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SEEDS GERMINATION PRE-SOWING TECHNIQUES AND GROWTH PERFORMANCE OF SOME SELECTED SAVANNA AGROFORESTRY TREE SPECIES

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ABSTRACT

The study was conducted at Forest Nursery Unit of Federal University Dutsin-Ma to assess seeds germination pre-sowing techniques and growth performance of some selected savanna agroforestry tree species. A 5 x 5 factorial in Randomized Complete Block Design (RCBD) was used for this experiment in four replicates. The factors were agroforestry tree seeds (AFTS); Acacia nilotica (AN); Parkia biglobosa (PB); Diospyros mespiliformis (DM^k); Detarium microcapum (DM^t); Adansonia digitata (AD) and pre-sowing treatments; Seeds soaked in 60 % diluted Tetraoxosulphate (VI) acid (H_2SO_4) (A); mechanical scarification (Ms); hot water at 60^0 C (HW); seeds soaked in water for 24 hours (W); control (C). The data were analyzed using analysis of variance (ANOVA) at p = .05. Days of emergence was observed to start on 6 days after sowing (DAS) in AN seed treated with H_2SO_4 for 5 minutes (AAN) and DM^k seeds soaked in water for 24 hours (WDM^k). AN seed soaked in H_2SO_4 for 5 minutes (AAN) and DM^t seeds soaked in H_2SO_4 for 5 minutes (ADM^t) gave the highest (60 % and 50 %) germination percentage respectively. AN had significantly higher values (19.58 and 22.78) on plant height (PH) at 8-10 weeks of sowing (WAS) respectively. There was no significant difference among the pre-sowing treatments on PH across the period of experiment. AD had consistent significantly higher values (207.73, 217.66, 226.67, 232.49 and 237.25) on leaf area (LA) at 2-10 WAS. In conclusion, AN and DM^t seeds soaked in H_2SO_4 acid for 5 minutes were the best performing seeds, while, the use of acid was an effective technique to break dormancy for improved seedling growth in the nursery.

Keywords: germination pattern, growth performance, savannah, agroforestry tree species, treatments, nursery.

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INTRODUCTION

Forests provide multiple ecosystem services spanning from local livelihoods and socio-economic development related goods and services such as food, wood, and water to the global ecological and economic services, such as ecosystem functioning, biological diversity, carbon dynamics, and climate. However, deforestation and forest degradation are causing a significant reduction in the provisioning of valuable ecosystem goods and services from forests in developing countries (Lundgren and Raintree, 2004).

Seed is fundamental for regeneration (both artificial and natural), hence, without viable seeds which its dormancy have been overcome, tree establishment may not be possible (Oyebamiji *et al.*, 2014). It should be noted that propagation through seeds is a very cheap method of agroforestry tree establishment (Oyebamiji *et al.* 2018 a, b). Conscientious effort has to be made in promoting correct and adequate pre-germination methods of seeds in order to make them available as seedlings for re-afforestation and reclamation projects to meet both local and international demands (Oyebamiji *et al.*, 2018 c).

Seed traits, including seed weight, germination pattern and growth performances are critical characters of the life histories of higher plants (Kar, 2007), and their importance to plant fitness is widely appreciated (Tremayne and Richards, 2000). Patterns of seed weight and germination and the respective controlling factors have been widely studied in the past few decades (Tremayne and Richards, 2000; Moles *et al*., 2007; Linkies *et al*., 2010).
Seed germination is the most important stage in a plant life cycle. Water, air, temperature and light are all essential for the seed germination process starting from imbibition, activation and succeeding manifestation. Germination speed is related to seedling vigor and it could be a significant determinant of good field performance (Gebauer *et al*., 2002).

Seedling quality is generally defined as ‘‘fitness for purpose’’, with the focus on identifying and discarding seedlings that are not likely to survive or will not grow very well after transplanting. Over the past two decades, various seedling quality assessment methods and their importance in predicting field performance have been developed and tested. Seedling morphological attributes, such as shoot height, root collar diameter, sturdiness (height to diameter ratio), and root to shoot ratio, are widely used to assess seedling quality at the time of planting.

In recent years, numerous studies were devoted to the physiological responses of seed germination and seedlings stages to chilling or osmotic stress (Davis and Jacobs, 2005); the ecological responses of the whole growing season remain largely unknown. However, problems which are encountered in the regeneration of seedlings in the savanna vegetation, which include, problems of seed collection, seed processing, seed storage, seed germination and seedling growth. Pre-sowing treatments of seed are intended to improve the survival or germination of seeds after sowing, and this is especially important in species which exhibit dormancy. The results obtained from the study will not only be useful for existing project evaluation, but also would contribute a great deal to the field of vulnerability studies. Hence, the study investigated effective methods of breaking seeds dormancy of some selected savannah agroforestry tree species with respect to their germination pattern and growth performance of the seedlings in the nursery.

MATERIALS AND METHODS

Study Area

The experiment was carried out in the nursery unit of the Department of Forestry and Wildlife Management, Federal University Dutsin-Ma, Katsina State, Nigeria. The area lies between latitude 12º28'18.3" N and longitude 07º29'15.4" E with an annual rainfall of 700 mm, which is spread from May to September. The mean annual temperatures range from 29-31º C, the high temperature normally occurs in April/ May and the lowest in December through February. The vegetation of the area is the Sudan savannah (Tukur and Kan, 2013; Oyebamiji *et al.* 2018 c).

Experimentation and Data Analysis

The experimental materials used were 60 % diluted Tetraoxosulphate (VI) acid (H_2SO_4) solution, water, river sand, top soil and cow dung, watering can, 40 cm x 32 cm polythene tubes and emery cloth. Potting mixture was prepared by sieving the river sand, top soil and cow dung with mixture ratio of 1:1:1 (top soil plus river sand plus manure) using 2 mm sieve. The top soil and river sand used were collected from the Department of Forestry Dutsin- Ma Local Government of Katsina State. Cow dung was collected at Federal University Dutsin-Ma Livestock Farm, while, agroforestry tree seeds (*Parkia biglobosa, Acacia nilotica, Detarium microcarpum, Diospyros mespiliformis and Adansonia digitata*) were procured from the Federal College of Mechanization Afaka, Kaduna State, Nigeria. The viability test was carried out before experimentation using simple floating method. The seeds were dropped in a beaker containing water. The seeds that floated indicated that they were not viable. Such seeds were removed and replaced. One thousand (1000) viable seeds were sterilized with 5 % sodium hypochlorite solution for 45 seconds to make the seeds free of contamination and make seeds healthy before sowing and then thoroughly rinsed in distilled water. A total of 200 viable seeds of was used in each of the treatments to make the total of 1000 seeds. Experiment was then laid out as 5 x 5 factorial in a Randomized Complete Block Design (RCBD) with agroforestry tree seeds and pre-germination treatments as factors.

Table 1: Dormant seeds of agroforestry trees subjected to pre-sowing treatments

Treatment	Description
AN	*Parkia biglobosa* seeds
PB	*Acacia nilotica* seeds
DM^k	*Detarium microcarpum* seeds
DM^t	*Diospyros mespiliformis* seeds
AD	*Adansonia digitata* seeds
A	Seeds soaked in 60 % diluted Tetraoxosulphate (VI) acid (H_2SO_4)
Ms	Mechanical scarification at the micropyle
HW	Hot water at 60^0 C
W	Seeds soaked in water for 24 hours
Control	Seeds not treated

Data Collection

Observation was on daily basis, while, data were collected at 2 weeks interval. Morphological growth parameters were measured on five (5) randomly tagged seedlings on which plant heights, leaf areas were measured, and days of emergence and germination percentage were also recorded. Plant heights of five (5) seedlings from each pot were measured from the root collar to the tip of the terminal shoot using ruler in centimetre (cm).

Leaf areas of five (5) seedlings from each pot were measured and obtained by linear measurement of leaf lengths and leaf widths as described by Ugese *et al.* (2008); (LA) = 4.41 + 1.41 x (L x W) was used to determine the leaf area, where L is length of leaf; W is width of leaf and LA is leaf area.

Days of emergence indicate the number of days seeds sprout from each pot and was observed and recorded.

Germination percentage (%) indicates the percentage of germination which was derived by dividing the total number of seed germinated by the total number of seed sown and then multiply by 100, the formula is estimated below:

$GP = NSG/TNS\ X\ 100$ …. [1]

Where:

GP = Germination percentage
NSG = Number of seeds germinated
TNSS = Total number of seeds sown

Statistical Data

Data were analysed using Analysis of Variance (ANOVA) with the Statistical Analysis System (SAS, 2003) computer package at 5 % level of significant to determine differences in the treatments effect, while, the Fishers' Least Significant Difference (F- LSD; $P \leq 0.05$) was used to separate the means of differences among the treatments.

RESULTS

Determination of Growth in Seedling Plant Heights

There was significant ($p \leq 0.05$) effect among the selected agroforestry tree seeds at 2-10 WAS. Meanwhile, *A. digitata* seeds were consistent with the significantly higher values ($p \leq 0.05$) (6.66, 8.88, 14.60, 18.78 and 22.13) on plant heights at 2-10 WAS respectively. However, *A. nilotica* seeds had significantly higher values ($p \leq 0.05$) (19.58 and 22.78) among others at 8 WAS and 10 WAS respectively. Furthermore, *D. microcarpum* seeds also showed significantly higher value (9.54) among other seeds at 4 WAS. Furthermore, there was no significant ($p \leq 0.05$) effect among the per-sowing treatments across the period of the experiment (Table 2).

Table 2: **Effect of agroforestry trees seeds and pre-sowings treatments on the plant heights at an interval of 2 weeks**

	Plant Heights				
Treatment	**2 WAS**	**4 WAS**	**6 WAS**	**8 WAS**	**10 WAS**
AF Tree Seeds					
Acacia nilotica	3.37^{c}	8.37^{ab}	13.31^{ab}	19.58^{a}	22.78^{a}
Parkia biglobosa	5.63^{b}	8.41^{ab}	11.58^{c}	15.61^{b}	16.22^{b}
Detarium microcarpum	6.35^{ab}	9.54^{a}	11.73^{bc}	16.10^{b}	16.61^{b}
Diospyrus mespiliformis	4.24^{c}	7.14^{b}	9.33^{d}	11.27^{c}	13.32^{c}
Adansonia digatata	6.66	8.88	14.60	18.78	22.13
SE±	0.262	0.413	0.541	0.664	0.765
Pre- Sowing Treatments					
Acid	4.99	8.28	11.36	15.86	17.67
MS	5.17	8.10	11.86	15.67	17.11
Hw	5.31	8.58	12.34	16.21	18.27
W	5.50	8.70	12.41	16.70	18.90
Control	5.29	8.68	12.57	16.91	19.10
SE±	0.407	0.474	0.713	0.973	1.152

Means followed by the same letters within the same column and treatment are not significantly different at 5 % level of probability using Least Significant Difference (LSD). SE±: Standard Error, AF: Agroforestry, ***Acid:*** *Seeds treated with 60 % diluted H_2SO_4,* ***Ms:*** *Mechanical scarification,* ***Hw:*** *Seeds soaked in hot water at 60^0 C,* ***W:*** *Seeds soaked in water at room temperature for 24 hours.*

Determination of Growth in Seedling Leaf Areas

A digitata seeds had consistent significantly higher values ($p \leq 0.05$) (207.73, 217.66, 226.67, 232.49 and 237.25) among other selected agroforestry tree seeds on leaf areas at 2-10 WAS respectively. However, *A. nilotica* had significantly lower values ($p \leq 0.05$) (0.08, 0.08 and 0.09) on the leaf areas at 6-10 WAS respectively. Meanwhile, there was no significant ($p \leq 0.05$) effect of the pre- sowing treatments on the leaf areas across the period of experiment (Table 3).

Days of Seedling Emergence Seeds of *A. nilotica* treated with 60 % diluted Tetraoxosulphate (V1) acid (H_2SO_4) (AAN) and *D. microcarpum* seeds soaked in water for 24 hours (WDM^{k}) had the earliest days of seedling emergence of 6 days after sowing (DAS). Meanwhile, *P. biglobosa* seeds not treated (Control) (CPB) had the longest days of seedling emergence (11 DAS) (Figure 1).

Germination Performance of Seeds Under Different Pre-Sowing Treatments

D. microcarpum (ADM^{t}) and *A. nilotica* (AAN) seeds treated with 60 % diluted Tetraoxosulpate (V1) acid (H_2SO_4) had the highest (60 % and 50 %) germination performance respectively. However, *A. digitata* seeds treated with water at room temperature (WAD) and seeds not treated (Control) (CAD) had the lowest (12.5 % and 12.5 %) germination performance respectively (Figure 2).

Table 3: **Effect of agroforestry tree seed and per- sowing treatments on the leaf areas at an interval of 2 week**

Treatment	Leaf Areas				
	2 WAS	**4 WAS**	**6 WAS**	**8 WAS**	**10 WAS**
AF Tree Seeds					
Acacia nilotica	0.05[b]	0.07[d]	0.08[c]	0.08[c]	0.09[c]
Parkia biglobosa	0.18[b]	0.26[cd]	0.31[c]	0.38[c]	0.47[c]
Detarium microcarpum	4.77[b]	5.76[b]	6.41[b]	6.10[b]	7.50[b]
Diospyros mespiliformis	4.85[b]	5.18[bc]	5.97[b]	6.58[b]	7.03[b]
Adansonia digitata	207.73[a]	217.66[a]	226.67[a]	232.49[a]	237.25[a]
SE±	0.922	4.304	0.671	0.634	0.620
Pre- Sowing Treatments					
Acid	44.17	46.63	48.11	49.92	50.90
Ms	43.92	47.25	48.60	50.13	51.43
Hw	43.01	44.82	47.62	49.10	50.46
W	43.96	45.53	47.73	48.78	49.73
Control	42.52	44.70	47.38	48.58	49.80
SE±	18.928	19.790	20.555	21.053	21.463

Means followed by the same letters within the same column and treatment are not significantly different at 5 % level of probability using Least Significant Difference (LSD). SE±: Standard Error, AF: Agroforestry, ***Acid:*** *Seed treated with 60 % diluted H_2SO_4,* ***Ms:*** *Mechanical scarification,* ***Hw:*** *Seeds soaked in hot water at 60^0 C,* ***W:*** *Seeds soaked in water at room temperature for 24 hours.*

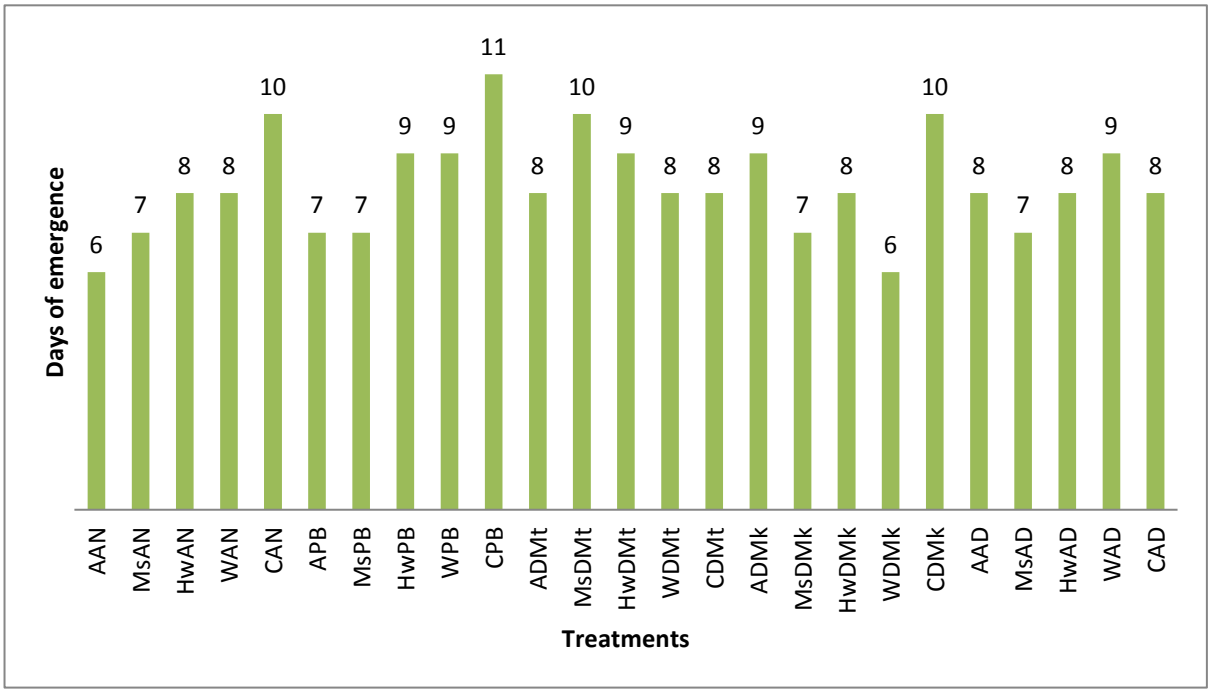

Figure 1: Effect of seeds and pre- sowing treatments on days of emergence

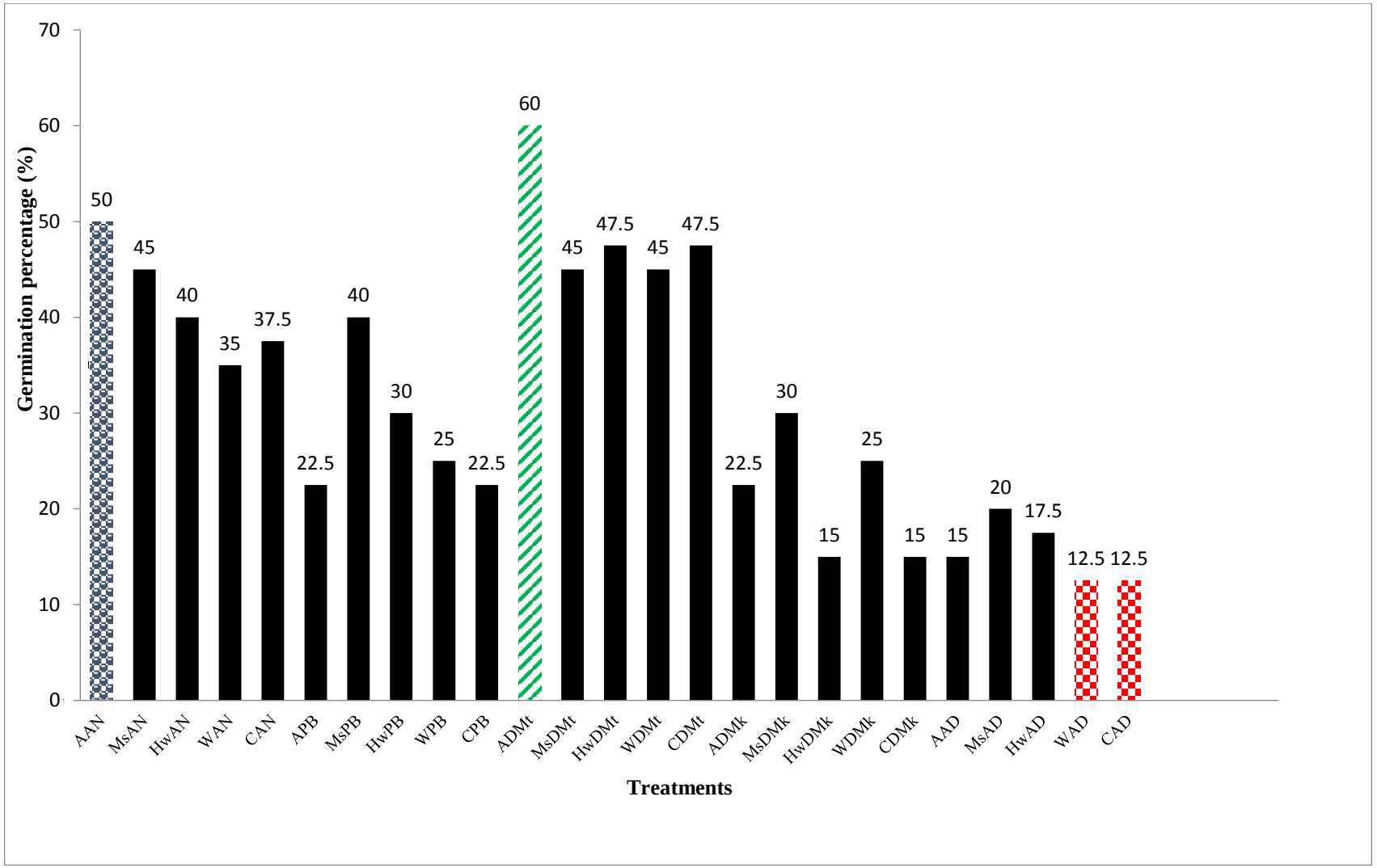

Figure 2: Effect of agroforestry tree seeds and pre- sowing treatments on germination percentage

DISCUSSION

Day of emergence of seedlings was noted to start 6 days after sowing (DAS) in *A. nilotica* seeds soaked in acid (AAN) and *D. microcarpum* seeds soaked in water for 24 hours (WDM^k). This early emergence was due to the impact of acid in eating up the seeds hard coat for cotyledon to break forth and also the imbibition of water by the seeds to soften the cotyledon for easy germination. These findings agree with Olatunji *et al.* (2012) who reported that seeds soaked in acid for a short time enhances seed germination and its germination percentage. However, seeds that stayed longer period in acid may likely have its embryo destroyed and thereby be prevented from germination as confirmed by Aréchiga *et al.* (2011). Meanwhile, the best pre-sowing treatments observed to produce the highest germination percentage were with the *A. nilotica* (AN) seeds soaked in H_2SO_4 for 5 minutes (AAN) and *D. mespiliformis* (DM^t) seeds soaked in H_2SO_4 for 5 minutes (ADM^t) gave the highest (60 % and 50 %) germination percentage respectively. This agrees with Adelani *et al.* (2014)*;* Oyebamiji *et al.* (2014) who reported that seeds used to have high germination percentage when pre-treated with H_2SO_4 acid for short period of time. However, seeds treated with diluted H_2SO_4 acid also induced germination progressively which must have occurred as a result of its effect on the seed coat. This therefore informed that pre-sowing treatments is necessary in seeds germination for an improved growth (Dayamba *et al.*, 2008, 2010 a; Oyebamiji *et al.*, 2014).

The result obtained from the study showed that there was significant effect ($p < 0.05$) of the agroforestry tree seeds on the pre-sowing treatments on plant seedlings height and leaf area respectively. The higher significant values of *A. nilotica* and *A. digitata* on plant heights at 8-10 WAS and leaf areas at 2-10 WAS were as a result of early germination of *A. nilotica* seeds and broadness in terms of area of *A. digitata* leaves.

CONCLUSION

It is concluded that agroforestry tree of *A. nilotica* (AAN) and *D. mespiliformis* (DM^t) seeds soaked in 60 % diluted Tetraoxosulphate (V1) acid (H_2SO_4) for 5 minutes was the best performing seeds among others and the use of (H_2SO_4) acid for 5 minutes was also an effective technique in breaking these savannah seeds dormancy for improved seedling growth in the nursery.

Acknowledgements

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Recommendation

The seeds pre-treated with 60 % diluted H_2SO_4 acid for 5 minutes for an increased germination should be handled with care and caution.

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