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Full Length Research Paper

Methods of braking seed dormancy on germination and early seedling growth of African locust bean (*Parkia biglobosa*) (JACQ.) Benth

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An experiment was conducted under a net house in the department of Crop, Soil and Pest Management of the Federal University of Technology Akure. This was to investigate the most effective pre-sowing treatments to break seed dormancy, to stimulate seed germination and to identify morphological traits for the assessment of *Parkia biglobosa* seedling vigour. Matured seeds of *P. biglobosa* were collected from farmers in Akoko in Southwest Nigeria, dried at room temperature and tested for viability by floatation. The seeds were then subjected to pre-treatment that includes: soaking in 100% sulphuric acid for one minute, mechanical scarification with sandpaper, soaking in boiling water for two minutes, soaking in cold water (at room temperature) for 24 h. At 12 weeks, the seedlings growth parameters were assessed: seedling height, leaf production, and diameter and branch production. Result obtained shows that all the treatments except soaking in boiling water improved seed germination and reduced Mean Germination Time (MGT). The mechanical scarification appeared to be the most effective method of pre-treatment having the highest germination percentage 91.7%. Plant height appeared to be the strongest morphological trait to identify vigorous seedlings of *P. biglobosa.* Higher value of plant heights, number of leaves, branches and stem girth were recorded on the seedlings treated with scarification while hot water treated seeds performed low. This study revealed that seeds mechanically scarified improved seed germination and seedling growth. It is therefore recommended that mechanical scarification of the seeds of *P. biglobosa* may be effective for breaking dormancy and improving the seedling vigour which can enhance the domestication and cultivation of these valuable seeds in the environment.

Key words: *Parkia biglobosa*, seed pre-treatment, mean germination time, seedling vigour index, scarification, morphological traits.

INTRODUCTION

The “locust bean”, *Parkia biglobosa* (Jacq.) Benth, ccurs in a diversity of agro-ecological zones, ranging from tropical forests with high rainfall to arid zones, from the lower Sudan Savanna Southwards to the derived Savanna and the lowland forest where mean annual rainfall may be less than 400 mm (Gbadamosi, 2005). The tree has the capacity to withstand drought conditions because of its deep tap root system and an ability to restrict transpiration. The “locust bean” tree is an important food tree and plays a very vital role in the rural economics of West African countries; virtually every part of the species is of value as food or fodder (Gbadamosi, 2002). The leaves are rich in nitrogen and used as manure. The yellow pulp surrounding the seed is edible in many forms and the seeds are made into condiments (iru), used extensively as flavouring and additives to soups and stews. The seed contain 54% fat and 30% protein in addition to vitamins and minerals such as calcium, potassium and phosphorus (Aliero, 2004). The branches are sometimes lopped for firewood, the pods and roots are used as sponges and as strings for musical instruments. The tree also serves as wind break and provides shade.

The tree is however, propagated mostly by seeds which

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Table 1. Germination percentage of the treated seeds.

Treatment	% mean at 7 DAS	% mean at 14 DAS	% mean at 21 DAS	% mean at 28 DAS	% mean at 35 DAS
Concentrated H_2SO_4 (A)	41.7^b	91.7^a	100^a	100^a	100^a
Mechanical scarification (B)	83.3^a	91.7^a	91.7^a	91.7^a	91.7^a
Hot water (C)	0^c	8.3^b	25^b	25^b	25^b
Coldwater (D)	0^c	50^{ab}	75^a	83.3^a	100^a
Control (E)	0^c	50^{ab}	91.7^a	91.7^a	91.7^a

Mean values with the same letters are not significantly different from each other.

has commercial value and highly sought by people for food. Hall et al. (1997) discovered that *P. biglobosa* possesses an exogenous dormancy in which the hard seed coat prevents its germination. Due to poor seed germination there is rapid depletion of the natural population of the tree. The numerous importance of the tree has however, called for its domestication and conservation and this can be achieved when there is an alternative means of breaking the dormancy characteristics posed by the seed of *P. biglobosa* the study aimed to assess the most effective pre-sowing treatment methods and its effect on the seedling growth.

MATERIALS AND METHODS

This experiment was conducted during the wet season (June) 2008 at the screen house of the Crop, Soil and Pest Management Department, Federal University of Technology, Akure, Ondo-State, Nigeria. The topsoil used was obtained from the Crop Type Museum in the department. The materials used for the experiment were polypots filled with the top soil in the screen house. Matured seeds of *P. biglobosa* were collected from the natural forest of Oka-Akoko, Akoko South West Local Government area of Ondo State Nigeria. The seeds were washed, sun dried and stored in trays for weeks in a cool dry place. The stored seeds of *P. biglobosa* were subjected to different treatments, which includes:

1. Acid treatment: The seeds were randomly selected and soaked in 100% concentrated H_2S0_4 for one minute and immediately air dried before sowing according to Aleiro (2004).
2. The mechanical treatment: The selected seeds were rubbed against the rough surface of the sand paper until slight exposure of the cotyledon of the seed.
3. Hot water treatment: The seeds treated were soaked in 100°C hot water for about two minutes and air-dried before sowing according to Aleiro (2004).
4. Cold water treatment: The seeds were soaked overnight for 24 h in cold water at room temperature and air-dried before sowing.
5. The seeds were sown without any treatment (as control)

The experiment was laid out in a completely randomized design and replicated three times. The seeds were watered at 3-5 days interval and weeding was done manually by hand pulling.

Data collection

Data were collected on the following parameters:

Germination rate (%): This was evaluated as the proportion of germinated seed expressed as germination percentage of the total number of seeds sown (ISTA, 1985) at 7, 14, 21, 28 and 35 day after sowing (DAS) that is,

(No of germinated seed / No of planted seed) x 100

Seedling assessment was carried out at weekly intervals beginning from the 24 DAS. Parameters assessed include: seedling height (using meter rule), numbers of leaves, numbers of branches and stem girth (using veneer caliper). The numbers of branches and numbers of leaves were counted manually. The data collected in percentage were transformed using the arc sin formula and then analyzed using the SPSS data package and the Duncan Multiple Range Test (DMRT) was used to separate the means found to differ significantly. Graphs were drawn using excel package.

RESULTS

The different treatments showed substantial variation in germination percentage at seven days after sowing (DAS) (Table 1). Seeds mechanically scarified with sandpaper had germination of 83.3% followed by seeds treated with concentrated acid with 41.7%, while seeds treated with hot water, cold water and the control had no germination at 7 days after sowing (DAS) (Table 1). By the 14th day after sowing, seeds treated with 100% concentrated H_2SO_4 and those mechanically scarified with sandpaper had 91.7% germination while seeds treated with cold water and the control had 50% germination and those treated with hot water treatment had 8.3% germination (Table 1). At 21 (DAS) seeds treated with concentration H_2SO_4 had 100% germination while those scarified with sandpaper and the control both had 91.7%. Seed treated with cold water had 75% germination and those treated with hot water had 25% germination. At 28 days after sowing (DAS) seeds treated with concentrated H_2SO_4 had 100% germination, those mechanically scarified and the control had 91.7%, while

Table 2. Mean values for seedling characteristics at (21 DAS).

Treatments	Plant height (cm)	Number of leaves/plant	Stem girth (cm)	Number of branched/plt
A	15.26[a]	9.25[ab]	0.1[a]	2[a]
B	14.28[a]	10.3[a]	0.1[a]	2[ab]
C	4.36[a]	4.2[d]	0.5[a]	1[b]
D	8.12[c]	7.1[c]	0.1[a]	1[b]
E	11.41[b]	8.2[bc]	0.1[a]	1[b]

Mean values with the same letters are not significantly different from each other.

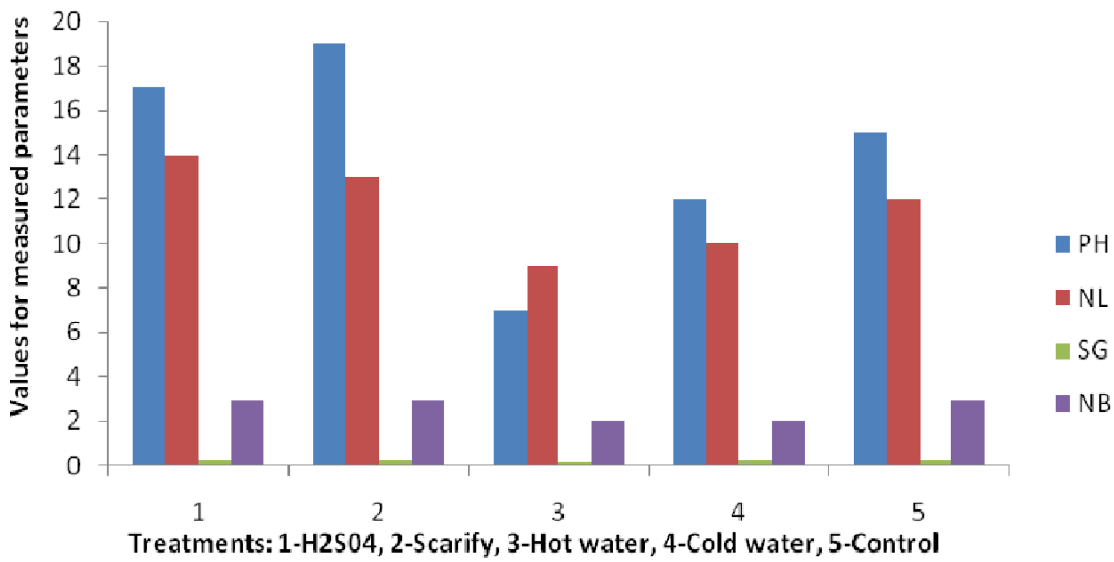

Figure 1.Seedlings growth parameters at 30 days after planting**.**

the cold water treated seeds had 83.3% and seeds treated with hot water had 25% germination. At 35 DAS, there was no change in seed germination over that recorded on the 28th day after sowing for the seeds subjected to the different pre-treatments (Table 1).

Seedling characteristics

The mean heights of seedlings from each treatment shown in Table 2 were significantly different from each other except for treatment A, B and C which had no significant difference. The mean values for the number of leaves in treatment A and B were not significantly different. Likewise the number of leaves for seedlings under treatment A and E both differed significantly from that of the seedlings from treatment C. There were no significant differences between the number of leaves in treatment D and E in (Table 2). The stem girth of all seedlings in (Table 2) showed no significant difference among all the treatments. At two weeks after sowing, the plant height of seedlings from all the treatments varied amongst each other in with seedlings from scarified seeds attained highest height (Figure 1). The numbers of leaves were more on the seedlings from H_2SO_4 treated seeds. The stem-girth of seedlings from treatments was the same but the number of branches varied from one treatment to the others with seedlings from seed treated with H_2SO_4, scarification and control higher than those treated with hot water and cold water respectively.

In Figure 2, plant height of seedlings from seeds treated with H_2SO_4 and scarification recorded same height which was better than that treated with cold water. Lowest numbers of leaves was recorded on seedlings from hot water treated seeds. The stem-girth of seedlings in all treatment remains relatively the same at the end of 3 weeks. However, the numbers of branches for the seedlings from control and hot water treated seeds was similar but higher than the number obtained from cold water treated seeds. From Figure 3, plant height obtained from scarified seeds was better than all other treatments. Shortest plant height was recorded on seedlings treated with hot water. The numbers of leaves was also highest in the seedlings from seeds scarified while cold water

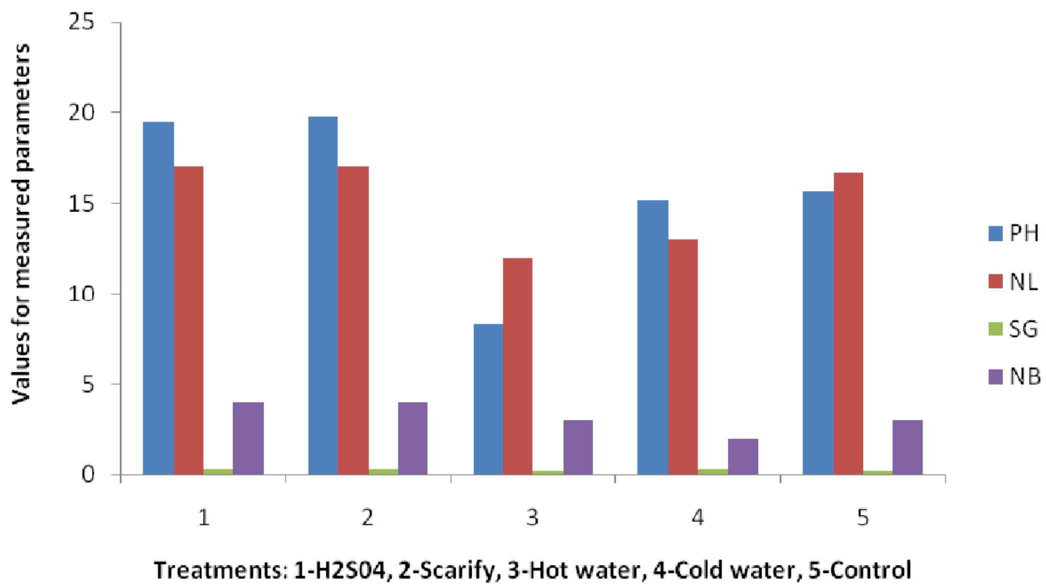

Figure 2.Seedlings growth parameters at 37 days after planting.

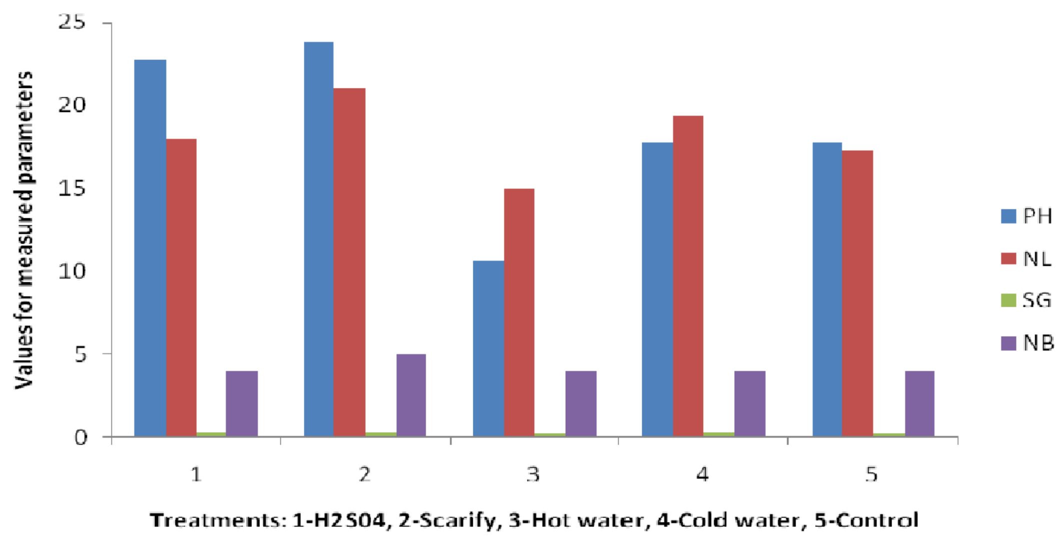

Figure 3. Seedlings growth parameters at 44 days after planting.

treated seeds also performed better than that treated with H_2SO_4. The stem-girth for all the seedlings does not differ from each other up to the end of 4th week. At 55 days after sowing, it was observed that highest plant heights were recorded on seedlings germinated from scarified, H_2SO4, and cold water treated seeds respectively while the lowest height was recorded on seeds treated with hot water (Figure 4). The numbers of leaves recorded also followed the same trend as obtained for plant height. Numbers of branches obtained from seedlings from all treatments were the same except for that obtained from scarified seeds which were higher than the others. The stem-girth of seedlings from seeds treated by scarification remains the biggest at the end of the 5th week while others showed similar result.

DISCUSSION

The differences observed in the germination percentage of seeds subjected to the different treatments (Table 1) implies a significant impact of the various pre-treatments on breaking the seed dormancy. The mechanical scarification by sandpaper had the highest speed of

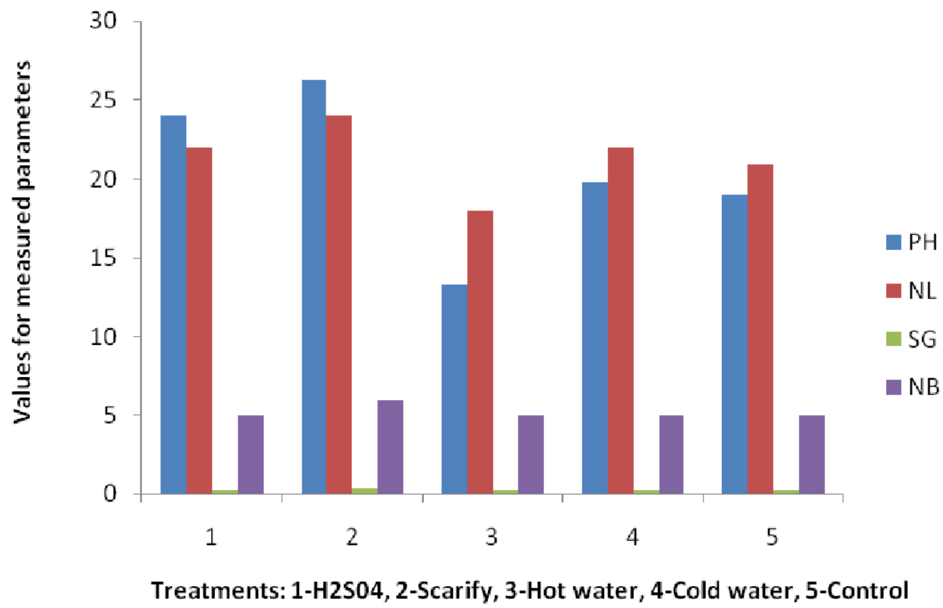

Figure 4. Seedlings growth parameters at 51 days after planting.

germination, which agrees with the report of Tomlinson et al. (2000) that seed dormancy resulting from an impermeable seed coat may be overcome by peeling off the coat. Germination must have occurred as a result of the partial exposure of the cotyledons of the seeds which permits the process of hydrolysis whereby hormones such as auxins and ethylene which could increase nucleic acid metabolism and protein synthesis are released (Uwaegbute, 1996). The seeds treated with concentrated H_2SO_4 also induced germination progressively which must have occurred as a result of its effect on the seed coat. It can be inferred from the result that dormancy of the seeds of *P. biglobosa* were probably associated with the seeds coat, since the treatment that induce germination were those that can effect disruption of the seed coat. Immersion of seed in highest concentrated sulphuric acid disrupts the seed coat. Aleiro (2004) concluded that 98% concentrated sulphuric acid gave the highest percentage of germination for *P. biglobosa* and within the shortest period as compared to 90, 70 and 50%, which indicates that the more rapidly the seed coat is ruptured the faster the rate of germination.

The seeds of *P. biglobosa* treated with hot water showed the least performance in germination percentage as a result of its effect on the seed coat that must have ruptured or damaged the seeds embryo. Sudden dip of dry seed in boiling water may lead to the rupture of the seed coat allowing water to permeate the tissues causing physiological changes and subsequent germination of the embryo (Agboola and Etejere, 1991; Agboola ad Adedire, 1998; Sabongari, 2001) but can as well be detrimental when in excess leading to the death of the seeds. The seeds of *P. biglobosa* treated with cold water for 24 h increased in germination percentage with time and at 35 DAS had attained 100% germination. The effect of this treatment is similar with the placing of seeds in a beaker containing tap water for 24 h (Aleiro, 2004). The seeds under control experiment gave similarly high germination but seeds took a longer period to germinate. The variations observed among the seedling growth characteristics such as plant height, stem-girth, numbers of leaves and numbers of branches can be attributed to the effect of the treatments the seeds were subjected to. Seedlings with the highest plant height, stem-girth, number of leaves and number of branches may be as a result of the early germination by the seedlings induced by the method of dormancy breakage. Significant relationships were observed between seed morphological characteristics and seedling vigour in *Terminalia invorensi* A. Chev (Oni, 1991). These parameters may be very useful in the promotion of rapid production of vigorous seedlings for nursery establishment or species for plantation establishment. Based on the result of this experiment in Table 2, Figures 1, 2, 3 and 4 seedlings from seeds that were mechanically scarified with sandpaper had performed best in comparison with time of germination and highest mean values for seedlings growth characteristics. The seedlings from seed treated with concentrated H_2SO_4 and cold water treatment differed significantly in terms of time of germination, plant height and number of branches (Figure 4). Furthermore, seeds treated with hot water showed the least performance both in germination percentage and seedling growth characteristics compared to the seedling under control experiment. Aliero (2004) reported that seed germination of *P. biglobosa* decreases when seeds were soaked in hot water for more than 4 s, suggesting that embryo may get destroyed on contact with boiling water for a prolonged period. However, it can be deduced from the experiment that the mechanically scarified seeds using the sandpaper had the best performance while the least performed treatment is the hot water treatment.

CONCLUSION AND RECOMMENDATION

The result from the study showed that seeds mechanically scarified improved seed germination and seedling growth. It is therefore recommended that mechanical scarification of the seeds of *P. biglobosa* may be effective for breaking dormancy and improving the seedling vigour which can enhance the domestication and cultivation of these valuable seeds in the environment.

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