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Effects of Pre-Germination Treatments and Sowing Depths on Early Growth of Sesban (Sesbania sesban)

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ABSTRACT

This study was carried out in Federal College of Forestry Mechanization Afaka, Kaduna to investigate means of enhancing the germination of Sesbania sesban seeds which has a very low germination rate under normal conditions. The seeds of S. sesban were soaked in water temperatures of 27^{0}C, 50^{0}C, 73^{0}C and 96^{0}C and sowing depths of 1, 2, 3, 4cm. The second experiments assessed the effect of sulphuric acid treatment duration and volume on the germination of S. sesban. Results showed that germination percentage values of S. sesban seeds ranged from 29.19 to 50.83% at various water temperatures. Germination percentage values of S. sesban seeds ranged from 34.17% to 41.67% at various sowing depths. Germination percentage values ranged from 26.67% to 30%, 30% to 46.67%, 30% to 33.33% and 46.67% to 60% for S. sesban seeds soaked in 27^{0}C, 50^{0}C, 73^{0}C and 96^{0}C water temperatures at various sowing depths respectively. Highest significant (P<0.05) value of 50.83% was recorded for S. sesban seeds soaked in 96^{0}C water temperature. Highest value of 41.61% was recorded for of S. sesban seeds sown at 1cm depth. The result of interactive effect showed the highest values of 60% for S. sesban seeds soaked in 96^{0}C water temperatures and sown at 1cm depth. Germination percentage of S. sesban seeds treated for 30 minutes in 98% concentration of sulphuric acid (90%) was significantly (P<0.05) higher than those of 10 minutes (87.78%) and 60 minutes (83.33%). Germination percentage values of S. sesban soaked in 20ml (90%) and 50ml (90%) were significantly (P<0.05) higher than that of 30ml (81.11%). The result of interactive effect of treatment duration and volume of acid on the germination of S. sesban seeds showed that germination percentage of S. sesban seeds soaked in 20ml (100%), 50 ml (90%) and 30ml (80%) of sulphuric acid for 30minutes were significantly (P<0.05) higher than one and other.

Keywords: Sulphuric acid, Germination, Temperature of water, Volume of acid.

INTRODUCTION

The species, *Sesbania sesban* (L) Merril belongs to the sub-family Papillonoideae, family leguminosae (Pandhare *et al.,* 2011, Gupta *et al*., 2011). The greatest species diversity occurs in Africa. *Sesbania sesban* is known by different vernacular names such as rivier boontjie (Afrikaans); girangire (Amharic) and sesban (Arabic) (Orwa *et al*., 2009; Pravin *et al.,* 2012). *Sesbania sesban* (L) Merril is an extremely versatile plant which makes significant contribution to the attainment of rural household food security through its contribution to increased food production, ethno medicinal and livestock feed. Preliminary phyto chemical screening revealed the presence of several chemical compounds such as triterpenoids, carbohydrates, vitamins, amino acids, proteins, tannins, saponins glycosides and steroids (Pravin Gomase *et al.,* 2012).

In addition, it plays vital roles in weed control, phyto remediation, anti-inflammation and anti-oxidant effect, abortion and anti-fertility agent, antimicrobial activity, firewood source, livestock feed and pasture improvement, green manure, mosquito repellant, live support and schistosoma control (Orwa *et al*., 2009; Pravin Gomase *et al.,* 2012). It is an agroforestry tree species of immense potentials. ICRAF (1997) defined agroforestry as a dynamics ecologically based natural resources management system that through the integration of trees on farm and in the agricultural landscape diversifies and sustain production of increased socio-economic and environmental users at all level. Agroforestry systems offer increased productive, socio economics, medicinal, industrial and ecological benefits compared to conventional agricultural as well as forest production methods (Adelani *et al*., 2013).

S. sesban has been used in experimental alley cropping systems to provide mulch and green leaf manure to intercrops (Pravin Gomase *et al.,* 2012). *S.sesban* is commonly used in alley cropping to restore soil fertility. Some of wood species recommended for soil restoration in alley cropping are *Leucaena leucocephala, Gliricidia sepium, Calliandra calothyrsus, Sesbania grandiflora, Alhorea cordifolia, and Sesbania sesban* (Aiyeloja *et al.,* 2000; Zerihum and Getachew, 2005). Most of the species are leguminous plants, thus they are capable of fixing atmospheric nitrogen, which is so vital for soil fertility restoration *(*Aiyeloja *et al.,* 2000). Alley cropping which is one of the agroforestry practices is also known as hedgerow-intercropping or boarder boundary planting. Alley cropping can be defined as a spatial approach to agroforestry in which agricultural crops are planted in alleys between multiple hedge-rows of nutrient recycling tree or shrubs. In alley cropping, the woody shrubs are kept pruned throughout the cropping season to control shade and above-ground competition as well as to produce fodder, green manure or mulch materials for the benefits of livestock associated crops or soil fertility. In spite of these enormous benefit of *S. sesban*, dearth of quantified information on pre-sowing treatments and factors affecting germination as sowing depth limited the domestication of this species. This necessitates research into pre-sowing treatments and sowing depth to increase the regeneration rate of this species, and equally to increasingly have more of its ample potential for

Nigerians.

MATERIAL AND METHODS

Experimental Site

The research was conducted in the nursery of the Federal College of Forestry Mechanization, Afaka, Kaduna. The College is located in the Northern Guinea Savannah ecological zones of Nigeria. The Garmin GPS 72 model was used to determine latitude 10^0 35^1 and 10^0 34^1 and longitude 7^0 21^1 and 7^0 20^1. The vegetation is open woodland with tall broad leave trees, usually with small holes and broad leaves *(*Otegbeye *et al.,* 2001).

Fruits Collection and Materials

The fruits of *S. sesban* were sourced from the mother tree at the Federal University of Agriculture Abeokuta, Nigeria. The seeds were extracted from the fruits and air dried. The viability of the randomly selected seed samples was assessed with the cutting method (Schmidt, 2000). The river sand of 2mm diameter was collected from the floor of the dam at the Federal College of Forestry Mechanization, Afaka, Kaduna and sterilized at 160^0C for 24hours(Adelani *et al.*, 2014b). Polypots of 20x5x5cm3 were filled with the sterilized sand in the nursery (Adelani *et al.,* 2014b).

Experimental Procedure

Experiment 1: Effect of different water temperatures and sowing depths on seed germination.

To investigate the effects of different water temperatures and sowing depths on the germination of the *Sesbania sesban* seeds, four water temperatures (27^0C, 50^0C, 73^0C and 96^0C) and four sowing depths (1, 2, 3 and 4cm) were involved. The water at room temperature (27^0C) served as the control. Thirty seeds were soaked in 27^0C, 50^0C, 73^0C and 96^0C water temperatures for 10 minutes. The seeds were removed from the water, washed with distilled water and air dried before they were sown in 1, 2, 3 and 4cm depth of sterilized sand in 20x5x5cm3 poly pots (Adelani *et al.,* 2014b).

Experiment 2: Effect of treatment duration and volumes of acid on the seed germination

To investigate the effect treatment duration and volumes of acid on the germination of *Sesbania sesban,* 270 seeds of *Sesbania sesban* extracted from their fruits were soaked for 10, 30 and 60 minutes in 20ml, 30ml and 50ml of 98% concentrated sulphuric acid. The seeds were removed and washed and air dried. Thirty seeds from each volume of acid were planted in 4cm depth of sterilized river sand (Adelani *et al.,* 2014a) in 20x5x5cm3 poly pots to test for germination (Adelani *et al.*, 2014b).

Data analysis

The germination count data was collected on the effects of pre-sowing treatments and sowing depths and was converted to percentage germination before subjecting to one way analysis of variance (ANOVA) using SAS (2003) software. Data collected was not transformed by arc sin transformation that is appropriate transformation for this experiment, because nearly all the values in the data lie between 30-70% (Akindele, 2004) and above. Comparisons of significant means were accomplished using Fischer's Least Significant Difference LSD at 5% level of significance. Germination percentage was recorded after plumule development. Germination count was recorded after the emergence of the plumule. Germination count was converted to germination percentage which was obtained as the number of seeds germinated divided by the total number of seeds planted and multiplied by 100.

RESULTS AND DISCUSSION

Effects of water temperatures and sowing depths on the germination of S. Sesban seeds

The results of the effect of water temperatures and sowing depths on the germination of *S. sesban* seeds are presented on Table.1. Mean germination percentage values of 29.19%, 38.33%, 31.67% and 50.83% were recorded for seeds of *S.sesban* soaked in 27^0C, 50^0C, 73^0C and 96^0C water temperatures respectively. Mean germination percentage values of 41.67%, 34.17%, 35% and 39.17% were recorded for 1cm, 2cm, 3cm and 4cm sowing depths respectively. The highest germination percentage value of 50.83% that was significantly ($P<0.05$) higher than others was recorded for seeds soaked in 96^0C water temperature. It can be deduced that the seeds of *S. sesban* require high water temperature. This is an indication that very high temperature was enough to break its hard seed coat so as to permit imbibitions as well as germination. Soaking seeds of *S. sesban* in hot water 70^0C for 10minutes increased the germination rate by approximately 20% compare to other treatments (Troug and Hans, 2007). Germination percentage values that ranged from 39.03% to 65.1% were recorded for *Balanites aegyptiaca* seeds treated with hot water of 70^0C for 24hours (Nour-El-Din, 2010). Contrary to this result, Adelani *et al.* (2014a) reported the highest germination percentage value of 67.5% for seeds of *Tamarindus indica* that were soaked in 27^0C water temperature which is the lowest water temperature used in this study.

Table 1: Effect of water temperatures and sowing depths on the germination of S. sesban seeds

Temperatures of water (^{0}C)	Percentage Germination (%)	Depths of Sowing of Seeds (cm)	Percentage Germination (%)
27	29.17^b	1	41.67^a
50	35.33^b	2	34.17^a
73	31.67^b	3	35.00^a
96	50.83^a	4	39.17^a
SE±	3.86	SE±	3.86

*Means on the same column having different superscripts are significantly different ($P<0.05$) vertically.

The results of interactive effects of water temperatures and sowing depths on the germination of *S. Sesban* seeds are represented on Table 2. Germination percentage values of 30%, 26.67%, 30% and 30% were recorded for seeds of *S. sesban* soaked in 27^{0}C water temperatures and sown at 1, 2, 3 and 4cm soil depth respectively. Germination percentage values of 46.67%, 30%, 33.33% and 43.33% were recorded for *S. sesban* seeds soaked in 50^{0}C water temperature and sown at the respective depths of 1, 2, 3 and 4cm. Germination percentage values ranged from 30% to 33.33% at various sowing depths for *S. sesban* seeds soaked in 73^{0}C water temperature, while for seeds of the species soaked in 96^{0}C water temperature, germination percentage values ranged from 46.67% to 60% at various sowing depths (Table 2). The highest germination percentage value of 60% was recorded in *S. sesban* seed that were soaked in 96^{0}C water temperature and sown at 1cm soil depth (Table 2). Thus, the results imply that *S. sesban* seeds require relatively high water temperature and shallow sowing for effective germination. Direct sowing of scarified seeds of *Lupinus campestris* at surface or at 3cm depth resulted in a range of 50-64% of germination under field condition (Gutierrez *et al.*, 2010). On the other hand, Hartmann *et al.* (1990) stated that sowing depth for forest tree seeds should generally be equivalent to the diameter or width length of that seeds. This is also in contrast to the highest germination percentage value of 17.08% that was reported for *Ricinodendron hendelotii seeds* sown at 16.5 cm depth (Anjah *et al*; 2013). Depth at which seeds are sown in the soil affects the germination of seeds and subsequently seedling growth (Bockus and Sholberg, 1996). Sowing depth affected the seed germination among the *Lupinus* tree species (Gutierrez et al., 2010).

Table 2: Interactive effect of water temperatures and sowing depths on the germination of S. sesban seeds

Temperatures (^{0}C)	Depths(cm)			
	1	2	3	4
27	30.00^a	26.67^a	30.00^a	30.00^a
50	46.67^a	30.00^a	33.33^a	43.33^a
73	30.00^a	33.33^a	30.00^a	33.33^a
96	60.00^a	46.70^a	46.67^a	50.00^a
SE±	7.728	7.728	7.728	7.728

*Means on the same row having different superscripts are significantly different (P<0.05) horizontally.

The effects of treatment duration and volume of acid on the germination of this species are presented in Table 3. Seeds of *S. sesban* that were treated with acid for 10, 30 and 60minutes of application had germination percentage values of 87.78%, 90%, 83.33% respectively, while seeds of the species soaked in 20, 30 and 50 ml of acid had mean germination percentage values of 90%, 81.11% and 90% respectively (Table 3). The highest germination percentage value of 90% that was significantly (P<0.05) higher than others was recorded for *S. sesban* seeds treated in acid for 30 minutes. The result is an indication that *S. sesban* seeds prefer moderate soaking time in acid which is enough to break the hard seed coat and enable germination of the seeds. Duration of exposure of seeds of forest trees to acid is critical and need to be quantified for each species since seeds exposed for a long period can be damaged easily (Schmidt, 2000). This agrees with the current study where soaking of seeds of *Terminalia sericea* in sulphuric acid for 3 and 4 hours gave 0% germination (Michael *et al.,* 2008). This fact was also confirmed by McDonald *et al.* (2002) on *Tamarindus indica* and *Prosopis africana* where immersion of seeds in sulphuric acid for more than 60 minutes increased the number of damaged seeds hence tremendously reducing germination percentages.

Table 3: Effect of treatment duration and volumes of acid on the germination of S. sesban seeds

Duration (Minutes)	Percentage Germination (%)	Volume of Acid (ml)	Percentage Germination (%)
10	87.78^b	20	90.00^a
30	90.00^a	30	81.11^b
60	83.33^c	50	90.00^a
SE±	0.642	SE±	1.111

*Means on the same column having different superscripts are significantly different (P<0.05) vertically.

On the other hand, seeds of *Acacia auriculiformis* that were soaked in H_2SO_4 for 10 minutes, recorded the best germination percentage of 96% followed by those seeds treated with H_2SO_4 for 5 minutes (92%) and the least among the sulphuric treatment was 76% (2 minutes) followed by control treatments (42%) (Olatunji *et al.*, 2012). In the same vein, Aduradola and Shinkafi (2003) reported enhanced seed germination with increasing treatment time for *Tamarindus indica*. Moreover, germination percentages of seeds of *Adansonia digitata* improved with increased period of soaking in the acid up to 3 hours (Adio *et al.,* 2006). Furthermore, Al-Menaie *et al.* (2010) reported that *Cassia siamea* scarified with H_2SO_4 at 50^{0}C for 24 hours recorded the highest germination percentage of 72 and *Cassia roxburghii* treated with H_2SO_4 at 21^{0}C for 48 hours observed the highest germination percentage of 28 during daily observations for two months after sowing. The variations in appropriate time of presowing for each species have been reported by various researchers. In this respect, Olmez (2011) indicated that the pretreatment by submersion in sulphuric acid for 1 minute should be used to overcome dormancy of the *Hippohae rhamnoides* seeds. Similarly, acid treatment at 98% concentration for seeds of *Adansonia digitata* soaked for 1 hour showed significant effect on germination (Falemara *et al.,* 2013).

In agreement with other recent researchers, Gupta *et al.* (1997) observed that pre-treated the *Glycyrrhiza glabra* seeds with concentrated H_2SO_4 for five minutes improved the germination. Also, Bhuse *et al.* (2001) reported that treating the seeds of *Cassia augustifolia* with H_2SO_4 for 12 minutes gave highest germination of 72 percent. The percentage germination of the seeds of *Acacia senegal* treated with 50% concentration of sulphuric for 15 minutes was significantly higher (89%) than those for 10 minutes (83%) and 5 minutes (70%)(Sikiratu, 2014). Sikiratu 2014 further stated that the seeds of *Acacia senegal* treated with 50%

concentration of hydrochloric acid for 15 minutes gave a significantly higher germination percentage (65%) than for 10 minutes (45%) and 5 minutes (28%). Furthermore, Mustapha (2001) observed that seed immersion in sulphuric acid for 10 minutes produced seedlings with high vigour. Also, Pandey *et al*. (2000) reported similar observation in chemical stimulation of seed germination in *Aconitum heterophyllum*. Various investigators had reported improved seed germination response following chemical scarification pretreatments (Pendly, 2001; Olvera-lavrillo *et al.,* 2003; Ajiboye *et al.,* 2009).

Highest value of 94.17% was recorded for the seeds of *Acacia auriculiformis* that were treated with 98% concentration of sulphuric acid for 10 seconds (Adelani *et al.,* 2014c).This result is corroborated with the report of Adelani *et al*. (2014a) who recorded the highest germination percentage value of 93.33% for 0.3g of seeds of *Tamarindus indica* that were treated in 98% concentration of sulphuric acid for 30 minutes. Furthermore, Karaguzel *et al.* (2004) reported that scarifying the seeds of *Lupinus varius* in concentrated sulfuric acid (36%) increased inhibition, improved germination, and seedling vigor index and growth characteristics of it, as duration of scarification increased up to 16h at 24^{0}C. Seeds of *Tetracarpidium conophorun* treated for 5minutes with 98% concentrated sulphuric acid had the highest percentage germination of 66% (Ehiagbanare and Onyibe, 2007). The highest germination percentage of 80% was recorded when seeds of *Parkia biglobosa* were treated with 98% sulphuric acid for 60 minutes (Isah, 2012). The reason for this could be partly adduced to the fact that 98% sulphuric acid was able to scarify seed coats through decreasing the inhibitory effect of seed coats and softening of the seed coat that accelerated water uptake and resulted in earlier and faster germination (Isah, 2012).

The results of interactive effects of treatment duration and volume of acid on the germination of *S. sesban* are presented on Table 4. The seeds that were soaked in 20, 30 and 50 ml of acid for 10 minutes had germination percentage values of 90%, 83.33% and 90% respectively. Germination percentage values of 100%, 80% and 90% were recorded for *S. sesban* seeds treated for 30 minutes in 20, 30 and 50 ml of acid. Germination percentage values of *S. sesban* seeds soaked in 20, 30 and 50 ml of sulphuric acid for 60 minutes were 80%, 80% and 90%. Germination percentage that was recorded for *S.sesban* seeds soaked in 20ml (100%); 30ml(80%) and 50ml (90%) of 98% concentrated sulphuric acid for 30 minutes was significantly (P<0.05) higher than one and other. The highest germination percentage of 100% was recorded for the seeds soaked in 20ml of 98% concentrated sulphuric acid for 30 minutes. This is an indication that best germination could be achieved at low volume of acid and under moderate treatment duration. Adelani *et al*. (2014a) reported that sulphuric acid enhanced germination in *T. indica* seeds when soaked for appropriate time of 30 minutes. Mackay *et al*. (2001) observed that non-scarified *Lupinus arboreus* seeds had germination lower than 5% and with immersion in H_2S0_4 for 0-60 minutes increased germination percentage (80%). Acosta-Percastegui and Rodriguez-Trejo (2005) reported that seeds of *Lupinus montanus* from Mexico scarified with concentrated H_2SO_4 in immersion of 15minutes resulted in 100% of germination.

Table 4: Interactive effect of treatment duration and volumes of acid on the germination of S. Sesban seeds

Treatment duration (min)	Volume of Acid (ml)		
	20	30	50
10	90.00^a	83.33^b	90.00^a
30	100.00^a	80.00^b	90.00^{ab}
60	80.00^b	80.00^b	90.00^a
SE±	0.907	0.707	0.907

*Means on the same row having different superscripts are significantly different (P<0.05) horizontally.

CONCLUSION

This investigation conducted on methods of improving germination in *S. sesban* seeds revealed that soaking the seeds of the species in highest water temperatures (96^{0}C) enhanced germination. The highest germination value of 90% was recorded for *S. sesban* seeds treated with sulphuric acid for 30 minutes, indicating that this duration is the best for treating the species. The highest germination percentage value of 100% was recorded for *S. sesban* seeds soaked in 20ml of concentration of sulphuric acid (98%) for 30minutes. Thus the seeds should be treated in 20ml of sulphuric acid for 30 minutes.

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