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Reviving the Resilient: Exploring Pre-Dormancy Breaking Treatments for *Acacia nilotica* (L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Acacia nilotica plays an important ecological role in its native habitats and has great relevance for restoration as well as in terms of economic worth. *Acacia nilotica* species frequently exhibit seed dormancy, which makes planting and seed testing difficult. In the present work, we examined the degree of dormancy and the impact of various pre-treatments on the dormancy breaking of *Acacia* species. Several tests were carried out against this backdrop to standardize the mechanical

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scarification, seed priming, and coating techniques. The results showed that mechanical scarification of *Acacia nilotica* seeds with @6 min scarification improved the seed germination percentage and vigour index percentage by 117 and 184 percent over the control. Correspondingly**,** the application of the TNAU seed coating formulation on *Acacia nilotica* seeds at 2g kg-1 increased the germination percentage and vigour index percentage by 129 and 186 percent, respectively, over the control. Also, humid priming of *Acacia* seeds (12 h soaking in water + 2 days humid incubation) resulted in a gradual increase in the seed germination percentage and vigour index percentage by 181 and 263 percent over the control. The seeds were not harmed by any of these treatments, which all reduced hard seeds to zero and improved germination percentages.

Keywords: Acacia nilotica; dormancy; mechanical scarification.

1. INTRODUCTION

Acacia nilotica, also known as the gum Arabic tree or babul tree, is a species of Acacia native to Africa, the Middle East, and the Indian subcontinent. Acacia nilotica has numerous uses and is highly valued for its various parts, i.e., gum Arabic, timber, medicinal uses, forage, and fodder [1]. This is used to treat illnesses like diarrheal, skin infections, dental problems, gastrointestinal problems, respiratory concerns, and more. Seed dormancy in *Acacia nilotica* can pose challenges to its propagation and regeneration. A few factors contribute to seed dormancy in Acacia nilotica: Seed Coat Hardness and Chemical Inhibitors To overcome seed dormancy *In Acacia nilotica*, mechanical scarification is mostly used. Chemical scarification softens the seed coat by using chemicals, whereas mechanical scarification requires physically nicking or scraping the seed coat. Scarification makes it possible for water and oxygen to reach the seed, which encourages germination.

With the advancement of seed coating technology over the past 20 years, it is now possible to enhance seeds easily and affordably, particularly for larger-seeded horticultural and agronomic crops. Seating the seed enhancement ingredient directly to the seed without masking its shape is one benefit of seed coating. The film coating allows the possibility to apply more enhancement layers as needed to increase performance and offers a uniform, yet precise deposition of chemicals at considerably lower rates than the conventional seed treatment systems [2-4].

The TNAU (Tamil Nadu Agricultural University) seed coating formulation developed in Coimbatore, India, is a hormone-based formulation that contains a combination of a hydrophilic polymer, growth hormone, pigment, and stabilizer. This seed coating formulation has shown positive effects on seed germination, seedling growth characteristics, stress tolerance, and seed storage potential in various agricultural and horticultural crops. According to research studies, such as those conducted by Karthi [5], Leelavathi [6], and Anil Kumar and Malarkodi [7], the TNAU seed coating formulation has demonstrated improved physiological potential in several crops.

The humid priming approach involves soaking the seeds in a loosely knotted cloth bag for a predetermined amount of time, then putting the bags in a closed and elevated container to provide humid, dark conditions that encourage the invigoration process. Seed cubes are made from various materials such as peat, coco coir, vermicompost, VAM, Bone meal, or other organic or synthetic materials. The substrate is designed to provide optimal water retention, aeration, and nutrient availability to support seed germination and early seedling development [8].

With this background, the main objective of the present study was the standardization of dormancy-breaking, seed coating, and humid priming treatments.

2. MATERIALS AND METHODS

2.1 Materials

The seeds of *Acacia nilotica* were collected from Forest College and Research Institute, Mettupalayam, and experiments were conducted in the Department of Seed Science & Technology Coimbatore.

2.2 Methods

2.2.1 Standardization of dormancy-breaking treatment

Seeds of *Acacia nilotica* were exposed to seed dormancy-breaking treatments by mechanical scarification at different intervals @ 5 min, 6 min, and 7 min. The mechanical scarified seeds are placed for germination in laboratory conditions in two replications. The observation took for germination percentage (ISTA, 2013), speed of emergence, seedling length, vigour index [9], and dry matter production.

2.2.2 Standardization of seed coating technique

Scarified seeds of *Acacia nilotica* were subjected to seed coating with 'TNAU seed coating polymer formulation' @ 2 g, 3 g, and 4 g kg-1 of seeds [8]. Daily observations for the germination of seeds were recorded.

2.2.3 Standardization of humid priming technique

Scarified seeds were subjected to humid priming. In this experiment, the *Acacia nilotica* seeds were soaked in water for two different durations, namely 12 and 24 hours, in separate containers [8]. The seeds were afterward placed in a container above an elevated platform after the water had been drained, tied in wet cloth bags, and placed there to allow the excess water to drain. The containers were closed tightly and moved to a dark environment to enable seed incubation. After being incubated for 1, 2, and 3 days, seeds were taken out and shade-dried for 12 hours to get back their original moisture content.

Daily observations of seed germination were kept, and the Magurie [10] formula was used to determine the pace of emergence. The number of healthy seedlings was counted after 14 days, and the mean was represented as a germination percentage. We measured and converted the root and shoot lengths to centimeters (cm). Following the measurement of the total seedling length (root length plus shoot length), the seedlings were placed in a paper cover, dried in the shade for 24 hours, and then dried in a hot air oven at 80±2ºC for another 24 hours to calculate the dry matter production (mg). Utilizing the Abdul-Baki and Anderson-recommended formula, the vigour index values were calculated, and the mean values were presented as whole numbers.

2.3 Statistical Analysis

The experiment was conducted using a completely randomized design (CRD). Two replicates of each treatment were performed. Data were analyzed by using the Excel tool for CRD.

3. RESULTS AND DISCUSSION

Three studies were conducted to standardize dormancy-breaking methods for Acacia nilotica. These tests covered mechanical scarification, coating, and priming approaches.

Three different periods were chosen for the first experiment to examine the impact of mechanical scarification on Acacia nilotica seeds (5, 6, and 7 min) (Table 1). The sixth-minute mechanical scarification showed the greatest potential to enhance seed germination and seedling establishment of *Acacia nilotica* by increased germination percentage (74), speed of germination (2.808), total seedling length (18.38), root length (8.685), shoot length (9.695), dry matter production (0.59) and vigour index (1357) compared to other treatments.

Ayala-Silva et al., [11], reported that mechanical scarification is an effective method of increasing seed coat permeability in *Tamarindus indica* seeds. Rusdy et al., [12] investigated how mechanical scarification affected the germination of Leucaena leucocephala seeds and concluded that scarifying seeds by clipping the seed coat around the micropyle at the distal end considerably improved germination. According to Tigabu and Oden [13], the mechanical scarification of *Albizia lebbeck* resulted in the highest mean daily germination (5.73%) compared to the control (0.015%). This process removed physical barriers to water imbibition and increased the rate of germination by weakening seed coat structures. Mohammad and Abdulrahman [14] reported that mechanically scarified *Delonix regia* seeds showed the highest germination rate (100%) compared to control seeds (20%). Muhammad and Amusa [15] reported that manually scarified Tamarindus indica seeds had the highest germination rate (70%) of all seeds tested.

The seeds were given three dosages to determine the impact of seed coating with the "TNAU seed coating formulation" on *Acacia nilotica* (2, 3, and 4 g kg-1) (Table 2). The dosage 2 g kg-1 had the greatest potential by increased germination percentage (78), speed of germination (3.557), total seedling length (17.875), root length (9.34), shoot length (8.535), dry matter production (0.6) and vigour index (1393) compared to other dosages.

These findings were consistent with those reported by Karthi [5], who stated that a TNAU seed coating formulation containing hydrophilic polymer and gibberellic acid improved seed germination and seedling vigour in a variety of crops (rice, maize, bajra, sorghum, ground nut, cotton, etc.) and horticultural crops (tomato, brinjal, chili, onion, bhendi, ridge gourd, bitter gourd).

When seeds germinate, gibberellins encourage the mobilization of reserves and reduce the mechanical resistance of the endosperm surrounding the radical tip, causing the radical to protrude [16]. Umarani et al. [17] developed a GA3-based seed coating formulation containing polymer, pigment, carboxy methyl cellulose, and gibberellic acid. The concentrations of the components were 79.25%, 20.0%, 0.5%, and 0.25%, respectively. Treating ribbed gourd seeds with 4g per kg of this formulation resulted in a 15% improvement in germination percentage, speed of germination, seedling length, and other parameters compared to the control group. Gibberellic acid (250 ppm) was shown to be the only growth hormone that effectively enhanced seed germination in Mohamed and Umarani [17] study on the impacts of other growth hormones, including GA3, ethrel, IAA, NAA, and IBA. Patel et al., [18], reported that Pterocarpus santalinus seeds treated with GA3 @ 500 ppm for 24 hours experienced earlier sprouting (7.67), greater germination percentage (66.67%), longer roots (3.57 cm), dry weight (24.77 g/plant), and a 63.33% survival rate.

Humid priming treatments were applied to *Acacia nilotica* seeds for 12 and 24 hours, respectively (Table 3). A humid incubation period of 1, 2, and 3 days of varied lengths is then followed. The best results were achieved by the 12 hours of soaking and 2 days of humid incubation, with the best germination rates of 90%, as opposed to a poor germination rate of 32% for the control.

It was discovered that the speed of emergence, seedling growth, and vigour index was superior in humid priming. The control seeds were discovered to have the lowest vigour index, seedling growth, and seed germination rates at the same period. In several crops, seed priming has been shown to have positive impacts on stand establishment, quick, uniform, and increased germination, improved seedling vigour and growth under a wide range of environmental conditions, and a decrease in phytochrome-induced dormancy [19-22]. When seeds are primed for germination, physiological tests have shown that their metabolic activity is boosted [23]. According to Faisal et al., [24], *Melia dubia* seeds had the highest germination percentage (20.67) following humid priming with GA3 250 ppm (24-hour soaking + 5-day humid incubation).

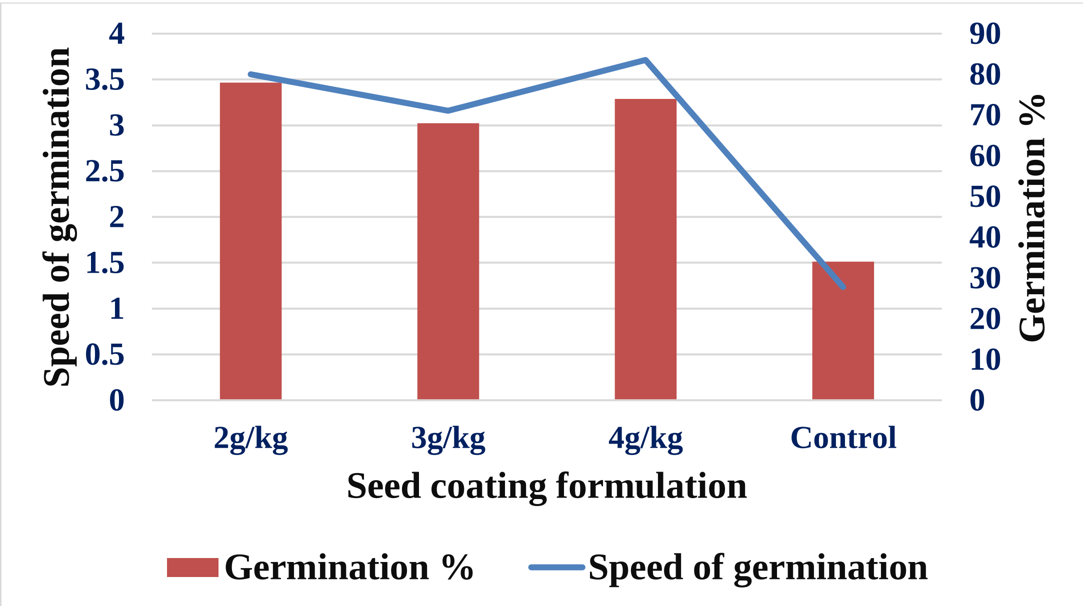

Fig. 1. Effect of Seed coating on the speed of germination and germination % of *Acacia nilotica* seeds

Table 1. Effect of mechanical scarification on seed germination and seedling vigour of *Acacia nilotica*

Treatments		Germination (%)	Speed of germination	Root length (cm)	Shoot length (cm)	Total seedling length (cm)	Dry matter production (Mg seedlings^{-10})	Vigor index
Control		34	1.26	6.21	7.82	14.03	0.53	477
Mechanical	**5 min**	68	2.58	7.86	8.86	16.73	0.56	1136
scarification	**6 min**	74	2.80	8.68	9.69	18.38	0.59	1357
	7 min	68	2.63	8.46	9.93	18.39	0.57	1253
Mean		61	2.32	7.80	9.07	16.88	0.56	1055
SEd		5.47	0.26	0.18	0.22	0.36	0.004	99.62
CD (P=0.05)		21.50	1.03	0.71	0.86	1.42	0.017	391.15

Table 2. Effect of seed coating on seed germination and seedling vigour of *Acacia nilotica*

Treatments		Germination (%)	Speed of germination	Root length (cm)	Shoot length (cm)	Total seedling length (cm)	Dry matter production (Mg seedlings^{-10})	Vigor index
Control		34	1.23	6.4	7.96	14.36	0.53	487
Seed	**2 g/kg**	78	3.55	9.34	8.53	17.87	0.6	1393
coating	**3 g/kg**	68	3.16	9.72	8.22	17.94	0.57	1220
formulation	**4 g/kg**	74	3.71	9.90	8.57	18.48	0.58	1365
Mean		63.5	2.91	8.84	8.32	17.16	0.57	1116
SEd		3.31	0.35	0.15	0.15	0.24	0.006	44.21
CD (P=0.05)		13.02	1.39	0.59	NS	0.95	0.024	173.61

Table 3. Effect of humid priming on seed germination and seedling vigour of *Acacia nilotica*

Humid priming		Germination %	Speed of Germination	Root length (cm)	Shoot length (cm)	Total seedling length (cm)	Dry matter production (Mg seedlings^{-10})	Vigor index
Soaking (h)	**Soaking (h)**							
Control		32	1.16	6.45	8.03	14.49	0.53	464
12 h	**1 d**	62	3.02	7.45	8.48	15.93	0.56	989
	2 d	90	5.19	9.88	8.81	18.69	0.60	1682
	3 d	76	3.76	8	8.5	16.5	0.59	1252
24 h	**1 d**	68	3.04	8.92	8.22	17.14	0.57	1167
	2 d	70	3.04	9.58	8.54	18.12	0.59	1267
	3 d	76	3.48	8.28	8.16	16.45	0.58	1249
Mean		67.71	3.24	8.36	8.39	16.76	0.57	1153.34
SEd		4.20	0.23	0.31	0.20	0.47	0.005	71.57
CD (P=0.05)		14.07	0.78	1.04	NS	1.60	0.018	239.34

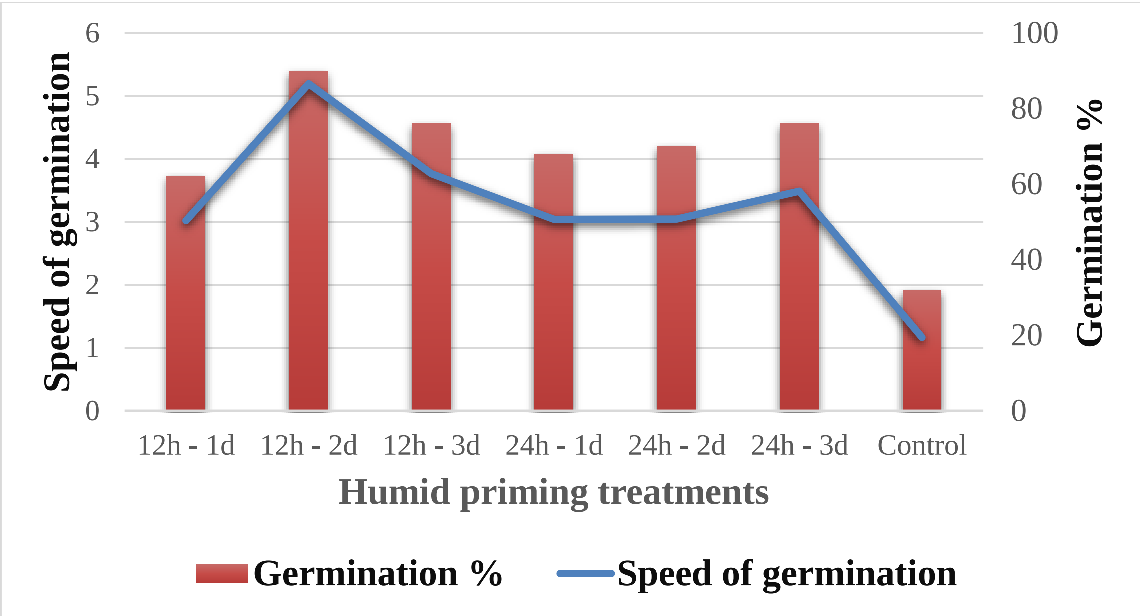

Fig. 2. Effect of Humid priming on the speed of germination and germination % of *Acacia nilotica* seeds

Mehta et al., [25] standardized seed priming durations to improve bitter gourd seed germination and seedling establishment. They used hydro priming at 20°C with different durations. Hydro-priming for 72 hours resulted in significantly faster emergence, higher germination rates, longer seedlings, greater seedling dry weight, and higher vigor index compared to other durations and controls. RNA and DNA synthesis is improved by seed priming [26]. In semi-arid tropics, organic seed priming promotes resilience to high temperatures and little moisture [27].

4. CONCLUSION

From the above experiments, encapsulating of improved seeds can successfully increase the germination percent and seedling vigour compared to untreated seeds. The seed coat gradually softens during an extended period of water-soaking and humid incubation, eventually becoming permeable to water. It is advised to soak clean seeds in water for an operational planting program of 12 hours, store them for 2 days for humid incubation, and then plant them in the designated forest location.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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