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Ascorbic Acid and Red Chilli Powder as Eco Friendly Seed Protectants for Improving Storability of BRRI Dhan 75

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ABSTRACT

The study evaluated the effects of ascorbic acid and red chilli powder as natural seed protectants on the storability of T. Aman rice (BRRI Dhan 75) seed under ambient storage conditions. A laboratory experiment was conducted using a Completely Randomized Design (CRD) with four replications. Thirteen treatments were tested, comprising an untreated control and twelve combinations of two doses each of ascorbic acid (500 and 750 mg/kg seed) and red chilli powder (2 and 3 g/kg seed), applied at storage initiation, eight months into storage, or at both time points. Across traits, values generally increased from initial readings to a peak at 140 DAS, followed by a decline at 200 DAS, reflecting an after-ripening phase followed by the onset of seed ageing. Red chilli powder applied at 2 g/kg seed, both at storage and again eight months after storage (T9), consistently produced the highest germination and vigor responses throughout the storage period (e.g., 96.58% germination, 19.03 cm shoot length, and 20.69 seedling vigor index at 140 DAS), while the untreated control (T0) performed the weakest at every stage. These findings indicate that seed treatment with red chilli powder, particularly at the lower dose with reapplication in mid-storage, effectively preserves rice seed physiological quality under ambient conditions, likely by limiting microbial and insect activity on the seed surface. This natural, low-cost approach offers a promising, eco-friendly alternative to synthetic seed protectants for enhancing long-term storability of transplanted aman rice seed, with implications for improving seed quality management among smallholder farmers.

Keywords: Seed Storage; Ascorbic Acid; Red Chilli Powder; Seed Vigor; Germination; Natural Seed Protectant

INTRODUCTION

Seed quality includes genetic quality, physical quality, and physiological quality. At physiological maturity, the seeds have the highest quality, i.e, the seed moisture content has decreased to below 20% so that, the seed dry weight is maximum and the seed viability is also maximum. The physiological quality of seeds can be indicated by the viability and vigor of seeds [1]. In Bangladesh, rice is often considered to be a political and strategic commodity because of its cultural, socioeconomic, and political importance [2]. The major issue of food security largely relies on the availability of and access to rice, as rice forms 70% of people's daily calorific requirement and 56% of their protein intake [3]. Rice cultivation also occupies 78% of the total cropped area in Bangladesh [3], with an annual production amount of 36.3 Mt and an average annual import of 0.5 Mt [4,5]. Rice is also an important economic crop, contributing 46% of the crop sector's gross domestic product (GDP) and 5% of the overall GDP in Bangladesh [6]. However, the overall food security issue of Bangladesh largely emphasizes the sustainable rice production system. Three varieties of rice (Oryza sativa subsp. indica) are largely grown in Aus, Aman, and Boro during distinct seasons. These three types of rice are associated with distinct rice ecosystems. Due to a double or triple cropping system, the area coverage of boro, aus, and aman is 85%, 27%-32%, and 52%-56%, respectively [7]. Seed preservation procedures are essential to maintain global food security because they preserve genetic variety and guarantee the supply of viable seeds. Farmers' stored seeds are typically highly infected with molds and stored grain pests, resulting in extremely low germination rates. Furthermore, if stored in

ideal conditions, a high-quality seed may also suffer significant deterioration [8]. Rice seeds must be properly dried since their high moisture content causes active respiration, which accelerates seed deterioration. Soon after harvest, deterioration begins, highlighting how crucial careful postharvest treatment is to maintaining seed integrity. Poor storage conditions can lead to loss of germination, vigor, and accumulation of pests, disease, and volatile toxic chemicals [9]. Many synthetic insecticides have been used for the past few decades to protect stored grains and other agricultural products against insect infestations. On the other hand, their widespread use has unintentionally poisoned non-target creatures and had other negative consequences on the ecosystem. Because of these chemicals extended environmental persistence and their introduction into the food chain, they are considered ecologically harmful. However, these problems can be lessened such that they have less of an effect on the rates at which seeds deteriorate while being stored by using a variety of chemicals, medications, and natural plant-based items as seed treatments. Due to presence of antibacterial and antifungal properties, organic acids like ascorbic acid and red chilli powder are frequently used in both the food sector and agriculture [10]. This study was undertaken to evaluate the quality parameters of rice seeds and seedlings at different storage periods following seed invigoration. The special objectives of the study were to find out the appropriate dose of ascorbic acid and red chilli powder for storing rice seeds in ambient conditions and to fix the appropriate time and frequency of seed treatment with ascorbic acid and red chilli powder during storage of rice seeds.

MATERIALS AND METHODS

Description of the Experimental Site

The laboratory experiment was conducted in the Agronomy laboratory at Sher-e-Bangla Agricultural University, Dhaka, Bangladesh.

Planting Materials

Healthy, uniformly sized, freshly harvested seeds of the T. aman rice variety BRRI Dhan 75 were collected from the SAU farm after aman rice production.

Treatments

The experiment followed a Completely Randomized Design (CRD) with four replications. Thirteen seed treatments were evaluated, comprising an untreated control and twelve combinations of two seed protectant doses of ascorbic acid or red chilli powder, each applied at storage, eight months after storage, or at both time points. The treatments are: T0 = Control, T1 = Ascorbic acid @ 500 mg/kg seed, applied at storage, T2 = Ascorbic acid @ 500 mg/kg seed, applied at 8 months after storage, T3 = Ascorbic acid @ 500 mg/kg seed, applied both at storage and 8 months after storage, T4 = Ascorbic acid @ 750 mg/kg seed, applied at storage, T5 = Ascorbic acid @ 750 mg/kg seed, applied at 8 months after storage, T6 = Ascorbic acid @ 750 mg/kg seed, applied both at storage and 8 months after storage, T7 = Red chilli powder @ 2 g/kg seed, applied at storage, T8 = Red chilli powder @ 2 g/kg seed, applied at 8 months after storage, T9 = Red chilli powder @ 2 g/kg seed, applied both at storage and 8 months after storage, T10 = Red chilli powder @ 3 g/kg seed, applied at storage, T11 = Red chilli powder @ 3 g/kg seed, applied at 8 months after storage and T12 = Red chilli powder @ 3 g/kg seed, applied both at storage and 8 months after storage

Seed Treatment Application

Twenty-gram lots of pure BRRI Dhan 75 seed were dry-dressed with the respective doses of ascorbic acid or red chilli powder in 250 mL plastic containers, following a modified procedure from [11]. Containers were shaken daily for seven days after treatment to ensure uniform adherence of the protectant to the seed surface.

Storage Conditions

A total of 52 plastic containers, each holding 20 g of uniformly sized, healthy seed, were prepared according to the treatment schedule and stored under ambient, dry conditions in the Agronomy Laboratory at Sher-e-Bangla Agricultural University for eight months with regular monitoring of storage temperature and cleanliness.

Data Recording

Seven days after treatments, seed quality was first assessed, and thereafter data were recorded at four intervals-initial (post-treatment), 80,140 and 200 days after storage (DAS)-for the following parameters: germination percentage, shoot length, root length, total seeding length, germination speed index (GSI), seedling vigor index (SVI), germination rate (GR), mean daily germination (MDG), and the relative value of each trait across the storage period.

Determination Of Seed Quality Parameters

Germination percentage (GP): Germination was tested in glass Petri dishes lined with filter paper as the growth medium. Germinated seeds were counted daily for 14 days, and GP was calculated following [12]:

GP (%) = (N1/N2) × 100

Where N1 is the number of germinated seeds, and N2 is the total number of seeds sown.

Root and shoot length: Root and shoot lengths of five randomly selected seedlings per treatment were measured (cm) 14 days after sowing, following [13]; total seedling length was computed as the sum of root and shoot length.

Germination speed index (GSI): GSI was calculated as the sum of the number of seeds germinated on each count date divided by the number of days to that count, following [14].

Seedling vigor index (SVI): SVI was calculated following [15]

SVI = (Germination % × Seedling length) / 100

Germination rate (GR): GR was calculated as GR = Final GP / t, where t is the germination period (14 days).

Mean daily germination (MDG): MDG was calculated following [16]:

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MDG = Total number of germinated seeds / Total number of days

Relative value: For each trait, the relative value at 80, 140 and 200 DAS was computed as the ratio of the value recorded at that interval to the corresponding initial (post-treatment) value.

Statistical Analysis

The recorded data were compiled, tabulated, and subjected to statistical analysis. Analysis of variance (ANOVA) was done with the help of Statistix 10.0. Treatment means were separated using the Least Significant Difference (LSD) test at the 5% probability level.

RESULTS

Germination Percentage

Significant changes were recorded for germination percentage of rice seeds at 80 days after storage (DAS), 140 DAS, and 200 DAS due to different seed treatments, but treatment effects were insignificant at the initial storage mentioned in Figure 1. It was remarked that germination percentage increased from the initial to 140 days and then started decreasing at 200 days. At 80 DAS, 140 DAS, and 200 DAS, the maximum germination percentages were found to be 96.58, 96.80, and 94.00, respectively, from the seed treatment of T9 (seed treated with red chilli powder @ 2 g/kg of seeds both at storage and 8 months after storage), while at the initial storage condition, this treatment effect was 79.8%. The minimum germination percentage (81.18, 81.40 & 78.60) was recorded at 80 DAS, 140 DAS and 200 DAS, respectively, from the control treatment T0 (no seed treatment), while initially it was 80.18%.

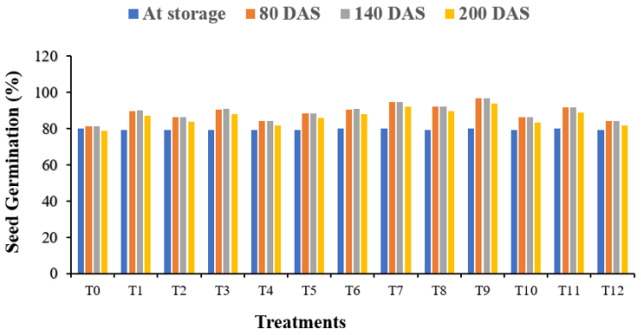


Figure 1: Effect of ascorbic acid and red chilli powder on germination percentage of BRRI dhan75 rice seeds (LSD0.05= 1.48, 1.14, 1.12 & 1.12 at initial, 80, 140 and 200 DAS, respectively).

Relative Value of Seed Germination

It was observed that the maximum relative value of seed germination (1.21, 1.21 and 1.18) was found at 80 DAS, 140 DAS and 200 DAS, respectively, from the seed treatment of T9 (seeds treated with red chilli powder @ 2 g/kg of seeds both at storage and 8 months after storage). The minimum relative germination percentage (1.01, 1.02, and 0.98) was recorded at 80 DAS, 140 DAS, and 200 DAS, respectively, for the control treatment T0, as shown in Table 1.

Treatments	Relative value of seed germination		
	80 DAS	140 DAS	200 DAS
T0	1.01	1.02	0.98
T1	1.13	1.14	1.10
T2	1.09	1.09	1.05
T3	1.14	1.15	1.11
T4	1.06	1.06	1.03
T5	1.11	1.12	1.08
T6	1.13	1.14	1.10
T7	1.18	1.19	1.15
T8	1.16	1.16	1.13
T9	1.21	1.21	1.18
T10	1.09	1.09	1.06
T11	1.15	1.15	1.11
T12	1.06	1.07	1.03

Table 1: Effect of Ascorbic Acid and Red Chilli Powder on Relative Value of Seed Germination

Shoot Length

Significant changes were recorded for shoot length of rice seedlings at 80 days after storage (DAS), 140 DAS and 200 DAS due to different seed treatments, but treatment effects were insignificant at the initial storage mentioned in Figure 2. It was remarked that shoot length increased from the initial to 140 days and then started decreasing at 200 days. At 80 DAS, 140 DAS, and 200 DAS, the maximum shoot length was found to be 19.03 cm, 19.53 cm, and 19.20 cm, respectively, from the seed treatment of T9 (seeds treated with red chilli powder @ 2 g/kg of seeds both at storage and 8 months after storage), while at the initial storage condition this treatment effect was 8.35 cm. The minimum shoot length (10.55, 10.77, and 10.54) was recorded at 80 DAS, 140 DAS, and 200 DAS, respectively, in

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the control treatment T0 (no seed treatment), whereas it was 8.36 cm initially.

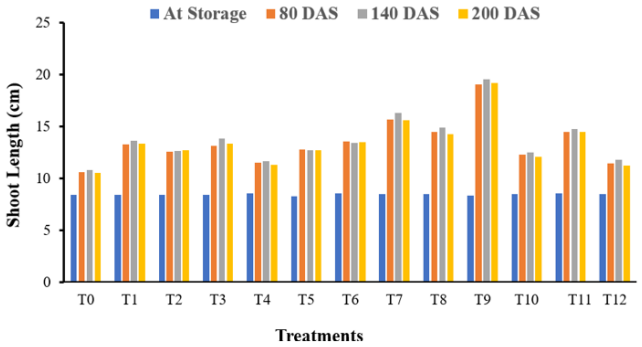


Figure 2: Effect of Ascorbic Acid and Red Chilli Powder on Shoot Length of BRRI Dhan75 Rice Seedling (LSD0.05=0.39, 0.50, 0.49 & 0.36 At Initial, 80, 140 And 200 DAS, respectively).

Relative Value of Shoot Length

From Table 2, it was observed that the maximum relative value of shoot length (2.28, 2.34 and 2.30) was found at 80 DAS, 140 DAS and 200 DAS, respectively, from the seed treatment of T9 (seeds treated with red chilli powder @ 2 g / kg of seeds both at storage and 8 months after storage). The minimum relative value of shoot length (1.26, 1.29 and 1.26) was recorded at 80 DAS, 140 DAS and 200 DAS, respectively, from the control treatment T0.

Treatments	Relative value of shoot length		
	80 DAS	140 DAS	200 DAS
T0	1.26	1.29	1.26
T1	1.58	1.63	1.59
T2	1.49	1.51	1.51
T3	1.56	1.65	1.59
T4	1.35	1.37	1.33
T5	1.55	1.54	1.54
T6	1.59	1.57	1.59
T7	1.84	1.92	1.84
T8	1.71	1.76	1.69
T9	2.28	2.34	2.30
T10	1.45	1.48	1.43
T11	1.69	1.72	1.69
T12	1.35	1.40	1.33

Table 2: Effect of Ascorbic Acid and Red Chilli Powder on The Relative Value of Shoot Length

Root Length

Significant change was recorded for root length of rice seedlings at 80 days after storage (DAS), 140 DAS and 200 DAS due to different seed treatments, but treatment effects were insignificant at initial storage. It was observed that root length increased from initial to 140 days and then started decreasing at 200 days. At 80 DAS, 140 DAS, and 200 DAS, the maximum root length was found to be 8.72, 8.88, and 8.39, respectively, from the seed treatment of T9 (seeds treated with red chilli powder @ 2 g/kg of seeds both at storage and 8 months after storage), while the initial storage condition was 4.81. The minimum root length (4.52, 4.71 and 4.32) was recorded at 80, 140 and 200 DAS, respectively, from the control treatment T0, while initially it was 4.56, as mentioned in Figure 3.

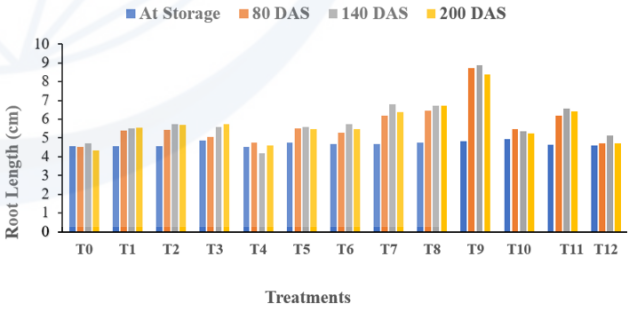


Figure 3: Effect Of Ascorbic Acid and Red Chilli Powder On Root Length of BRRI Dhan75 Rice Seedling (LSD0.05=0.41, 0.53, 0.57 & 0.56 At Initial, 80, 140 And 200 DAS, Respectively).

Relative Value of Root Length

From Table 3, it was observed that the highest relative value of root length (1.81, 1.85 and 1.74) was found at 80 DAS, 140 DAS and 200 DAS, respectively, from the seed treatment of T9 (seeds treated with red chilli powder @ 2 g/kg of seeds both at storage and 8 months after storage). The minimum relative value of shoot length (0.99, 1.03 and 0.95) was recorded at 80

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DAS, 140 DAS and 200 DAS, respectively, from the control treatment T0.

Treatments	Relative value of root length		
	80 DAS	140 DAS	200 DAS
T0	0.99	1.03	0.95
T1	1.18	1.21	1.21
T2	1.20	1.26	1.25
T3	1.04	1.15	1.18
T4	1.05	0.92	1.02
T5	1.16	1.18	1.15
T6	1.13	1.22	1.17
T7	1.33	1.46	1.37
T8	1.36	1.41	1.41
T9	1.81	1.85	1.74
T10	1.11	1.08	1.06
T11	1.34	1.42	1.39
T12	1.02	1.12	1.03

Table 3: Effect Of Ascorbic Acid and Red Chilli Powder on The Relative Value Of Root Length

Total Length

Significant change was recorded for total length of rice seedlings at 80 days after storage (DAS), 140 DAS, and 200 DAS due to different seed treatments, but treatment effects were insignificant at initial storage, as mentioned in Figure 4. It was observed that total length increased from initial to 140 days and then started decreasing at 200 days. At 80 DAS 140 DAS, and 200 DAS, the maximum total length was found to be 27.75 cm, 28.40 cm, and 27.58 cm, respectively, from the seed treatment of T9 (seeds treated with red chilli powder @ 2 g/kg of seeds, both at storage and 8 months after storage), while at initial storage condition it was 13.16. The minimum total length (15.07, 15.48, and 14.86) was recorded at 80 DAS, 140 DAS, and 200 DAS, respectively, from the control treatment T0 (no seed treatment), while at initially it was 12.93.

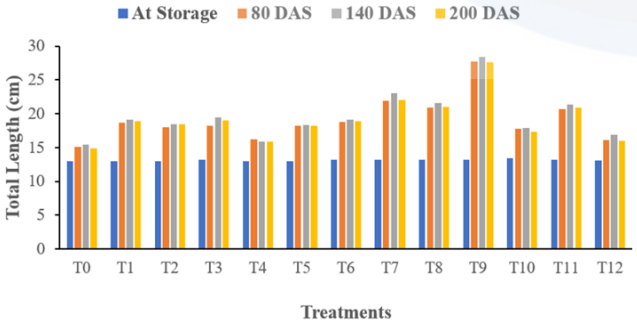


Figure 4: Effect of ascorbic acid and red chilli powder on total length of BRRI dhan75 rice seedling (LSD0.05=0.51, 0.75, 0.72 & 0.69 at initial, 80, 140 and 200 DAS, respectively).

Relative Value of Total Length

From Table 4, it was observed that the maximum relative value of total length (2.11, 2.16 and 2.10) was found at 80 DAS, 140 DAS and 200 DAS, respectively, from the seed treatment of T9 (seeds treated with red chilli powder @ 2 g/kg of seeds both at storage and 8 months after storage). The minimum relative value of total length (1.17, 1.20 and 1.15) was recorded at 80 DAS, 140 DAS & 200 DAS, respectively, from the seed treatment T0.

Treatments	Relative value of total length		
	80 DAS	140 DAS	200 DAS
T0	1.17	1.20	1.15
T1	1.44	1.48	1.46
T2	1.39	1.42	1.42

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T3	1.37	1.47	1.44
T4	1.25	1.22	1.22
T5	1.40	1.41	1.40
T6	1.43	1.45	1.43
T7	1.66	1.75	1.67
T8	1.58	1.63	1.59
T9	2.11	2.16	2.10
T10	1.33	1.33	1.29
T11	1.57	1.62	1.58
T12	1.23	1.30	1.22

Table 4: Effect of Ascorbic Acid and Red Chilli Powder on The Relative Value Of Total Length

Germination Speed Index (GSI)

Significant changes were recorded for the germination speed index of rice seeds at 80 days after storage (DAS), 140 DAS, and 200 DAS due to different seed treatments, but treatment effects were insignificant at the initial storage mentioned in Figure 5. It was observed that the germination speed index increased from the initial to 140 days and then started decreasing at 200 days. At 80 DAS, 140 DAS, and 200 DAS, the maximum germination speed index was observed to be 21.58, 22.42, and 21.60, respectively, from the seed treatment of T9 (seeds treated with red chilli powder @ 2 g/kg of seeds both at storage and 8 months after storage), while at the initial storage condition it was 8.42. The minimum germination speed index (11.39, 12.05, and 12.52) was recorded at 80 DAS, 140 DAS, and 200 DAS, respectively, in the control treatment T0 (no seed treatment), whereas it was 8.37 initially.

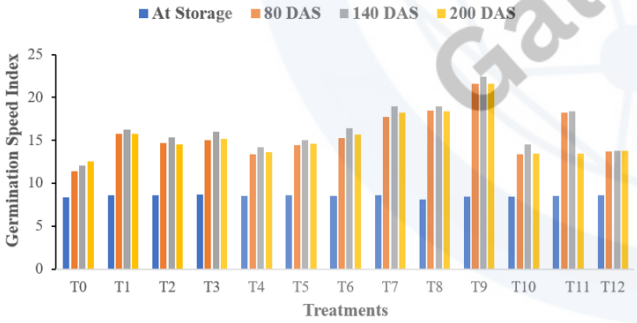


Figure 5: Effect of ascorbic acid and red chilli powder on germination speed index of BRRI dhan75 rice seedling (LSD0.05=0.40, 1.02, 1.77 & 1.33 at initial, 80, 140 and 200 DAS, respectively).

Relative Value of Germination Speed Index

It was observed that from Table 5, the maximum relative value of germination speed index (2.56, 2.66 and 2.57) was found at 80 DAS, 140 DAS and 200 DAS, respectively, from the seed treatment of T9 (seeds treated with red chilli powder @ 2 g/kg of seeds both at storage and 8 months after storage). The minimum relative value of total length (1.36, 1.44 and 1.50) was recorded at 80 DAS, 140 DAS and 200 DAS, respectively, from the control treatment T0.

Treatments	Relative value of Germination Speed Index		
	80 DAS	140 DAS	200 DAS
T0	1.36	1.44	1.50
T1	1.83	1.88	1.83
T2	1.71	1.79	1.68
T3	1.73	1.84	1.75
T4	1.56	1.67	1.60
T5	1.67	1.74	1.69
T6	1.79	1.92	1.84
T7	2.07	2.21	2.13

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T8	2.27	2.33	2.27
T9	2.56	2.66	2.57
T10	1.59	1.72	1.60
T11	2.14	2.15	1.57
T12	1.58	1.60	1.60

Table 5: Effect Of Ascorbic Acid and Red Chilli Powder on Relative Value of Germination Speed Index

Seedling Vigor Index (SVI)

Momentous change (from 5) was recorded for seedling vigor index of rice seeds at 80 days after storage (DAS), 140 DAS and 200 DAS due to different seed treatments, but treatment effects were insignificant at initial storage (Figure 6). It was observed that seedling vigor index was increased from initial to 140 days and then started decreasing at 200 days. At 80 DAS, 140 DAS and 200 DAS, the maximum seedling vigor index was found 20.69, 21.59 and 20.69, respectively, from the seed treatment of T9 (seeds treated with red chilli powder @ 2 g/kg of seeds both at storage and 8 months after storage), while at initial storage condition this treatment effect was 7.69. The minimum seedling vigor index (10.50, 11.22 and 11.61) was recorded at 80 DAS, 140 DAS and 200 DAS, respectively from the control treatment T0 (no seed treatment), while at initially it was 7.64.

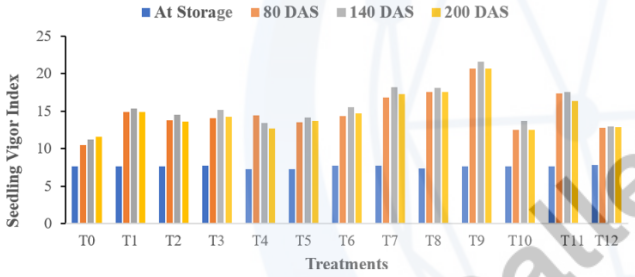


Figure 6: Effect of ascorbic acid and red chilli powder on seedling vigor index of BRRI dhan75 rice seedling (LSD0.05=0.37, 1.02, 1.77, 1.33 at initial, 80, 140 and 200 DAS, respectively)

Relative Value of Seedling Vigor Index

It was observed from Table 6 that the maximum relative value of seedling vigor index (2.69, 2.81 and 2.69) was found at 80 DAS, 140 DAS and 200 DAS, respectively, from the seed treatment of T9 (seeds treated with red chilli powder @ 2 g/kg of seeds both at storage and 8 months after storage). The minimum relative value of seedling vigor index (1.37, 1.47 and 1.52) was recorded at 80 DAS, 140 DAS and 200 DAS, respectively, from the control treatment T0.

Treatments	Relative value of Seedling Vigor Index		
	80 DAS	140 DAS	200 DAS
T0	1.37	1.47	1.52
T1	1.95	2.01	1.94
T2	1.82	1.91	1.78
T3	1.82	1.96	1.84
T4	1.99	1.84	1.75
T5	1.84	1.93	1.87
T6	1.85	2.00	1.90
T7	2.18	2.35	2.24
T8	2.37	2.45	2.37
T9	2.69	2.81	2.69
T10	1.62	1.78	1.63
T11	2.28	2.30	2.15
T12	1.64	1.66	1.64

Table 6: Effect Of Ascorbic Acid and Red Chilli Powder on Relative Value of Seedling Vigor Index

Germination Rate (GR)

A momentous change was recorded for the germination rate of rice seeds at 80 days after storage (DAS), 140 DAS, and 200

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DAS due to different seed treatments, but treatment effects were insignificant at initial storage (Figure 7). It was observed that the germination rate increased from initial to 140 days and then started decreasing at 200 days. At 80 DAS, 140 DAS, and 200 DAS, the maximum germination rate was found to be 6.90, 6.91, and 6.71, respectively, from the seed treatment of T9 (seeds treated with red chilli powder @ 2 g/kg of seeds both at storage and 8 months after storage), while at initial storage condition this treatment effect was 5.70. The minimum germination rate (5.80, 5.81 & 5.61) was recorded at 80 DAS, 140 DAS and 200 DAS, respectively, from the control treatment T0 (no seed treatment), while initially it was 5.73.

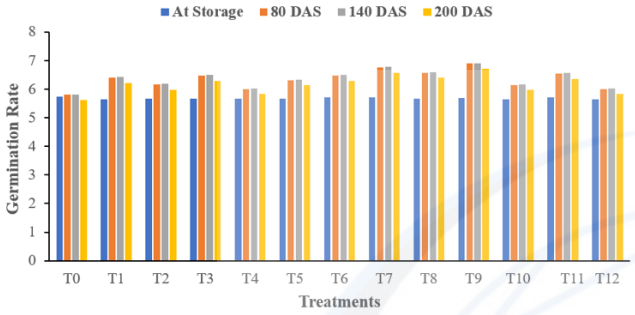


Figure 7: Effect Of Ascorbic Acid and Red Chilli Powder on Germination Rate of BRRI Dhan75 Rice Seedling (LSD0.05=0.11, 0.08, 0.08 & 0.08 At Initial, 80, 140 And 200 DAS, Respectively)

Relative Value of Germination Rate

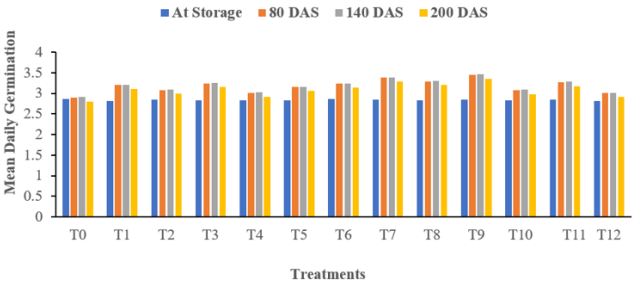
It was observed from Table 7 that the maximum relative value of germination rate (1.21, 1.21 and 1.18) was found at 80 DAS, 140 DAS and 200 DAS, respectively, from the seed treatment of T9 (seeds treated with red chilli powder @ 2 g/kg of seeds, both at storage and 8 months after storage). The minimum relative value of germination rate (1.01, 1.01 and 0.98) was recorded at 80 DAS, 140 DAS and 200 DAS, respectively, from the control treatment T0 (no seed treatment).

Treatments	Relative value of germination rate		
	80 DAS	140 DAS	200 DAS
T0	1.01	1.01	0.98
T1	1.13	1.14	1.10
T2	1.09	1.09	1.05
T3	1.14	1.15	1.11
T4	1.06	1.06	1.03
T5	1.11	1.12	1.08
T6	1.13	1.14	1.10
T7	1.18	1.19	1.15
T8	1.16	1.16	1.13
T9	1.21	1.21	1.18
T10	1.09	1.09	1.06
T11	1.15	1.15	1.11
T12	1.06	1.07	1.03

Table 7: Effect Of Ascorbic Acid and Red Chilli Powder on The Relative Value of Germination Rate

Mean Daily Germination (MDG)

A momentous change was recorded for mean daily germination of rice seeds at 80 days after storage (DAS), 140 DAS, and 200 DAS due to different seed treatments, but treatment effects were insignificant at initial storage (Figure 8). It was observed that mean daily germination was increased from initial to 140 days and then started decreasing at 200 days. At 80 DAS, 140 DAS, and 200 DAS, the maximum mean daily germination was found to be 3.45, 3.46, and 3.36, respectively, from the seed treatment of T9 (seeds treated with red chilli powder @ 2 g/kg of seeds both at storage and 8 months after storage), while at initial storage condition this treatment effect was 2.85. The minimum mean daily germination (2.90, 2.91 and 2.81) was recorded at 80 DAS, 140 DAS and 200 DAS, respectively, from the seed treatment T0 (no seed treatment), while initially this treatment effect was 2.86.



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Figure 8: Effect of ascorbic acid and red chilli powder on mean daily germination of BRRI dhan75 rice seedling (LSD0.05 = 0.05, 0.04, 0.04 & 0.04 at initial, 80, 140 and 200 DAS, respectively)

Relative Value of Mean Daily Germination

From Table 8, it was observed that the maximum relative value of mean daily germination (1.21, 1.21 and 1.18) was found at 80 DAS, 140 DAS & 200 DAS, respectively, from the seed treatment of T9 (seeds treated with red chilli powder @ 2 g/kg of seeds both at storage and 8 months after storage). The minimum relative value of mean daily germination (1.01, 1.02 & 0.98) was recorded at 80 DAS, 140 DAS & 200 DAS, respectively, from the seed treatment T0.

Treatment	Relative value of mean daily germination		
	80 DAS	140 DAS	200 DAS
T0	1.01	1.02	0.98
T1	1.13	1.14	1.10
T2	1.08	1.09	1.05
T3	1.14	1.15	1.11
T4	1.06	1.07	1.03
T5	1.12	1.12	1.08
T6	1.13	1.13	1.10
T7	1.19	1.19	1.15
T8	1.16	1.17	1.13
T9	1.21	1.21	1.18
T10	1.09	1.09	1.05
T11	1.15	1.15	1.12
T12	1.07	1.07	1.03

Table 8: Effect Of Ascorbic Acid and Red Chilli Powder on The Relative Value of Mean Daily Germination

DISCUSSION

Ascorbic acid (vitamin C) functions as an effective natural seed priming agent that protects seeds, enhances vigor, and improves stress tolerance. Red chilli powder also acts as a natural, organic protectant for seeds and stored grains by utilizing capsaicin to repel pests and prevent insect infestations. Red chilli is an easily damaged agricultural product that needs to be processed, one of the processing that can be done is drying the red chilli and then made into powder. This study aimed to determine the effect of chilli powder and to obtain the best ascorbic acid concentration in retaining the chemical content of chilli powder. Using ascorbic acid (Vitamin C) and red chilli powder for dry or wet seed treatment is a cost-effective, eco-friendly method used in modern sustainable agriculture. Together or individually, they act as safe physiological invigorators and natural protectants. Scientists revealed that most of the seed treatments can effectively enhance the desired parameters in the case of the direct-seeded method as well [23]. Considering all the characters, ascorbic acid, aspirin & red chilli powder were found to be the most effective ones. Ascorbic acid performed as the best treatment in terms of yield per square meter, harvest index & also produced the most effective no of tillers. So, we can conclude that seed treatments can be done for enhancing the yield & quality of the seeds in the direct-seeded method as well. Previous study [24] found that red chilli powder is the most effective treatment for improving the longevity of seeds. These eco-friendly and cost-effective mid-storage invigoration seed treatments can help farmers enhance the quality of their seeds and extend their storage life. Chilli fruits contain several bioactive phytochemicals such as Capsaicin, Dihydrocapsaicin, Carotenoids (capsanthin, capsorubin), flavonoids, and phenolics. Among these, Capsaicin is mainly responsible for the insecticidal property [25].

Several earlier workers also reported that increasing the dose of capsicum significantly reduced the lifespan of storage insects, confirming a clear dose-dependent toxic effect [26]. Scholars [27] concluded that capsicum Chinese powder applied at doses of 5, 10, 15, and 20 g per 100 kg of maize caused mortality rates of 75%, 80%, 90%, and 100%, respectively, against Sitophilus zeamais after two weeks, demonstrating strong insecticidal activity.

The experiment aimed to assess the influence of nano- and near-nano-sized powders of chilli, fenugreek and turmeric in three doses, viz. 1g, 2g, 3g of botanical powder per kg of seed, on seed physiological performances in oat [28]. In general, the botanical powders improved seed germination, shoot and root length, seedling dry-weight, and seed vigour indices as compared to control. The botanicals also reduced seed pathogen infection and improved seedling emergence and grain yield when treated seeds were planted in the field. However, the responses of seed to the botanical treatments were dose-dependent and varied across the botanicals. Results of this experiment reaffirm the traditional knowledge of beneficial

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effects of botanicals on plant seed performance and show the importance of using them in nano and near-nano forms. The cowpea weevil, Callosobruchus maculatus (Fab.), is the most destructive pest of stored grain legumes, which can inflict huge losses in terms of quantity and quality. An experiment was conducted at Post Harvest Technology Centre, Bapatla, Guntur District, Andhra Pradesh during 2015-16 to evaluate the efficacy of some plant powders viz., Malabar nut, curry leaf, basil, tobacco, neem, black pepper, red chilli, sweet flag, turmeric, clove and asafetida as grain treatment at 0.4% (w/w) against pulse beetle in stored blackgram under no-choice and free-choice conditions [29].

The current study's results were consistent with scientists [17,18,19,20], who observed that the percentage of rice seeds that germinated during storage was higher when seed treatments were applied than when no seed treatments were applied. Scholars revealed a similar outcome, noting that treated stored rice seeds had longer shoots than non-treated stored seeds [20]. They found that treated stored seeds displayed a greater root length than nontreated stored seeds, supporting the stated outcome. Additionally, researchers [21] found a similar outcome with soybeans. They [20] found that rice from treated stored seeds had longer shoots and roots than rice from untreated stored seeds. This result was consistent with their findings. According to scholars [20], who also validated the current study's findings, treated seeds before storage exhibited a faster rate of germination than control seeds. Scholars concluded that the treated seeds had a higher vigor index in rice seeds, which matched the results of the present inquiry [22].

CONCLUSION

The study shows the possibility of using organic products such as Ascorbic acid @ 750 mg/kg seed and red chilli powder @ 2 g/kg seed, applied both at storage and 8 months after storage for BRRI Dhan75 production. On the basis of the present findings, rice seed growers may be advised to use ascorbic acid and red chilli powder as eco-friendly seed protectants for long storability of BRRI Dhan 75 production.

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DECLARATIONS

CONFLICT OF INTEREST

The authors declare that they have no relevant financial or non-financial interests to disclose.

AUTHOR CONTRIBUTIONS

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Saleh Ahmed. The first draft of the manuscript was written by Saleh Ahmed, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Conceptualization: Imamuddin; Methodology: Saleh Ahmed; Formal analysis and investigation: Saleh Ahmed; Writing-original draft preparation: Saleh Ahmed; Writing - review and editing: Deen Mohammad Deepo, Sharmin Fatema, Suraiya Jitu, Md.Naziur Rahman Pavel, Towfiqul Anwar, Abdullah Al Jubair; Funding acquisition: Md.Naziur Rahman Pavel, Abdullah Al Jubair, Ferdous Habib; Supervision: Imamuddin, Md.Shahidul Islam.

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