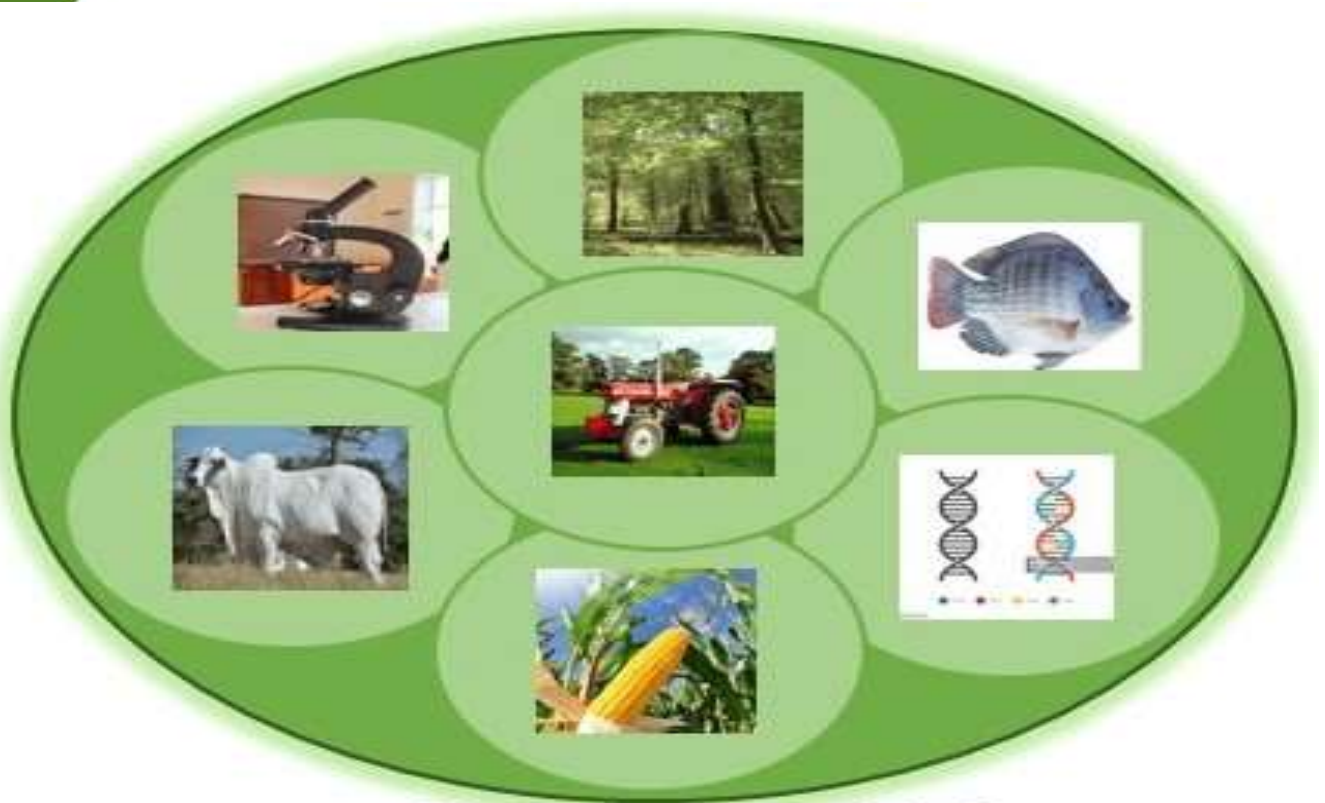




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EFFECT OF DIFFERENT METHODS OF BREAKING SEED DORMANCY ON *MIMOSA PUDICA* AND *ALBIZIA LEBBECK* SEEDS AT BORNO STATE UNIVERSITY

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ABSTRACT

Seed dormancy is a serious adaptive feature that prevents seeds from germinating under unfavorable conditions. However, dormancy can limit uniform and timely germination in agricultural and horticultural production. This study evaluated different methods of breaking seed dormancy on selected crop seeds at Borno State University, Maiduguri, Nigeria. The experiment tested physical, chemical, and hormonal treatments including mechanical scarification, soaking in concentrated sulfuric acid, soaking in gibberellic acid (GA3), and control (no treatment). Seeds of *Mimosa pudica* and *Albizia lebeck* were used as model species with hard seed coats exhibiting physical dormancy. Germination percentage, mean germination time, and seedling vigor index were measured. Results showed that sulfuric acid treatment for 10 minutes and GA3 soaking at 200 ppm significantly enhanced germination rate and seedling vigor compared to control and mechanical scarification. The study concludes that acid scarification and hormonal treatment are effective dormancy-breaking methods suitable for seeds with physical dormancy in the Sahel region. These findings provide practical procedures to improve seedling establishment for agroforestry and crop production programs at Borno State University and surrounding areas.

Keywords: Seed dormancy, *Mimosa pudica*, *Albizia Lebec*

Introduction

Seed dormancy is a common physiological mechanism that prevents viable seeds from germinating under favorable environmental conditions until specific internal or external cues are met. This adaptive trait enhances species survival by synchronizing germination with optimal conditions for seedling establishment (Baskin & Baskin, 2014). However, in agroforestry and restoration

programs, dormancy presents a major challenge because it delays seedling production and stand establishment. Many tropical legumes, including *Mimosa pudica* (sensitive plant) and *Albizia lebeck* (Kalgo), exhibit hard seed coats that restrict water imbibition, a phenomenon referred to as physical dormancy (Dakshini et al., 2021)..



Mimosa pudica, a creeping annual legume native to tropical regions, is valued for its medicinal and soil-improving properties but is also recognized as a problematic weed in some agroecosystems. Its seeds are characterized by impermeable seed coats that impose strong dormancy, necessitating pre-sowing treatments for improved germination (Sahoo et al., 2018). Similarly, *Albizia lebbek*, a multipurpose tree species widely distributed in Africa and Asia, is an important agroforestry species providing fodder, timber, shade, and environmental benefits. However, its seeds also possess hard testa, which imposes dormancy and hinders large-scale propagation efforts (Chauhan et al., 2019).

Breaking seed dormancy is therefore crucial for enhancing the propagation and utilization of both species. Different methods such as mechanical scarification (nicking or sandpapering), hot water soaking, chemical scarification using concentrated acids, and hormonal treatments have been reported as effective in improving germination in leguminous species (Motsa et al., 2017). Acid scarification in particular has been widely applied for hard-seeded legumes because it erodes the impermeable seed coat, enhancing water uptake and gas exchange (El-Keblawy and Al-Rawai, 2019). Hot water treatments are more environmentally friendly and cost-effective, although their effectiveness varies with seed species and exposure duration. The importance of dormancy-breaking research in Nigeria cannot be overstated, particularly in the Sahel and Sudan savannah zones, where agroforestry contributes significantly to food security, ecosystem resilience, and rural livelihoods. Many valuable indigenous tree and shrub species in these regions, such as *Mimosa pudica* and *Albizia lebbek*, exhibit hard seed coats that impose physical dormancy, hindering uniform and timely germination. This challenge often leads to

poor seedling establishment, which limits large-scale afforestation, reforestation, and sustainable land management efforts (Sharma et al., 2020).

Materials and Methods

At Borno State University, Maiduguri, evaluating the response of *Mimosa pudica* and *Albizia lebbek* seeds to different dormancy-breaking methods is crucial for identifying effective, affordable, and environmentally friendly techniques that can enhance germination. Such findings will be vital for promoting their integration into agroforestry systems, ecological restoration programs, and medicinal plant production. Moreover, developing simple dormancy-breaking techniques can enable farmers, nurserymen, and community-based forestry projects to produce large numbers of seedlings efficiently, thus contributing to land rehabilitation, biodiversity conservation, and climate change adaptation in Nigeria's semi-arid regions.

This study, therefore, provides a scientific basis for selecting appropriate pre-germination treatments that improve the propagation success of these multipurpose species, aligning with national and global goals for sustainable natural resource management and ecosystem restoration.

Study Area

This experiment was carried out at the Plant Science and Biotechnology Laboratory, Borno State University, Maiduguri (Lat. 11.8443°N, Long. 13.1609°E). The area lies within the Sahelian agro-ecological zone of northeastern Nigeria, characterized by a long dry season (typically October to May) and a short rainy season (June to September). Average annual temperatures range between 27°C and 40°C, with low and erratic rainfall averaging 500–700mm per annum. The soils are predominantly sandy loam, low in organic

matter and fertility, and highly prone to desiccation and erosion during dry months. The selection of Maiduguri as the study site is strategically important because the Sahelian environment poses major constraints to seed germination, establishment, and survival of many agroforestry and leguminous species. Studying dormancy-breaking techniques under these conditions provides realistic insights into the adaptability and regeneration potential of *Mimosa pudica* and *Albizia lebbek* in semi-arid ecosystems. Moreover, the Plant Science and Biotechnology Laboratory provides controlled conditions and analytical facilities suitable for evaluating the effects of different dormancy-breaking methods on germination and early seedling growth. Hence, conducting this research in Maiduguri ensures that the findings will be practically applicable to similar Sahel and Sudan savanna environments, thereby contributing to improved seed technology, nursery management, and sustainable agroforestry development in arid and semi-arid regions of Nigeria.

Seed Collection and Handling

Mature pods of *Mimosa pudica* and *Albizia lebbek* were collected from natural stands around Maiduguri. Seeds were extracted manually, cleaned, and stored at ambient laboratory conditions before experiments.

Experimental Design

A Completely Randomized Design (CRD) was used with four treatments and three replicates. Each replicate consisted of 50 seeds per treatment for each species.

3.4 Treatments Applied

Treatment Code	Description
T1	Control (no treatment, soaked in distilled water for 24 hrs)
T2	Mechanical scarification by abrasion with fine sandpaper

T3 Chemical scarification by soaking in concentrated H_2SO_4 (98%) for 10 minutes followed by rinsing

T4 Hormonal treatment by soaking in 200 ppm GA₃ solution for 24 hours

Germination Test Procedure

Seeds were placed in Petri dishes lined with moist Whatman filter paper, maintained at $25 \pm 2^\circ C$, with 12-hour light cycles in a growth chamber. Moisture was maintained throughout the 21-day germination period by regular spraying.

Data Collection

Germination Percentage (GP):

$$\text{Number of germinated seeds} / \text{total seeds} \times 100$$

Mean Germination Time (MGT):

$$MGT = \frac{\sum(n_i \times d_i)}{\sum n_i}$$

$$MGT = \frac{\sum n_i \times d_i}{\sum n_i}$$

where n_i = number of seeds germinated on day d_i .

Seedling Vigor Index (SVI):

$$SVI = GP \times \text{mean seedling length (cm)}$$

$$SVI = GP \times \text{mean seedling length (cm)}$$

Statistical Analysis

Data were subjected to Analysis of Variance (ANOVA) using SPSS v25. Means were compared using Duncan's Multiple Range Test (DMRT) at $P \leq 0.05$.

Results and Discussion

Germination Percentage

Results showed significant differences ($P \leq 0.05$) in germination percentages among treatments. Seed treated with Sulfuric acid recorded the highest germination in both species, with *Albizia lebbek* slightly outperforming *Mimosa pudica*. GA₃ treatment also significantly increased germination, whereas mechanical scarification offered moderate improvement. The untreated seeds

had poor germination, consistent with the presence of physical dormancy due to impermeable seed coats (Baskin & Baskin, 2014).

This could be attributed to Sulfuric acid ability to effectively soften or erodes the seed coat, enabling water uptake, which is the critical first step in germination. This result is in

accordance with the findings of (Demir et al., 2002). GA₃ likely acts on the embryo's physiological dormancy mechanisms, stimulating growth-promoting enzymes (Khan et al., 2012). Mechanical scarification may not sufficiently weaken the seed coat uniformly, accounting for its intermediate results (Baskin & Baskin, 2014).

Table 1. Germination Percentage (%) of *Mimosa pudica* and *Albizia lebbek* under Different Treatments

Treatment	<i>Mimosa pudica</i>	<i>Albizia lebbek</i>
Control (No treatment)	30.0 c	28.0 c
Mechanical Scarification	62.0 b	65.0 b
Sulfuric Acid (10 min)	88.0 a	92.0 a
GA ₃ (200 ppm, 24 hrs)	78.0 ab	81.0 ab
SE±	3.15	3.07

Means followed by the same letter (s) in a treatment group are not significantly different at 5% level using DMRT, *= Significant at 5% NS = not significant, WAS = Weeks after sowing

Mean Germination Time and Seedling Vigor Index

Mean germination time was shortest in seeds treated with sulfuric acid, followed by GA₃, indicating faster germination (Table 2). The control seeds took significantly longer, reflecting dormancy persistence. Faster germination reduces vulnerability to environmental stresses and competitors. This rapid response is advantageous in the Sahel's short rainy season, where rapid seedling establishment is vital. Seedling vigor index followed the same trend as germination percentage, with sulfuric acid and GA₃ treatments producing the most vigorous seedlings (Table

Mechanical Scarification	6.7 b	7.1 b
Sulfuric Acid (10 min)	4.2d	3.9 d
GA ₃ (200 ppm, 24 hrs)	5.1c	4.8 c
SE±	0.3	0.25

Means followed by the same letter (s) in a treatment group are not significantly different at 5% level using DMRT, *= Significant at 5% NS = not significant, WAS = Weeks after sowing

Seedling Vigor Index

Seedling vigor index followed the same trend as germination percentage, with sulfuric acid and GA₃ treatments producing the most vigorous seedlings (Table 3). Vigor is critical for survival in the field, particularly under abiotic stresses like drought and high temperatures.

Table 2. Mean Germination Time (days) of *Mimosa pudica* and *Albizia lebbek* Seeds

Treatment	<i>Mimosa pudica</i>	<i>Albizia lebbek</i>
Control (No treatment)	9.8a	10.2 a

Table 3. Seedling Vigor Index of *Mimosa pudica* and *Albizia lebbek* Seeds

Treatment	<i>Mimosa pudica</i>	<i>Albizia lebbek</i>
Control (No treatment)	930 d	890 d
Mechanical Scarification	1425c	1510c
Sulfuic Acid (10 min)	2175a	2310a
GA ₃ (200 ppm, 24 hrs)	1980 b	2035b
SE±	52.85	53.22

Means followed by the same letter (s) in a treatment group are not significantly different at 5% level using DMRT, *= Significant at 5% NS = not significant, WAS = Weeks after sowing

Discussion

The findings of this study confirm that seed coat impermeability is a major barrier to germination in *Mimosa pudica* and *Albizia lebbek* (Oyelakin et al., 2016). The hard seed coat prevents water and gas exchange, maintaining dormancy until natural weathering occurs. This adaptation ensures survival in harsh environments but poses challenges for propagation and nursery establishment.

The superior germination response from sulfuric acid treatment agrees with reports by Aref et al. (2011) and Sharma et al. (2020), who found that acid scarification effectively erodes the waxy and lignified seed coat, promoting rapid and uniform water absorption. The method is efficient, cost-effective, and suitable for large-scale seedling production, particularly for hard-coated leguminous species.

Similarly, gibberellic acid (GA₃) significantly enhanced germination and vigor by stimulating enzymatic activity that softens the endosperm and triggers embryo growth (Khan et al., 2012). This suggests that, apart from physical dormancy, a degree of physiological dormancy exists in these species. Comparable results were reported by Tanimu et al. (2017), who observed improved germination and early growth in *Acacia* and *Parkia* species treated with GA₃.

Mechanical scarification improved germination but lacked the uniformity and

effectiveness of acid or hormonal treatments. Variation in the depth of abrasion often leads to inconsistent seed coat removal or embryo injury (Khan et al., 2019). Nonetheless, mechanical methods remain practical and environmentally friendly for small-scale nurseries where access to chemicals is limited. The low germination rate of untreated seeds further confirms the need for pretreatment to overcome dormancy and ensure uniform seedling emergence. Rapid and synchronized germination achieved through effective treatments is especially vital under Sahelian conditions, where short rainy seasons and erratic moisture availability restrict growth periods. Vigorous seedlings produced from treated seeds are likely to establish faster and survive better under drought and high temperature stress, enhancing afforestation and agroforestry success in semi-arid regions. Overall, the study demonstrates that acid and GA₃ treatments are the most reliable dormancy-breaking methods for *Mimosa pudica* and *Albizia lebbek* seeds. These methods can significantly improve germination efficiency, seedling vigor, and field establishment, thereby supporting sustainable land rehabilitation, reforestation, and agroforestry development in the Sahel and Sudan savannah zones of Nigeria.

Conclusion

This study demonstrated that seed dormancy in *Mimosa pudica* and *Albizia lebbek* is primarily due to seed coat impermeability, which restricts water absorption and gas exchange. Among the treatments tested, sulfuric acid scarification proved most effective in promoting rapid and uniform germination, followed by gibberellic acid (GA₃), which successfully overcame physiological dormancy and enhanced seedling vigor. Mechanical scarification also improved germination but was less consistent compared to chemical or hormonal treatments. The poor performance of untreated seeds confirmed the necessity of pretreatments for viable propagation. Effective dormancy-breaking methods such as acid and GA₃ treatments are therefore crucial for improving seedling production, field establishment, and survival of these species in the semi-arid Sahelian environment. Adoption of these techniques will contribute significantly to afforestation, ecological restoration, and sustainable agroforestry development in northern Nigeria and similar dryland regions.

Recommendations

Sulfuric acid scarification and GA₃ soaking are recommended for breaking seed dormancy of *Mimosa pudica* and *Albizia lebbek* under Maiduguri conditions. These treatments significantly improve germination percentage, reduce germination time, and enhance seedling vigor. Mechanical scarification is moderately effective but less consistent.

Adoption of these practices will improve propagation success for agroforestry, restoration, and conservation efforts in Borno State and similar Sahelian environments.

Promote sulfuric acid and GA₃ treatments in local nurseries with proper safety training for handling acids.

Investigate dormancy-breaking methods for other native Sahelian species to support broader reforestation initiatives.

Educate local farmers and extension workers on seed treatment techniques to enhance agroforestry adoption.

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