



REVIEW ARTICLE

PROTECTIVE SEED MECHANISM IN RICE: A REVIEW

Susma Adhikari^{a*}, Arati Chapai^a, Kiran Prasad Upadhayaya^b^aAgriculture and Forestry University, Rampur, Chitwan^bAgriculture Section, Madi Municipality, Chitwan, Nepal*Co-corresponding author Email: adksushma01@gmail.com

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ABSTRACT

Rice (*Oryza sativa*) is one of the main staple food of Nepal. It is widely grown in about 50% of the total agricultural land of Nepal (International Rice Commission Newsletter.Html, n.d.). In 2020, Rice production for Nepal was 5.55 million tonnes. Rice production of Nepal was improved from 2.34 million tonnes in 1971 to 5.55 million tonnes in 2020 growing at an average annual rate of 2.72% (Nepal Rice, Paddy Production, 1961-2021.Pdf, n.d.). So, it is important to value rice and protect it from various hazards. Their quality seed production and conservation are necessary to sustain future food security. Rice seeds are major vector of plant propagation and is a critical development stage with many specifications (Rajjou and Debeaujon, 2008). Seed coat is a major factor for seed protection as it is the primary defense against adverse environment conditions. Seed coat protects the seed from hydration stress and electrolyte leakage during the germination period (Mohamed-Yasseen et al., n.d.). Similarly, seed treatment is also a yield limiting and seed protecting factor in Nepalese condition as disease is mainly transmitted through seeds (Amgai et al., 2012). Moisture maintenance, harvesting techniques, temperature and humidity regulation are also quite needed for seed protection (Rice Knowledge Bank, n.d.).

KEYWORDS

Rice, Seed treatment, Seed viability, Seed longevity, Disease, Protective mechanism

1. INTRODUCTION

In Nepalese condition, the major yield hampering factor mainly in paddy is infestation of disease (Amgai et al., 2012). Seed, soil, insect, air, water are the major mediators of disease transmission. As we know for every plant the major vector of plant propagation is seed which acts as a critical development stage with various specifications. That is why healthy and quality seed is must for the better yield and quality of rice production. It is functionally can be treated as reproductive unit of plant. Even though seed is harvested as feed source or grain, a viable and true seed is expected to be efficient for producing a seedling which must be alive for further germination. It is truly a challenging and rigorous job to produce and protect seed as high-quality seeds have various principal qualities and benefits for an excellent performance in field. Local gardeners, farmers, greenhouse operators and other admit that best quality seeds produced by renown seeds companies are mostly required for success (McDonald and Copeland, 1997).

Similarly, seed is the foundation of any crop including rice. To obtain the best product value and good quality, rice seed must be sown, grown, harvested, stored and processed in a right way. Planting high-quality seeds at a reduced rate can result in improved emergence (>70%), greater uniformity, reduced need for replanting, and vigorous early growth. This, in turn, enhances resistance to insects and diseases while decreasing weed pressure, potentially increasing yield by 5-20% (Rice Knowledge Bank, n.d.). Various strategies are employed to preserve seeds, such as conserving them in their natural habitats (in situ conservation) within protected areas and storing them outside their natural habitat (ex-situ preservation), typically in gene banks. To protect rice seeds for better yield various process and methods are applied as,

1.1 Seed Treatment

Generally, seed treatment refers to the application of disinfect materials

like fungicides, insecticides, radiation, conditioned water and other home available remedies to protect or disinfect seeds from soil borne and seed borne pathogenic organisms.

Diseases that transmit through seeds are foot rot, brown spot, blast and bacterial blight (Manandhar et al., 1992). Seed treatment in rice also reduces damage, enhances CHO mobilization and improves emergence and seedling establishment under flooded condition (Rajjou and Debeaujon, 2008). The pathogen, which basically harbors on rice seed, is the suitable inoculum for the disease development of the rice field (Mew and Gonzales, 2002).

1.1.1 Seed Treatment by Breaking Dormancy

Most of the seed varieties have a dormancy period during which germination rates are low. To enhance seed growth, several treatments can be applied:

- Exposing seeds to high temperatures (40–42°C) for 1–2 days before planting.
- Seed priming: soaking seeds for 4–8 hours and then drying them before planting. After priming, seeds should be planted within 1 to 2 days.
- Pre-germination: immersing seeds in water for 12–24 hours until small shoots emerge from the seeds. In colder weather, seeds may require soaking for 36–48 hours.

After soaking the seeds should be dried and drained in a bag for at least 24 hours but in a shaded area with good air circulation. Seeds tends to be damaged if bag temperatures go high above 42°C. Seeds should be sowed using broadcast or drum seeding methods before the roots reach a length of 5mm. When determining the planting rate, account for a 10-30%

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increase in seed weight due to expansion (Rice Knowledge Bank, n.d.).

1.1.2 By Inoculation

This is for N fixation by rice seedlings. Use 1 g of Azospirillum sp. inoculant (as a powder) per kg of seed and mix with primed wet seed just before sowing (Rice Knowledge Bank, n.d.).

1.1.3 By Fungicide Treatment

This one is used in Asia but rarely.

- 3 grams of fungicide (like Benlate + Mancozeb or Arazone red alone) per kg of seed is mixed with 5 ml of water inside a plastic bag or bottle.
- Spread fungicide solution around the container walls.
- Add seeds to the container, seal it, and shake well to ensure the seeds are evenly coated with the fungicide solution.
- Wear protective equipment and follow appropriate safety procedures (Rice Knowledge Bank, n.d.).

1.1.4 By Using Locally Available Product; Botanicals and Organic Materials.

Various local organic as well botanical ways were evenly effective as compare to the harsh chemical methods for rice seed treatment. We know, organic materials are eco- friendly, non-hazardous, cheap and easily available. Research was done in various districts of western hill (Kaski, Tanahu, Lamjung, Gorkha) to evaluate the effectiveness of the seed treatment on rice yield parameters at different locations. Seven seed treatment procedures, namely: Besar+Soda, Besar+Soda+Hing, Cow-Urine, Salt-Water, Asuro+Titepati, Sisnoo+Aduwa and Saff+Plantomycin were used. In the western region of Nepal, sun drying and the use of titepati and asuro leaves are common practices to reduce the diseases (Pandey et al., 1996; Subedi et al., 1992). Here, researchers found that Besar+soda can be used as best seed treatment procedure in rice which lowered the rice field diseases and maximize the rice grain yield along with straw yield significantly (Amgai et al., 2012).

2. SEED COAT

The seed coat serves as the primary protection for seeds against harsh environmental conditions. The embryo and other seed components are protected with seed coat from physical and chemical barriers, unfavorable conditions and protects the seed against infection and deterioration caused by microorganisms (Mohamed-Yasseen et al., n.d.). The importance of the seed coat in determining seed longevity has been recognized for a long time (Becquerel, 1906). Seeds with tough seed coats generally have prolonged viability (Bass, 1980; Priestley, 1986). Examples include hard seeds like Canna, Lotus, and Lupinus, which have remained viable for over 500 years (Bass, 1980). Crack, crevices and other weak structures in the seed coat allow path for fungal infection which leads to seed deterioration (Christiansen and Justus, 1963; Mayne et al., 1969; Mohamed-Yasseen et al., 1993).

There have been limited efforts to specifically breed seeds for extended

storage capabilities. Using hot water to treat seeds effectively eliminates microorganism contamination, a common issue with the accelerated-aging method, even when fungicides and bactericides are applied (Bahattacharyya et al., 1985). This treatment is commonly employed to resist both external and internal seed-borne pathogens such as bacteria, fungi and nematodes (Ventura and Garrity, 1987). However, it will cause mechanical stress to seed coats (Brant et al., 1971).

3. SEED LONGEVITY

Some plants seed show tolerance to the harsh environmental conditions if they are in the state of desiccation. The metabolic activity decreases significantly to a very low level (quiescence) if seeds are dry, anyway they possess the ability to germinate for longer periods (Buitink and Leprince, 2008). Understanding the intricate factors that determine seed longevity is critically important from ecological, agronomic, and economic perspectives. As per recent investigation, a large heterogeneity and inequality for longevity between seeds originating from different plant species has been reported (Walters et al., 2005). As seeds degrade in storage, they lose their vitality, become increasingly vulnerable to stresses during germination, and eventually lose the ability to sprout. Environmental and genetic factors such as storage temperature, seed moisture content, and seed quality has significant role in influencing the rate of aging (Walters et al., 2005; Walters, 1998). Genetic approaches in rice showed that seed longevity is controlled by several genetic factors, allowing the detection of quantitative trait loci (QTL) (Miura et al., 2002). Methods like transcriptome and proteome profiling have also been beneficial in identifying potential markers for seed vigor (Holdsworth et al., 2008). The testa's role in seed longevity is crucial for preserving minimal metabolic activity and shielding against diverse environmental stresses. Processes that counteract free radicals and detoxification mechanisms are intricately linked to regulating the balance between prooxidants and antioxidants throughout seed storage and germination. When the capacity of prooxidant scavenging systems is overwhelmed, it can impair detoxification mechanisms, ultimately resulting in irreversible seed death (Rajjou and Debeaujon, 2008).

4. SEED STORAGE

It is necessary to store the seeds after harvest properly. Applying all the measures since germination like seed treatment, temperature maintenance, application of nutrients, seed coat analysis, seed longevity practices are not sufficient. Maintaining proper moisture, relative humidity, temperature during storage is also equally important (Rice Knowledge Bank, n.d.). At first, for maintaining physical purity, weeding and harvesting is done at proper time. During storage after harvesting, quality hampering determinants such as weed seeds, impurities and immature grains should be sorted (Tang and Ngome, 2015). Threshing should be carried out on a clean surface, and winnowing must be performed diligently to remove immature seeds, low-quality seeds, and inert materials. Proper maintenance of optimal moisture levels during storage is essential as it directly affects the longevity and vigor of the seeds. The amount of moisture should be less than 14% and preferably less than 12% for extended storage times (Rice Knowledge Bank, n.d.). The use of resistance type moisture meter is the most practical option to measure moisture amount at the time of harvesting which generally gives quick result and only use small sample.

Table 1: Target moisture content for each of the key postproduction operation

Operation	Desired moisture content	Primary losses
Harvesting	20–25%	shattering if grain is too dry unfilled and many green grains if too wet
Threshing	20–25% for mechanical threshing less than 20% for hand threshing	incomplete threshing, grain damage, and cracking/breakage
Drying	final moisture content is 14% or lower	spoilage, fungal damage, discoloration
Storage	less than 14% for grain storage less than 12% for seed storage less than 9% for long term seed preservation	fungal, insect, and rat damage loss of vigor
Milling	13–14%	grain cracking and breakage over milling.

Source: (Rice Knowledge Bank, n.d.)

The given table summarizes the target moisture content for each of the key postproduction operation.

5. CONCLUSION

After reviewing numerous articles and journals, various ways to protect the seed of rice, ways to treat it, before and after harvest requirements for seed longevity was known. Seed treatment by biological method was quite ecological while fungicide treatment is quite effective. Similarly, role of

seed coat was found to be valued in seed viability as it protects from hydration stress and electrolyte leakage. In addition, seed longevity (protection, detoxification and repair) practices were also touched. Hence, by studying the above article we will be more informed about quality seed and will be more concerned about the ways to protect it.

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The authors will ensure data transparency.

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Data availability: All data generated or analyzed during this study are included in this review article.

DECLARATIONS

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