	1.8	9.3	1.5	1.6	1.8	1.1	3.3	24.9	1.7	71.7
SD	1.8	5.2	7.8	1.3	4.8	1.4	0.9	1.3	0.6	2.4	7.6	1.2	14.8
SE	0.3	0.8	1.2	0.2	0.8	0.2	0.1	0.2	0.1	0.4	1.2	0.2	2.3

Note*: 1. Alternaria alternata 2.Bipolaris oryzae 3.Curvularia lunata 4.Cladosporium sp. 5.Fusarium sp. 6.Microdochium oryzae 7.Nigrospora oryzae 8.Pyricularia oryzae 9. Rhizoctonia solani 10. Sarocladium oryzae 11. Trichoconis padwickii 12. Ustilaginoidia virens.***** Assayed after 100 days of harvest. * Non-aromatic varieties, used as check.

Table 2: Seed Germination of Aromatic Rice Varieties Harvested on *Aman* Cropping Season

Sl. No	Name of the Varieties	Normal Seedling%	Abnormal Seedling %	Fresh Seed%	Hard Seed%	Dead Seed%
1	BadshabhogTapl- 63	83	4.67	0	0.67	11.67
2	Baoijhak	85	6.33	0	1	7.67
3	Basmati Tapl- 90	90.33	4.33	0	1	4.33
4	Basmati PNR- 346	88.67	3	0	0.33	8
5	Begun bichi	91	5	0	0	4
6	Benapul	90.33	3.67	0	0.33	5.67
7	Bhogganjia	84.67	5.66	0.33	0.33	9

8	BRRI dhan- 28*	97.33	0.33	0	0	2.33
9	BRRI dhan- 38	87.33	4.33	0	1.67	6.67
10	BRRI dhan-39*	89.33	3.33	0.33	0	7
11	Chinigura	89	5	0	0.33	5.67
12	Chinikani	88.33	4.33	0	0.67	6.67
13	Darshal	93.33	2.67	0	0.67	3.33
14	Daiargura	87.33	6.33	0	0	6.33
15	Elai	76.33	12	0.67	1	10
16	GandhoKasturi	85.33	6	0	0.67	8
17	Gandhoraj	91.33	2	0	0.33	6.33
18	HatisailTapl- 101	94.67	3	0	0.33	2
19	Jamaisohagi	92.67	3.67	0	0	3.67
20	JataKatari	81	12	0	0	4.67
21	Jasso-balamTapl- 25	88	6	0	1.67	4.33
22	Jira Katari	87.67	5	0	2	5.33
23	Kalijira	92	2.67	0	1.33	3.67
24	Kalomai	91	4.67	0	0	4.33
25	KaminiSoru	81.67	9.67	0	1.33	7.33
26	Kataribhog	88	5.67	0	1	5.35
27	Khazar	38.67	14.33	0	1.67	45.33
28	LaljiraTapl- 130	90	4	0	0	6
29	Niemat	73.67	6.33	0	1.33	18.67
30	Nizersail*	89	4	0	1	6
31	PhilipphineKatari	84.33	8.67	0	0	7
32	Premful	87.67	8	0	0	4.35
33	Radhunipagal Tapl-77	94.33	3	0	0	2.67
34	Rajbhog	88.33	4.67	0	0	6.67

35	Shaibal	92.67	3.33	0	0	4
36	SakkorKhore	92.67	5	0	0	2.33
37	Sarwati	77.67	3.67	0	0	18.67
38	Sugandha- 1	89.33	4	0	0	6.67
39	Tilkapur	88	6	0	0.67	5.33
40	Uknimadhu	93	2.33	0	0	4.67
$\bar{x}$						
86.85		86.85	5.2	0.0	0.5	7.3
SD						
SE1.46		9.3	2.8	0.1	0.6	7.1
SE		1.5	0.4	0.0	0.1	1.1

Note: Mean of three replications, Based on top paper method (ISTA, 2003).
*Non-aromatic varieties, used as check.

Table 3: Seedling Vigor of Aromatic Rice Varieties Harvested on *Aman* Cropping Season

Sl. No	Name of the Varieties	Root Length(cm)	Shoot Length(cm)	Germination%	Vigor Index
1	BadshabhogTapl- 63	2.98	5.80	83	728.74
2	Baoijhak	3.34	5.80	85	776.90
3	Basmati Tapl- 90	3.9	7.14	90.33	997.24
4	Basmati PNR- 346	5.13	6.58	88.67	1038.33
5	Begun bichi	4.06	4.40	91	769.86
6	Benapul	4.94	6.04	90.33	991.82
7	Bhogganjia	6.54	4.64	84.67	946.61
8	BRRI dhan- 28*	9.62	5.51	97.33	1472.60
9	BRRI dhan- 38	3.66	6.64	87.33	899.50
10	BRRI dhan- 39*	9.65	5.53	89.33	1356.03
11	Chinigura	7.42	4.64	89	1073.34
12	Chinikani	2.84	3.64	88.33	572.38
13	Darshal	3.08	4.08	93.33	668.24
14	Daiargura	3.56	3.38	87.33	606.07

15	Elai	8.44	3.82	76.33	935.81
16	GandhoKasturi	4.08	5.06	85.33	779.92
17	Gandhoraj	2.80	4.5	91.33	666.71
18	HatisailTapl- 101	3.46	5.72	94.67	869.07
19	Jamaisohagi	5.13	4.58	92.67	899.83
20	JataKatari	1.92	3.68	81	453.60
21	JassobalamTapl- 25	3.04	4.60	88	672.32
22	Jira Katari	3.6	5.10	87.67	762.73
23	Kalijira	4.82	5.06	92	908.96
24	Kalomai	6.02	5.38	91	1037.40
25	KaminiSoru	3.02	3.70	81.67	548.82
26	Kataribhog	3.34	4.39	88	680.24
27	Khazar	7.10	2.56	38.67	373.55
28	LaljiraTapl- 130	4.96	4.56	90	856.80
29	Niemat	7.6	3.74	73.67	835.42
30	Nizersail*	6.38	5.53	89	1059.99
31	PhiliphineKatari	4.13	4.40	84.33	719.33
32	Premful	3.17	3.43	87.67	578.62
33	Radhunipagal Tapl-77	2.80	5.83	94.33	814.07
34	Rajbhog	4.36	2.96	88.33	646.58
35	Shaibal	4.58	5.02	92.67	889.63
36	SakkorKhore	3.07	5.10	92.67	757.11
37	Sarwati	8.42	5.48	77.67	1079.61
38	Sugandha- 1	4.2	4.02	89.33	734.29
39	Tilkapur	6.46	4.04	88	924.00
40	Uknimadhu	5.36	4.48	93	915.12
$\bar{x}$		4.82	4.76	86.85	835.68
SD		1.99	1.02	9.26	219.96
SE		0.32	0.16	1.46	34.78

*Non-aromatic varieties, used as check.

Research results as well as farmers experience suggest that seed quality may be an important factor leading to poor seedling establishment and thus, selection of high vigor seed may be a strategy to improve crop establishment. Seed vigor tests often give better predictability of field performance. Among the forty varieties studied, vigor index varied from 1472.60 to as low as 373.55, corresponding to the varieties BRRI dhan 28 and Khazar.

Variety Khazar showed the lowest vigor index (373.55) and highest percentage of total fungal association (95.5%). So, it can be concluded that highest level of fungal association was also responsible for lower vigor index (Figure 2). Probably the load of inoculum of the pathogenic fungi in seeds was much higher in this case. Earlier reports also support this view (Yashoda and Anahosur, 2000; Deka and Ali, 1995; Sachan and Agarwal, 1994).

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