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Berchemia discolour response to different scarification methods

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We assessed the response of *Berchemiadiscolor* to different scarification methods at the National Forestry Commission in Harare in 2013. Five treatments: soaking seed in sulphuric acid, soaking seed in hot water after boiling, nicking using secateurs, and nicking combined with soaking in hot water, and a negative control were used. Data were analyzed using GenStat Version 13 of 2011. Treating seeds with acid and nicking improved germination while seeds in the control treatments had very low germination, as did seeds scarified in hot water. Germination and early seedling vigor were significantly influenced by scarification. Acid scarification can be used as a pre-treatment for *B. discolor* seeds. It is also recommended that growers consider other exogenous factors like media pH and temperature that may affect the germination of *B. discolor* than just breaking dormancy.

Keywords:*B. discolor*, scarification, pre-treatment, germination, growth

Introduction

The cultivation of indigenous and exotic fruits for sub-Saharan Africa's domestic markets can bring increased revenues for smallholders and improve the diets of local consumers (Jamnadass *et al*., 2011). Indigenous fruit trees are particularly used during periods of seasonal food shortages and are often the only available fruit source of high nutrients (Mojeremane and Tshwenyane, 2004). Zimbabweans in drought prone areas like Matebeleland North and South, the Zambezi Valley and the Lowveld make indigenous fruits a reliable source of food in times of hunger. Many families in these areas keep a close watch as harvest times draw near and there is generally a scramble for the fruits when they ripen. The fruits are also served as snacks between meals under normal circumstances (Mithöfer, 2006; The Zimbabwean, April 1st 2012). Most of the indigenous fruit have been commercialized by traders who sell them in towns and cities (Akinifesi *et al.*, 2008). Rural dwellers also try to make a

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living from selling the indigenous fruits locally at schools, growth points and roadside markets. Urban consumer demand of indigenous fruits is on the increase as the price of exotic fruits is continually rising (Dhliwayo *et al*., 2003). Indigenous fruit trees are important traditional sources of nuts, fruits, spices, edible oil and beverages (Okafor, 1985). They are an important source of food, providing an alternative source of nutrition (Muok et al., 2001) and medicine (Adebooye and Opabode, 2004). Indigenous fruits are a rich source of nutrients and also provide food for wild animals. Baobab fruits, for example, provide six times vitamin C compared to an orange and have calcium level higher than that of a cow's milk (Ondachi, 2001). In Zimbabwe, they contribute 6.4% and 5.5% of cash and in-kind income to households living in Murehwa district and Takawira resettlement area respectively (Mithöfer and Waibel, 2003). Examples of the indigenous fruits include *Uapacakirkiana*, *Ziziphusmauritiana*, *Cucumismetuliferus* and *Berchemia discolor*.

Most growers are discouraged from growing *B. discolor* as it takes long to germinate from seed. *B. discolor* seeds have a dormancy mechanism (Mgangamundo, 2001) and are difficult to germinate (Msanga, 1998). In order to improve germination a pre-treatment is necessary. Scarification is one of the popular methods commonly used to break dormancy on such types of seeds. It is any process of scratching, breaking or mechanically altering the seed coat to make it permeable to water and gases (Hamilton, 1999). Scarification can either be done chemically by soaking seed in concentrated acid or mechanically by rubbing seed coats with sand-paper, nicking with a knife poking poles in the seed, filing with a metal file, or cracking gently with a hammer to weaken the seed coat (Evans and Blazich, 2010). Other methods include hot water scarification and use of heat or smoke (Luna *et al.*, 2008). The objectives of this study were to determine the effect of different scarification methods on germination and early seedling vigor of *B. discolor*seeds.

Materials and methods

The experiment was carried out at the National Forestry Commission (NFC) in Highlands (17^{o} 48' 27" South, 31^{o} 5'17" East) Harare, Zimbabwe. The NFC is an area of relatively cold climatic conditions. It is characterized by red soils. The average day and night temperatures are 27^{o}C and 16^{o}Crespectively. The average daily relative humidity and wind speed is 71% and 11kph/7mph respectively. The experimental design used after the scarification process was Completely Randomized Block Design (CRBD). The treatments used in the experiment are presented in Table 1.

Table 1. Treatments used

Treatment	Scarification method
1	Acid soaking
2	Hot water soaking
3	Nicking only
4	Nicking and hot water soaking
5	Control

Certified seed (Tree 1 type or clone) collected in 2013 from Katsoma Village in Buhera was used in the study. Seeds were randomly selected from a pack of clean seed weighing 1 401 kg. The selected sample of 200 seeds was grouped into different categories and placed into 5 labeled khaki envelopes as follows: acid treatment; hot water soaking, nicking only, nicking and hot water soaking and the negative control. Nicking was done using secateurs where the small top pointed part of the seed was removed manually taking care not to injure the embryo. Nursery trays for planting were filled with sandy loam soil. Tap water was left to boiling point (100^{o}C) and then poured into a glass jar. The seeds were placed in the hot water and left for 10 minutes before removing and planting immediately. Battery acid with a concentration of 33 % sulfuric acid was used in the experiment. The acid was carefully poured into another 1.3 litre glass jar. The seeds were placed in the acid for 20 minutes then removed soon after and immediately planted. During the acid and hot water treatments the seed to acid or water ratio was 1:6 parts. A stop timer was used to measure the 10 and 20 minutes soaking times. The soil pH, which was tested at the University of Zimbabwe's Department of Soil Science Laboratory, was 4.7. The nicked seeds as well as the control seeds which did not receive any treatment were planted. The other nicked seeds were soaked in hot water for 10 minutes in the same manner and procedure as the hot water treated seeds then planted. Planting was done at a depth of 1cm. Trays were filled with the soil then 1cm deep holes were made in it using a finger. Seed was then placed and covered with additional soil. The seeds were planted one in a single cell, giving a total of 10 seeds per treatment per block. Planting was done in the greenhouse with regulated temperatures and an average of 28^{o}C. The planted seeds were watered using micro jets or jet sprayers for 15 minutes 3 times daily. Weeding on sight was done occasionally.

Data collection and analysis

Measurements taken were germinated seeds, days to emergence; germination percentages and the stem length and number of leaves per seedling.

Germination was recorded daily for 22 days and the stem length and number of leaves were measured and recorded once after 21days from the day of the first germination. A ruler was used to measure stem length and leaf length. Data were analyzed using GenStat version 13. ANOVA was used to compare the difference between means (scarification methods). For significant differences between the treatment means LSD was used to separate means at 0.05 probability level.

Results and discussions

There was a significant effect of the scarification methods used on the germination of *B. discolor* seeds P<0.05 P=0.004 (Figure 1).

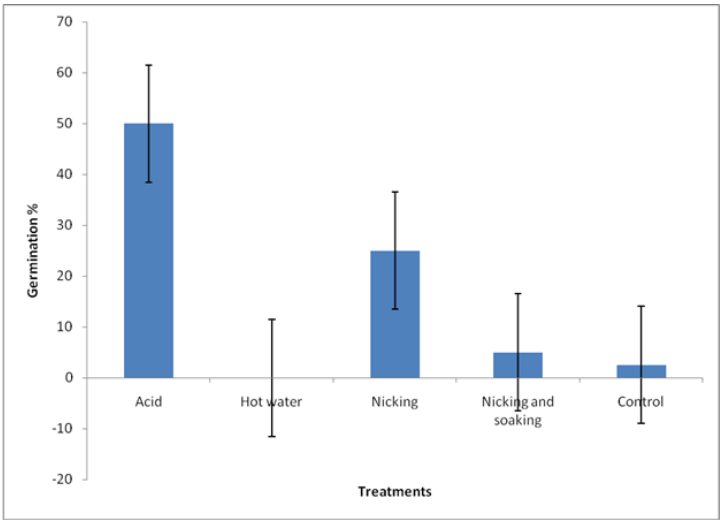

Fig. 1. Effect of scarification methods on the germination of *B. discolor* seeds
Vertical bars represent LSD standard error bars of means.

Acid scarification had the highest germination of 50% followed by nicking 25%. Hot water treatment, nicking combined with hot water soaking and the control did not have a significant difference and had low germination. Removal of both internal and external dormancy of the seed could explain the higher germination of acid treated seeds as compared to other treatments. Seed nicking might have allowed water and gases into the seed enhancing their germination. In the nicking combined with hot water treatment, hot water applied to the nicked seeds might have killed some of the exposed seeds' embryo (Hamilton and Midcap, 1999). Dehgan *et al.* (2003) describe how the immersion of *Lupinusdiffusus* seeds in 90^0C water for 24 hours killed or severely injured them and prevented them from emerging. Hot water treatment

alone might not have been enough to break the seeds' dormancy. The results can be supported by Leif *et al.* (2011) who established that germination of common elderberry seeds that were soaked in hot water was not significantly different from the control treatment which had very low germination. In the same experiment acid treatment improved germination. Sixtus *et al.* (2003) also observed that hot water treatment to *Ulexeuropaeus* seeds was not significantly different from the control seeds. In another experiment by Ibiang *et al.* (2012) sulfuric acid treated *Tetrapleuratetraptera* seeds had the highest germination (90%) and the mechanically scarified seeds had 85% while non scarified seeds had the least germination percentage of 18.3%.

There was a significant effect of scarification method on the days to emergence of *B. discolor* seeds $P<0.05$ $P=0.001$ (Table 2).

Table 2. Effect of scarification methods on the days to germination of *B. discolor* seeds

Scarification	Means
Acid	33.8^{a}
Hot water	0^{c}
Nicking	39^{a}
Nicking combined with soaking	21^{b}
Control	8.5^{c}
CV%	34.80
LSD	12.04
P-value	0.001

Acid scarification and nicking had no significant difference. Acid scarification and nicking had the first emerged seeds 26 days after planting. Hot water scarification and the control had no significant difference and the first seeds from the nicking combined with soaking treatment emerged after 39 days from planting. Acid scarification had the highest number of seeds that germinated earlier. Saied *et al.* (2008) observed that acid and mechanical scarification decreased days to first emergence of *Ziziphusspina-christi* seeds by 2-4 days and 12-10 days to 50% emergence.

There was a significant effect of the scarification methods on the early seedling vigor or characteristics of *B. discolor* seedlings as reflected by stem length and number of leaves. Karaguzel *et al.* (2004) concluded that acid treatments increased imbibitions, germination percentages and improved early seedling growth characteristics of *Lupinus*spp. There was a significant effect of scarification method on the stem length of the *B. discolor* seedlings $P<0.05$ $P=0.001$ (Figure 2).

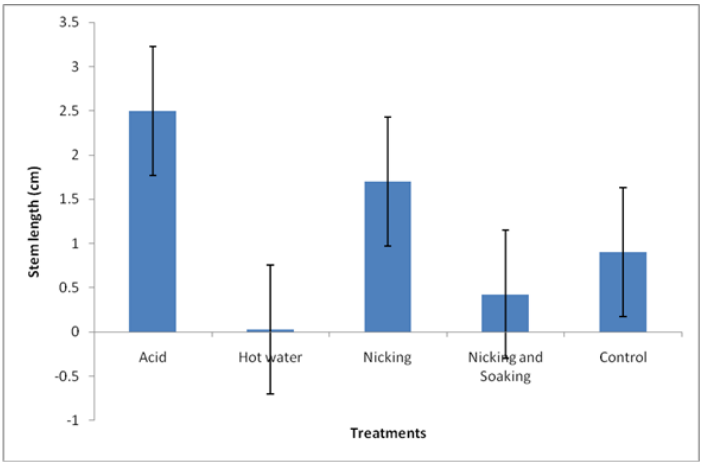

Fig. 2. Effect of scarification methods on the stem length of *B. discolor* seedlings
Vertical bars represent LSD standard error bars of means.

Acid treated seeds had seedlings with the longest stems (average 2.5cm). Acid treatment and nicking were not significantly different. Nicking, nicking combined with soaking and the control were also not significantly different. Hot water scarification was not significantly different from nicking combined with soaking and the control even though the seeds did not germinate. Nasir *et al*. (2001) found that acid scarified almond nut seeds and boiling in water for 15 minutes had higher seedling height than the rest. There was a significant effect of scarification method on the number of leaves of the *B. discolor* seedlings $P<0.05$ $P=0.005$ (Figure 3).

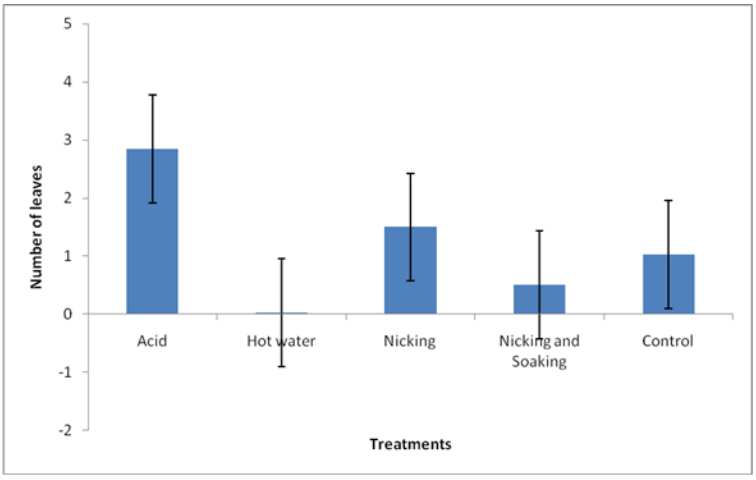

Fig. 3. Effect of scarification methods on the number of leaves of *B. discolor* seedlings
Vertical bars represent LSD standard error bars of means.

Acid scarified seed had seedlings with the most leaves followed by nicking. Hot water treatment nicking, nicking combined with soaking and the control had no significant difference. This could be because the seedlings had few leaves due to reduced plant growth (Karaguzel*et al.,* 2004) due to low prevailing temperatures during the time of the experiment.

Overall, there was poor and delayed germination of *B. discolor* seeds. The highest germination percentage attained was 50%. This could have been because germination of *B. discolor* is generally very difficult and poor as the seeds normally take up to 21 days and above to germinate without any pre-treatment applied (Msanga, 1998). The poor germination could also have been due to the fact that the season in which the experiment was carried out had generally low temperatures. The experiment was done towards winter when temperatures were starting to decline. Low temperatures inhibit or lower germination because of reduced enzymatic activities (Breidenbach *et al.,* 2001). Media pH could have affected germination in this experiment as the soil used had a pH of 4.7. Lower soil pH can inhibit or lower germination and growth of certain crops (Deska *et al.,* 2011). Research by Turner *et al.* (1988) on *Paulownia tomentosa*showed that seedling emergence and growth were significantly reduced in soil with a pH of 4.5 when compared with seedlings grown on soils with pH 5.5 and 6.5.

Conclusions and recommendations

From the study it is concluded that method of scarification significantly affects germination and early seedling vigor of *B. discolor* seeds. Treating seeds with acid and nicking had improved germination. Germination and early seedling vigor were significantly influenced by scarification. Acid scarification can therefore be applied as a pre-treatment method for improving germination and early seedling vigor of *B. discolor* seeds. However, the exogenous factors like media pH, temperature of the environment and the season in which they are grown must also be considered. Planting could be done using media with a pH that is above 4.7 and greenhouse or nursery temperatures of about 30^{o}C and above and planting could be done between November and March. Research on the effects of scarification combined with stratification and on increasing the soaking period for acid scarification and hot water soaking from the 20 and 10 minutes respectively as used in the experiment is recommended.

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