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Effect of Dormancy Breaking Techniques Through Physical and Mechanical Scarification on the Germination of Noni Seed (*Morinda Citrifolia*)

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A B S T R A C T

The noni plant (*Morinda citrifolia* L.) has many benefits, especially in the fields of health and textiles as a natural dye alternative to environmentally unfriendly synthetic dyes. The use of noni is still limited because its cultivation is rarely carried out, constrained by dormancy which causes a long germination time.The reseacrh aims to determine the effect of mechanical and physical scarification on the germination of noni seeds (*Morinda citrifolia*). The design used was a completely randomized design (CRD) with several treatment combinations, namely control, 12-hour soaking, 24-hour soaking, sanding, piercing and a combination of mechanical and physical scarification. The parameters observed included germination time (days), germination percentage (%), plant length (cm), root length (cm), and number of rotten seeds. The results of the analysis of variance showed that the treatment had a significant effect on germination time, but there was no significant difference in germination percentage, plant length, root length, and rotten seeds. The average germination time ranged from 32.83 to 45.78 days, with sanding and 12-hour soaking treatments accelerating germination time compared to the control. The germination percentage was 75%–91%, plant length was 3.06–5.8 cm, and root length was 3.29–5.11 cm

INTRODUCTION

The noni plant (*Morinda citrifolia* L.) is a plant that has many benefits, especially in the field of health. In addition to its health benefits, the noni plant (*Morinda citrifolia*) can be used as a synthetic dye derived from organic materials found in the noni root. Morindin in the noni root produces red and yellow colors, allowing the roots to be used as a substitute for environmentally unfriendly synthetic dyes (Sofiani *et al*, 2024). Textile industry wastewater containing toxic chemicals and synthetic dye residues is difficult to decompose, causing environmental pollution (Subagyo, 2021).

In the context of natural dye utilization, the results obtained are consistent with previous studies using organic dyes, such as chlorophyll, which have an efficiency ranging from 2–3%. These findings indicate that with further optimization, noni root extract has the potential to become an environmentally friendly dye alternative for Dye-Sensitized Solar Cells (DSSC) (Syamsuddin & Sani, 2025).

Aquatic microorganisms that serve as bioindicators of water quality can be killed by pollution from these dyes. Water pollution can disrupt the nutritional balance in water, making it difficult for aquatic plants such as algae and other plants to grow. In addition, this water pollution reduces soil fertility, inhibits plant growth, and worsens the balance of the ecosystem in the area around the source of the waste. Therefore, it is necessary to mitigate the use of synthetic dyes in batik by using natural dyes.

Natural dyes must be selected from environmentally friendly materials so that the waste produced does not become a problem for the environment. One natural dye commonly used on batik cloth is the root of the noni plant (*Morinda citrifolia*), which can produce a reddish-yellow dye (Nintasari & Amaliyah, 2016). The potential of noni (*Morinda citrifolia*) as a medicinal plant and natural dye source can be widely utilized by the community as an economically valuable product by maximizing the management of noni plants, both the fruit as a traditional medicine and the stems and roots as natural dyes. However, there is no guarantee of the sustainability of this commodity's utilization, considering that most of its population grows wild on community land and very little is cultivated (Susilo et al., 2014). Generative propagation is one method of cultivation to produce noni seedlings using seeds (Tirta & Purba, 2021). Noni seeds take up to 37 days to germinate without scarification (Susilo *et al*, 2014). This shows that noni seeds take a long time to germinate, so certain treatments are needed to accelerate seed dormancy by performing scarification so that the seeds can germinate more quickly. This must be adjusted to the seedling needs required by the community as an economic commodity. Therefore, research is needed on how to identify effective methods to accelerate the breaking of noni seed dormancy and how physical scarification and mechanical scarification affect noni germination.

METHODS

The research was conducted from 5 May to 5 August 2025. The nursery was located in the Greenhouse of the Forestry Study Programme, Faculty of Agriculture, Mataram University, Mataram, West Nusa Tenggara. The tools used in this research were writing instruments, sandpaper, needles, rulers, polybags, sprayers, labels, and containers. The materials used in this study were noni seeds, water for seed soaking and plant watering, and sand as a planting medium.

The research was conducted using the experimental method with a completely randomized design (CRD). CRD is an experimental design in which the treatment is randomized to all experimental units (Irawan, 2022). In this research, there were two factors in the CRD, namely the mechanical factor (M) and the physical factor (F). The mechanical treatment factor (M) consisted of three factors, namely M0 = control, M1 = seed sanding, and M2 = seed pricking. The physical treatment factor (F) consisted of three factors, namely F0 = control, F1 = soaking in water for 12 hours, and F2 = soaking in water for 24 hours. The repetition in this study was carried out 3 times, resulting in 27 experiments. Each experimental unit was filled with 4 seeds, so the total number of noni seeds used was 108 seeds.

The growing medium used in this study was sand. The growing medium was sieved to separate stones and debris so that the sand was clean. The sieved sand was then placed in 25 cm x 25 cm polybags, 27 bags in total. There were 18 seeds to be sanded, 18 seeds to be pricked out, and 18 seeds without treatment. Seed sanding was done by rubbing sandpaper on the embryo point of the seed. After sanding, the seeds were separated into containers, as was the pricking treatment, where the noni seeds (*M. citrifolia*) were pricked with a needle at the embryo point until scratched, then placed in a different container from the sanded seeds. Each seed in each container was divided into 3, then the seeds were soaked in plain water for 12 hours, soaked for 24 hours, and left untreated (control) according to the treatment combination. After scarification, the seeds are sown in the prepared medium. Each polybag is filled with 4 seeds, then the seeds are watered sufficiently to maintain moisture. Plant maintenance includes watering and weeding. Watering is done every day in the morning and evening, according to the needs of the seeds and growing medium. Watering is not done if it rains. Weeding is done if there are weeds that can interfere with seed growth. The parameters observed in this study consisted of germination time (days), germination percentage (%), root length (cm), sprout length (cm), and number of rotten seeds.

RESULTS AND DISCUSSION

The research was conducted for 90 days from May 5 to August 5 2025 at the Greenhouse of the Forestry Study Program, Faculty of Agriculture, Mataram University. The results of the analysis of variance of the effects of mechanical and physical scarification on the germination of noni (*M. citrifolia*) on all parameters measured are presented in Table 1.

Table 1. Results of Variance Analysis of Dormancy Breaking Using Physical and Mechanical Scarification

Treatment	Parameter				
	WK	**PK**	**PT**	**PA**	**BB**
M0F0 (control)	36,92 ab	1,4 a	4,99 a	3,78 a	0 a
M0F1 (12-hour immersion)	38,56 ab	1,05 a	3,53 a	4,27 a	0,3 a
M0F2 (24-hour immersion)	32,83 b	1,22 a	3,06 a	5,11 a	0,2 a
M1F0 (Sanding)	45,78 a	1,05 a	5,29 a	3,29 a	0,3 a
M1F1 (Sanding and 12-hour soaking)	40,33 ab	1,31 a	5,12 a	3,68 a	0,16 a
M1F2 (Sanding and 24-hour soaking)	37,58 ab	1,31 a	3,68 a	4,08 a	0,16 a
M2F0 (piercing)	36,92 ab	1,4 a	4,69 a	4,75 a	0,1 a
M2F1 (piercing and 12-hour immersion)	38,92 ab	1,4 a	5,8 a	4,34 a	0,1 a
M2F2 (piercing and 12-hour immersion)	43 ab	1,13 a	5,28 a	3,77 a	0,26 a

Note: Figures Followed by Different Letters in the Same Row Are Significantly Different At the 5% BNT Level

Germination Time (WK)

Based on the results of variance analysis and further testing of the germination time parameter, there were significant differences between treatments. The highest germination time value was obtained in the M1F0 (sanding) treatment, which was 45.78 days, significantly different from the M0F2 (24-hour soaking) treatment, which was 32.83 days. The M0F2 treatment showed the fastest germination time, while M1F0 showed the slowest germination time. This difference indicates that the combination of mechanical and physical scarification affects the speed of noni (*M. citrifolia*) seed germination.

Treatment M0F2 (soaking for 24 hours) indicated that this combination could break seed dormancy faster, thereby accelerating the germination process of noni seeds (*M. citrifolia*), while the M1F0 treatment (sanding) showed that this combination was less effective in accelerating the germination process of noni seeds (*M. citrifolia*). Soaking the seeds helps soften the hard and impermeable skin of noni seeds (*M. citrifolia*), allowing water to enter the embryo and triggering the initial physiological process for germination (Murniati & Suminar, 2006). This statement is in line with the results of Dharma et al's (2015) research. Seed coats that are permeable allow water and gas to enter the seed so that the imbibition process can occur. Scarification or dormancy breaking treatments on seeds can enhance this imbibition process.

Sprout Percentage (PK)

Based on the results of the analysis of variance, the overall average of both mechanical and physical treatments ranged from 1.05 to 1.40% (Table 1). All treatments produced statistically similar values, indicating that there were no significant differences between treatments. It can therefore be concluded that the treatments were not effective in increasing the germination percentage of noni (*M. citrifolia*) seeds. Dormancy breaking treatments using mechanical and physical methods had no significant effect on the germination rate of noni (*M. citrifolia*) seeds. The germination rate of seeds in this study was categorized as high and stable in all treatments. This condition indicates that the seed quality is quite good, which is one of the factors affecting the germination percentage.

The high germination percentage in almost all treatments was due to internal factors such as viability, food reserves, and the physiological condition of the embryo. According to Sivana et al (2025), seed viability greatly affects germination success; seeds with sufficient food reserves and good embryos will germinate very well. Supportive environmental conditions and adequate water requirements help the initial metabolism of the embryo so that the seed can germinate well.

Plant Length (PT)

The results of the analysis of variance showed that mechanical and physical scarification and the combination of mechanical and physical treatments had no significant effect on plant length. The average plant length obtained was between 3.06 and 5.8 cm. The M2F1 treatment (piercing and 12-hour soaking) produced the highest average of 5.8 cm, while the M0F2 treatment (24-hour soaking) produced the lowest average of 3.06 cm. Statistically, all treatment variations showed the same group, so there was no significant difference. This shows that the early growth of plants is greatly influenced by seed factors and food reserves available in the seed embryo. Overall, the absence of any effect from the dormancy breaking treatment with mechanical and physical scarification shows that the early phase of plant length is uniform or the same. This condition shows that the treatment and research environment are homogeneous, resulting in high average plant values for all treatments that are not significantly different.

According to Tohari (2002) in Dharma's (2015) research, plant growth is generally characterized by an increase in the number of cells followed by a process of cell enlargement, so that the size and mass of plants increase over time. Light availability is one of the factors that contribute to plant height growth. Adequate light availability can affect plant metabolism, which plays a role in the formation of stems and leaves (Waruw et al., 2024). The control treatment showed the same response as scarified seeds, so that plant height and length did not differ significantly. The photosynthesis rate of plants affected the height of noni plants but did not affect the germination (dormancy breaking) of noni seeds (*M. Citrifolia*)

Root Length (PA)

Based on the analysis of variance of the research results using mechanical and physical scarification and a combination of the two treatments, it was found that there was no significant difference in root length. The average root length obtained was between 3.29 and 5.11 cm. The highest value was obtained from treatment M0F2 (24-hour soaking), which was 5.11 cm, and the lowest was obtained from treatment M1F0 (sanding), which was 3.29 cm. Statistically, all treatments were in the same group, so there was no significant effect.

The M1F1 treatment (sanding and 12-hour immersion) and M1F2 treatment (sanding and 24-hour immersion) produced root lengths of 3.68 cm, while the M1F0 treatment (sanding) produced 4.08 cm. treatment M2F0 (piercing) produced a relatively high average root length of 4.75 cm, and the combination of treatments M2F2 (piercing and 24-hour soaking) produced a lower root length of 3.77 cm. These treatments tended to be similar and were in the same group, so there was no significant difference.

Roots are organs that absorb water and nutrients, making them an important indicator in the early stages of plant growth. Seeds without treatment (control) responded to water absorption in the same way as those subjected to physical scarification (soaking). The relatively similar root lengths in all treatments indicate that mechanical and physical scarification treatments did not have a significant effect on the early phase of root growth in noni plants (*M. citrifolia*). The parameters in this study did not have a significant effect, but early scarification in the M0F2 treatment (24-hour soaking) in this study resulted in good root length among all treatments and other treatment combinations. This condition was due to the imbibition and permeability of the seed coat, so that the seed embryo grew faster and stimulated the roots to grow faster and longer.

Rotten Seeds (BB)

The results of the analysis of variance of the research results using mechanical and physical scarification and a combination of both treatments (Table 1) show that rotten seeds are not significantly different. The average rotten seeds obtained were between 0 and 0.3. The highest value was obtained from treatment M0F1 (12-hour soaking), M1F0 (sanding), and M2F2 (piercing and 24-hour soaking), which was 0.3, and the lowest was obtained from treatment M0F0 (control), which was 0. Statistically, all treatments were in the same group and therefore had no significant effect. According to Farantika (2017), pathogens carried by seeds can cause decay, necrosis in seed tissue, reduced viability and germination, and damage to the resulting seedlings. The presence of these pathogens greatly determines the quality and grade of the seeds produced. This can occur due to variations in seed viability or the ability of seeds to adapt to the duration of seed soaking.

Mechanical treatment with sanding or piercing and physical treatment with soaking can trigger seed rot. Scratches on the seed coat caused by sanding can trigger the entry of fungi and bacteria into the seed embryo, causing the seed to rot. According to Pranata et al (2018) in Pratiwi's (2022) study, seeds that have undergone scarification treatment tend to be more susceptible to infection by pathogens found in soil or planting media with humid conditions. Wounds on the seed surface caused by the scarification process provide greater opportunity for pathogens to enter and develop, which can result in damage or even death of the seeds, ultimately inhibiting the germination process.

CONCLUSION

Based on the results of research on the effect of breaking dormancy through mechanical and physical scarification on the germination of noni seeds (*M. citrifolia*), the following conclusions can be drawn:

1. Breaking the dormancy of noni seeds (*M. citrifolia*) through mechanical and physical scarification in this study shows that the dormancy breaking treatment has a significant effect on the germination time. Physical scarification treatment was more effective than mechanical scarification in breaking the dormancy of noni seeds (*M. citrifolia*) in accelerating germination, namely with a 24-hour soaking treatment (M0F2).
2. The results showed that the interaction between mechanical and physical scarification treatments did not have a significant effect on most of the mangosteen (*M. citrifolia*) seed germination parameters, including germination percentage, plant length, root length, and seed rot. The interaction between treatments only had a significant effect on germination time.

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