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Full Length Research Paper

Effect of pre sowing treatments on seed germination and early seedling growth of three agroforestry tree species in Arba Minch district, Southern Ethiopia

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The study was conducted to explore the effects of different seed treatments on germination and seedling growth performance of *Balanites aegyptiaca* L., *Cordia africana* (Lam.) and *Annona muricata* L. at Arba Minch district, southern Ethiopia. The experiment was laid out in a completely randomized block design with 6 treatments for each species. The treatments were control, soaking in hot water for 5 minutes, soaking in cold water for 24 hours, soaking hot-cold water for 2-1 minutes, abrasion with sand paper and Nicking with seed clipper. Each treatment was replicated four times. A total of 1800 treated seeds were sown comprising of 600 seeds per species and 150 seeds per replication. The analysis of variance revealed that almost all germination and growth parameters of *Cordia africana*, *Balanites aegyptiaca* and *Annona muricata* were significantly ($p<0.05$) influenced by seed pretreatments. Among all seed pretreatments, abrasion showed maximum value of *Cordia africana* and *Balanites aegyptiaca*. While, socking seeds in cold water for 24 hours was more effective in germination and growth parameters of Annona muricata. The study recommended further studies required on other parameters such as germination energy, germination energy index and seedling vigor.

Key words: Dormancy, Germination, Early Seedling Growth, Pre-treatment, Seed

INTRODUCTION

Seeds are excellent dispersal unit and means of propagating higher plants which have emerged in the course of plant evolution. They provide the most natural means of plant reproduction, preservation of genetic variability in angiosperm plants. According to Mo"gomba, 2007; Hartmann and Kester, 2007 Propagation through seeds is considered to be one of the most reliable, efficient and universally applied methods [1].

Seed germination and early seedling growth phases are considered critical for raising a successful crop as they directly determine the crop stand density and consequently the yield of resultant crop. It is indicated that seed germination, seedling growth, and survival percentage are governed by many intrinsic and extrinsic factors and are species specific [2].

According to Hartmann and Kester (2002), seed germination is influenced by type of substrate used and environmental factors such as oxygen, water, temperature and for some species may be affected by light. Most tropical legume species have a water-impermeable seed coat that results in physical dormancy. Therefore, dormant seeds should be pre-treated before sowing to get good germination and desirable quantity of seedlings in the nursery. Thus, this study was aimed to evaluate the impact of pre-sowing treatment on the germination and early growth performance of *Balanites aegyptiaca* L., *Cordia africana* Lam. and *Annona muricata* L. at Arba Minch district, Southern Ethiopia [3].

MATERIALS AND METHODS

Description of the study area

Arba Minch is located 504 km and 275km away from Addis Ababa and Hawassa respectively, in South and Southwest direction.

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It is geographically situated between 6°03'00'' N latitude and 37°37'00'' E longitude and at an altitude of 1225 m.a.s.l. in the southern escarpment of the Rift valley. The study area obtains an annual rainfall of 830.7 mm with the mean minimum and maximum temperature of 17.30°C and 30.60°C, respectively (NMA, Southern Branch,). The district includes portions of two rift valley lakes (Abaya and Chamo) and Nechsar national park is located between two lakes [4].

Seed sources and collection

Seeds were collected from selected sites of Arba Minch district based on the availability of the multipurpose tree species. As mentioned by Abraham et al., dominant or co-dominant trees with clear bole, well developed crown and with abundant drupes were selected for seed collection. Seeds were collected from all parts of the crown by selecting matured seeds before fall down to the ground. The collected fresh seeds were then mixed to form a composite seed lot for each species. The seeds were processed manually by neutralizing hands and de-pulping them to prevent pathogen. Processed seeds were washed, spread evenly and air dried. The seed viability was checked by dipping seeds in a container containing tap water [5].

Experimental design and treatments

The field experiment was laid out Completely Randomized Block Design (CRBD) with four replications. There were six treatments in the experiment: T1, soaking in hot water (35T°C) for 5minutes; T2, soaking in cold water for 24 hrs; T3, soaking in alternate hot-cold water for 2-1 minutes (hot water 35°C); T4, abrasion with sand paper; T5, nicking with seed clipper; T6, the control. Each treatment had 100 seeds making a total of 6000 seeds per species. Seeds were sown on June 21, 2021 in polybags (diameter 16 cm × depth 17 cm size) filled with the soil ratio of 2:1:1 (forest soil: sand: manure). All nursery activities applied as per recommendations [6].

Data collection

Data on the seed germinated was recorded regularly until the polybags showed no new germination at least for 21days consecutive counts. Data on seedling height, root collar diameter, root length, leaf number and leaf area were collected continuously for three rounds recorded with 21 days interval from three randomly selected seedlings from each treatment per species. All the seedlings were measured for total shoot height and root length, root collar diameter, and number of leaves [7]. Finally, Seedling biomass data were totally collected from 216 seedlings (72 seedlings per species). Seedling biomass data were collected from three randomly selected seedlings from each treatment per species after 3 months of experimental period. The shoots and roots of the fresh seedlings were carefully separate by cutting with a dissecting knife. The roots of the harvested seedlings were washed thoroughly to minimize the detachments of the fine roots. The respective shoot and roots of each seedling were dried in oven at 60 ± 1°C for 48 hours.

Statistical analysis

The collected data were analyzed using SAS software version 9.0 (SAS, 2002). Differences between treatment means were detected using Least Significant Difference (LSD) at 0.05 [8].

RESULTS AND DISCUSSION

Effect of pre-sowing treatments on seed germination parameters

The current study revealed that all germination parameters of three agroforestry tree species significantly affected by pre-sowing seed treatments (Table 1). From current study, Abrasion was the most effective treatment for *Balanites aegyptiaca* and *Cordia africana*, while soaking in cold water for 24hrs showed maximum value in A. muricata for all germination parameters except mean germination time where maximum value recorded at control treatment. The maximum effect of abrasion on seed germination of *Balanites aegyptiaca* and *Cordia africana* could be attributed to softening of the seed coat that makes easy for seeds to respire, intake water and oxygen there by breaking dormancy. Our result is in agreement with who reported highest germination parameters with mechanical abrasion in case of *Prosopis juliflora* and *Dalbergia sissoo* [9].

Maximum result of cold water treatment in *A. muricata* might be due to adequate imbibition of moisture and air into the seed and enhancement of embryo metabolic process with the help of amylase enzyme converting starch and protein in to readily available form of simple sugar to produce energy for commencement of germination and radicle and plumule elongation. This study is agreed with the findings of who demonstrated highest (82.85%) germination percentage of seeds soaked in cold water for 96 hours in *Annona reticulata* [10].

Table 1. Effect of pre-sowing treatments on germination parameters of three agroforestry tree species.

Tree species	Treatments	Parameters				
		G%	Rate	Value	Time	Index
B. aegyptiaca	Control	69.0^{e}	0.91^{cd}	0.29^{e}	19.2^{a}	2.4^{d}
	SHW	74.0^{d}	0.97^{c}	0.51^{c}	19.2^{a}	2.5^{d}
	SCW	81.0^{bc}	1.17^{b}	0.46^{cd}	18.7^{b}	2.8^{cd}
	SHCW	76.0^{d}	1.00^{c}	0.41^{ij}	18.9^{b}	2.7^{cd}

	Abrasion	93.0^{a}	1.43^{a}	0.66^{a}	18.5^{bc}	4.5^{a}
	Nicking	86.0^{b}	1.12^{b}	0.57^{b}	19.0^{a}	3.3^{b}
C. africana	Control	73.0^{cd}	1.22^{de}	0.64^{e}	16.8^{a}	2.9^{d}
	SHW	80.0^{bc}	1.33^{bcd}	0.94^{C}	14.8^{c}	3.43^{cd}
	SCW	81.0^{bc}	1.35^{bc}	0.95^{C}	15.09^{b}	3.5^{bcd}
	SHCW	76^{cd}	1.31^{bcd}	0.87^{d}	15.0^{b}	3.34^{bcd}
	Abrasion	94^{a}	1.56^{a}	1.66^{a}	12.8^{d}	4.3^{a}
	Nicking	87^{b}	1.45^{ab}	1.38^{b}	15.1^{b}	3.6^{bc}
A. muricata	Control	74.0^{d}	0.97^{c}	0.23^{d}	20.1^{a}	2.96^{d}
	SHW	76.0^{d}	1.00^{c}	0.32^{bc}	18.9^{b}	3.7^{bc}
	SCW	92.0^{a}	1.38^{a}	0.74^{a}	15.0^{c}	4.4^{a}
	SHCW	82.0^{c}	1.08^{b}	0.28^{d}	19.1^{ab}	3.2^{cd}
	Abrasion	87.0^{b}	1.12^{b}	0.36^{b}	18.6^{bc}	3.5^{bcd}
	Nicking	80.0^{c}	1.05^{bc}	0.30^{bc}	18.6^{bc}	4.0ab

Note: Mean values followed by the same letter(s) with in a column for a given treatment are not statistically different at 0.05. SHW=Seed soaking in hot water for 5 minutes; SCW=Seed soaking in cold water for 24 hrs; SHCW=Seed soaking in alternate hot-cold water for 2-1 minutes

Effect of pre-sowing treatments on seedling growth performance

The study showed significant effects on seedling growth performance of three agroforestry tree species (Table 2). It was observed that all growth parameters of *Balanites aegyptiaca* and *Cordia africana* were found maximum values at abrasion treatment. The reason for better performance of abrasion for *Balanites aegyptiaca* and *Cordia africana* might be promotion of physiological processes to form new leaves and induce vegetative growth at a faster rate. Growth performance on *Annona muricata* showed maximum result in cold water treatment. The possible reason might be due to hydrolysis of complex into simple sugars that are easily utilized in the synthesis of auxins and proteins. Our finding was supported by who observed maximum effect of growth parameters on seeds soaked in cold water for 24 hours in *Annona squmosa* [11].

Table 2. Effect of pre-sowing treatments on germination parameters of three agroforestry tree species.

Tree species	Treatments	Parameters				
		PH(cm)	LA (cm^2)	NL	RCD (cm)	RL(cm)
B. aegyptiaca	Control	16.05^{e}	1.75^{d}	22.75^{e}	0.23^{cd}	9.12^{d}
	SHW	16.88^{d}	2.00^{cd}	23.75^{cd}	0.25^{bc}	9.80^{cd}
	SCW	17.64^{c}	2.14^{c}	24.50^{c}	0.26^{bc}	10.30^{c}
	SHCW	17.07^{cd}	2.07^{bc}	23.75^{cd}	0.25^{bc}	9.98^{bc}
	Abrasion	19.64^{a}	2.64^{a}	27.80^{a}	0.30^{a}	12.6^{a}
	Nicking	18.84^{b}	2.29^{b}	26.25^{b}	0.27^{b}	11.7^{b}
C. africana	Control	14.54^{f}	15.51^{e}	5.25^{d}	0.23^{d}	12.9^{e}
	SHW	17.08^{e}	17.92^{d}	6.0^{cd}	0.27^{c}	14.7^{cd}
	SCW	17.84^{d}	19.38^{C}	6.25^{c}	0.28^{c}	15.4^{c}
	SHCW	16.20^{c}	17.43^{d}	5.25^{d}	0.26^{d}	14.1^{cd}
	Abrasion	22.74^{a}	23.35^{a}	9.50^{a}	0.62^{a}	20.4^{a}
	Nicking	20.74^{b}	21.30^{b}	7.75^{b}	0.36^{b}	17.9^{b}
A. muricata	Control	9.88^{d}	7.50^{e}	5.0^{d}	0.31^{cd}	5.8^{c}

	SHW	10.33^{cd}	8.14^{d}	5.50^{c}	0.33^{bc}	6.3^{bc}
	SCW	13.13^{a}	10.87^{a}	7.75^{a}	0.47^{a}	8.6^{a}
	SHCW	10.68^{c}	8.64^{bc}	5.25^{cd}	0.33^{cd}	6.5^{bc}
	Abrasion	11.05^{b}	8.93^{b}	6.50^{b}	0.35^{bc}	6.8^{b}
	Nicking	10.55^{c}	8.37^{bc}	5.25^{cd}	0.33^{bc}	6.4^{bc}

Note: Mean values followed by the same letter(s) with in a column for a given treatment are not statistically different at 0.05. SHW=Seed soaking in hot water for 5minutes; SCW=Seed soaking in cold water for 24 hrs; SHCW=Seed soaking in alternate hot-cold water for 2-1 minutes; PH=Plant Height; LA=Leaf Area; NL=Number of Leaves; RCD=Root Collar Diameter; RL=Root Length

Effect of pre-sowing treatments on fresh and dry biomass

The results of the current study revealed that all pre sowing seed treatments significantly affected the fresh and dry biomass of all species (Table 3), where maximum fresh and dry biomass was recorded for *B. aegyptica* and *C. africana* at abrasion. Different result was found by who reported lower fresh and dry root biomass at mechanical abrasion of seed as compared to cold water pre-treatments of seed in case of *Gleditsia caspica*. *A. muricata* showed maximum value of fresh and dry biomass recorded for soaking in cold water for 24 hrs. The better performance of cold water treatment over rest of the treatments in A. muricata might be due to softened seed coat that allowed moisture in to embryo and enhanced vegetative growth of the seedling. Our finding was in agreement with who reported highest fresh and dry root biomass for cold water treatment in case of *Tamarindus indica* [12].

Table 3. Effect of pre-sowing treatments on fresh and dry biomass of three agroforestry tree species.

Tree species	Treatments	Parameters			
		Root fresh weight (g)	Shoot fresh weight (g)	Root dry weight (g)	Shoot dry weight (g)
B. aegyptiaca	Control	2.08^{d}	5.03^{d}	1.10^{e}	1.75^{d}
	SHW	2.73^{c}	6.22^{bc}	1.36^{d}	2.30^{c}
	SCW	2.60^{c}	5.83^{c}	1.45^{cd}	2.10^{cd}
	SHCW	2.50^{c}	5.72^{c}	1.41^{cd}	2.02^{cd}
	Abrasion	4.79^{a}	9.20^{a}	2.81^{a}	3.80^{a}
	Nicking	3.2^{b}	7.46^{b}	1.72^{b}	2.60^{b}
C. africana	Control	6.19^{e}	65.2^{f}	1.40^{d}	12.06^{f}
	SHW	7.60^{c}	73.2^{d}	1.64^{c}	13.61^{d}
	SCW	7.80^{c}	77.4^{c}	1.73^{c}	14.1^{c}
	SHCW	6.80^{d}	69.2^{e}	1.53^{cd}	12.6^{e}
	Abrasion	10.70^{a}	92.9^{a}	2.68^{a}	17.7^{a}
	Nicking	9.10^{b}	86.4^{b}	1.90^{b}	15.6^{b}
A. muricata	Control	0.93^{cd}	2.08^{d}	0.19^{cd}	0.58^{cd}
	SHW	1.30^{b}	3.26^{b}	0.27^{b}	0.92^{b}
	SCW	1.76^{a}	5.18^{a}	0.42^{a}	1.41^{a}
	SHCW	1.31^{b}	2.27^{cd}	0.22^{bc}	0.64^{c}
	Abrasion	1.30^{b}	2.73^{c}	0.24^{bc}	0.76^{bc}
	Nicking	1.06^{bc}	2.42^{cd}	0.21^{bc}	0.68^{c}

Note: Mean values followed by the same letter(s) with in a column for a given treatment are not statistically different at 0.05. SHW=Seed soaking in hot water for 5minutes; SCW=Seed soaking in cold water for 24 hrs; SHCW=Seed soaking in alternate hot-cold water for 2-1 minutes.

CONCLUSION

Softening the seed coat by mechanical abrasion was found most effective pre-sowing seed treatment for Balanites aegyptiaca and Cordia africana. However, the Soaking of seeds in cold water at ambient temperature for 24 hours gave best results in the promotion of germination, early growth and development of seedlings of *Annona muricata*. The better performance of mechanical scarification over all other treatments in case of Balanites aegyptiaca and *Cordia africana* could be attributed to softening of seed coat that allowed water to permeate the tissues causing physiological changes and subsequent germination of the embryo. The result of the present study recommends the nursery owners or other seedling producer organizations to apply mechanical abrasion method for maximum germination and better seedling growth of *Balanites aegyptiaca* and *Cordia africana*, but cold water treatment of seed for 24hrs is best mechanism for *Annona muricata*. Further research needs to be conducted on the pre-sowing treatments by including other parameters such as; germination energy, germination energy index and seedling vigor.

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