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EFFECT OF FOUR PRE- STORAGE SEED TREATING CHEMICALS ON MAINTAINING SEED QUALITY AND REDUCING STORAGE COST OF RICE SEED

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ABSTRACT

A laboratory experiment was conducted at the department of Agronomy, SAU, Dhaka with two rice varieties (BR11 and BRRI dhan87) and five pre- storage seed treating chemicals (no pre-storage seed treatment, ascorbic acid @ 500 mg kg^{-1} seed, common bleaching powder @ 2 g kg^{-1} seed, red- chilli @ 2 g kg^{-1} seed and aspirin @ 2 g kg^{-1} seed). The treatments were arranged in a completely randomized design with four replications. Eighty containers of which forty were filled with 250 g BR11 and rest with 250 g BRRI87 rice seeds. Seeds of each container were treated as per treatment. Seed quality attributes viz., germination (%), viability (%), germination speed index, seedling vigor index, seedling dry weight, mean root length of seedling, mean shoot length of seedling, mean total length of seedling and relative values of these parameters were recorded at storage, 8 months after storage and 9 months after storage. Results indicated that up to 8 months after storage germination, viability, relative seed germination and relative viability were statistically similar in both BR11 and BRRI dhan87. But at 9 months after storage, these parameters were reduced drastically in BR11, whereas statistically similar to at 8 months after storage. Ascorbic acid and red chilli showed improved status in these parameters at 9 months after storage remarkably in BR11, whereas in BRRI dhan 87 effects were negligible.

Keywords: pre- storage, rice, seed treating chemicals, seed quality, storage cost

INTRODUCTION

Rice (*Oryza sativa*) is a key food security crop in many countries of the world including Bangladesh. It is one of the most important and extensively cultivated cereal crops in Bangladesh since the ancient time (Rashid and Fakir, 2002). In Bangladesh, approximately 80% of the total cultivated land covering about 11.20 million hectares produces 43.50 million tones of rice annually (Anonymous, 2009).

Although rice is the staple food of the people of Bangladesh and cultivated extensively, yet its yield is low compared to other rice growing countries of the world. Some of the factors contributing to low yields of rice include pests and diseases, low- quality seeds, water scarcity and lack of appropriate storage facilities (Onyango, 2014). Seed is one of the vital inputs for crop production. It has been shown that only by using good quality seed rice yield could be increased by 15 to 20% (Islam *et al.,* 2010).

In Bangladesh, more than 80% of the rice seeds are produced and preserved by farmers (Fakir and Islam, 2007), which are not produced and preserved following proper seed technological knowledge. Seed storage is an important aspect of any sound seed program, because badly stored seeds are not much helpful to produce healthy and vigorous plants. Seed deterioration starts immediately after harvest and therefore, post- harvest handling of rice seed plays a key role in the maintenance of seed quality (Vange *et al.,* 2016). It is important to preserve the genetic integrity of seeds during storage to retain high seed quality (Pradhan and Badola, 2012). Factors that affect the quality of seed during storage include drying temperature, seed moisture content, pest and disease infestation, packing material and duration of storage (Jyoti and Malik, 2013) of which storage temperature and moisture content are the crucial.

Seed processing and storage facilities of Bangladesh Agricultural Development Corporation (BADC) are inadequate to cater for both public and private sector needs. Seed production, processing and storage require elaborate infrastructure and sizeable capital, beyond the capacity of most NGOs and private sector enterprises. There is a genuine dearth of quality seeds. However, provisions of

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maintaining continuous artificial lower temperature and lower relative humidity in controlled environment for storing seeds requires high cost which makes the seed price very high.

Therefore, farmers themselves supply most seeds but since they have inadequate knowledge of producing and preserving good seeds, quality of seeds at farmers level deteriorates very fast (Kabir *et al.,* 2013). They store their seeds in gunny bags, earthen pots, tin boxes, gola etc. and these storage bags or containers are kept in ambient higher temperature. Due to high temperature and high moisture content, certain biochemical changes take place in seeds when stored in ambient temperature.

Among the biochemical changes take place in seeds during storage, lipid peroxidation, protein inactivation, enzyme inactivation and oxidative damage are the most important through which seeds are deteriorated very fast (Layek *et al.,* 2012). Due to lack of proper knowledge of farmers to produce quality seeds, lack of providing infrastructural facilities of storing quality seeds with low cost by public sectors specially by BADC and storing seeds in ambient conditions by the farmers, seed quality deteriorates very fast and thereby rice production decreased remarkably.

Pre- storage treatment of seeds with antioxidants *viz.,* tocopherol, starch phosphate, ascorbic acid, cinnamic acid and butylated hydroxy toluene (BHT) have been reported to improve seed vigour and storability in maize and mustard (Islam *et al.,* 2012), french bean, pea, lentil, millet (Chhetri *et al.,* 1993) and jute (Chaudhury and Choudhuri, 1994). In view of protecting biochemical degradation in seeds during storage and lowering the cost of seed storage, appropriate seed treating chemicals should be identified for rice seed. Therefore, this experiment was initiated to develop an effective seed treatment technique for maintaining quality of rapidly deteriorating rice seed during storage, to increase the productivity of rice by utilizing quality rice seed by the farmers and to increase availability of quality rice seed to the farmers at lower price.

MATERIALS AND METHODS

A laboratory experiment was conducted from December 2019 to September 2020 at the Department of Agronomy in Sher-e- Bangla Agricultural University to find out the appropriate pre- storage treatment technique for rice in order to increase rice productivity through maintaining seed quality during seed storage and reducing storage cost. The experiment was comprised two factors; factor- A:two varieties viz., V_1 = BR11 and V_2 = BRRI dhan87, factor- B: five seed pre- storage seed treatments, viz., T_0 = no seed treatment (control), T_1 = Celin (a.i., ascorbic acid @ 500 mg / kg of seed), T_2 = Carbendazim (Carbamate group, i.e., aspirin @ 2 g/ kg seed), T_3 = Common bleaching powder (a.i. calcium hypochlorite @ 2 g / kg seed) and T_4 = Red chilli powder (@ 2 g / kg of seed), and were arranged in randomized complete block design with four replications. The experiment was set at room temperature using 40 containers where each replication included 10 (2 varieties × 5 pre- storage treatments) containers. First of all, collected seeds were sun- dried and each pot was filled with 250 g seeds (twenty containers with BR11 rice seed and twenty with BRRI dhan87 rice seed). Thereafter all the containers were given treatment marks with replication and seeds were treated with pre- storage seed treating chemicals as per treatment. At starting of storage, at 8 months after storage and at 9 months after storage, data on germination percentage, seed viability, germination speed index, seedling vigor index, seedling dry weight, mean seedling shoot length, mean seedling root length, mean total seedling length, relative seed germination percentage, relative seed viability, relative germination speed index were recorded. The data were statistically MSTAT- C computer package program and mean separation were done by 5% level of significance (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Germination percentage

Pre- storage seed treatment had variable effects on germination percentage under different seed storage durations of two rice varieties (Table 1). Results indicated that although the initial germination percentage (GP) at the beginning of storage was higher in BR11 (95.5%) compared to BRRI dhan87 (92.0%), finally at 9 months after storage germination percentage were reduced, respectively by 46%

and 88% under control condition (without pre- storage seed treatment). There was a drastical reduction in GP from 8 months to 9 months after storage in BR 11 compared to BRRI dhan 87. Finally in BR11, significantly highest reduction in GP (46.0% GP and 51.8% reduction compared to initial GP) was found in the treatment having without pre- storage seed treatment. Pre- storage seed treatment with ascorbic acid (AA) and red chilli showed the significantly lowest reduction in GP (66.0% GP and 30.9% reduction compared to initial GP), which were statistically similar to that of treatment consisting pre- storage seed treatment with aspirin (GP 64% and reduction 33% compared to initial GP). Whereas in BRRI dhan87, pre- storage treatment with AA and aspirin showed the highest reduction in GP (GP 86.0% and 8.5% reduction compared to initial GP), which were statistically followed by that of treatment consisting without pre- storage seed treatment. Pre-storage seed treatment with bleaching powder showed significantly lowest reduction in GP (92% GP and 2.1% reduction compared to initial GP), which was significantly followed by that of treatment consisting pre- storage seed treatment with red chilli (GP 90% and reduction 4.3% compared to initial GP). These results are in conformity with the findings of Ahmad *et al.* (2012) and Kumar *et al.* (2020).

Table 1. Seed germination (%) and seed viability (%) of two rice varieties at different storage period as influenced by pre storage seed treatment

Treatment	Seed germination (%)						Seed viability (%)					
	BR 11			BRRI Dhan87			BR 11			BRRI Dhan87		
	At storage	8 months after storage	9 months after storage	At storage	8 months after storage	9 months after storage	At storage	8 months after storage	9 months after storage	At storage	8 months after storage	9 months after storage
Control	95.5	90.0 (-5.8)	46.0 (-51.8)	94.0	92.0 (-2.1)	88.0 (-6.4)	97.5	93.0 (-4.6)	37.5 (-61.5)	98.0	93.0 (-5.1)	84.0 (-14.3)
AA	95.5	90.0 (-5.8)	66.0 (-30.9)	94.0	92.0 (-2.1)	86.0 (-8.5)	97.5	90.5 (-7.2)	66.5 (-31.8)	98.0	92.0 (-6.1)	79.0 (-19.4)
Aspirin	95.5	94.0 (-1.6)	64.0 (-33.0)	94.0	88.0 (-6.4)	86.0 (-8.5)	97.5	96.0 (-1.5)	65.0 (-33.3)	98.0	87.0 (-11.2)	84.0 (-14.3)
Bleaching powder	95.5	90.0 (-5.8)	54.0 (-43.5)	94.0	96.0 (+2.1)	92.0 (-2.1)	97.5	88.5 (-9.2)	46.5 (-52.3)	98.0	92.5 (-5.6)	86.0 (-12.2)
Red chili	95.5	88.0 (-7.9)	66.0 (-30.9)	94.0	94.0 (0.0)	90.0 (-4.3)	97.5	86.0 (-11.8)	64.5 (-33.8)	98.0	90.0 (-8.2)	82.5 (-15.8)
$LSD_{(0.05)}$	NS	1.8	3.2	NS	1.8	3.2	NS	1.9	2.8	NS	1.9	2.8
CV (%)	1.8	2.4	3.6	1.8	2.4	3.6	1.9	2.7	3.3	1.9	2.7	3.3

Seed Viability

Pre- storage seed treatment had variable effects on seed viability under different seed storage duration of two rice varieties (Table 1). Results indicated that the initial seed viability (SV) at storage was more or less similar in BR11 (97.5%) and in BRRI dhan87 (98.0%), finally at 9 months after storage germination percentage were reduced, respectively to 37.5% and 84.0% under control condition (without pre- storage seed treatment). There was a drastical reduction in SV from 8 months to 9 months after storage in BR11 compared to BRRI dhan87. Finally in BR11, significantly highest reduction in SV (37.5% SV and 61.5% reduction compared to initial SV) was found in the treatment having without pre- storage seed treatment. Pre- storage seed treatment with ascorbic acid (AA) showed the significantly lowest reduction in SV (66.5% SV and 31.8% reduction compared to initial SV), which was statistically similar to that of treatment consisting pre- storage seed treatment with aspirin (SV 65% and reduction 33.3% compared to initial SV) and red chilli (SV 64.5% and reduction 33.8% compared to initial SV). Whereas in BRRI dhan87, pre- storage treatment with AA the highest reduction in SV (SV 79.0% and 19.4% reduction compared to initial SV), which was statistically different from that of all other treatment. Pre-storage seed treatment with bleaching powder showed significantly lowest reduction in SV (86% SV and 12.2% reduction compared to initial SV), which was significantly followed by that of treatment consisting pre- storage seed treatment with red chilli and without pre- storage seed treatment (SV 84% and reduction 14.3% compared to initial SV). These results are in conformity with the findings of Basra *et al.* (2006) and Kumar *et al.* (2020).

Germination speed index

Variable effects were observed due to pre- storage seed treatment on germination speed index (GSI) under different seed storage duration of two rice varieties (Table 2). Results indicated that the initial germination speed index (GSI) at storage was much lower in BR11 (9.19) compared to that in BRRI dhan 87 (12.40), at 8 months after storage, GSI was increased in BR11 (12.70) whereas it was more or less similar in BRRI dhan87 (12.17) and finally at 9 months after storage GSI was reduced respectively to 4.83 and 9.80 under control condition (without pre- storage seed treatment). There was a drastical reduction in GSI from 8 months to 9 months after storage in BR11 compared to BRRI dhan87. Finally in BR11, significantly highest reduction in GSI (47.44%) compared to initial GSI was found in the treatment having without pre- storage seed treatment whereas this reduction was 21.77% in BRRI dhan87. Pre- storage seed treatment with red chilli in BR11 showed the significantly lowest reduction in GSI (7.93 and 13.71% reduction compared to initial GSI), which was statistically similar to that of treatment consisting pre- storage seed treatment with ascorbic acid (AA) (GSI 7.75 and reduction 15.67% compared to initial GSI) and aspirin (GSI 7.43 and reduction 19.15% compared to initial GSI). On the other hand, in BRRI dahn87, finally significantly highest reduction in GSI (26.69%) compared to initial GSI was found in the treatment having pre- storage seed treatment with AA, whereas this reduction was 15.67% in BR11. Pre- storage seed treatment with bleaching powder in BRRI dhan87 showed the significantly lowest reduction in GSI (GSI 10.80 and 12.9% reduction compared to initial GSI), which was significantly different from that of all other treatments. Pre- storage seed treatment with red chilli (GSI 9.97 and reduction 19.60% compared to initial GSI) and aspirin (GSI 9.90 and reduction 20.16% compared to initial GSI) showed statistically identical reduction. These results are also supported for three oilseed crops by the findings of Dolatabadian and Sanavy (2008), which showed the remarkable reduction in GSI after a certain period of storage as well as the improvement in this parameter with pre- storage treatments using ascorbic acid.

Seedling vigor index

Variable effects of pre- storage seed treatment were observed on seedling vigor index (SVI) under different seed storage duration of two rice varieties (Table 2). Results indicated that the initial seedling vigor index (SVI) at storage was comparatively higher in BR11 (17.90) compared to that in BRRI dhan87 (16.74), at 8 months after storage SVI was increased both in BR11(20.65) and BRRI dhan87 (22.41) and finally at 9 months after storage SVI was drastically reduced in BR11 (8.05) whereas it was more or less similar in BRRI dhan 87 (21.06) compared to that of 8 months after storage under control condition (without pre- storage seed treatment). Finally, at 9 months after storage, pre- storage seed treatment with ascorbic acid (AA) in BR11 showed the significantly lowest reduction in SVI (13.46 SVI and 24.80% reduction compared to initial SVI), which was statistically different from that of all other treatments. Treatment, consisting pre- storage seed treatment with aspirin showed statistically similar reduction (SVI 11.22 and reduction 37.31% compared to initial SVI) to that of red chilli (SVI 11.19 and reduction 37.49% compared to initial SVI), which are significantly different from that of bleaching powder (SVI 9.80 and reduction 45.25% compared to initial SVI) and without pre- storage seed treatment (SVI 8.05 and reduction 55.03% compared to initial SVI). Whereas at 9 months after storage in BRRI dhan87, pre- storage treatment with AA showed the significantly lowest reduction in SVI (SV 16.37 and 2.21% reduction compared to initial SVI), which was statistically different from that of all other treatment. Whereas, pre-storage seed treatment with bleaching powder showed significantly different reduction SVI (20.22 SVI and 20.79%% reduction compared to initial SV), which was significantly followed by that of red chilli (SVI 20.23 and 20.85% reduction compared to initial SVI), aspirin (SVI 20.32 and 21.39% reduction compared to initial SVI) and without pre- storage seed treatment (SVI 21.06 and reduction 25.81% compared to initial SVI). The results obtained for BR11 are also supported for three oilseed crops by the findings of Dolatabadian and Sanavy (2008), which showed the remarkable reduction in SVI after a certain period of storage as well as the improvement in this parameter with pre- storage treatments using ascorbic acid.

Table 2. Germination speed index and seedling vigor index of two rice varieties at different storage period as influenced by pre- storage seed treatment

Treatment	Germination speed index (GSI)						Seedling vigor index (SVI)					
	BR 11			BRRI Dhan87			BR 11			BRRI Dhan87		
	At storage	8 months after storage	9 months after storage	At storage	8 months after storage	9 months after storage	At storage	8 months after storage	9 months after storage	At storage	8 months after storage	9 months after storage
Control	9.19	12.70 (+38.19)	4.83 (- 47.44)	12.40	12.17 (-1.85)	9.70 (-21.77)	17.90	20.65 (+15.36)	8.05 (-55.03)	16.74	22.41 (+33.87)	21.06 (+25.81)
AA	9.19	12.82 (+39.50)	7.75 (-15.67)	12.40	12.55 (+ 1.21)	9.09 (- 26.69)	17.90	21.19 (+18.38)	13.46 (-24.80)	16.74	23.45 (+40.08)	16.37 (-2.21)
Aspirin	9.19	13.23 (+43.96)	7.43 (-19.15)	12.40	11.38 (- 8.23)	9.90 (- 20.16)	17.90	22.23 (+24.19)	11.22 (-37.31)	16.74	22.66 (+ 35.61)	20.32 (+21.39)
Bleaching powder	9.19	12.15 (+32.21)	6.43 (-30.03)	12.40	13.25 (+ 6.85)	10.80 (- 12.9)	17.90	21.08 (+17.77)	9.80 (-45.25)	16.74	23.86 (+42.53)	20.22 (+20.79)
Red chili	9.19	11.72 (+27.53)	7.93 (-13.71)	12.40	13.28 (+7.10)	9.97 (- 19.60)	17.90	18.14 (+1.34)	11.19 (-37.49)	16.74	23.88 (+42.65)	20.23 (+20.85)
$LSD_{(0.05)}$	NS	0.92	1.12	NS	0.92	1.12	NS	1.92	1.22	NS	1.92	1.22
CV (%)	2.30	2.02	3.20	2.30	2.02	3.20	2.34	2.02	3.52	2.34	2.02	3.52

Figures in the parentheses indicate reduction/increment in SV compared to initial SV (at storage); negative signs indicate reduction and positive signs indicate increment

Seedling dry weight

Variable effects of pre- storage seed treatment were observed on seedling dry weight (SDW) under different seed storage duration of two rice varieties (Table 3). Results indicated that the initial seedling dry weight (SDW) at storage was comparatively higher in BR11 (13.50 mg seedling^{-1}) compared to that in BRRI dhan87 (11.50 mg seedling^{-1}), at 8 months after storage SDW was increased both in BR11(18.00 mg seedling^{-1}) and BRRI dhan87 (17.10 mg seedling^{-1}) and finally at 9 months after storage SDW was reduced both in BR11 (11.10 mg seedling^{-1}) and BRRI dhan87 (12.10 mg seedling^{-1}) compared to that of 8 months after storage under control condition (without pre- storage seed treatment). Finally, at 9 months after storage, although pre- storage seed treatment with ascorbic acid (AA) in BR11 showed the lowest reduction in SDW (11.20 mg seedling^{-1} SDW and 17.04% reduction compared to initial SDW), was statistically similar to that of all other treatments along with control (without pre- storage seed treatment). Whereas at 9 months after storage in BRRI dhan87, pre- storage treatment with AA increased SDW (SDW 12.20 mg seedling^{-1} and 6.09% increment compared to initial SDW), which was statistically similar to that both of control (without pre- storage seed treatment and treatment consisting red chilli (SDW 12.1 mg seedling^{-1} and 5.22% increment compared to initial SDW). Whereas, pre-storage seed treatment with both aspirin and bleaching powder showed significantly lowest reduction in SDW (SDW 10.10 mg seedling^{-1} and 12.17% reduction compared to initial SDW). Ishrat *et al*. (2014) and Kumar *et al*. (2020) supported the results obtained for BR11 from their experimental findings with maize and onion, respectively where SDW were reduced after a certain period of storage as well the improvement of these parameter by dry- seed treatment with ascorbic acid.

Mean root length of seedling

Variable effects of pre- storage seed treatment were observed on mean root length of seedling (MRLS) under different seed storage duration of two rice varieties (Table 3). Results indicated that the initial mean root length of seedling (MRLS) at storage were more or less similar in BR11 (13.58 cm) and BRRI dhan87 (13.65 cm), at 8 months after storage MRLS was reduced 17.45% in BR 11 (MRLS 11.21 cm) and 21.25% in BRRI dhan 87 (MRLS 10.75 cm) compared to that of initial MRLS. Finally at 9 months after storage MRLS was reduced 46.39% in BR11 (MRLS 7.28 cm) and 50.40% in BRRI dhan87 (MRLS 6.77 cm) compared to that of initial MRLS under control condition (without pre-storage seed treatment). Finally, at 9 months after storage, pre- storage seed treatment with ascorbic acid (AA) in BR11 showed the significantly lowest reduction in MRLS (8.84 cm MRLS and 34.90% reduction compared to initial MRLS), which was statistically similar to that of bleaching powder and control (without pre- storage seed treatment). Treatment, consisting pre- storage seed treatment with aspirin showed the highest reduction (MRLS 6.54 cm and reduction 51.84% compared to initial MRLS) which was statistically similar to that of red chilli (MRLS 6.94 cm and reduction 42.56% compared to initial MRLS). Whereas at 9 months after storage in BRRI dhan87, pre- storage treatment with aspirin showed the significantly lowest reduction in MRLS (MRLS 9.64 cm and 29.38% reduction compared to initial MRLS), which was statistically different from that of all other treatment. Pre-storage seed treatment with AA showed significantly highest reduction in MRLS (5.58 cm MRLS and 59.12%% reduction compared to initial MRLS), which was statistically similar that of control (MRLS 6.77cm and 50.40% reduction compared to initial MRLS). Mean root length of seedlings as influenced by the treatments were also supported by the findings of Pal and Basu (1994).

Table 3. **Seedling dry weight and mean seedling root length of two rice varieties at different storage period as influenced by pre- storage seed treatment**

Treatment	Seedling dry weight (SDW) (mg seedling^{-1})						Mean seedling root length (MSRL) cm)					
	BR 11			BRRI Dhan87			BR 11			BRRI Dhan87		
	At storage	8 months after storage	9 months after storage	At storage	8 months after storage	9 months after storage	At storage	8 months after storage	9 months after storage	At storage	8 months after storage	9 months after storage
Control	13.5	18.0 (+33.33)	11.1 (-17.78)	11.5	17.1 (+48.70)	12.1 (+5.22)	13.58	11.21 (-17.45)	7.28 (-46.39)	13.65	10.75 (-21.25)	6.77 (-50.40)
AA	13.5	13.4 (-0.74)	11.2 (-17.04)	11.5	16.5 (+43.48)	12.2 (+6.09)	13.58	11.30 (-16.79)	8.84 (-34.90)	13.65	11.18 (-18.10)	5.58 (-59.12)
Aspirin	13.5	18.5 (+37.04)	10.1 (-25.19)	11.5	19.0 (+65.22)	10.1 (-12.17)	13.58	12.25 (-9.79)	6.54 (-51.84)	13.65	12.25 (-10.26)	9.64 (-29.38)
Bleaching powder	13.5	16.1 (+19.26)	10.1 (-25.19)	11.5	17.0 (+47.83)	10.1 (-12.17)	13.58	11.62 (-14.43)	7.80 (-42.56)	13.65	10.94 (-19.85)	8.22 (-39.78)
Red chili	13.5	16.5 (+22.22)	10.1 (-25.19)	11.5	16.5 (+43.48)	12.1 (+5.22)	13.58	9.47 (-30.27)	6.94 (-48.90)	13.65	11.19 (-18.02)	7.90 (-42.12)
$LSD_{(0.05)}$	NS	1.12	0.56	NS	1,12	0.56	NS	1.18	1.68	NS	1.18	1.68
CV (%)	2.53	2.37	2.8	2.53	2.37	2.8	2.79	2.14	3.01	2.79	2.14	3.01

Mean shoot length of seedling

Variable effects of pre- storage seed treatment were observed on mean shoot length of seedling (MSLS) under different seed storage duration of two rice varieties (Table 4). Results indicated that the initial mean shoot length of seedling (MSLS) at storage was comparatively higher in BR11 (5.67 cm) compared to BRRI dhan87 (4.77 cm), at 8 months after storage MSLS was increased 107.05% in BR 11 (MSLS 11.74 cm) and 185.53% in BRRI dhan87 (MSLS 13.62 cm) compared to that of initial MRLS. Finally at 9 months after storage MRLS was increased 80.42% in BR11 (MSLS 10.23 cm) and 239.83% in BRRI dhan87 (MSLS 16.21 cm) compared to that of initial MSLS under control condition (without pre- storage seed treatment).

Finally, at 9 months after storage, pre- storage seed treatment with ascorbic acid (AA) in BR11 showed the significantly highest increment in MSLS (11.55 cm MSLS and 103.70% increment compared to initial MSLS), which was statistically similar to that of aspirin. Treatment consisting pre- storage seed treatment with red chilli showed the lowest increment (MSLS 10.02 cm and increment 76.72% compared to initial MSLS), which was statistically similar to that of all other treatments except that of AA. Whereas at 9 months after storage in BRRI dhan87, control treatment (without pre- storage seed treatment) showed the significantly highest increment in MSLS (MSLS 16.21 cm and 239.83% increment compared to initial MSLS), which was statistically different from that of all other treatments.

Pre-storage seed treatment with AA showed significantly lowest increment in MSLS (13.46 cm MSLS and 182.18%% increment compared to initial MSLS), which was statistically similar that of all other treatments accept that of control and red chilli. These results regarding mean shoot length of seedlings were inconformity with the findings of Moori and Eisvand (2017), and Schopfer *et al*. (2001).

Mean total length of seedling

Variable effects of pre- storage seed treatment were observed on mean total length of seedling (MTLS) under different seed storage duration of two rice varieties (Table 4). Results indicated that the initial mean root length of seedling (MTLS) at storage were more or less similar in BR11 (19.25 cm) and BRRI dhan87 (18.42 cm), at 8 months after storage MTLS was increased 19.22% in BR11 (MTLS 22.95 cm) and 32.30% in BRRI dhan87 (MTLS 24.37 cm) compared to that of initial MTLS. Finally at 9 months after storage MTLS was reduced 9.04% in BR11 (MTLS 17.51 cm) whereas was increased 24.76% in BRRI dhan87 (MTLS 22.98 cm) compared to that of initial MTLS under control condition (without pre- storage seed treatment). Finally, at 9 months after storage, pre- storage seed treatment with ascorbic acid (AA) in BR11 significantly increased MTLS (20.39 cm MRLS and 5.92% increment compared to initial MTLS), whereas it was reduced in all other treatments. Treatment, consisting pre-storage seed treatment with red chilli showed the lowest reduction (MTLS 16.96 cm and reduction 11.90% compared to initial MTLS), which was statistically followed by that of aspirin (MTLS 17.53 cm and reduction8.94% compared to initial MRLS) and control (without pre- storage seed treatment). Whereas at 9 months after storage, all the pre- storage treatments increased MTLS but were remain lower except that of aspirin compared to that of control treatment (without pre- storage seed treatment) in BRRI dhan87. Pre- storage seed treatment with aspirin showed the highest MTLS (MTLS 23.93 cm and 29.91% increment compared to initial MTLS), which was statistically similar to that of control and significantly different from that of all other treatments. Pre-storage seed treatment with AA showed significantly lowest increment in MTLS (19.04 cm MTLS and 29.91%% increment compared to initial MRLS), which was statistically different that os all other treatments. Pre- storage treatment red chilli and bleaching powder showed the statistically similar increment in MTLS, which were significantly different from that of all other treatments. These results were also inconformity with the findings of Mandal and Basu (1986) and Ahmad *et al.* (2012).

Table 4. Mean seedling shoot length and total seedling length of two rice varieties at different storage period as influenced by pre- storage seed treatment

Treatment	Mean seedling shoot length (MSSL) (cm)						Total seedling length (SL) (cm)					
	BR 11			BRRI Dhan87			BR 11			BRRI Dhan87		
	At storage	8 months after storage	9 months after storage	At storage	8 months after storage	9 months after storage	At storage	8 months after storage	9 months after storage	At storage	8 months after storage	9 months after storage
Control	5.67	11.74 (+107.05)	10.23 (+80.42)	4.77	13.62 (+185.53)	16.21 (+239.83)	19.25	22.95 (+19.22)	17.51 (-9.04)	18.42	24.37 (+32.30)	22.98 (+24.76)
AA	5.67	12.25 (+116.05)	11.55 (+103.7)	4.77	14.32 (+200.21)	13.46 (+182.18)	19.25	23.55 (+22.34)	20.39 (+5.92)	18.42	25.50 (+38.44)	19.04 (+3.37)
Aspirin	5.67	11.42 (+101.41)	10.99 (+93.83)	4.77	14.12 (+196.02)	14.29 (+199.58)	19.25	23.67 (+22.96)	17.53 (-8.94)	18.42	26.37 (+43.16)	23.93 (+29.91)
Bleaching powder	5.67	11.82 (+108.47)	10.34 (+82.36)	4.77	13.93 (+192.03)	13.87 (+190.78)	19.25	23.44 (+21.77)	18.14 (-5.77)	18.42	24.87 (+35.02)	22.09 (+19.92)
Red chili	5.67	11.16 (+96.83)	10.02 (+76.72)	4.77	14.23 (+198.32)	14.58 (+205.66)	19.25	20.63 (+7.17)	16.96 (-11.9)	18.42	25.42 (+38.00)	22.48 (+22.04)
$LSD_{(0.05)}$	NS	1.23	1.01	NS	1.23	1.01	NS	1.14	1.04	NS	1.14	1.04
CV (%)	2.82	2.26	3.21	2.82	2.26	3.21	2.54	2.63	3.51	2.54	2.63	3.51

Figures in the parentheses indicate reduction/increment in SV compared to initial SV (at storage); negative signs indicate reduction and positive sign indicate increment

Functional relationship between germination percentage and other seed quality attributes

The functional relationship indicated that significant positive correlations were found, between germination speed index and germination percentage ($r = 0.94^{**}$), between seedling vigor index and germination percentage ($r = 0.81^{**}$), and seedling dry weight and germination percentage ($r = 0.61^{*}$) in BR11 (Table 5). Whereas, in BRRI dhan87, the significant positive correlations were found between germination speed index and germination percentage ($r = 0.63^{*}$), between seedling vigor index and germination percentage ($r = 0.68^{*}$), mean root length of seedling and germination percentage ($r = 0.60^{*}$), and mean total length of seedling and germination percentage ($r = 0.64^{*}$) (Table 6). The functional correlation between seed viability and germination percentage both in BR11 and BRRI dhan87 indicates that their positive correlation was insignificant (r = 0.41 for BR11 and r = 0.45 for BRRI dhan87). It might be due that bleaching powder and aspirin may induce some extent dormancy.

Table 5. Functional relationship between germination percentage and other seed quality attributes of BR11 as influenced by pre- storage seed treatment

Seed quality attributes	**Regression equation and correlation coefficient (r)**	
Seed viability	y = 24.01x – 27.0	r= 0.41
Germination speed index	y = 9.003x - 3.10	r= 0.94**
Seedling vigor index	y = 5.754x - 3.14	r= 0.81**
Seedling dry weight	y = 0.555x + 1.00	r= 0.61*
Mean root length of seedling	y = 0.865x + 0.34	r= 0.51
Mean shoot length of seedling	y = 0.627x + 0.21	r= 0.39
Mean total length of seedling	y = 0.348x + 0.55	r= 0.21

**. Correlation is significant at 0.01 level (2-tailed)

Table 6. Functional relationship between germination percentage and other seed quality attributes of BRRI dhan87 as influenced by pre- storage seed treatment

Seed quality attributes	Regression equation and correlation coefficient (r)	
Seed viability	y = 1.045x + 1.5	r= 0.45
Germination speed index	y = 12.94x - 3.1	r= 0.63*
Seedling vigor index	y = 4.431x + 0.83	r= 0.68*
Seedling dry weight	y = 7.745x	r= 0.54
Mean root length of seedling	y = 11.38x - 1.13	r= 0.60*
Mean shoot length of seedling	y = 5.966x + 1.63	r= 0.40
Mean total length of seedling	y = 3.955x + 0.5	r= 0.64*

**. Correlation is significant at 0.01 level (2-tailed)

CONCLUSION & RECOMMENDATION

Results indicated that up to 8 months after storage, germination, viability, relative germination and relative viability were statistically similar to that at storage both in BR11 and BRRI dhan 87. But at 9 months after storage, these parameters were reduced drastically in BR11, whereas were statistically similar to that at 8 months after storage in BRRI dhan87. Ascorbic acid and red chilli improved these parameters at 9 months after storage remarkably in BR11, whereas in BRRI dhan87 effects were negligible. This may also be indicated that ascorbic acid and red chilli powder might have positive effect on storability of BR11, which was deteriorated faster than BRRI dhan87 under the condition of the study. Therefore, it may be recommended that a further study may be conducted to optimize the dose and time of application of ascorbic acid and red chilli powder for BR11 or other rice seed which may be deteriorated rapidly.

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