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Article

Seed treatment for improving quality of hybrid seeds of rice

Mst. Arjina akter , A.K.M. Kamal Hasan , Sheikh Afsar Uddin and Ismail Hossain*

Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

*Corresponding author: Professor Dr. Ismail Hossain, Department of Plant Pathology, Faculty of Agriculture, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh. Tel.: +8809167134; Fax: +88-091-61510; E-mail: dhossain69@gmail.com

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Abstract: Seeds of 15 hybrid rice varieties viz. Durber, Agomoni, Meghna, Hybrid super, Moyna, Tia, Gold, Aloron, Jagoron, Suborno, Safollo, Hira-1, Hira-2, Hira-4 and Hira-6 were collected from five different seed producing companies of Bangladesh. BAU-Biofungicide (3%), extracts of Garlic (1:1), Allamanda leaf (1:1) Bavistin (0.3%), Thiovit (0.3%) and Provax (0.3%) were used for treating seeds to improve quality of hybrid seeds of rice. The moisture content of seed samples ranged 12.20% to 14.37%, where highest moisture content was found in variety Meghna and lowest in variety Moyna. 1000-seed weight of seed samples ranged from 20.00 to 26.00g, where highest weight was recorded in Hira-4 and lowest was recorded both in Aloron and Hira-1. Seed health test revealed 11 different seed borne fungi viz. Bipolaris oryzae (0.0 to 25.5%), Fusarium moniliforme (0.00 to 3.0%), Fusarium oxysporum (0.0 to 18.0%), Aspergillus flavus (0.00 to 11.0%), Aspergillus niger (0.00 to 5.0%), Aspergillus candidus (0.00 to 15.0%), Penicillium spp. (0.0 to 7.0%) , Alternaria padwickii (0.0 to 1%), Alternaria tenuis (0.0 to 11.0%), Curvularia lunata (0.0 to 40.0%) and Nigrospora oryzae (0.0 to 4.0%) . Germination test resulted normal seedlings from 26.00 to 97.00%, where highest was recorded in variety Jagoron that treated with BAU-Biofungicide resulting highest increase in number of normal seedlings by 239.28% over untreated control. BAU-Biofungicide significantly decreased (upto 90.00%) formation of abnormal seedlings over untreated control. Moreover, BAU-Biofungicide increased up to 713.78% Vigor index over untreated control.

Keywords: hybrid rice; seed; treatment; quality improvement

1. Introduction

Rice (*Oryza sativa* L.) is the most important cereal crop and one of the major sources of calories for a large percentage of the world population, particularly in Asia (Datta, 1981). It alone provides 76% of the total calories and 66% of the protein in a typical Bangladeshi diet of the people (Bhuiyan *et al*, 2002). It (*Oryza sativa*) is the staple food of Bangladeshi people and it constituted about 90% of the total food grain production. It covers about 75% of the total cultivable land in Bangladesh (Ahmed *et al*. 2013). Rice covers about 11533.60 ha land in Bangladesh and the production of rice is 33890 tons where 644.94 ha land is covered by hybrid rice and the production of hybrid rice is 3022 tons (BBS, 2012). The average world yield of rice is 3.84 tons/ha (Ahmed *et al*. 2013). But the average yield of rice in Bangladesh is only 2.98 tons/ha. So the average per hectare production of rice in Bangladesh is extremely low as compared to other rice growing countries of the world. Rice covers about 11533.60 ha total cropped area in Bangladesh where 1138.46 ha by Aus, 5582.60 ha by Aman and 4812.15 ha by Boro season (BBS, 2012). The production of rice in Aus, Aman and Boro season is 2332, 12798 and 18759 tons, respectively (BBS, 2012).

Seed is one of the most important technologies for crop production. For successful crop production there is no other alternative but to use good seed. This is true for all crops including rice. It has been shown experimentally that only by using good quality healthy seed, rice yield could be increased by 10-15% (Mia *et al*., 2004). In the

Philippines, yield increase due to use of good quality seed was 7-25% (Diaz *et al*., 2001).The yield of conventional rice varieties is comparatively low and it seems impossible to change this yield with reachable resources under the prevailing situation. At this situation hybrid rice varieties may be a break through which could help to achieve the goal of self-sufficiency of food. Therefore, cultivation of hybrid varieties of rice is the utmost priority for increasing yield. In Bangladesh, more than 78 hybrid rice varieties are grown in the field and about 75% of seed demand is met from import mostly from China (Ora *et al.* 2011). Major constraints in hybrid rice adoption were identified; these were high cost of seed, requirement of more crop care and management time, high pest and disease attack, low profits and lack of suitability for home consumption. Seed borne diseases are very important from the following points of view; (i) introduction of new pathogens (ii) quantitative and qualitative crop losses and (iii) permanent contamination of soil (Ora *et al*. 2011).Among reasons of low yield of rice, diseases pose a major threat to its production (Ou, 1985; Groth *et al*. 1991; Webster, 1992). Most of the diseases of rice are seed borne. In Bangladesh, approximately 2.5 million tons of rice worth more than Tk. 12000 Millions lost annually due to diseases caused by seed borne pathogens (Fakir *et al*. 2003). A total of 153 seed borne pathogens were detected from rice of which 18% are of quarantine importance, 65% are native and 17% are storage pathogens (IRRI, 1987). Evidently, there is a need to increase the yield of the crop by controlling seed-borne fungal pathogens. Among the control practices used, seed treatment is one of the effective technique to eliminate seed borne inocula which prove the 'arsenal' of Plant Pathology is now equipped with most sophisticated ammunitions to wage war on the unscrupulous pathogens, which are many and deceitful. Treatments of seed should be done as a routine practice as it is a cheap insurance against possible disasters at a later stage (Bilgrami and Dube 1976).The disease can be controlled by the application of fungicides. Thrimurty (1986) and Karmakar (1992) have reported the efficacy of carbendazim (Bavistin) in reducing disease severity. Existing practice of chemical control is too costly, particularly for poor farmers in the country.

Botanicals in controlling pathogens against certain fungal pathogens have been reported by Hossain *et al*., (1997), Suratuzzaman *et al*., (1994), Fakir and Khan (1992), Miah, (1990) and Assdi and Behroozin (1987). BAU-Biofungicide resulted significant higher germination and plant stand, less disease incidence and higher yield of different crops (Hossain, 2011), Chowdhury*et al.* (2013), Hossain and Hossain (2012). The present study was conducted to assess quality of hybrid seeds of rice and their improvement by seed treatment.

2. Materials and Methods

2.1. Study area

The experiment pertaining to the present investigation was carried out in the Seed Pathology Centre (SPC), Bangladesh Agricultural University (BAU), Mymensingh; Eco-friendly Plant Disease Management Laboratory and MS Laboratory of the Department of Plant Pathology, BAU, Mymensingh, Bangladesh.

2.2. Determination of moisture content and 1000-seed weight

Moisture content of the collected seed samples were determined with the help of electronic moisture meter before preserving the seed in seed storage at Eco-friendly Plant Disease Management Laboratory, Department of Plant Pathology, BAU, Mymensingh and the moisture content of seed was expressed in percentage. For each seed sample 1000 seed-weight was taken with the help of electronic balance. The seed weight was taken after counting 1000- seed at Eco-friendly Plant Disease Management Laboratory and expressed in percentage.

2.3. Detection of seed borne fungi by blotter method

To detect the seed borne pathogens associated with the seeds in seed samples the Blotter method was used by following ISTA rules for seed testing (ISTA, 1996). In this method, three layers of blotting paper (Whatman filter no. 1) were soaked in sterilized water and placed at the bottom of 9 cm dia plastic petridish and thereafter 25 seeds were plated. Eight replicates (petridishes) were used for each sample where 200 seeds were needed. The seeds in the petridishes were incubated in the incubation chamber at 20 ± 2 °C under alternating cycles of 12 hours near ultraviolet (NUV) light and darkness for 7 days. Time to time watering was done to keep the blotting paper moist.

2.4. Seed treatment and vigor test

Seed treatment for improving quality of seeds studied by treating seeds with BAU-Biofungicide (3%), a Trichoderma based preparation along with extracts of two botanicals viz Garlic (Allium sativum) (1:1) and Allamanda leaf (Allamanda cathartica) (1:1) and three selected chemicals namely Bavistin (0.3%), Thiovit

(0.3%) and Provax (0.3%) (Hossain, 2011). The seeds were treated by soaking in solutions for 1 hr of each treatment separately, except in control. In case of control, seeds were soaked in normal water. After 1 hour the fungicidal solutions were drained out and the moistened seeds were kept in the blotter paper to remove excess moisture from the seed surface. Then the seeds were ready for sowing on blotter (blotter method) and tray experiment. Seeds were set for each treatment according to ISTA rules for testing germination of seeds (ISTA 2001). Germination was recorded twice at 7 and 14 days after sowing. Normal seedlings, abnormal seedlings, non-germinated seed and diseased seedlings were counted and expressed in percentage. Vigor test was done following (ISTA, 2001). After 14 days shoot and root length were measured by using measuring scale. 15 seedlings (30 seedlings of each treatment) were randomly selected for measurement of shoot or root length. The seedling vigor was determined following the formula of Baki and Anderson (1972):
Vigor index= (mean of root length+ mean of shoot length) X % of seed germination.

3. Results and Discussion

The result of moisture content of collected hybrid seed samples varied significantly from one to another, while minimum (12.20%) and maximum (14.37%) records were made in Moyna and Meghna, respectively (Table 1). In respect of 1000 - seed weight, the varieties of hybrid rice were also found to vary significantly from one to another, where minimum 1000-seed weight (20.00g) was found in variety Aloron and Hira-1, but maximum weight (26.00g) was recorded in Hira-4 (Table 1). According to Henderson and Christensen (1961), the upper limits of moisture content of rice seeds generally considered safe for long time storage under average condition was 13%. Uddin (2005) determined moisture content of farmers seeds of Begumgonj upazilla of Noakhali district that ranged from 11.86 to 13.83%. Fakir *et al*. (2002) determined the moisture content of farmers seeds collected from Rajshahi, Bogra and Rangpur. They reported that moisture content of farmers seed of 2002 ranged from 7.0 to 13.9% varying with respect to crop season, farmers and locations of seed collection. According to Christensen and Lopez (1965) moisture content of rough rice seed ranged from 13.4 to 13.8%, but 14.15 to 15.34% moisture content of farmers stored rice seed of Joydevpur had been reported by Rahman, (2002 b).

Table 1. Moisture status and 1000-seed weight of hybrid rice seeds collected from different seed sources.

Sl. No	Variety	Seed source	Moisturecontent (%)	1000-seed weight (g)
1	Durber	Ispahani Agro. Ltd, Gazipur, Bangladesh	12.40 cd	24.00 ab
2	Agomoni	Ispahani Agro. Ltd, Gazipur, Bangladesh	12.63 bc	24.00 ab
3	Meghna	Ispahani Agro. Ltd, Gazipur, Bangladesh	14.37 a	22.00 bc
4	Hybrid super	BADC, Mymensingh, Bangladesh	12.43 bcd	24.00 ab
5	Aloron	BRAC, Mymensingh, Bangladesh	12.57 bc	20.00 c
6	Jagoron	BRAC, Mymensingh, Bangladesh	12.60 bc	24.00 ab
7	Moyna	Lal Teer Seed Co. Ltd., Mymensingh, Bangladesh	12.20 d	21.67 bc
8	Tia	Lal Teer Seed Co. Ltd. Mymensingh, Bangladesh	12.73 b	22.00 b
9	Gold	Lal Teer Seed Co. Ltd. Mymensingh, Bangladesh	12.47 bcd	21.67 bc
10	Safollo	Supreme Seed Co. Ltd. Mymensingh, Bangladesh	12.57 bc	22.00 bc
11	Suborno	Supreme Seed Co. Ltd. Mymensingh, Bangladesh	12.67 bc	24.00 ab
12	Hira-1	Supreme Seed Co. Ltd. Mymensingh, Bangladesh	12.67 bc	20.00 c
13	Hira-2	Supreme Seed Co. Ltd. Mymensingh, Bangladesh	12.60 bc	22.00 bc
14	Hira-4	Supreme Seed Co. Ltd. Mymensingh, Bangladesh	12.37 cd	26.00 a
15	Hira-6	Supreme Seed Co. Ltd. Mymensingh, Bangladesh	12.63 bc	22.00 bc
Level of Significance			**	**

** = Significant at 1% level of significance.

Table 2. Health status of hybrid rice seeds collected from different seed sources (blotter method).

SL. No.	Variety	Seed source	Percent seed borne fungi										
			Bipolaris oryzae	***Fusarium moniliforme***	***Fusarium oxysporum***	***Aspergillus flavus***	***Aspergillus niger***	***Aspergillus candidus***	***Alternaria padwickii***	***Alternaria tenuis***	***Penicillium* spp.**	***Curvularia lunata***	***Nigrospora oryzae***
1	Durber	Ispahani Agro. Ltd.	0.0	1.5	1.0	11.0	0.0	10.0	0.0	0.5	0.5	1.0	0.0
2	Agomoni	Ispahani Agro. Ltd.	3.0	0.0	3.5	2.0	0.0	0.5	0.0	0.0	1.0	0.5	0.0
3	Meghna	Ispahani Agro. Ltd.	1.0	2.0	10.5	9.0	3.0	2.0	0.0	0.0	0.0	3.5	2.5
4	Hybrid super	BADC	5.5	1.5	9.0	3.0	1.0	2.5	0.0	0.5	1.0	1.5	0.0
5	Aloron	BRAC	0.0	0.0	2.5		1.0	0.0	0.0	0.5	0.0	0.5	0.0
6	Jagoron	BRAC	5.5	0.0	1.5	2.5	0.0	1.0	0.0	0.0	2.5	3.5	0.5
7	Moyna	Lal Teer Seed Co. Ltd.	24.0	0.0	0.0	8.0	5.0	15.0	0.0	1.0	1.5	1.5	4.0
8	Tia	Lal Teer Seed Co. Ltd.	25.5	0.0	6.0	1.0	0.0	8.0	0.0	2.5	2.0	10.0	2.0
9	Gold	Lal Teer Seed Co. Ltd.	14.0	2.0	6.5	4.0	0.0	12.0	0.0	5.0	6.0	40	3.5
10	Safollo	Supreme Seed Co. Ltd.	10.0	3.0	14.0	0.0	0.0	2.0	0.0	11.0	2.0	5.0	0.0
11	Suborno	Supreme Seed Co. Ltd.	7.0	3.0	9.5	6.5	2.0	7.0	0.0	8.0	0.0	9.0	2.0
12	Hira-1	Supreme Seed Co. Ltd.	8.5	0.0	2.0	0.0	0.0	1.5	0.0	6.0	1.0	2.0	0.0
13	Hira-2	Supreme Seed Co. Ltd.	10.0	1.0	5.0	4.0	0.0	0.0	0.0	6.0	7.0	0.0	0.0
14	Hira-4	Supreme Seed Co. Ltd.	10.5	0.0	18.0	2.5	0.0	5.5	0.0	2.0	0.0	4.5	2.0
15	Hira-6	Supreme Seed Co. Ltd.	10.0	1.0	12.5	4.0	2.0	5.0	0.0	3.0	4.5	3.0	0.0

Table 3. Effect of seed treatment on normal seedlings of different varieties of hybrid rice in Bangladesh (tray method).

Sl No.	Variety	% Normal seedlings						
		Treatment						
		T_1	T_2	T_3	T_4	T_5	T_6	T_7
1.	Durber	86.00 a (+75.51)	66.00 b (+34.70)	84.00 a (+71.43)	77.00 ab (+57.14	79.00 a (+61.22	83.00 a (+69.39)	49.00 c
2.	Agomoni	84.00 a (+43.83)	70.00 c (+20.69)	83.00 ab (+43.10)	71.00 bc (+22.41)	76.00 abc (+31.03)	82.00 abc (+41.38)	58.00 d
3.	Meghna	88.00 a (+60.00)	70.00 b (+27.27	80.00 ab (+45.45)	75.00 ab (+36.36)	74.00 b (+34.55)	79.00 ab (+43.64)	55.00 c
4.	Hybrid super	93.00 a (+69.09)	63.00 cd (+14.54)	76.00 bc (+38.18)	65.00 cd (+18.18)	72.00 bc (+30.91)	83.00 ab (+50.91)	55.00 d
5.	Aloron	85.00 a (+84.79)	56.00 cd (+21.74)	78.00 ab (+69.57)	60.00 cd (+30.43)	60.00 cd (+30.43)	68.00 bc (+47.83)	46.00 d
6.	Jagoron	97.00 a (+169.44)	73.00 b (+102.78)	82.00 b (+178.78)	75.00 b (+108.33)	79.00 b (+119.44)	75.00 b (+108.33)	36.00 c
7.	Moyna	88.00 a (+158.82)	77.00 b (+126.48)	86.00 a (+152.94)	78.00 b (+129.41)	78.00 b (+129.41)	82.00 ab (+141.18)	34.00 c
8.	Tia	85.00 a (+226.92)	54.00 c (+107.69)	84.00 a (+223.08)	66.00 b (+53.85)	68.00 b (+161.54)	82.00 a (+215.38)	26.00 d
9.	Gold	85.00 a (+226.92)	54.00 c (+107.69)	84.00 a (+223.08)	66.00 b (+153.85)	68.00 b (+161.54)	82.00 a (+215.38)	26.00 d
10.	Safollo	90.00 ab (+109.30)	77.00 c (+79.07)	91.00 a (+111.63)	80.00 c (+86.05)	81.00 bc (+88.38)	86.00 abc (+100.00)	43.00 d
11.	Suborno	90.00 ab (+109.30)	77.00 c (+79.07)	91.00 a (+111.63)	80.00 c (+86.05)	81.00 bc (+88.38)	86.00 abc (+100.00)	43.00 d
12.	Hira-1	94.00 a (+135.0)	82.00 b (+105.0)	94.00 a (+135.0)	90.00 ab (+125.0)	90.00 ab (+125.0)	96.00 a (+140.0)	40.00 c
13.	Hira-2	95.00 a (+239.28)	83.00 b (+196.43)	94.00 a (+235.71)	89.00 ab (+217.86)	91.00 a (+225.0)	91.00 a (+225.0)	28.00 c
14.	Hira-4	83.00 a (+69.39)	61.00 cd (+24.49)	77.00 ab (+57.14)	68.00 bc (+38.78)	68.00 bc (+38.78)	72.00 abc (+46.94)	49.00 d
15.	Hira-6	91.00 a (+139.48)	80.00 a (+110.53)	90.00 a (+136.84)	84.00 a (+121.05)	82.00 a (+115.79)	87.00 a (+128.95)	38.00 b

Data in parenthesis indicate % increase over control.

T_1 = BAU-Biofungicide (3%), T_2 = Garlic extract (1:1), T_3= Allamanda leaf extract (1:1) T_4 = Bavistin (0.3%), T_5 = Thiovit (0.3%), T_6= Provax (0.3%), and T_7 = Control (untreated)

Table 4. Effect of seed treatment on abnormal seedlings of different varieties of hybrid rice in Bangladesh (tray method).

Sl No.	Variety	% Abnormal seedlings						
		Treatment						
		T_1	T_2	T_3	T_4	T_5	T_6	T_7
1.	Durber	7.00 b (-58.83)	7.00 b (-58.83)	3.00 b (-82.35)	6.00 b (-64.70)	1.00 b (-94.12)	8.00 b (-52.95)	17.00 a
2.	Agomoni	5.00 bc (-61.54)	4.00 bc (-69.23)	3.00 c (-76.92)	10.00 ab (-23.08)	10.00 ab (-23.08)	4.00 bc (-69.23)	13.00 a
3.	Meghna	1.00	5.00	4.00	7.00	12.00	11.00	2.00
4.	Hybrid super	5.00 b (-76.20)	26.00 a (+23.18)	6.00 b (-71.43)	15.00 ab (-28.57)	24.00 a (-14.29)	5.00 b (-76.19)	21.00 a
5.	Aloron	3.00 bc (-40.00)	10.00 a (-100.00)	2.00 c (-60.00)	1.00 c (-80.00)	4.00 bc (-20.00)	8.00 ab (-60.00)	5.00 abc
6.	Jagoron	1.00 b (-50.00)	11.00 ab (-450.00)	10.00 ab (-400.00)	14.00 a (-600.00)	9.00 ab (-350.00)	18.00 a (-800.00)	2.00 b
7.	Moyna	6.00	6.00	6.00	7.00	6.00	6.00	13.00
8.	Tia	4.00 b (-87.88)	9.00 b (-72.73)	7.00 b (-78.79)	10.00 b (-69.69)	7.00 b (-78.79)	5.00 b (-84.85)	33.00 a

Sl No.	Variety	% Abnormal seedlings						
		Treatment						
		T_1	T_2	T_3	T_4	T_5	T_6	T_7
9.	Gold	4.00 b (-87.88)	9.00 b (-72.73)	7.00 b (-78.79)	10.00 b (-69.69)	7.00 b (-78.79)	5.00 b (-84.85)	33.00 a
10.	Safollo	2.00 c (-71.42)	14.00 a (-100.00)	3.00 bc (-57.14)	11.00 a (-57.14)	10.00 ab (-42.86)	7.00 abc (-0.00)	7.00 abc
11.	Suborno	2.00 c (-71.43)	14.00 a (-100.00)	3.00 bc (-57.14)	11.00 a (-57.14)	10.00 ab (-42.86)	7.00 abc (-0.00)	7.00 abc
12.	Hira-1	2.00 b (-90.0)	9.00 ab (-55.0)	2.00 b (-90.0)	5.00 b (-75.0)	5.00 b (-75.0)	2.00 b (-90.0)	20.00 a
13.	Hira-2	3.00 bc (-83.33)	8.00 b (-55.56)	1.00 c (-94.44)	3.00 bc (-83.33)	1.00 c (-94.44)	2.00 bc (-88.89)	18.00a
14.	Hira-4	8.00 b (-66.67)	15.00 b (-37.5)	12.00b (- 50.0)	11.00 b (-54.17)	15.00 b (-37.5)	11.00 b (-54.17)	24.00a
15.	Hira-6	2.00 b (-80.0)	4.00b (- 60.0)	3.00 b (-70.0)	3.00 b (-70.0)	2.00 b (-80.0)	1.00 b (-90.0)	10.00a

Data in parenthesis indicate % decrease over control.
T_1 = BAU-Biofungicide (3%), T_2 = Garlic extract (1:1), T_3= Allamanda leaf extract (1:1) T_4 = Bavistin (0.3%), T_5 = Thiovit (0.3%), T_6= Provax (0.3%), and T_7 = Control (untreated)

Table 5. Effect of seed treatment on non-germinated seeds of different varieties of hybrid rice in Bangladesh (tray method).

Sl No.	Variety	% Non germinated seeds						
		Treatment						
		T_1	T_2	T_3	T_4	T_5	T_6	T_7
1.	Durber	6.00 d (-82.35)	27.00 b (-20.59)	13.00 cd (-61.77)	17.00 c (-50.00)	20.00 bc (-41.18)	6.00 d (-82.35)	34.00 a
2.	Agomoni	11.00	26.00	14.00	19.00	14.00	14.00	19.00
3.	Meghna	11.00 c (-73.17)	24.00 b (-41.46)	15.00 bc (-63.41)	19.00 bc (-53.66)	22.00 bc (-46.34)	11.00 c (-73.17)	41.00 a
4.	Hybrid super	2.00 b (-90.91)	9.00 b (-59.09)	4.00 b (-81.82)	8.00 b (-63.64)	3.00 b (-86.36)	9.00 b (-59.09)	22.00a
5.	Aloron	4.00 d (-90.24)	36.00 bc (-12.20)	20.00 cd (-51.22)	39.00 b (-4.88)	36.00 bc (-12.19)	24.00 bc (-41.47)	41.00a
6.	Jagoron	2.00 d (-96.61)	16.00 b (-72.88)	8.00 bcd (-86.44)	11.00 bcd (-81.35)	12.00 bc (-79.67)	6.00 cd (-89.83)	59.00a
7.	Moyna	6.00 d (-88.68/)	17.00 b (-67.92)	7.00 cd (-86.80)	15.00 b (-71.69)	14.00 bc (-73.59)	12.00 bcd (-77.36)	53.00a
8.	Tia	11.00 d (-73.17)	37.00 ab (-9.76)	9.00 d (-78.05)	24.00 c (-41.46)	25.00 bc (-39.02)	13.00 cd (-68.29)	41.00a
9.	Gold	11.00 d (-73.17)	37.00 ab (-9.76)	9.00 d (-78.05)	24.00 c (-41.46)	25.00 bc (-39.02)	13.00 cd (-68.29)	41.00a
10.	Safollo	6.00 b (-87.76)	7.00 b (-85.71)	6.00 b (-87.76)	9.00 b (-81.64)	8.00 b (-83.68)	7.00 b (-85.71)	49.00a
11.	Suborno	6.00 b (-87.76)	7.00 b (-85.71)	6.00 b (-87.76)	9.00 b (-81.64)	8.00 b (-83.68)	7.00 b (-85.71)	49.00a
12.	Hira-1	4.00 b (-89.74)	9.00 b (-76.92)	5.00 b (-87.18)	4.000 b (-89.74)	5.00 b (-87.18)	3.00 b (-92.31)	39.00 a
13.	Hira-2	2.00 bc (-96.30)	9.00 b (-83.33)	4.00 bc (-92.60)	8.00 bc (-85.19)	6.00 bc (-88.89)	0.40 c (-99.26)	54.00 a
14.	Hira-4	9.00 b (-50.0)	8.00 b (-55.56)	3.00 b (-83.33)	9.00 b (-50.0)	7.00 b (-61.11)	5.00 b (-72.22)	18.00 a
15.	Hira-6	7.00 b (-86.80)	15.00 b (-71.70)	7.00 b (-86.80)	13.00 b (-75.48)	15.00 b (-71.70)	12.00 b (-77.36)	53.00 a

Data in parenthesis indicate % decrease over control.
T_1 = BAU-Biofungicide (3%), T_2 = Garlic extract (1:1), T_3= Allamanda leaf extract (1:1) T_4 = Bavistin (0.3%), T_5 = Thiovit (0.3%), T_6= Provax (0.3%), and T_7 = Control (untreated)

Table 6. Effect of seed treatment on vigor index of different varieties of hybrid rice in Bangladesh (tray method).

Sl No.	Variety	% Vigor index						
		Treatment						
		T_1	T_2	T_3	T_4	T_5	T_6	T_7
1.	Durber	2353.96 a (+214.08)	1423.92 d (+89.99)	2164.40 ab (+188.79)	1541.93 d (+105.73)	1783.62 c (+137.99)	1978.39 bc (+163.97)	749.48 e
2.	Agomoni	2045.16 a (+216.42)	1192.10 d (+84.44)	1824.89 ab (+182.34)	1331.87 d (+106.06)	1472.63 cd (+127.84)	1640.09 bc (+153.74)	646.35 e
3.	Meghna	2338.02 a (+282.40)	1534.74 d (+151.02)	2025.38 b (+231.27)	1620.12cd (+164.99)	1818.09bc (+197.35)	1939.06 b (+217.15)	611.41 e
4.	Hybrid super	2246.64 a (+257.93)	1493.11d (+137.88)	1991.22ab (+217.23)	1632.29cd (+160.05)	1742.22bcd (+177.57)	1863.64bc (+196.81)	627.68 e
5.	Aloron	1839.97 a (+202.50)	1081.40 (+77.79)	1483.47bc (+143.89)	1109.46 d (+82.40)	1272.42cd (+109.20)	1607.22ab (+164.23)	608.26 e
6.	Jagoron	2313.21 a (+389.78)	1549.30 e (+228.03)	2107.45 b (+346.21)	1643.36de (+247.95)	1784.38cd (+277.81)	1874.67 c (+296.92)	472.30 f
7.	Moyna	2603.13 a (+468.84)	1779.02 b (+288.75)	2978.26 a (+550.82)	1980.45 b (+332.78)	1960.26 b (+328.36)	2024.73 b (+342.45)	457.62 c
8.	Tia	2608.65 a (+633.78)	1701.54 c (+378.62)	2548.25 a (+616.79)	2000.81 b (+462.79)	2057.59 b (+478.78)	2099.54 b (+490.58)	355.51 d
9.	Gold	2662.10 a (+713.78)	1727.23 c (+427.99)	2558.05 a (+681.97)	1986.00 b (+507.09)	2072.39 b (+533.51)	2116.02 b (+546.84)	327.13 d
10.	Safollo	2309.63 a (+363.93)	1677.62 c (+236.98)	2300.31 a (+362.06)	1941.65c (+290.01)	1960.96 b (+293.89)	1844.74c (+270.55)	497.84 d
11.	Suborno	2438.68 a (+435.70)	1684.94 c (+270.13)	2378.71 a (+422.53)	1949.31 b (+328.20)	1947.32 b (+327.77)	1847.39bc (+305.82)	455.23 d
12.	Hira-1	2503.87 a (+311.60)	1712.08 c (+181.43)	2522.78 a (+314.70)	1874.43bc (+208.12)	1941.20bc (+219.09)	2097.96 b (+244.87)	608.34 d
13.	Hira-2	2508.31a (+299.58)	1752.43c (+179.25)	2658.75a (+323.68)	1884.94c (+200.37)	1961.71c (+212.60)	2114.13b (+236.90)	627.54 d
14.	Hira-4	3027.22 a (+326.73)	1474.22 d (+107.88)	2771.16ab (+290.63)	1800.95 d (+153.87)	2155.14 c (+203.80)	2441.96bc (+244.23)	709.40 e
15.	Hira-6	2474.31a (+329.34)	1721.66b (+198.74)	2517.87a (+336.90)	1859.50b (+222.66)	1939.61b (+236.56)	2073.76b (+259.84)	576.30 c

Data in parenthesis indicate % increase over control.

T_1 = BAU-Biofungicide (3%), T_2 = Garlic extract (1:1), T_3= Allamanda leaf extract (1:1) T_4 = Bavistin (0.3%), T_5 = Thiovit (0.3%), T_6= Provax (0.3%), and T_7 = Control (untreated)

Health status of hybrid rice seeds of 15 varieties were tested by standard blotter incubation test (Table 2). It revealed that the seeds were found to be associated with 11 different seed borne fungi belonging to six genera viz. *Bipolaris oryzae, Fusarium moniliforme, Fusarium oxysporum, Aspergillus flavus, Aspergillus niger, Aspergillus candidus, Alternaria padwickii, Alternaria tenuis, Penicillium spp., Curvularia lunata,* and *Nigrohpora oryzae*. The incidence of *Bipolaris oryzae* (0.0 to 25.5%), *Fusarium moniliforme* (0.00 to 3.0%), *Fusarium oxysporum* (0.0 to 18.0%), *Aspergillus flavus* (0.00 to 11.0%), *Aspergillus niger* (0.00 to 5.0%), *Aspergillus candidus* (0.00 to 15.0%), *Penicillium spp*. (0.0 to 7.0%) , *Alternaria padwickii* (0.0 to 1%), *Alternaria tenuis* (0.0 to 11.0%), *Curvularia lunata* (0.0 to 40.0%) and *Nigrospora oryzae* (0.0 to 4.0%) were recorded. Out of the samples tested, Moyna, Tia, Gold, Safolo, Hira-2, Hira-4 and Hira–6 were recorded to have higher degree of seed borne pathogens. The association of seed borne fungi of rice had also been observed by a good number of researchers (Mia and Fakir, 1977; Mendoza and Monila, 1980; Mia and Mathur, 1983; Agarwal *et al*. 1990; Sharma *et al*, 1997, Bicca *et al.* 1998, Fakir. 2000, Naeem Khalid *et al*. 2001 and Fakir *et al*. 2003). Mandoza and Molina (1980) analyzed the seed samples of 10 rice varieties following blotter method of seed health test. They reported that *Drechslera oryzae, Trichoconis padwickii, Fusarium moniliforme, Curvularia oryzae, Curvularia lunata* and *Aspergillus spp*. were associated with the seed and causing 32%, 10%, 5%, 8%,6%, and 2% seedling abnormalities, respectively.

The tested samples resulted normal seedlings 26.00 to 97.00%, where the highest percentage of normal seedling was recorded when the seeds of Jagoron variety were treated with BAU-Biofungicide. Upto 239.28% higher formation of Normal seedlings, respectively over control was achieved by treating seeds with BAU-

Biofungicide (Table 3). This finding is supported by Naznin and Hossain (2004), Sultana *et al*. (2009) and Hossain (2011). On the other hand, it results significant decrease (upto 90.00%) in formation of abnormal seedlings over the control treatment (Table 4). The highest non-germinated seed (59.00%) was obtained from untreated control while the lowest non-germinated seed (2.00%) was recorded when seeds treated with BAU Bio-fungicide (Table 5). The lowest decrease of non-germinated seeds (96.61%) over control was recorded when seeds treated with Provax which was followed by seed treatment with BAU-Biofungicide and Allamanda leaf extract. The lowest deccrease of non-germinated seeds (4.88%) over control was found in Bavistin followed by Garlic clove extract (Table 5). The vigor index ranged from 327.13 to 2978.26.Vigor index of treated seeds also increased by up to 713.78% over the untreated control when seeds treated with BAU-Biofungicide (Table6). This is an agreement with the findings of Hossain (2011). All the botanicals significantly increased the germination percentage and growth characters of rice seedling. The present findings supported by the reports of Ahmed *et al.* (2013); Roy *et al.* (2011), Amin *et al.* (2009) and Hoassain *et al.* (2005). Ahmed *et al.* (2013) evaluated five different plants extracts viz Garlic, Allamanda, Neem, Chirata and Bishkatali with two dilutions (1:1 and 1:2) for rice seed treatment. Garlic extract (1:1) dilution found superior for successfully reduction of seed-borne infection and also increased seed germination up to 68.39% over control. Neem (1:1) and Chirata (1:1) extracts also increased seed germination up to 66.09% and 67.81%, respectively. Among the five plant extracts with two dilutions (1:1 and 1:2), garlic (1:1) were most effective in controlling seed-borne fungal flora of rice followed by Neem (1:1) and Chirata (1:1) extract.. Roy *et al.* (2011) reported that five plant extracts viz. garlic tablet, Allamanda tablet, Neem leaf extract, Bishkatali leaf extract and Zinger rhizome extract were assessed as seed treating agents against seed-borne pathogens of jute. Garlic tablet was effective in controlling seed-borne fungal infection; consequently the seed germination was high. The effect of Allamanda tablet was similar to that of garlic tablet. Neem leaf extract was able to reduce seed-borne fungi but the other three extracts were not effective in controlling seed-borne infection. The performance of garlic tablet was similar to that of Vitavax-200. A significant increase in seedling vigor was also observed over untreated control after garlic treatment. Amin *et al.* (2009) reported the efficacy of garlic tablets in controlling seed-borne fungal pathogens of cucumber. Suspension of garlic tablet prepared in water at the concentrations of 1:3, 1:4, 1:5 and 1:6. Seeds of cucumber were treated with the suspensions for 15 minutes. Seeds under control were treated with plain water. All concentrations of the material caused significant decrease in the prevalence of seed-borne fungi, occurrence of abnormal seedlings and rotten seeds as compared to control. On the other hand, germination increased over control due to seed treatment with garlic tablet. The higher increase in germination and reduction in occurrence of seed-borne fungi, rotten seed and abnormal seedling were corroborated with higher doses of garlic tablet. Hoassain *et al.* (2005) tested different plant parts of Bishkatali, Vatpata, Garlic, Gagra, Bitter gourd and Neem against fungi associated with wheat seeds by blotter method. Out of 6 plant species, Neem extract was turned up as superior among the selected extracts followed by Garlic, Bishkatali and Vatpata.

4. Conclusions

Based on the findings of the present study it may be concluded that among different seed treatment agents BAU-Biofungicide (3%) has been proved as superior for improving quality of hybrid seeds of rice and considered as effective, economic and eco-friendly disease management strategy.

Conflict of interest

None to declare.

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