



Effect of different seed treatments on breaking the dormancy of rice seeds (*Oryza sativa* L.) variety At 307

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Abstract

Rice (*Oryza sativa* L.) is one of the most popular field crops among other cereals worldwide. It occupies approximately 34 percent (0.77 million ha) of Sri Lanka's total cultivated area. Despite the growing demand for rice, yields have been low. Prolonged dormancy is one of the reason for lower paddy yield in Sri Lanka. Due to prolonged seed dormancy, seeds do not germinate and farmers face problems. The study investigated the effect of different seed dormancy breaking techniques on rice variety At 307. This experiment was carried out in the Eastern University Sri Lanka crop science laboratory from August to November 2023. The Petri dish experiment was laid out in a completely randomized design with six treatments and five replications. The treatments are T1 (2% of Urea), T2 (2% of MOP), T3 (Oven drying at 50 °C for 24 hours), T4 (Sun drying for 24 hours), T5 (Water soaking for 24 hours), and T6 (Water soaking for 48 hours). 25 seeds were placed in a Petri dish. Parameters such as germination percentage, seed germination index, seed vigour index, mean germination time, shoot length of seedlings, root length of seedlings, fresh weight of seedlings and dry weight of seedlings were collected. The collected data were statistically analyzed using Minitab 17 version software and mean comparison within treatments was performed by Turkey's test. The results revealed that different seed dormancy-breaking techniques had a substantial ($P < 0.05$) impact on rice variety At 307. This experiment revealed that sun drying for 24 hours was the best dormancy-breaking method compared with other methods. Sun drying for 24 hours significantly breaks the dormancy of the rice variety At 307, increases the germination percentage (93.6%) and enhances vigor index (1293.9). The study concluded that sun drying for 24 hours could be recommended to break the prolonged dormancy of rice variety At 307.

Keywords: Germination percentage, prolonged seed dormancy, seed vigour index, sun drying, rice

Introduction

Rice (*Oryza sativa* L.) ranks among the three most crucial grain globally, serving as a staple diet for approximately 40% of the world's population (Doku *et al.*, 2016) [1]. In 2016, more than 700 million tons of rice were produced annually on an estimated 158 million acres of land worldwide (USDA, 2016). Asia is home to 90% of the world's rice production, with China and India being the two biggest producers. Rice serves as the primary crop, crucially meeting 45% of the total calorie and 40% of the total protein requirements for an average Sri Lankan (Bhagya and Ekanayake, 2020) [3].

Despite the growing demand for rice, there has been a persistent issue of low yields (Emomg'or *et al.*, 2009). Several factors contribute to this challenge, including pest and disease infestations, the use of low-quality seeds, water scarcity, and inadequate storage facilities and prolonged seed dormancy (Onyango, 2014) [5].

Seed dormancy poses challenges in agriculture as it can hinder the establishment of plants. However, it is a crucial survival mechanism in which seeds delay germination until the optimal time and conditions, presenting both advantages and disadvantages (Kildisheva *et al.*, 2020) [6]. The occurrence of seed dormancy in paddy is dual-edged, presenting challenges for post-harvest seed testing while also offering benefits in terms of strategic germination timing (Hanumanthappa *et al.*, 2016) [7]. During seed dormancy, metabolic processes such as the synthesis of nucleic acids and proteins, as well as increases in enzyme and respiratory activities, are notably subdued. Direct correlation between the delay in harvesting and the reduction in dormancy duration, with the number of days or weeks of delay reflecting the extent of dormancy shortening

(Pill, 1995) [8]. Dormancy behavior (intensity, persistency, and mechanism of dormancy) has a significant impact on the effectiveness of the dormancy-breaking approach. Depending on the genotype or variety, seed dormancy behaves differently. The proportion of dormant seeds at harvest determines the intensity of dormancy. The effectiveness of the breaking dormancy method is also affected by variety (Wahyuni and Nugraha, 2002).

Numerous methods are employed to break down seed dormancy. Mechanical and chemical removal of the seed coat is often utilized to overcome exogenous dormancy. Techniques such as grinding seeds with abrasives or sand, and sacking them (impaction), are commonly applied to scarify seed coats (Mousavi *et al.*, 2011) [11]. Various techniques, including heating, chilling, drastic temperature fluctuations, brief immersion in boiling water, using a needle to pierce the seed coat, or exposing seeds to specific radio frequencies, can modify seed coat integrity, allowing the penetration of water and gases. However, the effectiveness of these treatments in breaking dormancy may be contingent on the duration of application. Additionally, chemical treatments are employed to induce the degradation of the seed coat (Tung and Serrano, 2011) [12].

There are several methods that can be used to break the dormancy of rice seeds At 307, such as the water soaking method, oven drying method, sun drying method, and chemical method (Urea, MOP), but there has been no research done on the At 307 rice variety with the above-mentioned methods. Through this work, a dormancy-breaking treatment that is both affordable and effective can be offered to the farming community, preventing delays in sowing and uneven plant growth. Faster breeder seed production also requires dormancy-breaking procedures.

Material and Methods

Experimental location

Lab experiment was carried out at the laboratory of department of crop science, Eastern University, Sri Lanka from August to November 2023. During the experimental period, the ambient temperature and the relative humidity was $30\text{ }^{\circ}\text{C} \pm 2^{\circ}\text{C}$ and $70 \pm 5\%$ respectively.

Experimental design

The Petri dish experiment was conducted using a completely randomized design (CRD) with 6 treatments and 5 replications. The treatments are T1 (2% of Urea), T2 (2% of MOP), T3 (Oven drying at $50\text{ }^{\circ}\text{C}$ for 24 hours), T4 (Sun drying for 24 hours), T5 (Water soaking for 24 hours), and T6 (Water soaking for 48 hours). In this experiment, 30 Petri dishes were used, and 25 paddy seeds were placed in each petri dish.

Collection of seeds

The paddy variety "At 307" was used for this study, and seeds were collected from Polonnaruwa Seed Farm.

Seed dormancy breaking methods

Oven drying

Freshly harvested dried seeds underwent heat treatment at $50\text{ }^{\circ}\text{C}$ in the oven. Following the heat treatment, the seeds were soaked in water at room temperature overnight, precisely for 24 hours, and then subjected to germination tests.

Sun drying

Freshly harvested dried seeds were sealed in transparent polythene bags and exposed to sunlight for two days (24 hours). Subsequently, the dried seeds were soaked in water for 24 hours and then subjected to germination testing. During this process, the temperature reached $48\text{ }^{\circ}\text{C}$. A thermometer was utilized to measure the temperature of the seed samples.

Soaking in water

Seed samples were soaked in water for both 48 hours and 24 hours.

Soaking in Urea

Seed samples were soaked in 2% Urea for 24 hours. Solution was prepared by dissolving 2 grams of Urea in 100 ml of water.

Soaking in MOP

Seed samples were soaked in 2% MOP (Muriate of Potash) solution for 24 hours, prepared by dissolving 2 grams of MOP in 100 ml of water.

Data collection

Parameters such as germination percentage, seed germination index, seed vigour index, mean germination time, shoot length of seedlings, root length of seedlings, fresh weight of seedlings and dry weight of seedlings were collected.

Analysis of Data

Collected data were statistically analyzed using the statistical software Minitab 17, and the mean comparison within treatments was performed by Tukey's test at a 5 % significant level.

Calculation

$$\text{Germination percentage} = \frac{\text{Total number of Seeds germinated}}{\text{Total seeds}} \times 100$$

$$\text{Seed Germination Index} = \frac{\sum \text{Number of germinated seeds on a particular day (GT)}}{\text{Number of days from the start of the experiment (DT)}}$$

$$\text{Seed vigour index} = \text{Germination percentage (\%)} \times \text{seedling length (cm)}$$

$$\text{Mean germination Test} = \frac{\sum \frac{n \times d}{N}}$$

Where,

n = number of seeds germinated on each day

d = number of days from the beginning of the test

N = total number of seeds germinated at the termination of the experiment

(Ellis and Roberts, 1981).

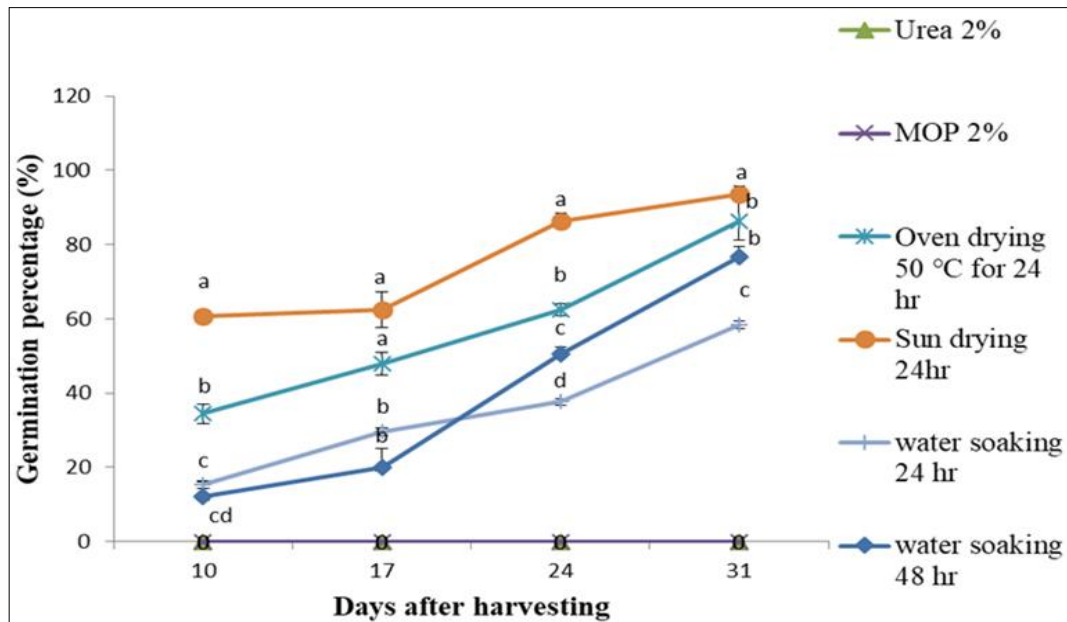
Results and discussion

Germination percentage (%)

The effect of different seed dormancy-breaking treatments on the germination of rice variety At 307 is shown in figure 1. Germination percentage was significantly ($P < 0.05$) influenced by seed dormancy breaking methods on the 10th, 17th, 24th, and 31st days after harvest. The results indicate a progressive rise in germination percentages across all treatments as the days advanced. The findings demonstrated a substantial impact on seed dormancy due to treatments involving 24-hour oven drying, 24-hour sun drying, water soaking, and chemical treatments. The highest germination percentage was recorded in 24 hours of water soaking and the lowest germination percentage was noted in chemical treatments. The data suggests that treatments, such as 2% urea and 2% MOP, exhibit no discernible impact on breaking the dormancy of rice seeds, as evidenced by the absence of significant differences between the treatments.

According to the provided data, the sun drying treatment for 24 hours exhibited the highest mean germination percentage, reaching 93.6% on the 31st day after harvesting. Following closely, water soaking for 48 hours achieved a germination percentage of 76.8%, while oven drying for 24 hours at 50°C resulted in a germination rate of 75.2%. Additionally, on the 24th day after harvest, the sun drying treatment showed a germination percentage of 86.4%, indicating a significant breakthrough in seed dormancy.

The increased germination resulting from the heat treatment likely played a crucial role in overcoming the limitation of oxygen availability to the embryo. This effect may be attributed to the induction of cracks in the hulls of dormant seeds, thereby enhancing germinability. These observations align with the earlier findings of Janaiah *et al.* (2006) [14]. Additionally, Waheed *et al.* (2012) [15], who reported an increase in the germination of hulled rice seeds following heat treatment at 50°C in various rice cultivars. Tung *et al.* (2011) [12], who reported that the heat treatment method for breaking paddy seed dormancy was found to be the most effective in enhancing the germination rate.



Error bar denotes a standard error of five replicates. The letter 'ns' denotes a difference that is not Significant at The probability level of 0.05. The mean value in a column with a different letter or Letters indicates that the Difference is significant by Tukey’s test at the 0.05 level of probability.

Fig 1: The effect of different seed dormancy-breaking treatments on the germination of rice variety At 307

Seed vigour index

Table1 describes the impact of various seed dormancy-breaking treatments on the seed vigour index of the rice variety At 307. Seed vigour index was significantly (P<0.05) altered due to the application of diverse dormancy breaking treatments. The findings reveal notable differences in the seed vigour index at 14, 21, 28, and 35 days after harvest. The maximum seed vigour index was observed in

sun drying for 24 hours (1293.9), followed by oven drying at 50 °C for 24 hours (1006.7), and water soaking for 48 hours (963.4). In contrast, the lowest seed vigour index was noted in the treatments involving 2% urea and 2% MOP at 35 days after harvest. Interestingly, no significant difference in seed vigour index was observed between the treatments of sun drying for 24 hours and oven drying at 50 °C for 24 hours at 35 days after harvesting.

Table 1: The impact of various seed dormancy-breaking treatments on the seed vigour index of the rice variety At 307.

Treatments	14 days	21 days	28 days	35 days
Urea 2%	0.00±0.00 ^c	0.00±0.00 ^c	0.00±0.00 ^c	0.00±0.00 ^d
MOP 2%	0.00±0.00 ^c	0.00±0.00 ^c	0.00±0.00 ^c	0.00±0.00 ^d
Oven drying(50°C-24hr)	497.0±47.1 ^a	594.9±42.9 ^a	804.3±53.7 ^b	1006.7±25.2 ^b
Sun drying (24hr)	528.9±43.1 ^a	742.2±91.7 ^a	1157.0±108.0 ^a	1293.9±42.0 ^a
Water soaking (24hr)	240.5±58.8 ^b	329.5±67.0 ^b	578.9±46.5 ^b	796.9±42.5 ^c
Water soaking (48hr)	196.7±67.1 ^b	249.6±70.8 ^b	700.0±35.7 ^b	963.4±40.8 ^b
F-Table	*	*	*	*

The value is the average of five replicates. The letter 'ns' denotes a difference that is not significant at the probability level of 0.05. The mean value in a column with a different letter or letters indicates that the difference is significant by Tukey’s test at the 0.05 level of probability.

Farooq *et al.* (2004) ^[17] demonstrated the significant impact of pre-sowing temperature treatments on rice’s germination and vigour. Conversely, Lee *et al.* (2002) noted that high temperatures in dry heat treatments can decrease seed viability and seed vigor. The beneficial effects of dry heat treatment may be attributed to the rise in total sugar contents and α-amylase activity, which showed a positive correlation with germination rate, as observed by Basra *et al.* (2004) ^[17].

In a prior experiment, Farooq *et al.* (2005) ^[20] exposed japonica and indica rice seeds to dry heat treatment at 40 °C for 72 hours and 60 °C for 24 hours. For indica rice, the dry heat treatment at 40 °C for 72 hours led to increased vigor. Vigorous seeds, found that efficient mobilization of reserves from storage tissues to the embryo axis occurred, and this capacity manifested in enhanced seedling growth, ultimately contributing to plant productivity (Isely, 1957) ^[21].

Germination index

Table 2 outlines the impact of various seed dormancy-breaking treatments on the germination index of the rice variety At 307. Significant differences (P<0.05) were observed in the germination index at 14, 21, 28 and 35 days after harvest. The maximum germination index was documented in sun drying for 24 hours (44.53), followed by oven drying at 50 °C for 24 hours and water soaking for 48 hours. In contrast, the lowest germination index was noted in the chemical treatment at 35 days after harvest. Notably, there was no significant difference in the germination index between the treatments of oven drying at 50 °C for 24 hours and water soaking for 48 hours at 35 days after harvest. The consistent high values observed for sun drying for 24 hours suggest that this treatment exhibited a more robust dormancy-breaking effect compared to the others.

Table 2: The Effect of different seed dormancy breaking treatments germination index of rice variety At 307

Treatments	14 days	21 days	28 days	35 days
Urea 2%	0.00±0.00 ^c	0.00±0.00 ^d	0.00±0.00 ^e	0.00±0.00 ^d
MOP 2%	0.00±0.00 ^c	0.00±0.00 ^d	0.00±0.00 ^e	0.00±0.00 ^d
Oven drying(50°C-24hr)	14.72±1.17 ^a	23.69±2.35 ^{ab}	28.38±0.99 ^b	35.71±0.21 ^b
Sun drying (24hr)	16.14±0.37 ^a	29.50±3.50 ^a	35.11±0.86 ^a	44.53±1.18 ^a
Water soaking (24hr)	7.13±1.14 ^b	15.17±2.02 ^{bc}	15.42±0.70 ^d	26.05±0.81 ^c
Water soaking (48hr)	6.14±2.20 ^b	11.59±2.79 ^c	22.28±0.95 ^c	34.11±1.52 ^b
F-Table	*	*	*	*

The value is the average of five replicates. The letter 'ns' denotes a difference that is not significant at the probability level of 0.05. The Mean value in a column with a different letter or letters indicates that the difference is significant by Tukey's test at the 0.05 level of Probability.

Farooq *et al.* (2004) [17] documented that subjecting rice seeds to heat treatment at 40 °C for 72 hours resulted in the highest germination energy and germination index compared to the control group. In contrast, Ramin *et al.* (2016) [22] observed that drying wheat seeds at elevated temperatures (above 40 °C) significantly decreased their germination index compared to seeds dried at lower temperatures. As per Ramin *et al.* (2016) [22], air drying and oven drying did not have a notable impact on the germination index of wheat seeds, while sun drying significantly increased the germination index.

Mean germination time

Table 3 elucidates the impact of various seed dormancy-breaking treatments on the mean germination time of the rice variety At 307. Notable differences (P<0.05) were observed in mean germination time at 14, 21, 28 and 35 days after harvest. Sun drying for 24 hours, followed by oven drying at 50 °C for 24 hours and soaking in water for 48 hours, exhibited significantly higher mean germination times at 35 days after harvesting.

Consistently, sun drying for 24 hours displayed the highest values, suggesting that this treatment exerted a more potent dormancy-breaking effect compared to the other treatments.

Table 3: The Effect of different seed dormancy breaking treatments on Mean Germination Time of rice variety At 307

Treatments	14 days	21 days	28 days	35 days
Urea 2%	0.00±0.00 ^c	0.00±0.00 ^d	0.00±0.00 ^e	0.00±0.00 ^d
MOP 2%	0.00±0.00 ^c	0.00±0.00 ^d	0.00±0.00 ^e	0.00±0.00 ^d
Oven drying(50°C-24hr)	25.06±0.39 ^{ab}	25.84±0.21 ^{ab}	26.16±0.31 ^{ab}	26.99±0.09 ^{ab}
Sun drying (24hr)	26.46±0.20 ^a	27.01±0.25 ^a	27.16±0.30 ^a	27.48±0.29 ^a
Water soaking (24hr)	23.97±0.53 ^b	24.02±0.93 ^c	24.86±0.62 ^b	26.11±0.27 ^c
Water soaking (48hr)	24.02±0.86 ^b	25.13±0.08 ^{bc}	26.03±0.29 ^{ab}	26.47±0.22 ^{bc}
F-Table	*	*	*	*

The value is the average of five replicates. The letter 'ns' denotes a difference that is not significant at the probability level of 0.05. The mean value in a column with a different letter or letters indicates that the difference is significant by Tukey's test at the 0.05 level of probability.

Bewley *et al.* (2013) highlighted that the mean germination time serves as a metric for assessing the speed and temporal distribution of germination. Orchard, (1977) [24] proposed that a lower mean germination time indicates a faster germination rate within a population of seeds. This observation aligns with the findings of Soltani *et al.* (2015) [25], who emphasized that while mean germination time accurately measures the time required for a batch to germinate, it may not strongly correlate with the temporal uniformity of germination and does not account for a fixed germination percentage. In a related context, Windauer *et al.* (2012) [26] suggested that elevated temperatures can expedite the germination rate. Conversely, germination tends to be sluggish when the temperature is reduced to 5 °C. This variability in germination time is attributed to metabolic reactions and enzyme activity during the germination process.

Shoot length of seedling (cm)

Table 4 illustrates the impact of various seed dormancy-breaking treatments on the shoot length of seedlings of the rice variety At 307. There is a significant (P<0.05) differences among the treatment on shoot length of seedlings of the rice variety At 307. Notably, there were no significant differences (P>0.05) observed among treatments, including oven drying at 50 °C for 24 hours, sun drying for 24 hours, and water soaking for 24 hours and 48 hours. Among these treatments, the highest shoot length was recorded in sun drying for 24 hours (4.708 cm), followed by oven drying at 50 °C for 24 hours (4.48 cm), and water soaking for 48 hours (4.35 cm) at 35 days after harvest. It is important to note that these treatments did not contribute significantly to the increase in the shoot length of seedlings.

Table 4: The Effect of different seed dormancy breaking treatments on shoot length of seedlings of rice variety At 307

Treatments	14 days	21 days	28 days	35 days
Urea 2%	0.000±0.000 ^b	0.000±0.00 ^c	0.000±0.000 ^b	0.000±0.000 ^b
MOP 2%	0.000±0.000 ^b	0.000±0.00 ^c	0.000±0.000 ^b	0.000±0.000 ^b
Oven drying(50°C-24hr)	4.108±0.199 ^a	4.138±0.26 ^a	4.422±0.171 ^a	4.480±0.144 ^a
Sun drying (24hr)	4.108±0.606 ^a	4.234±0.21 ^a	4.694±0.411 ^a	4.708±0.521 ^a
Water soaking (24hr)	3.300±0.396 ^a	3.386±0.20 ^a	4.104±0.345 ^a	4.308±0.129 ^a
Water soaking (48h)	4.058±0.664 ^a	4.100±0.44 ^a	4.232±0.284 ^a	4.350±0.259 ^a
F-Table	*	*	*	*

The value is the average of five replicates. The letter 'ns' denotes a difference that is not significant at the probability level of 0.05. The mean value in a column with a different letter or letters indicates that the difference is significant by Tukey's test at the 0.05 level of probability.

Martinez-Gomez and Dicenta (2001) [27] highlighted the need to enhance the efficacy of breaking seed dormancy through methods such as drying at high temperatures and chemical treatment. Lambers *et al.* (2019) [28] contributed to this understanding by noting that lower temperatures induce a slower metabolic rate in seeds, resulting in slower growth (seedling length). Conversely, higher temperatures lead to accelerated plant metabolism, causing a faster dissipation of the seed's energy required for growth. Enthalpy-based approaches explain that as temperatures rise, the energy

within water increases, subsequently raising diffusion pressure. This increase in pressure enhances metabolic and enzyme activity while decreasing the internal potential of a seed. Consequently, this promotes increased water absorption, leading to a more rapid hydration process at higher temperatures a physical mechanism that can accelerate germination.

Root length of seedlings (cm)

Table 5: The Effect of different seed dormancy breaking treatments on root length of seedlings of rice variety At 307

Treatments	14 days	21 days	28 days	35 days
Urea 2%	0.000±0.00 ^b	0.000±0.00 ^b	0.000±0.00 ^b	0.000±0.00 ^b
MOP 2%	0.000±0.00 ^b	0.000±0.00 ^b	0.000±0.00 ^b	0.000±0.00 ^b
Oven drying (50°C-24hr)	4.108±0.19 ^a	7.976±1.05 ^a	8.026±0.24 ^a	8.448±0.37 ^a
Sun drying (24hr)	4.108±0.60 ^a	7.870±0.25 ^a	7.936±1.14 ^a	8.564±0.26 ^a
Water soaking (24hr)	3.300±0.39 ^a	6.916±0.76 ^a	7.688±0.71 ^a	7.964±0.23 ^a
Water soaking (48hr)	4.058±0.66 ^a	7.208±0.337 ^a	7.978±0.848 ^a	8.092±0.295 ^a
F-Table	*	*	*	*

The value is the average of five replicates. The letter 'ns' denotes a difference that is not significant at the probability level of 0.05. The mean value in a column with a different letter or letters indicates that the difference is significant by Tukey's test at the 0.05 level of probability.

Table 5 illustrates the impact of various seed dormancy-breaking treatments on the root length of seedlings of the rice variety At 307. There is a significant ($P < 0.05$) differences among the treatment on root length of seedlings of the rice variety at 307. The results indicated no significant difference ($P > 0.05$) among treatments, including sun drying for 24 hours, oven drying at 50 °C for 24 hours, water soaking for 24 hours, and water soaking for 48 hours. However, the seeds treated with sun drying for 24 hours exhibited the highest root length of seedlings (8.564 cm), followed by oven drying at 50 °C for 24 hours (8.448 cm), water soaking for 48 hours (8.092 cm), and water soaking for 24 hours (7.964 cm) at 35 days after harvest.

The research study revealed that dry heat induces a mechanical alteration in the seed coat, effectively breaking the physical dormancy of the seed. As a consequence of this alteration, the seed coat becomes fractured, enabling increased imbibition, ultimately promoting germination (Bradstock and Auld, 1995) [29]. In line with these findings, Farook *et al.* (2005) reported that a combination of heating followed by soaking in water resulted in reduced germination time and increased root length of seedlings.

Additionally, Bahuguna *et al.* (2015) [30] found that high temperatures in seedlings can lead to detrimental effects, such as the destruction of cell membranes, inhibition of photosynthesis, and an increase in oxidative damage, ultimately causing harm to root growth.

Fresh weight of seedlings (g)

Table 6 delineates the impact of various seed dormancy-breaking treatments on the fresh weight of seedlings of the rice variety At 307. There is a significant ($P < 0.05$) differences among the treatment on fresh weight of seedlings of the rice variety At 307. The table reveals no significant differences in seedling fresh weight among the treatments of sun drying for 24 hours, oven drying for 24 hours, and water soaking for 24 hours, as well as water soaking for 48 hours. However, the highest fresh weight was observed in sun drying for 24 hours, followed by 48 hours of water soaking, oven drying for 48 hours, and 24 hours of soaking at 35 days after harvesting. Conversely, the lowest values were recorded in 2% Urea and 2% MOP treatments, with no significant difference observed between these two treatments in terms of the fresh weight of seedlings.

Table 6: The Effect of different seed dormancy breaking treatments on fresh weight of seedlings of rice variety At 307

Treatments	14 days	21 days	28 days	35 days
Urea 2%	0.000±0.00 ^b	0.000±0.00 ^b	0.000±0.00 ^b	0.000±0.00 ^b
MOP 2%	0.000±0.00 ^b	0.000±0.00 ^b	0.000±0.00 ^b	0.000±0.00 ^b
Oven drying (50°C-24hr)	0.039±0.00 ^a	0.070±0.00 ^a	0.071±0.02 ^a	0.071±0.00 ^a
Sun drying (24hr)	0.044±0.00 ^a	0.072±0.00 ^a	0.073±0.01 ^a	0.074±0.00 ^a
Water soaking (24hr)	0.041±0.0 ^a	0.052±0.01 ^a	0.055±0.00 ^a	0.070±0.00 ^a
Water soaking (48hr)	0.040±0.001 ^a	0.069±0.005 ^a	0.071±0.006 ^a	0.072±0.00 ^a
F-Table	*	*	*	*

The value is the average of five replicates. The letter 'ns' denotes a difference that is not significant at the probability level of 0.05. The mean value in a column with a different letter or letters indicates that the difference is significant by Tukey's test at the 0.05 level of probability.

As per Sikder *et al.* (1967) [31], the utilization of pre-heat treatment has been shown to induce germination and break dormancy in rice seeds. Additionally, the application of this treatment has been associated with an increased crop growth rate, resulting in higher fresh weight of seedlings. The

significant improvement observed in both germination and the fresh weight of rice seedlings is likely linked to the mechanical disruption of seed coverings induced by heat, leading to the subsequent leaching of inhibitors from the seeds.

Dry weight of seedlings (g)

Table 7 presents the impact of various seed dormancy-breaking treatments on the dry weight of seedlings of the rice variety At 307. There is a significant ($P<0.05$)

Differences among the treatment on dry weight of seedlings of the rice variety At 307. The results indicate no significant differences between treatments, including sun drying for 24 hours, oven drying for 24 hours, water soaking for 24 hours, and water soaking for 48 hours.

Table 7: The Effect of different seed dormancy breaking treatments on dry weight of seedlings of rice variety At 307

Treatments	14 days	21 days	28 days	35 days
Urea 2%	0.0000±0.0000 ^b	0.0000±0.0000 ^b	0.0000±0.0000 ^b	0.0000±0.0000 ^b
MOP 2%	0.0000±0.0000 ^b	0.0000±0.0000 ^b	0.0000±0.0000 ^b	0.0000±0.0000 ^b
Oven drying(50°C-24hr)	0.0136±0.0006 ^a	0.0149±0.0004 ^a	0.0167±0.0004 ^a	0.0169±0.0004 ^a
Sun drying (24hr)	0.0145±0.0004 ^a	0.0150±0.0004 ^a	0.0151±0.0002 ^a	0.0181±0.0002 ^a
Water soaking (24hr)	0.0142±0.0005 ^a	0.0146±0.0010 ^a	0.0146±0.0010 ^a	0.0148±0.0008 ^a
Water soaking(48hr)	0.0139±0.0001 ^a	0.0147±0.0010 ^a	0.0152±0.0003 ^a	0.0170±0.0001 ^a
F-Table	*	*	*	*

The value is the average of five replicates. The letter 'ns' denotes a difference that is not significant at the probability level of 0.05. The mean value in a column with a different letter or letters indicates that the difference is significant by Tukey's test at the 0.05 level of probability.

Conclusion

In conclusion, the present study highlights the effect of different seed dormancy-breaking techniques on rice variety At 307. The result reveal that sun drying for 24 hours (48°C) significantly breaks the dormancy of the rice variety at 307 when compared with other treatments. Sun drying for 24 hours (48 °C) significantly increases the germination percentage, seed germination index, seed vigour index, mean germination time, shoot length of seedlings, root length of seedlings, fresh weight of seedlings and dry weight of seedling. Sun drying for 24 hours significantly breaks the dormancy of the rice variety at 307 and increases the germination percentage (93.6%) and enhances vigor index (1293.9). Overall, this study suggests that sun drying treatments break the dormancy significantly, increase the yield, also prevent delays in sowing and uneven plant growth. This finding will help add knowledge about breaking the dormancy of rice seeds by the sun drying method. It is recommended that rice farmers wishing to use sun drying as a pretreatment for breaking dormancy in rice, break the dormancy at 48 °C to serve electricity and other heat energy sources. It is an effective and easy method to break the dormancy of rice, and it can be economically recommended to break the dormancy of rice variety At 307.

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