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Optimizing potential of Coconut water as an Organic Priming Agent for Jujube (*Ziziphus mauritiana* L.)

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ABSTRACT
The seed is the main source of rootstock production in Jujube, but its hard seed coat make it difficult for the seed to germinate which adversely impact the growth of fruit. Therefore, seed priming technique is used because it involves the controlled hydration. There are several priming agents but our study revolves around coconut water which requires a comprehensive discussion as it is highly potential for enhancing the germination in various crops yet its effect on the growth traits of (*Ziziphus mauritiana* L.) needs to be assessed. Therefore, a research was carried out at SAU nursery, Department of Horticulture, Sindh Agriculture University Tandojam in the year 2023 to examine the effect of coconut water on the germination and growth response of Jujube. The trial was implemented by following the Completely Randomized Design (CRD) with a factorial arrangement and three replicates. The treatments comprised of priming durations of coconut water P_1=7 hours, P_2=9 hours, and P_3=11 hours and concentrations of coconut water T_1=10%, T_2=20%, and T_3=30%. The research findings elaborated that Jujube seeds when primed in coconut water for 11 hours presented the better results for seed emergence percent, Germination index, length of shoot (cm), Seedling Vigor Index, Sturdiness Quotient, Depth of roots. The comparison of solution displayed that Jujube seed emerges and grows well under priming solution of 30% coconut water. Hence, the research concludes that jujube seeds be primed in 30% solution for 11 hours for optimum emergence and substituent growth characters

Keywords: Coconut Water, Jujube, Seed Priming

INTRODUCTION

Jujube *(Ziziphus mauritiana)*, a small thorny tree hailing from the family Rhamnaceae which consists of 58 genera and 900 species approximately (Kaleem et al., 2014). Originally being spread out from the Middle East region to the Indian subcontinent, but currently is planted commercially in arid regions across the globe (Panchal and Panchal, 2010). In many regions, Jujube is grown as a hedge due to their spines which create effective live-fencing (Rahman et al., 2018). Jujube has the capability to withstand extreme droughts and tolerate the waterlogged conditions (Jat et al., 2004; Azam et al., 2006). Jujube contains high amounts of ascorbic acids, possessing minerals, carotenes and phenolics (Koley et al., 2011).
Z. mauritiana L. has an evergreen nature containing small spines, and exhibits several branches of drooping nature on each plant, pointed stipules are often embellished (Prakash et al., 2021). The height reaches up to 15m having a trunk of 40 cm in diameter (Orwa et al., 2009). This fruit tree is recognized for showcasing protandry, which is the maturation of male reproductive organs leading to the female reproductive organs (Prakash et al., 2021).

The source of rootstock production in Jujube is seed; each stone contains around three seeds embedded in the endocarp of fruit. Due to its hard seed coat, seed germination is a problem in this nutritious fruit (Boora, 2016). Hard seed coat, identification of types and sizes are the factors that inversely impact the germination and growth of indigenous species (Sodimu et al., 2020). The quick germination of seeds and germination percent relies on the

viability, post ripening status and existence of endogenous hormones (Boora, 2016). If seed is stored for a longer period of time, its viability is lost. Since immediate sowing is not done after seed collection, pre seed sowing treatment is necessary in order to avoid financial and time wastage. It is important to pre-treat the seeds of these species to increase water accessibility and oxygen in the seeds and to get optimum germination and better plant establishment (Sodimu et al., 2020). Seed priming activates the metabolic processes that occurs in the early germination phases, and rapid emergence in the seedlings from the primed seeds is often observed, that leads to a vigorous growth, and a better performance in the harsh conditions (Cramer, 2002). Solution composition and osmotic potential affects the seed priming (Chinnusamy et al., 2005).

In our study we primed the seeds with coconut water, which is a liquid endosperm of coconut, and is a multipurpose organic product (Jean et al., 2009). It is a source of sugars, amino acids, vitamins and minerals (Mantene et al., 2003). Auxin (IAA and ABA), gibberellins, and zeatin (cytokines) are phytohormones found in coconut water in varying concentrations (Tan et al., 2014), but the primary components are sugar and minerals (Prades et al., 2012).Coconut water increases the seedling germination very quickly (Saat et al., 2002), and poses a profound impact on the germination rate (Patino et al., 2011). Therefore, the current study was attempted to examine seed germination and seedling growth of Jujube treated by various concentrations and durations of coconut water.

MATERIALS AND METHODS

Area of study: The current research was performed in, 2023 at SAU nursery, Department of Horticulture, Sindh Agriculture University, Tandojam, to examine the effect of priming with coconut water on jujube seeds.

Procurement of seeds: Fresh and ripe fruits were collected from vigorous Jujube trees located in a farm in the vicinity of Tando Jam. The seeds were removed from the ripe fruits, rinsed with the tap water, and then left to dry in the shade for 24 hours.

Preparation of coconut water concentration: Mature coconuts were bought from the fruit market of Tando Jam, and were thoroughly cleaned in order to remove any surface contaminants. Coconuts were cracked and opened to assess the water from the endosperm of the coconut fruit using a suitable tool. The coconut water was strained using a cheesecloth in order to avoid any solid debris present in it. It was diluted with distilled water to achieve the concentrations (v/v): 10%, 20% and 30% solution, this solution was prepared through measuring volume of coconut water and distilled water.

Experimental Layout: The Completely Randomized Design (CRD) was used to perform experiment with double factors. The factors included different priming durations and priming solutions. The obtained seeds were primed for 7 hours, 9 hours, and 11 hours in 10%, 20% and 30% solution of coconut water.

Observation Methodology: Percentage of seed emergence was obtained by using the formula: GP = (Total number of seeds / Number of germinated seeds) × 100. The germination index (GI) was determined through: GI = ∑ (Day of first count × Number of seeds germinated on day i). shoot length was measured using a standard measuring scale. The seedling vigor index (SVI) was calculated by multiplying the germination percentage by the mean plant height, using the formula SVI = Germination percentage × Mean plant height. Lastly, the sturdiness quotient (SQ) was determined by dividing the stem diameter by the plant height, using the formula SQ = Stem diameter / Plant height, depth of roots was measured with measurement scale.

Statistical Analysis: The data was statistically analyzed via statistics 8.1 computer software (Statistics, 2006). The LSD test was applied to compare treatments' superiority, where necessary.

RESULTS

Seed Germination%: The analysis of seed germination percentage demonstrated that both the priming solution concentration and priming durations significantly affected germination outcomes. Seeds primed for 11 hours showed a notably higher germination rate, whereas seeds primed for 7 hours exhibited the lowest germination percentage. In terms of solution concentration, the 30% priming solution produced the highest germination rate, while the lowest rate was observed with a 10% solution, furthermore, the interaction between solution concentrations and priming duration was significant, indicating that the influence of priming duration depended on the solution concentration. Thus, the optimal germination was achieved at 11 hours with a 30% priming solution, reaching a 94.39% germination rate, while the lowest germination was recorded with a 10% solution primed for 7 hours (28.07%).

Germination Index: The Germination Index was notably influenced by the priming solution concentrations and the interaction of both factors. Seeds primed with a 20% solution exhibited a lower germination index, while a significant increase was observed with a 30% solution. The significant interaction between priming solution concentrations and durations suggests that the optimal priming time is dependent on the solution used, with seeds

primed with a 30% solution for 11 hours demonstrating greater germination index (3.5) as compared to the 30% solution for 7 hours (1.03).

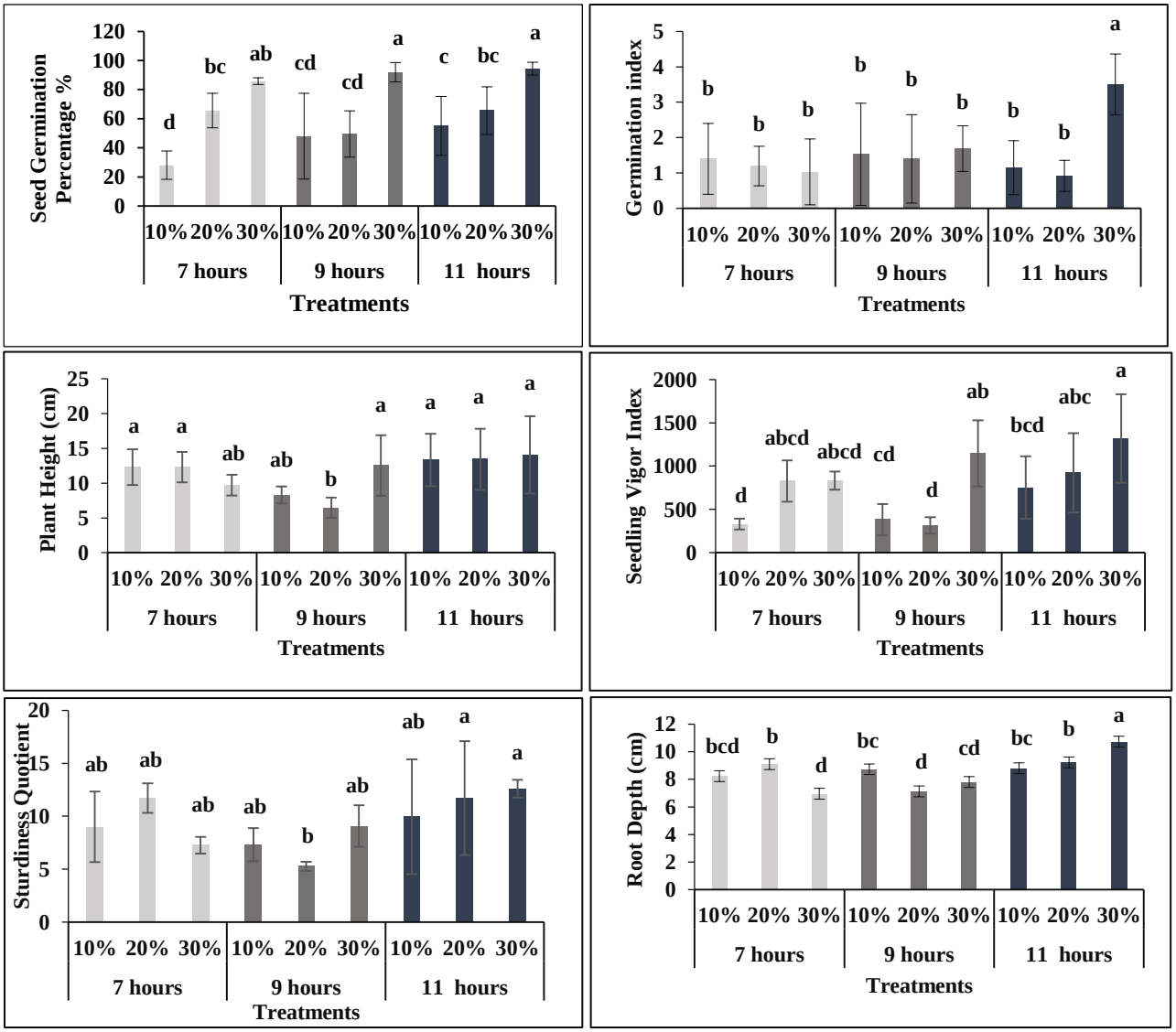
Plant height: The observed results indicate that the highest plant height was achieved when seeds were treated with a 30% solution for 11 hours (14.05). This suggests that the combination of this solution concentration and soaking duration provided optimal conditions for enhanced seedling growth, likely due to improved nutrient absorption or enhanced physiological processes during germination. In contrast, the least plant height was recorded when seeds were treated with a 20% solution for 9 hours (6.47).

Seedling vigor index: The observation resulted that seedling vigour index was significantly impacted by the individual effects of priming durations and solution percent. While, interactive results showed that the highest seedling vigor index was recorded when seeds were treated with a 30% solution for 11 hours (1319.9). On the other hand, the lowest seedling vigour index was observed when seeds were primed in 30% solution for 7 hours (315.9).

Sturdiness Quotient: The data revealed that the individual and interactive effect of both the factors, priming solutions and the durations of priming significantly influenced the sturdiness quotient. Seeds primed for 11 hours solution exhibited a significantly higher sturdiness quotient, however, the seeds primed for 9 hours resulted in lowest sturdiness Quotient. Results concerning to the Solution percent showed that the 30% priming solution was effective as compared to 10% solution. Additionally, the interaction between solution percent and duration of priming was significant, indicating that the effect of priming time duration depending on the solution used. The maximum sturdiness quotient (12.6%) were obtained at 11 hours with 30% priming solution, while the lowest results were noted with 10% solution under 7 hours of priming (5.28%).

Root Depth: The root depth of Jujube seeds in response to coconut water priming was significantly influenced by the priming durations, solution concentrations, and the interaction between these two factors. The highest root depth was observed with a priming duration of 11 hours, while the lowest depths were recorded at 7 hours. In terms of solution concentrations alone, the 30% solution yielded the greatest root depth. When examining the interaction between solution concentration and durations, the maximum root depth of 10.73 cm was achieved with a 30% solution primed for 11 hours, while the minimum depth, 6.95 cm, was noted at 7 hours with a 30% solution. This suggests that both the length of priming and the concentration of coconut water played critical roles in determining root development in Jujube seedlings.

Figure 1. Effect of coconut water and priming concentration on germination and growth traits of jujube



DISCUSSION

The essential phases in crop quality and development include uniform seed germination, seedling growth, and an even plant establishment (Waqas et al., 2019). Therefore, priming technique is used to enhance the quality of seed as seed priming involves controlled hydration and drying to boost pre-germinative metabolic processes leading to a quick germination (Dawood, 2018), which is linked to the initial dormancy of seed because of insufficient moisture content before priming (Adhikari et al., 2021), hence, whenever the seeds are subjected to priming sources, seed dormancy is eliminated regulating proper germination (Maity and Tripathy, 2009; Lutts et al., 2016). Likewise in our study, seed germination and seedling growth got a surge when primed with coconut water, it could be because of coconut water being the natural component, possesses crucial hormones like cytokinin, auxin and gibberellin and other substances which regulate germination and growth (Bey et al., 2006).

The observations of our study showed that the longer duration of seed priming (11 hours) resulted in satisfactory seed germination, our outcomes are in accordance with the observation of (Sharma et al., 2014) who observed that seed treatment with the coconut water solution led to a significant improvement in the germination rate, similar findings were seen in the study of (Chuwang et al., 2018) where seed priming with coconut water had the highest germination %. Sodimu et al. (2020) conducted a research trial on Jujube recorded similar results as obtained in our study, the results of their study depicted that the germination percentage of Jujube seeds soaked in hot water at

100^{o}C for 20 minutes was significantly greater and it resulted in germination % of (47.67) in contrast to the other hot water treatments which were done for 10 minutes and 15 minutes, subsequently.

Jujube seeds produced seedlings with improved height in our study which can be because of gibberellin present in the coconut water, the results of (Okoli, 2022) stated the similar findings in soursop seed primed in coconut water for the duration of 72 hours showed tallest seedlings (16.03 cm) however priming for 48 hours resulted in dwarf plantlet (8.77 cm). According to Undie and Agba (2018) plant height was significantly higher under coconut seed priming, as the observations of their study depicted that seed germination and the growth and development of seedling was found to have positive impact of coconut water because of the active growth promoters in coconut water as they also include amino acids, nitrogenous compounds, organic acids, enzymes, sugars and lipids (Arditi, 2008). These growth regulators might have played the diverse functions in cola nut seedling growth and development. In accordance to our work, Yong (2009) stated that including coconut water in plant tissues promotes the development of larger, more vigorous, and significantly more resilient plantlets compared to those in the control group. Origenes and Lapitan (2020) found profound effect of coconut water in seedling height in their study. It was observed that where 100% coconut water was used had numeric advantage on the height of seedlings due to the presence of variety of nutrients in various levels in coconut water including Auxin (IAA and IBA), cytokinins, and gibberellins which regulates growth and development and results in better height of plants (Setiawati et al., 2010). Auxin has the ability to enhance protein production in plant tissues, which can result in increased cell wall permeability. This, in turn, promotes both cell division and elongation, contributing to accelerated growth and cytokinins stimulate the growth of roots and shoots, which in turn, will increase the height, it supports cell division, promoting the rapid growth (Huan and Tanaka, 2004) while Gibberellin being diterpenoids hormones contributes to all developmental processes of plant (Achard and Genschik, 2009). Nora et al. (2018) found the similar results where increased plant height was seen due to long treatment of cacao immersion in coconut water.

According to Dunsin et al. (2016) coconut water possess primary components such as cytokinins and auxins (Wu and Bu, 2009), it was seen in the study of (Siahaan, 2004) that the usage of coconut water as PGR enhanced the growth and development of red chili, similarly study of Reddy et al. (2021) showed improved seedling vigour index in the pigeon pea upon organic priming. Various studies have shown that hormones from coconut water can boost soybean yield by 64%, increase peanut production by 15%, and enhance vegetable growth by 20-30%. Khan et al. (2023) found in their study that maximum sturdiness quotient was observed when seeds were primed with distilled water and the lowest sturdiness quotient was found when the seeds were unprimed, this study aligns with our results where we found that priming with coconut water profoundly impacted the sturdiness quotient aiding into maximum sturdiness quotient which proves that these seedlings are vigorous and resilient, greatly increasing their likelihood of survival when transplanted (Takoutsing et al., 2014). The sturdiness quotient shows that whether seedlings are robust or slender. While it serves as a reliable measure of resilience to physical stress across all plants, it is highly important for seedlings that grows in container, where a high sturdiness quotient can often signal unwanted slender growth (Budiman et al., 2015).

In our study maximum root depth was observed under high coconut water percent which corresponds with the study of Lakmali and Seran (2022) where they observed that the highest root depth was observed under maximum concentration of coconut water. Marne et al. (2020) found deeper roots of plants grown from seeds that were were primed with coconut water. As per the study of Setyaningsih et al., (2019), coconut water soaking aids into the length of roots in king palm. Extended soaking resulted in longer and well developed roots. Seed priming with fresh coconut water produced the greatest root length, likely due to enhanced cell division in the apical meristem of the seedling roots, stimulated by the plant growth hormones present in the coconut water (Lakmali and Seran, 2022). According to the stud of Vanajah and Thayamini (2019), coconut water had significant impact on the root depth of Peppermint stem cuttings.

CONCLUSION

Priming with various concentrations of coconut water and priming durations on jujube seeds had significant effects on several growth parameters including plant height, seedling vigour index, sturdiness quotient, and root depth. The results confirmed that seed priming with coconut water promoted early germination. Seed priming is an effective technique to regulate rapid seed germination, the seeds primed in 30% priming solution for 11 hours yielded superior results, indicating that this interaction is effective in enhancing seed germination and overall seedling growth of jujube plant.

RECOMMENDATIONS

It is recommended that for robust seedling production within due time, the germination and quality can be strengthened by pre-sowing seed treatment under 30% of coconut water for 11 hours. Moreover further research is suggested to explore the effects of coconut water on the germination and growth traits of jujube

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AUTHOR'S CONTRIBUTION

Designed the study and wrote the initial draft of the manuscript: A. Talpur, A.A. Khaskheli, performed the study and collected data: M.Y.K. Talpur, Helped in data analysis: N. Nizamani, Provided technical help: A. Talpur, Assisted in assembling the data: G. Khaskheli, Assisted in data analysis: A.A. Khaskheli, Offered technical input and helped in writing of manuscript: M.Y.K. Talpur, Assisted in review and editing of the manuscript: G.H Khaskheli

CONFLICTS OF INTEREST

The authors have declared no conflict of interest

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