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Filing considerably breaks seed dormancy of *Berchemia discolour* Hemsley

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In this study, the effectiveness of different pre-treatment methods for the breakings of seed dormancy in *Berchemia discolour* Hemsley seeds was assessed. Viable seeds were randomly sampled and subjected to different pre-treatment methods which include filing, soaking in 98% concentrated sulphuric acid, pre-chilling and boiling. For each treatment, ten seeds were used and three replications were done for each treatment. The investigation revealed that filing enhances seed germination and seed dormancy is likely due to the hard seed coat which has to be weakened or broken gently to avoid embryo damage, thus facilitating germination. Although, filing caused seeds to germinate, the mean germination rate of 13.3% that was achieved is too low to make this investigation conclusive. Further studies similar to this are recommended to improve the germination rate to higher than 30%.

Key words: Dormancy, filing, germination, pre-chilling, pre-treatment.

INTRODUCTION

Berchemia discolour Hemsley (bird plum/brown ivory) is a shrub or tree with a dark flacking bark, with height range of 3-20 m. It is widely distributed, but tends to be more abundant at low altitudes, along rivers and on termite mounds. The tree is browsed by game. Its bark and leaves are used medicinally (van Wyk and van Wyk, 1997; Adebooye and Opabode, 2004; McGaw et al., 2007) and the yellow-brown wood is hard, attractive and suitable for furniture. *B. discolour* fruits are edible, sweet tasting and used in beverage making. The fruits can be eaten fresh, sun dried or boiled with sorghum and the fruit pulp has high vitamin C content (Kamumvuri, 2004).

B. discolour plants produce numerous small fruits susceptible to various mechanisms of dispersal. However, very few, if any plants are evident in a locality reflecting a low germination rate relative to the seed population (van Wyk and van Wyk, 1997). The seeds enter dormancy at maturity and are difficult to germinate under natural environmental conditions due to the seed hard coat (van Wyk and van Wyk, 1997). Seeds require

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a specific trigger or change in the surrounding environment to break dormancy and germinate under favourable conditions (Williams et al., 2003; Zoghi et al., 2011; Long et al., 2014).

Commercial standards for exotic trees would be satisfied by a germination rate of above 90% to minimize seed wastage. Indigenous trees have poor germination rates when compared with exotic ones. An improved germination rate of above 50%, if achieved, would be satisfactory and can be conclusive that this method is effective in breaking seed dormancy and can be utilized commercially (Majaju and Zananga, 2006). Application of the pre-treatment method of filing should be improved so as to achieve a better germination rate. Seed coat impermeability is not the only cause for prolonged and low germination for *B. discolour* and it is recommended that the seeds be chopped at the radicle end followed by soaking in cold water and drying in the sun for 24 h as a method to promote germination (Walck et al., 2012).

Majaju and Zananga (2006), working on indigenous tree species in Zimbabwe, germinated a variety of trees and observed varied germination rates. Though pre-treatments used were not highlighted, the following results were found: *B. discolour* 30% germination over 4 weeks, *Uapaca kirkiana* 70% in 3 weeks, *Pterocarpus angolensis* 40% in 4 weeks, *Azanza garckeana* 65% in 4 weeks, *Brachystegia boehmii* 82% in 3 weeks and *Brachystegia spiciformis* 85% in 4 weeks (Majaju and Zananga, 2006)

B. discolour seeds have hard seed coats that confers physical dormancy and scarification is one of the popular methods commonly used to break dormancy on such types of seeds (Tibugari et al., 2013). Scarification is any process of scratching, breaking or mechanically altering the seed coat to make it permeable to water and gases (Evans and Blazich, 2010;, Zoghi et al., 2011; Paul et al., 2003). Hard seeds can be softened by subjecting them to artificial pre-treatment mechanisms, either via scarification or stratification.

B. discolour is of great value, however its utilization commercially is currently limited because of the problems encountered in the species regeneration through seeds. Establishing *B. discolour* plantations would be of great benefit to communities given that the fruits are produced during the cold and dry seasons when there are few other types of fruits and vegetables and therefore can help to provide a healthy diet (Whyman, 1993). Hence, the main aim of this study was to access the effectiveness of different seed pre-treatment methods in breaking seed dormancy for higher regeneration of the species.

MATERIALS AND METHODS

Seed collection

Sun dried fruits of *B. discolour* were collected from the Mavuradonha and Chimhanda areas in Mt Darwin and Rushinda districts, respectively in Zimbabwe. The seeds were extracted from the fruits by removing the exterior fruit pulp and were taken for viability tests. Seeds from the two areas were bulked and treated as collected from a single population before viability tests were performed.

Seed viability testing

The floatation and observation processes were used to test the viability of the seeds. Seeds were observed thoroughly using a hand lens for cracks or other physical damage by insects or other pests. Cracked seeds and those bored by insects were removed from the samples. Seeds were then placed in a container with a 10 cm water column. The column length ensured a clear distinction between the seeds that sunk and those that floated. According to Visser (1994), the seeds that sank are viable. The test may not be entirely reliable, but is sufficient for seeds that have to be germinated as some viability tests, such as the analysis of protein synthesis, would result in the destruction of the seed.

Experimental design and treatments

Seed pre-treatment methods carried out were: soaking in 98% concentrated sulphuric acid, nicking/cutting, filing, boiling, hot water treatment, moist pre-chilling, moist pre-warming and a control in which the seeds were left intact.

The control

Thirty untreated seeds were sown in fifteen plastic pots. Each of the pre-treatments was replicated three times.

Seed scarification methods

Soaking in 98% concentrated sulphuric acid

Thirty seeds were placed in a 200 ml beaker and covered in 100 ml of 98% concentrated sulphuric acid. Seeds were gently stirred to soak and then removed after twenty minutes and washed thoroughly with distilled water before being planted.

Nicking/cutting

Thirty seeds had their tips cut cross-sectionally using a sharp knife, exposing the seed embryo. Care was taken to avoid cutting the seed embryo. The seeds were then immediately sown.

Filing

Thirty seeds had their tips filed using a file. This was done until a tiny hole appeared exposing the embryo before the seeds were planted.

Boiling

Thirty seeds were soaked in boiling water for 20 min.

Hot water treatment

Thirty seeds were soaked in boiled water overnight and planted after twenty hours.

Table 1. Mean number of germinated *B. discolour* seeds by various pre-treatments.

Method of pre-treatment	N (number of trials)	Mean germinated ± SE (*B. discolour*)
Filing	3	1.33±1.33[a]
Nicking/cutting	3	0.00± 0.00[b]
Sulphuric acid (98% concentration)	3	0.00± 0.00[b]
Hot water scarification	3	0.00± 0.00[b]
Boiling	3	0.00± 0.00[b]
Pre-chilling	3	0.00± 0.00[b]
Control	3	0.00± 0.00[b]
Filing and pre-chilling	3	0.00± 0.00[b]
Nicking and pre-chilling	3	0.00± 0.00[b]
Sulphuric acid and pre-chilling	3	0.00± 0.00[b]

[a,b]Means within the same column with different superscripts are significantly different at P<.05.

Seed stratification methods

Moist pre-chilling

Thirty seeds were embedded in 50 cm^3 of moist sand in a closed glass bottle. They were then stored in a refrigerator at 5°C for 5 days under regular monitoring of the setup to ensure that the medium remained moist. The seeds were remoistened during the period and planted.

Moist pre-warming

Thirty seeds were embedded in 50 cm^3 of moist sandy soil in a closed glass bottle stored at 60 to 70°C for 5 days. After this incubation period, the seeds were planted.

Seed treatment by both scarification and stratification

In one treatment, thirty seeds were filed and then pre-chilled before being planted. The other thirty nicked seeds were also pre-chilled and then planted. Thirty sulphuric acid scarified seeds were also pre-chilled and then planted. Thirty seeds were treated with boiling water for 20 min and were pre-chilled before being planted.

Planting

Planting was done in potted loam soil. Fifteen 100 cm^3 plastic pots were used per each treatment. In each pot, two holes of about 1 cm depth were drilled by fingers, and two seeds were sown. Watering was done three times a day using a fine spray and where necessary, weeding was performed. Sowing was done in a shaded well ventilated garden.

Data analysis

Data were statistically analyzed using SPSS version 22.0. The effects of the pre-treatment methods on *B. discolour* seed germination were tested using LSD post-hoc tests at the P<0.05 level of significance.

RESULTS

Filing was the only successful pre-treatment methods found to break dormancy of *B. discolour* seeds and result in germination. All the other pre-treatments failed to germinate the seeds within a period of 28 days (Table 1).

Seeds that had been cut had empty embryo cavities and seeds from all the other pre-treatments were found intact. This implies that seeds were still viable and dormancy had not been broken.

DISCUSSION

There was a significant difference (p<0.05) between filed seeds and seeds by other pre-treatments in which filing of the seeds managed to break dormancy and resulted in marginal germination. The mean germination rate of 13.3% is too low and makes this investigation inconclusive.

Seeds pre-treated by boiling, hot scarification, pre-chilling and all the others were recovered and observed. These were found intact and undamaged. It therefore shows that the seeds may have remained in the soil dormant and still viable. Since *B. discolour* trees are commonly found on termite mounds, termites (*Isoptera* spp.*)* may be involved in breaking seed dormancy. The termites may also fetch the seeds from sites of dispersal

and bring them to the mounds. Termites eat the hard seed coat and even the embryos of the *B. discolour* seeds. However, some termites may eat the seed coats and leave the seeds without damaging the embryos. This process could allow germination to take place, as the seed coats will be weak.

Results show that weakening of the seed coat by opening a tiny hole to the cavity holding the embryo enhances germination. The three methods of seed scarification used which include filing, cutting and soaking in sulphuric acid, which help weaken the seed coat, should have resulted in germination. However, cutting of the seed coat to expose the embryo resulted in no germination. It may be suggested, that the process of cutting may have damaged the embryo in the process resulting in its failure to germinate. Seed germination influenced by sulphuric acid is due to its capability to rupture seed coat enhancing absorption and thus imbibition of seeds. For seeds scarified by sulphuric acid, failure to germinate may also be attributed to the duration spent by the seeds in the concentrated acid, which may have been too short to cause enough weakening of the seed coats or the duration may have been long enough to cause damage to the embryo thereby failing germination (Salisbury and Ross, 1992; Ali at al., 2011).

When seeds are treated by boiling, the intention is to open up holes on the seed coat closed by plugs. This is achieved by increasing internal seed pressure as noted by Salisbury and Ross (1992). Failure by the seeds to germinate after boiling treatments may indicate that *B. discolour* seeds have no strophiolar clefts and plug as in some seeds. Strophiolar clefts are plugs covering special openings present in the seed coats which enhance germination by being loosened or removed to allowing water into the seed (Bewley and Black, 1994). Boiling therefore does not result in the germination of *B. discolour* seeds as it does not affect the hard coat. High temperatures may have a negative effect on the germination of *B. discolour* seeds. It can be speculated that, boiling could have killed the embryo and thus prevented any chance of germination.

Stratification did not achieve germination in *B. discolour* seeds. Low temperatures are indicated in Whyman (1992) as causing damage to *B. discolour* seeds. Cold and moist warm treatments did not soften the seed coats. After the 28 days in the soil, the seeds were observed intact with their seed coats still very hard. The subjection to cold may have damaged the embryo and resulted in no germination (Whyman, 1993). Seed treatments with hot water had been described to improve germination of hard seed coat species by uplifting water and oxygen permeability of the testa of seed coat (Ali at al., 2012). In this study, cold and hot water seed stratification failed to encourage *B. discolour* seed germination. Permeability of the seed coat to water was not improved by stratification. Seeds that had double pre-treatment were initially scarified and later stratified. No germination was achieved from any of the double treatments. Pre-chilling of seeds that had initially been filed could have damaged the embryo and failed seed germination.

Naturally, it is suggested that *B. discolour* seeds germinate by breaking of the barrier to water and gases provided by the hard seed coat. This might be achieved by exposing the seed-exocarp to attack by ants or alternate wetting and drying. These mechanisms achieve dormancy breakage in teak trees as noted by Davison and Fairlamb (1976). Our results provide evidence that *B. discolour* seeds enter into dormancy after maturation in their fruits. The seeds' germination is dependent upon mechanisms that break dormancy.

Conclusion

Results of this study show that methods of scarification, particularly filing considerably influences germination of *B. discolour* seeds. Similar studies are therefore recommended to improve the effect of filing and other scarification methods on breaking seed dormancy in *B. discolour.* Improvements on the other pre-treatment methods should be made in later investigations to verify findings of this study. Research should be intensified to investigate the physiology of seed germination and dormancy of indigenous species to help identify suitable pre-treatments to break dormancy which should result in high germination rates within short periods. Attention to propagation of indigenous species which are under extinction threats due to over harvest and land degradation is recommended.

Conflict of Interest

The authors have not declared any conflict of interest.

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