Study on the Effect of Priming on the Storage Resistance of Rice

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Abstract: In order to explore the effect of water-induced treatment on the storability of rice seeds, Longgeng 301 rice seeds were used as a test material. Seeds were treated with distilled water in the dark for different time, respectively, and blotted with absorbent paper. Dry surface moisture, drying at room temperature to dry the seeds to the initial moisture content into the storage cabinet(4℃,RH 40%). Identification of seed vigor and evaluation of its protective enzyme activity by standard germination and accelerated aging tests after storage for different periods of time. Using sand bed method to identify the rice seedlings' enzyme activity, and the effects of water-induced treatment on the storage stability. Artificial accelerated aging test was used to monitor the changes of seed germination potential, germination rate, and other indicators before aging compared with that before aging, and to explore the effect of water initiation on seed quality after aging. According to the experimental data, it was found that the germination rate and vigor index of rice seeds after 12 h water treatment were improved. The germination potential and vigor index of the seeds that were treated for 12h after aging and storage for one year were significantly higher than that of the untreated and other treatment time seeds, indicating that the 12h water-induced treatment can increase the seed vigor to a certain extent. It provides a theoretical basis for improving the storability of rice seeds.

1. Introduction

Rice is an annual gramineous plant, the most important food crop in the world, and the largest food crop in China. After the rice seed is removed from the outer shell, it is called rice. The stable production of rice guarantees the safety of food in China. However, rice is wasteful of tens of billions of pounds per year due to aging deterioration and mildew during storage. [1] At the same time, the decline in germination rate of rice during storage also caused a lot of losses. Since most of the production and storage of rice are in the south, the humid climate in the south is particularly prone to mold and insect damage. However, high-standard low-temperature libraries or air-conditioning libraries not only require a large amount of resources but also continue to consume energy. Therefore, it is undoubtedly a cost-effective way to solve or alleviate aging deterioration by enhancing the storage stability of seeds. Improving the storage stability of rice seeds by some methods is of great significance for reducing the loss of seed storage and improving national food security.

There are two methods for studying the storage resistance of rice, including natural aging method and artificial aging method. The natural aging method is to store seeds under natural conditions. During this period, the germination power of the seeds will gradually decrease. Although this method is the closest to the characteristics of seed storage, this method is time consuming and therefore is not used in actual research. Widely used; artificial aging method often uses some methods to deal with the process of accelerating seed aging. Although it is somewhat different from natural aging method, it can make up for the long time defects of natural aging method, so it is widely used by researchers. The storage resistance of rice is generally evaluated from two aspects.

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As a kind of edible rice, the rice still has the original taste and taste after long-term storage; on the other hand, as a seed or germplasm preservation, the seed still possesses after long-term storage. Most of the current related research is the latter. For many years, researchers have evaluated the germination rate, germination potential, GI, VI, and half-life of rice seed storage resistance [2], in addition to fatty acid values, kinematic viscosity and other indicators. The rice seeds are stored in a place with high oxygen content, and the lipase in the seeds is in contact with the lipid, resulting in hydrolysis and deterioration of the seed fat. Ros gradually increases in the process of seed aging, accelerating the aging process [3-6]. During the storage period, the biomacromolecules in the cells are damaged, and the degree of injury increases with the storage time and the storage environment.

In recent years, China has studied the genetic factors and gene mapping of rice storage. Studies have found that the lack of lipoxygenase increases the storage capacity of rice. Seed water content is important for seed storage, and seed water content is greatly affected by rice starch and amylose content. Therefore, the storage tolerance of rice may be related to the type of rice starch. Quantitative traits that control rice storage tolerance are present in many parents. By molecular labeling, multiple synergistic quantitative trait loci can be aggregated to produce greater storage resistance. However, it has taken time to discover a new rice variety. If some methods can be used to improve the storage capacity of rice, it is undoubtedly a solution to solve rice storage problems quickly and effectively.

Studies have shown that PEG is used for osmotic adjustment of soybean seeds with different degrees of aging. The water absorption rate of treated soybean seeds is reduced, the cell membrane is repaired, seed vigor and stress resistance are improved, and the activity of some enzymes is significantly increased after seed germination, emergence of neat seedlings, strong seedlings [7]. Huo Yuqin and others found that seeds treated with different concentrations of PEG after aging treatment at the same time increased the germination rate of seeds to different extents compared with untreated seeds. When the aging time was 0h, the germination potential of soybean seeds treated with different concentrations of PEG was almost twice that of the control group [8]. Dong Jing et al. found that the germination potential and germination rate of osmotic-regulated seeds were improved by PEG, and the wheat seeds treated by PEG had a certain degree of difference compared with the water-treated control. PEG-induced treatment can promote seed germination, and can also improve peroxidase and malondialdehyde activity to some extent in physiological and biochemical aspects [9]. Ma Xiangli et al found that the seed vigor first increased and then decreased during storage, and the seed vigor reached the highest after one year, which was suitable for seed use. Seed vigor can be improved by water-priming treatment, and the effect of seed improvement is most pronounced in the harvest year. The key factors for seed vigor after water initiation are CAT activity and soluble sugar content [10].

Seed vigor is an important indicator for monitoring seed quality, and high vigor seeds have greater growth potential. High-vigorous seeds can better resist adverse environments such as high temperature and high humidity. Seed vigor is formed during the dehydration period of seed growth, and the basis of seed vigor is the accumulation of storage materials [11]. As the seeds become more and more mature, the protein, starch and other substances inside the seeds increase, the germination rate and vigor of the seeds gradually increase, reaching the highest level in the physiological maturity stage [12]. Enhancing the storage stability of seeds by increasing seed vigor is an important direction to solve the problem of seed storage.

Seed priming is a technique for promoting seed germination and improving the seedling uniformity and seedling strength based on the biological mechanism of seed germination. Among them, the use of more liquid is controlled by osmotic adjustment to control the slow absorption of the seed to stay in the second stage of the water swell of the seed, and then gradually back to the physiological preparation of the seed germination, so that the seed emergence is rapid and tidy [8,13-14] . Seed initiation promotes cell membrane, DNA repair and enzyme activation, keeping the seed in a metabolic state ready for germination, but the radicle does not extend. Compared with the liquid, the cost of the liquid is high, the aeration is poor, the microorganism is easy to reproduce, and the initiator remaining on the seed is not easy to be removed, the biological initiation requires relatively expensive equipment and is not easy to operate; the water is more expensive, simple, quick and easy to separate. At present, there are many studies on the initiation of liquid initiators. Salicylic acid, PEG [8], proline and gibberellin are used as seed initiators, and there are few initiators for water. Therefore, through the water-priming treatment of rice seeds with different storage time, the changes of rice seed vigor and physiological and biochemical substances under water-initiated conditions and their relationships were expounded, in order to provide theoretical basis for the in-depth study of seeds.

In recent years, although it has attracted the attention of some researchers in the field of domestic seed research, it is still in the initial stage, and most of them are studies on the impact of seed vigor. It is still rare to find research on the storage resistance of seeds, which triggers the technology in practice. The application has not been promoted. The predecessors' research on rice seeds is mainly in the aspects of variety selection, hybrid rice, rice taste, etc. The effect of water on the storage tolerance of rice seeds has not been reported. This research project focuses on the rapid decline of seed vigor level during the storage of rice seeds, and the poor storage characteristics of rice seeds, especially hybrid rice seeds. The key technology is adopted for seed initiation, and a variety of trigger conditions are used to find the most excellent initiation strategy, exploring the technical methods to improve the storage capacity of rice seeds, has certain research value. The germination test of rice seeds with different storage time after initiation was carried out to clarify the changes of rice seeds in germination potential and germination rate after different time of water initiation, and to explore the effects of water on the storage tolerance of rice, in order to improve rice. Seeds provide guidance for storage resistance.

2. Materials and Methods

2.1 Materials.

Japonica rice Longgeng 301 were used in this research.150 seedings were randomly selected from each of the treated rice seeds for sand bed culture, and the seedlings were taken for enzyme activity after 14 days.

2.2 Seed Priming.

The initial water content of an appropriate amount of seed detector was obtained from the rice seedlings of Longgeng 301. Weigh 6 pieces of Longgeng 301 rice seeds, each 500g, rinse off, and remove impurities such as straw. 5 of them were placed in a plastic box, respectively, distilled water was added to the seed, and the remaining part was dried with filter paper to dry the surface moisture and returned to the initial water content at room temperature, placed in a bag, and stored at 4℃. The cabinet is saved. Five seeds were placed in a 25 ℃ artificial climate chamber for initiation treatment in the dark conditions for 12, 24, 36, 48, 60 h. After the end of the initiation, the surface moisture is absorbed by the filter paper, and then placed indoors to dry to the initial water content, and then placed in a bag and stored in a 4 ° C storage cabinet.

2.3 Seed Aging Treatment.

Take about 100g of rice seeds and lay a layer in the aging box. Do not pile up. Inject the tap water into the germination box about 1cm from the bottom, place a layer of seeds on the iron bed in the germination box, put it into the aging box, turn on the humidifier, and adjust the temperature. During the period, observe the instrument panel and replenish the deionized water in the humidifier. The germination potential, germination rate, germination index and vigor index after seed aging treatment were determined by using unaged seeds as a control.

2.4 Enzyme Activity Assay.

Soluble protein content, catalase, peroxidase and superoxide dismutase were measured based on the traditional methods.

3. Results

3.1 Effect of Water on Seed Quality.

Seed quality usually refers to the quality of the variety and the quality of the sowing. The quality of sowing refers to the quality associated with emergence in the field. In this study, the quality of seeds was tested by evaluating the germination rate, germination potential, germination index, vigor index and enzyme activity of the seeds after water-induced treatment. The germination test to determine the seed vigor level after initiation as shown in Table 1 shows that the seed germination potential, germination rate, germination index and vigor index reached the maximum at 12 h after water initiation treatment, but the difference was not significant with other treatments and controls. ($P<0.05$). After the water was initiated, the seeds were subjected to artificial aging test. (Figure 1) The germination rate of the seeds decreased significantly after the initiation time was longer than 24 hours. When the application was carried out in production, it was necessary to control the initiation time to avoid the decrease of seed vigor caused by long-term soaking. After the water-induced treatment, the seeds had different degrees of mildew after aging, and the mildew was more severe after the water-induced treatment for 48 and 60 hours of aging (Figure 2).

Table 1 Effects of water-initiated treatment on rice seed vigor at different times

Treat time	Germination potential(%)	Germinaiton rate(%)	Germination index	Vigor index
0h	81	93	69.31	27.03
12h	81	94	69.51	28.96
24h	75	88	64.80	27.00
36h	78	89	66.07	26.64
48h	67	86	60.01	24.81
60h	62	90	60.36	24.95

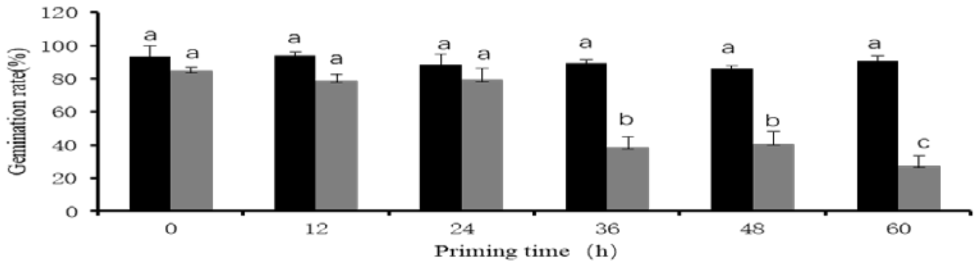

Figure. 1 Seed germination rate after water priming treatment and aging

Left, Germination rate after priming, Right, Germination rate after priming and aging

Figure. 2 Appearance characteristics of Longgeng 301aging treated seeds after water treatment

Note A, B, C, D, E, and F represent seeds after 0, 12, 24, 36, 48, and 60 hours of water priming treatment, respectively.

3.2 Effect of Water on Seed Quality after 1 Year of Water Initiation and Storage.

The seed germination of rice was initiated and stored for 1 year using standard germination test (Table 2, Figure 3). The results showed that the seed germination potential, germination index and vigor index were relatively high at 4 h after water initiation treatment, and the germination potential was 45%. The germination index was 34.33, and the seed vigor index was 14.30, which was significantly different from the treatment of 36, 48, 60h ($P<0.05$). The germination rate of rice seeds treated with water for one year and stored for one year was not significantly different under each treatment condition. The germination rate of the aged seeds after storage for one year showed a downward trend. The seed germination rate of the water-induced treatment at 36h, 48h and 60h was significantly lower than that of the rice seeds which did not initiate and initiate treatment for 12h and 24h (Figure 3). The germination rate of rice seeds treated with water for 12h and 24h after aging and then stored for one year showed a downward trend, but the decline was not significant. The results of artificial accelerated aging test on rice seeds that were initiated and stored for 1 year showed that after one year of storage of rice seeds at different times, with the increase of the initiation time, the growth of seed bacteria increased and the seed quality decreased (Figure 4).).

Table 2 Effect of water-induced treatment and storage on rice seed vigor after one year at different times

Treat time	Germination potential (%)	Germinaiton rate (%)	Germination index	Vigor index
0h	88	100	77.46	31.50
12h	78	99	71.87	29.47
24h	85	96	72.16	29.10
36h	68	91	66.15	26.46
48h	67	91	65.13	26.48
60h	64	91	62.08	25.65

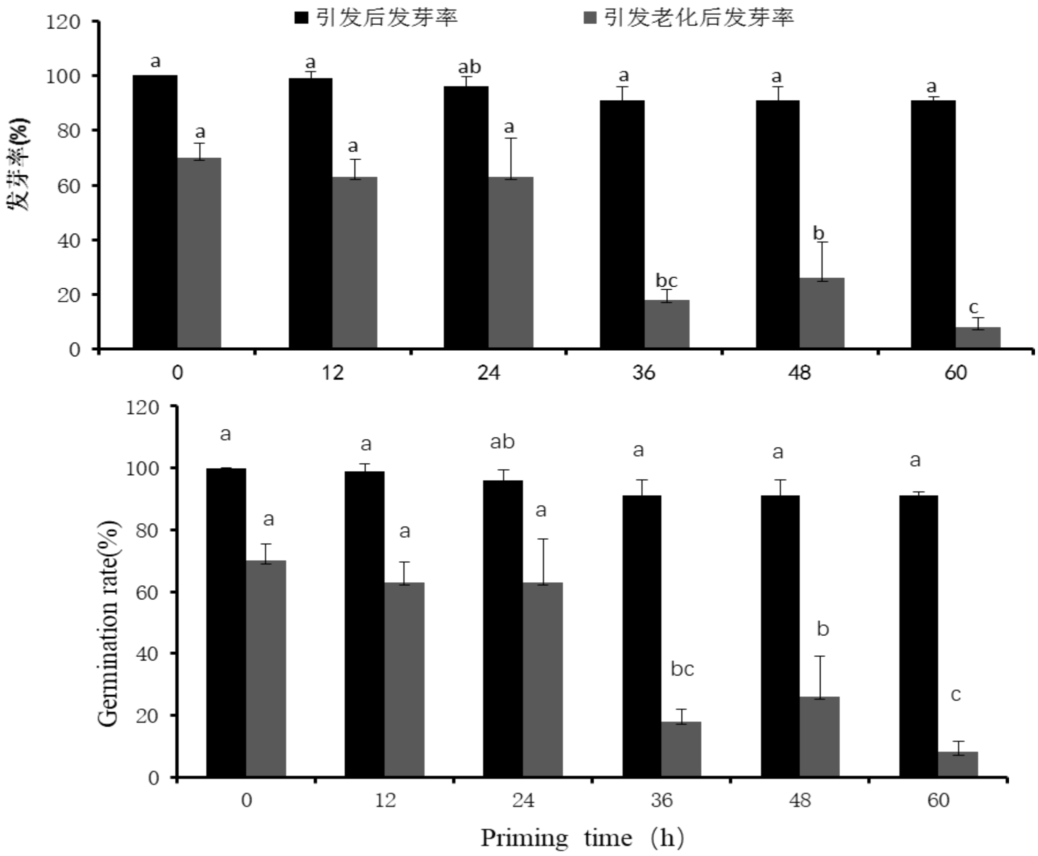

Figure. 3 Germination rate after one year of water storage and aging of seed storage

Left, Germination rate after priming, Right, Germination rate after priming and aging

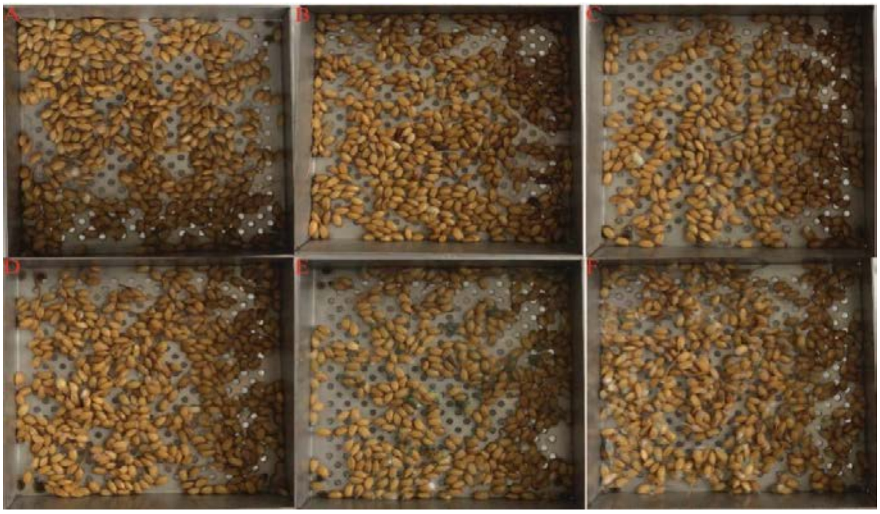

Figure. 4 Appearance characteristics of Longgeng 301seeds primed by water and stored for one year after aging treatment

Note A, B, C, D, E, and F represent seeds after 0, 12, 24, 36, 48, and 60 hours of water priming treatment, respectively.

3.3 Effect of Water on the Vigor of Longgeng 301 Seed.

The activity index of Longyan 301 rice seed decreased with the prolongation of the initiation time. The seed vigor index of rice treated for 12 hours was slightly higher than that of other treated and untreated seeds. The seed vigor index of rice was significantly lower than that of 48h and 60h. The rice seed vigor index at 12 h of treatment was initiated (Figure 5). The germination index of the seeds after water treatment showed a downward trend. The seed vigor plants at 36h, 48h and 60h after treatment were significantly lower than the uninitiated treatment and initiation treatment for 12h and 24h (Figure 5). The vigor index of rice seeds treated with water treatment at 36, 48 and 60 hours decreased greatly, indicating that the water-induced treatment for 36, 48 and 60 hours was not conducive to the improvement or even maintenance of rice seed vigor.

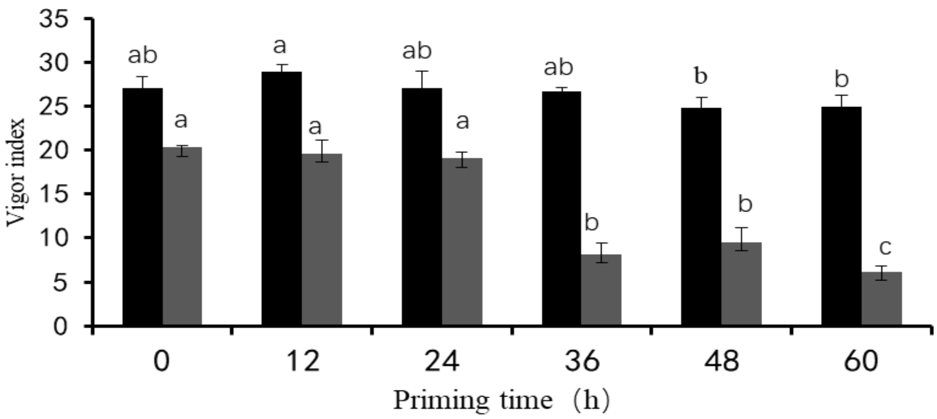

Figure 5 Vigor index of seed after water priming treatment and aging

Left, Vigor index after priming, Right, Vigor index after priming and aging

3.4 Effect of Water Priming and Storage for 12 Months on Seed Vigor of Longgeng 301.

In order to explore the effect of water initiation and storage on the vigor of rice seeds, the vigor level of seeds treated with water for different periods of time and stored for 1 year was tested. Whether caused by aging or not, water priming reduced the seed vigor of rice seeds after storage for 1 year (Table 3, Figure 6). From the impact of the initiation time on the seed vigor index, the initiation of a certain time can increase the vigor index of the seed, but the increase is not significant.

After 1 h of seed germination, the seed vigor index was the highest at 14.31, which was 1.3 higher than that of the uninitiated seed after storage. The vigor index of the seed that was induced for 24 h was 14.28. After 60 hours of seed germination, the vigor index was the lowest, only 1.54; the difference of vitality index after untreated, induced 12h and induced 24h seed aging was not significant. After aging, the vigor index of the seeds showed a downward trend, but the decline was different. The seed vigor index of the seeds treated with different initiation time decreased after aging. The virological index of rice seeds after treatment and treatment for 12h and 24h decreased little compared with that before aging, and the water induced treatment 36, 48, The 60-hour rice seed vigor index decreased greatly, indicating that the long-term initiation treatment may have some adverse effects on the seed, resulting in a decrease in seed vigor index. Comparing the seed vigor index after aging and storage for one year after aging, it can be found that the decrease of the vigor index of rice seeds after 12 hours and 24 hours of water-initiated treatment is smaller than that of non-water-initiated treatment, indicating that to some extent 12 hours and 24 hours. An hourly water initiating treatment can reduce the degree of seed aging.

Table 3 shows the activity index after one year of storage after treatment for different time and initiation of treatment and aging.

Priming time	0h	12h	24h	36h	48h	60h
After priming	31.50	29.46	29.10	26.46	26.48	25.65
After priming and aging	13.01	14.31	14.28	2.91	4.43	1.54

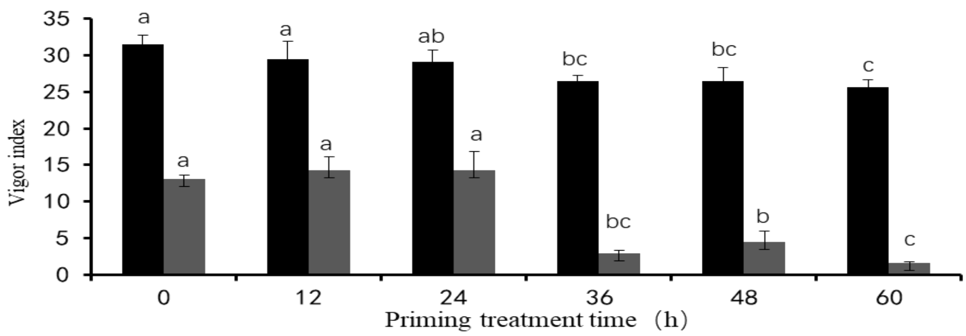

Figure 6 Vigor index of seed after water priming treatment and aging one year later

Left, Vigor index after priming, Right, Vigor index after priming and aging

3.5 Effects of Water on Physiological Activities of Rice Seedlings.

Protective enzyme activity is an indication of the growth status of plant seedlings. The higher the activity, the stronger the viability and the stronger the tolerance to stress. The CAT activity (Figure 7), POD activity (Figure 8) and SOD activity (Figure 9) of rice seedlings were determined and analyzed. It was found that the CAT activity of seedlings under different water inoculation treatments was not significantly different between treatments, and the treated seedlings were induced. The POD activity reached its lowest value at 36 h after the initiation treatment, which was significantly lower than that of the seeds which were initiated for 12 h and 24 h. Rice seedlings that were inoculated for 12 h and 24 h had the highest POD activity values (Figure 8). The POD activity and SOD activity of the rice seedlings which were induced to be treated for 12 and 24 hours were higher than those of the uninitiated treatment. The water-initiated treatment for a certain period of time can increase the activity level of SOD in seedlings. The treatment at 12h can increase the SOD activity of rice seedlings to some extent, while the long-term initiation treatment (36h, 48h) can significantly reduce the SOD activity of rice seedlings (Figure 9).). The seed enzymes of the seeds treated with water for 12h reached the maximum, the CAT activity was 4676U/mgprot, the POD activity was 73019 U/mgprot, and the SOD activity was 6228 U/mgprot.

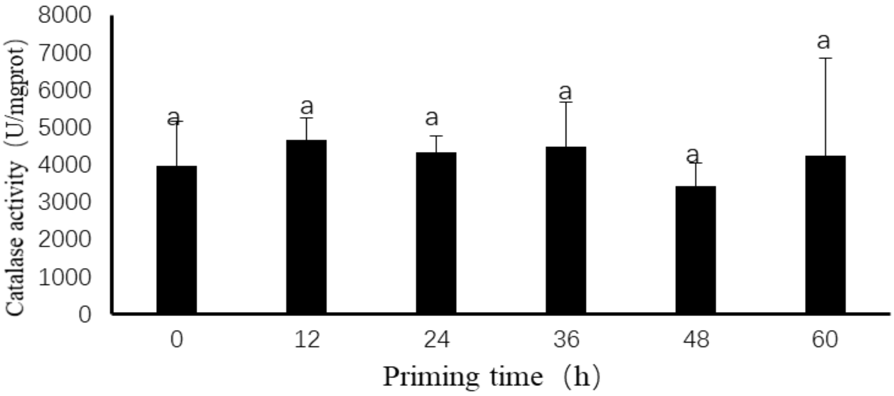

Figure. 7 Effect of water priming treatment on CAT of rice seedlings at different times

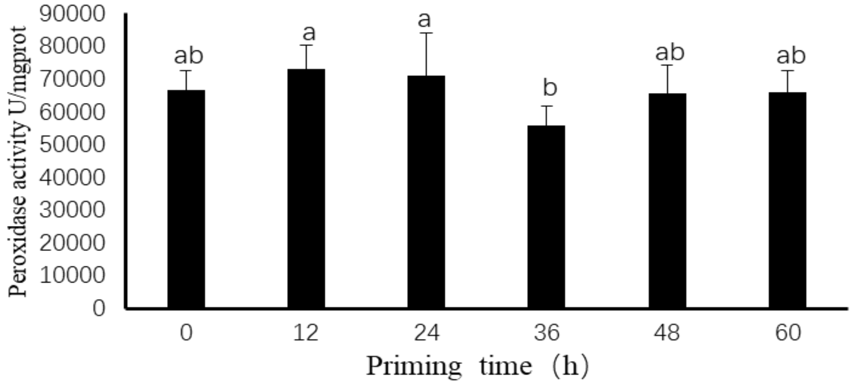

Figure. 8 Effect of water priming treatment on POD of rice seedlings at different times

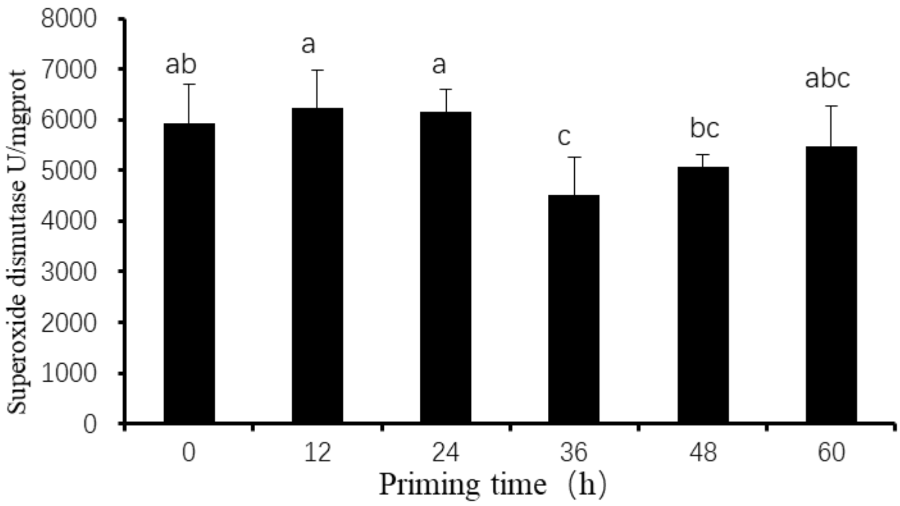

Figure. 9 Effect of water priming treatment on SOD of rice seedlings at different times

4. Discussion

4.1 Control of Water Content in Rice Seed and seed Treated by Water.

If the water content is too high during storage, the respiration will be vigorous, and a large amount of heat will be released, causing the temperature of the seed pile to rise, causing some physiological reactions, causing the physiology of the embryonic cells to decline or even lose vitality. Ensuring the proper water content of the seed after it is triggered is an important way to reduce the damage of the seed. Excessive treatment time will cause the seed storage protein to be degraded and the enzyme involved in seed germination will be activated to initiate seed germination. When the water is triggered, the seeds are dried back in time, which can reduce the seed swelling damage to a certain extent and maintain the quality of the seeds.

4.2 Analysis of the Effect of Water on the Storage Tolerance of Rice Seeds.

According to the germination potential, germination rate, germination index and vigor index measured by germination test, the germination experiment after the initiation showed that the germination potential of rice seeds induced by water for 12 hours had no significant difference with the uninduced rice seeds, and the germination rate The germination index and vigor index were slightly higher than those of uninitiated rice seeds, but the difference was not significant. The germination potential and germination rate of rice seeds at other treatment time were lower than the uninduced levels, and the difference was not significant. The effect of water on the activity level of rice seeds is not obvious.

The results of the germination test carried out after the artificially accelerated aging of the seeds subjected to the treatment showed that the germination potential of the seeds treated with the treatment was lower than that of the unprimed seeds, and the difference between the results of 12h and the untreated was not significant, and the initiation of 60h was not initiated. The difference is large, and it is speculated that excessive water treatment may cause swelling damage to the seed. The germination experiment was carried out after the treated seeds were stored for 5 months with the uninitiated treatment. The results showed that the overall germination potential decreased, but there was no significant difference in germination rate, germination index and vigor index. The germination potential, germination rate and vigor index of the seeds treated with the treated and untreated seeds after one year of storage, untreated, treated for 12h and treated for 24h were not significant, and the seed germination potential of 36, 48, 60h was induced. There is a significant downward trend. After the artificially accelerated aging of the treated seeds, the storage 1 year vigor index decreased significantly, and decreased with the increase of the initiation time. From the results of artificially accelerated aging seed germination test, the seeds treated with water for 12h and 24h were better, which improved the storage resistance of rice seeds to some extent. The results of enzyme activity test showed that the 12-hour water-priming treatment could maintain the high CAT, POD and SOD activities of rice seedlings. Moderate water initiation treatment (such as 12h) can improve the storage stability of rice seeds to some extent[16].

The results showed that the activity index and enzyme activity of rice seeds treated with water for 12h were relatively high after one year of storage, indicating that moderate water initiation treatment may increase or maintain high vigor of seeds for a long time, providing seed production and storage for rice.

Acknowledgements

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