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RESEARCH ARTICLE

Effect of Seed Treatments and Containers on the Storability of Rice (Var.TRY3) Harvested at Different Maturity Stages using a Combine Harvester

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ABSTRACT

The present investigation aims to study the impact of different maturity stages on the moisture content and storability of the rice variety TRY 3. The seeds were harvested using a combine harvester at various maturity stages: physiological maturity, 2 days after, 4 days after, and 6 days after physiological maturity. The seeds were treated with water-soluble polymer at a rate of 4 mL + 12 mL water per kg and vithai amirtham at 25 mL per kg of seed, and compared with untreated control seeds. The treated seeds were stored under ambient conditions in both super grain and gunny bag containers, alongside the control seeds. Quality parameters were measured initially and at monthly intervals for 12 months to evaluate seed storability. Results showed that seeds harvested at the physiological maturity stage exhibited the highest germination percentage, longest root and shoot lengths, increased dry matter production, the highest seedling vigour index, the lowest pathogen incidence, and the lowest seed leachate levels. Seeds stored in super grain bags demonstrated higher germination rates and seedling vigour index, and lower insect and pathogen incidence and seed leachate levels, compared with seeds stored in gunny bags, regardless of treatment. In conclusion, the TRY 3 rice variety harvested at the physiological maturity stage, treated with water-soluble polymer at 4 mL + 12 mL water per kg of seed, and stored in super grain bags-maintained seed quality above minimum seed certification standards for up to 12 months.

Keywords: TRY 3 rice variety, Maturity stages, Moisture content, Storability, Seedling vigour

INTRODUCTION

Seed quality is the most crucial factor influencing crop growth, development, and yield processes, potentially increasing yield by 5-20%. Seed deterioration during storage is a gradual, inevitable process that results in significant losses. Seeds tend to lose viability and vigour during storage, making information on the storability of seed lots from harvest until the next planting season essential for any seed

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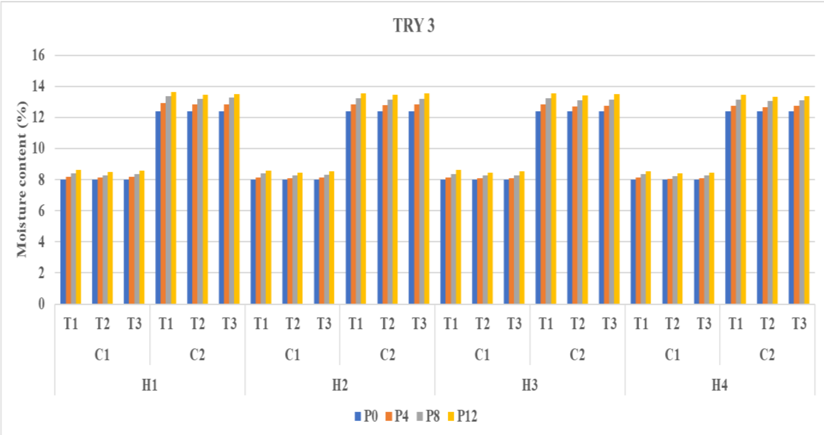
production program (Govindaraj *et al*., 2017). Seed vigour and viability during storage are affected not only by genetic differences among genera and varieties but also by various physicochemical factors, including seed moisture content, relative humidity, temperature, initial seed quality, and the physical and chemical composition of the seeds. Factors like gaseous exchange, storage structures, and container types also play a significant role in determining seed longevity. To mitigate quantitative and qualitative losses caused by biotic and abiotic stresses during storage, several strategies have been employed. One such approach involves polymer seed coatings, which act as a binding material to seal minor cracks and imperfections on the seed coat, preventing fungal invasion. Additionally, polymer coatings serve as a physical barrier that restricts oxygen movement and protects against inhibitors from the seed coverings, ultimately reducing seed aging. Proper storage in secure containers further maintains seed quality over time. The combine harvester integrates multiple harvesting operations into a single process, including reaping, threshing, and winnowing, ultimately producing clean seeds of crops such as rice, maize, soybean, and black gram. The adoption of modern mechanized harvesting tools, including combine harvesters, mini-combine harvesters, and reapers, is increasingly essential to save time, reduce labour dependency, minimize harvesting losses, and enhance cropping intensity, crop productivity, and farmers' economic returns (Hasan *et al*., 2020). In rice cultivation, combine harvesting is widely recognized as an effective strategy to meet peak labour demand and reduce field losses associated with traditional manual harvesting practices. Despite these advantages, many seed growers and farmers often perceive, without empirical evidence, that combine harvesting may lead to excessive mechanical damage, reduced germination, and diminished seed vigour and viability, making it seemingly unsuitable for seed paddy. Moreover, there is a lack of systematic research evaluating the impact of combine harvesting on seed crops harvested beyond the physiological maturity stage and their seed quality. In view of this knowledge gap, the present study was undertaken to investigate the effect of seed treatments and containers on the storability of TRY3 rice variety harvested at different maturity stages using a combine harvester.

MATERIAL AND METHODS

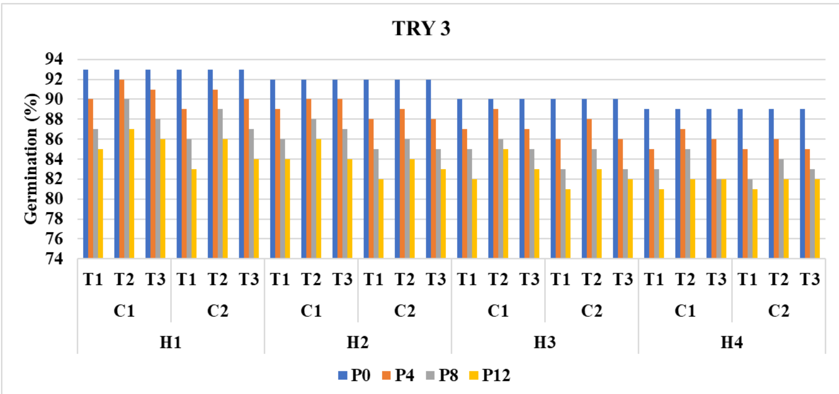
The study was conducted at the Department of Basic Engineering and Applied Sciences, Agricultural Engineering College and Research Institute, Tamil Nadu Agricultural University, Kumulur, from 2023 to 2025. Rice seed crop (Var. TRY 3) was harvested using a combine harvester at different seed moisture levels (19% to 27%) with four distinct maturity stages. The treatments included harvesting the seed crop at physiological maturity (H1), 2 days after physiological maturity (H2), 4 days after physiological maturity (H3), and 6 days after physiological maturity (H4). The seeds collected from different maturity stages were cleaned and graded. The graded seeds were stored in both super grain bag (C1) and gunny bag (C2) containers with 8 to 10.20 percent moisture content following the treatment of control (T1), water-soluble polymer 4g + 12mL water/kg of seed (T2), and vithai amirtham 25mL/kg of seed (T3). The treated seeds were stored under ambient conditions. The experiment was designed using FCRD with three replications. Various quality parameters were recorded initially and monthly for 12 months to assess seed storability. For the germination test, seeds were placed on a rolled towel. For each treatment, 400 seeds were sown in 8 replications of 50 seeds each. Seed germination was calculated as the percentage of seeds producing normal seedlings. Fourteen days after sowing (ISTA, 2011), ten seedlings from each replication were randomly selected, and the root and shoot lengths were measured, with the mean value recorded. Ten random seedlings were dried in a hot air oven at 85°C for 24 hours, and the dry weight was recorded and expressed as $g.seedling^{-10}$. The vigour index was calculated using the formula (Abdul – Baki and Anderson, 1973): Vigour Index = Percentage germination x Total seedling length (cm). Seeds were also analyzed for electrical conductivity (Presley, 1958), dehydrogenase activity (Kittock and Law, 1968), insect infestation percentage, and pathogen infection percentage under each treatment (ISTA, 1999). The results were subjected to statistical analysis for significant differences (P=0.05) using the methods of Panse and Sukhatme (1999). Percentage values were arcsine-transformed before statistical analysis.

RESULTS AND DISCUSSION

The results of the study on the effect of seed treatments and containers on the storability of the TRY3 rice variety, harvested at different maturity stages using a combine harvester, revealed that the maturity stage of harvest significantly influenced the moisture content, the container used for storage, the treatment applied, and the period of storage (Fig.1). Among the maturity stages, physiological maturity recorded the highest moisture content (10.65%) compared to six days after physiological maturity (10.54%). The study showed a slight increase in seed moisture content over the storage period, regardless of container and treatment. The moisture content did not fluctuate much during storage, especially in polymer-coated seeds stored in either a super grain bag or a gunny bag, mainly because the polymer protected the seeds from moisture absorption from the storage environment (West *et al.*, 1985; Govindaraj *et al.,* 2017). Higher moisture content and temperature reduce the shelf life of paddy seeds (Kaliyan *et al*., 2006). Moisture content is associated with a decline in seed quality. Harrington's thumb rule states that storability increases as moisture content decreases. For every 1% reduction in moisture content, the shelf life doubles over a range of 5 to 15%. It was reported that there is a negative logarithmic relation between moisture content and longevity (Ellis *et al.,* 1990).



Moisture content (%)



Germination (%)

Fig 1. Effect of maturity stages, combine harvesting, storage containers and seed treatments on moisture content (%) and germination (%) of TRY3 rice variety

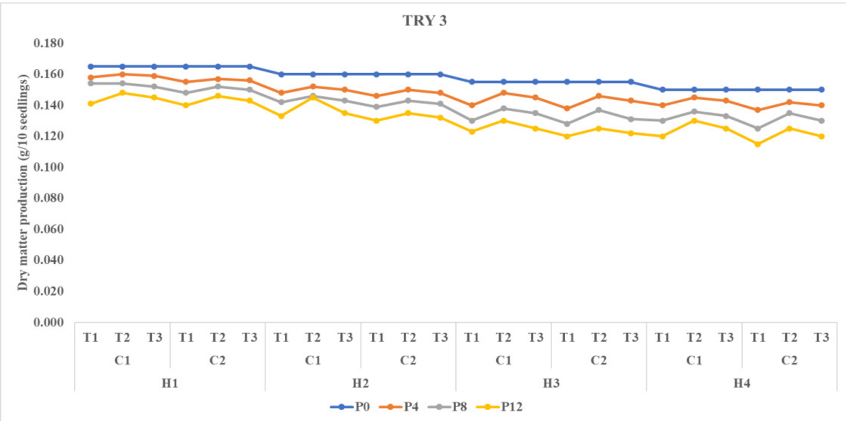
H_1 – At Physiological maturity
H_2 – Two days after physiological maturity
H_3 – Four days after Physiological maturity
H_4 – Six days after Physiological maturity

P0- Initial Period of storage
P4- 4 months of storage
P8- 8 months of storage
P12- 12 months of storage
C_1-Super grain bag
C_2-Gunny bag

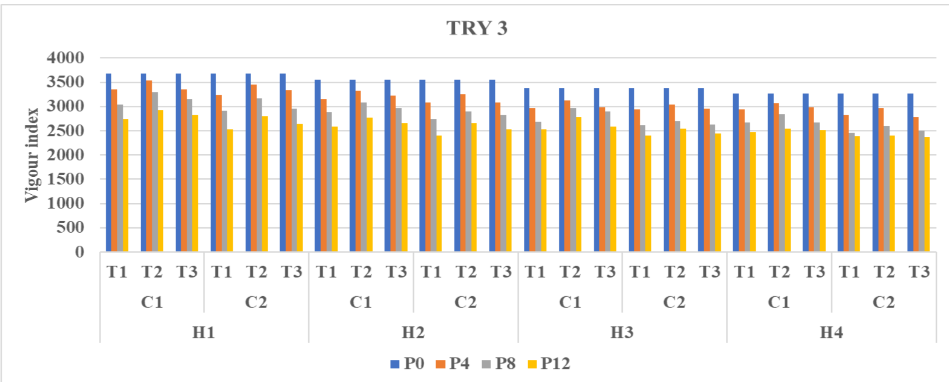
T_1-Control
T_2-Water Soluble Polymer 4mL + 12 mL water/kg
T_3- Vithai Amirtham 25 mL/kg of seed

Germination was significantly influenced by the maturity stage of harvest, containers used for storage, treatments, storage period, and their interactions. Among the maturity stages, the physiological maturity stage registered the highest germination (89%), followed by the two days after physiological maturity stage (88%), and the lowest germination was recorded at six days after physiological maturity (85%). Seeds stored in super grain bags (C_1) retained higher germination (87%) than those stored in gunny bags (C_2 86%). Seeds coated with a water-soluble polymer (4 mL + 12 mL water/kg) showed the highest germination (88%), followed by vithai amirtham (87%), while the control showed the lowest germination (86%). Seed germination decreased with increasing storage period. The highest germination was observed during the initial storage period (91%) and decreased to the lowest level after 12 months (83%). Overall, the interaction effects of harvesting method, storage container, and seed treatment were significant (Fig. 1). Similar trends were observed in root length, shoot length, dry matter production, and vigour index (Fig. 2).

Govindaraj *et al.,* (2017) reported that rice varieties CR1009 Sub 1, improved white ponni, and CO 51 showed higher germination in manual harvesting and



Dry matter production (g/10 seedlings)



Vigour index

Fig 2. Effect of maturity stages, combine harvesting, storage containers and seed treatments on dry matter production (g/10 seedlings) and vigour index of TRY3 rice variety

H_1 – At Physiological maturity
H_2 – Two days after physiological maturity
H_3 – Four days after Physiological maturity
H_4 – Six days after Physiological maturity

P0- Initial Period of storage
P4- 4 months of storage
P8- 8 months of storage
P12- 12 months of storage
C_1-Super grain bag
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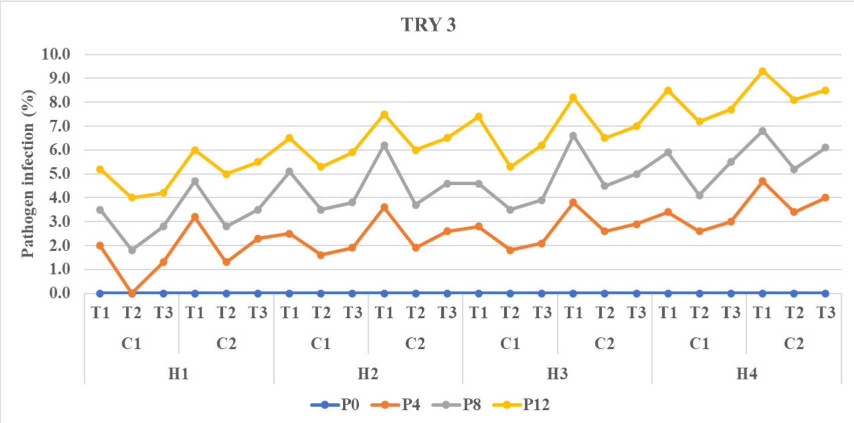
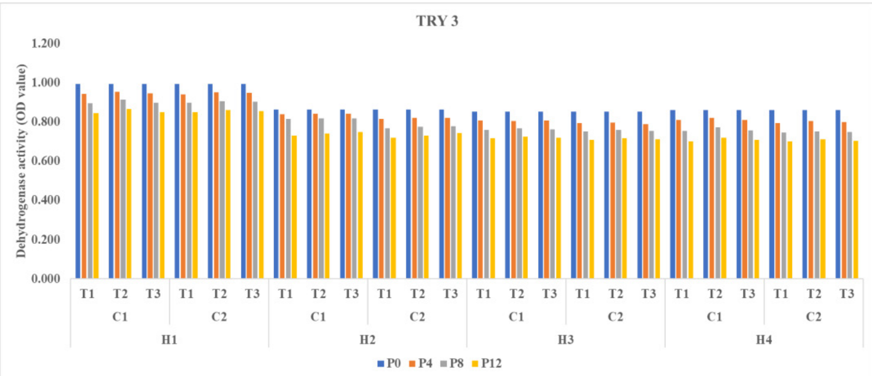
T_1-Control
T_2-Water Soluble Polymer 4mL + 12 mL water/kg
T_3- Vithai Amirtham 25 mL/kg of seed

manual threshing, followed by combine harvesting, with the lowest germination percentage observed in manual harvesting and mechanical threshing, attributing the declines to enzyme activity. Furthermore, super grain bags and seeds coated with water-soluble polymer exhibited the highest germination percentage, dry matter production, and seedling vigour. At the same time, the control showed the lowest germination rate, possibly due to mitochondrial membrane degradation, leading to a reduction in the energy supply required for germination. The rice seeds CO51, CR1009 Sub 1, and improved white ponni were harvested and threshed by different methods, then coated with a water-soluble polymer (4 mL + 12 mL of water). kg^{-1} at 8% moisture content and packed in super grain bags-maintained seed quality above minimum seed certification standards for up to twelve months of storage. These findings were consistent with previous studies conducted on rice. The impact of combine harvesting, manual harvesting, and threshing on two rice varieties, namely ADT 36 and BPT 5204, was examined under storage in gunny bags at ambient temperature for 12 months duration, revealing that seeds harvested by the combine harvester maintained an optimum germination reaching 83% for ADT 36 and 82% for BPT 5204 even after 12 months of storage. Their recommendation emphasized harvesting these rice varieties at 20% moisture content using a combine harvester to meet the minimum seed certification standard of 80%,



Pathogen infection (%)



Dehydrogenase activity

Fig 3. Effect of maturity stages, combine harvesting, storage containers and seed treatments on Pathogen infection (%) and dehydrogenase activity of TRY3 rice variety

H_1 – At Physiological maturity
H_2 – Two days after physiological maturity
H_3 – Four days after Physiological maturity
H_4 – Six days after Physiological maturity

P0- Initial Period of storage
P4- 4 months of storage
P8- 8 months of storage
P12- 12 months of storage
C_1-Super grain bag
C_2-Gunny bag

T_1-Control
T_2-Water Soluble Polymer 4mL + 12 mL water/kg
T_3- Vithai Amirtham 25 mL/kg of seed

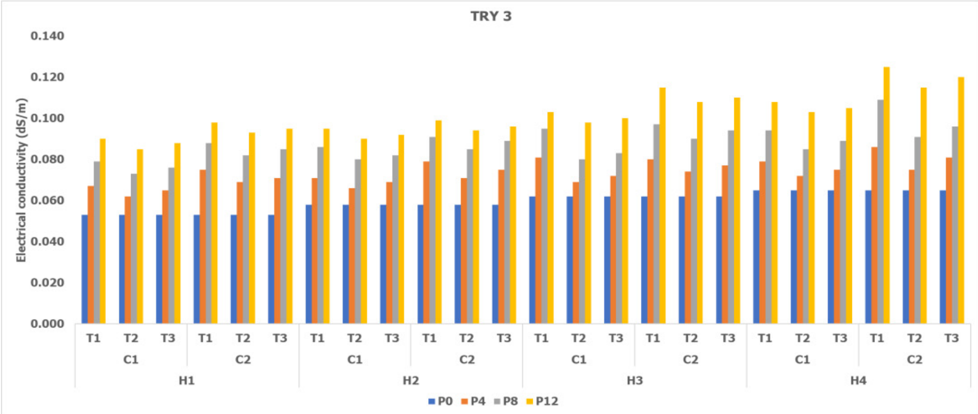


Fig 4. Effect of maturity stages, combine harvesting, storage containers and seed treatments on electrical conductivity (dS/m) of TRY3 rice variety

H_1 – At Physiological maturity
H_2 – Two days after physiological maturity
H_3 – Four days after Physiological maturity
H_4 – Six days after Physiological maturity

P0- Initial Period of storage
P4- 4 months of storage
P8- 8 months of storage
P12- 12 months of storage
C_1-Super grain bag
C_2-Gunny bag

T_1-Control
T_2-Water Soluble Polymer 4mL + 12 mL water/kg
T_3- Vithai Amirtham 25 mL/kg of seed

sustaining quality for up to 9 months of storage. The use of hermetic storage bags proved more effective than traditional methods, achieving 97% germination with 1% damage, whereas traditional storage yielded 95% germination with 6% damaged grains (Awal *et al.,* 2017). Seeds stored in PICS (Purdue Improved Crop Storage) bags and super grain bags retained the highest seed germination for a longer time than other storage materials in rice (Khatri *et al.,* 2019).

Electrical conductivity and dehydrogenase activity were significantly influenced by harvesting stage, container, treatment, and storage period. Among the maturity stages, physiological maturity had the lowest electrical conductivity (0.074 dSm^{-1}), and electrical conductivity was highest at 6 days after physiological maturity (0.087 dSm^{-1}). Super grain bags showed lower electrical conductivity (0.072 dSm^{-1}), while seeds stored in gunny bags showed higher electrical conductivity (0.083 dSm^{-1}). Seeds coated with water-soluble polymer at 4 mL + 12 mL water/kg had the lowest electrical conductivity (0.079 dSm^{-1}), while the control had the highest (0.086 dSm^{-1}). The minimum electrical conductivity was observed during the initial storage period (0.064 dSm^{-1}) and reached a maximum after 12 months (0.110 dSm^{-1}). In dehydrogenase activity, among the maturity stages, the physiological maturity stage showed the highest (0.925) and the six days after physiological maturity, the lowest (0.781). Super grain bags showed the highest dehydrogenase activity (0.830), while the lowest was observed in seeds stored in gunny bags (0.819). Seeds coated with water-soluble polymer (4 mL + 12 mL water/kg) registered the maximum (0.829), while the minimum was in the control (0.821). The maximum dehydrogenase activity was observed during the initial period of storage (0.856) and reached a minimum after 12 months of storage (0.713) (Fig. 3; Fig. 4).

Electrical conductivity increased with higher moisture content. A decrease in enzymatic activity in stored seeds over time led to reduced germination and vigor. Dehydrogenase activity gradually decreased with increasing storage period, resulting in a loss of seed quality. Pathogen and insect infestation were assessed, with infection increasing as maturity stages and storage duration increased. Among the containers, seeds stored in super grain bags had the lowest pathogen infection rate compared to those stored in gunny bags. T1 (control) had the highest infection rate. In contrast, T2 (water-soluble polymer) had the lowest value (Fig. 3). A similar trend was observed with insect infestation, which increased with maturity stage and storage duration across all rice varieties. The highest insect infestation was observed six days after physiological maturity. Super grain bags had the lowest insect infestation compared to gunny bags, with T1 (control) having the highest infestation and T2 (water-soluble polymer) having the lowest.

CONCLUSION

This study concludes that rice seed crop (Var. TRY3) harvested with a combine harvester at physiological maturity or up to six days after the physiological maturity stage, then reduced to a moisture content of 8%, coated with water-soluble polymer at 4 mL + 12 mL of water per kilogram of seed, and packed in a super grain bag, maintained more than 80% germination. It also met the Indian Minimum Seed Certification Standards for up to twelve months.

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