International Journal of Applied Environmental Sciences
ISSN 0973-6077 Volume 12, Number 5 (2017), pp. 857-863

http://www.ripublication.com

Enhancement of seedling emergence and early growth of *Leucaena leucocephala* by hot water, mechanical and acid scarification pre-treatments

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Abstract

The effect of hot water, mechanical and acid scarification on seedling emergence and early growth of *Leucaena leucocephala* were studied. The results of various seed scarification methods revealed that all seed scarification pre-treatments improved seedling emergence and early growth of *Leucaena leucocephala*. Soaking the seeds in sulfuric acid for 20 and 24 minutes resulted in the highest percentage of seedling emergence, plant height, number of leaves, biomass dry weight and the lowest emergence index, followed by mechanical scarification by clipping the seeds around the micropyle and soaking the seeds in hot water for four minutes. The lowest percentage of seedling emergence and early growth were found in control. It can concluded that seed scarification is needed to improve seedling emergence and early seedling growth of *Leucaena leucocephala* with acid scarification is the best method.

Keywords: Leucaena, seed scarification, seedling emergence, early growth

INTRODUCTION

The total area of grassland and pasture in Indonesia is estimated to be 80 million ha and these areas are host to more than 90% of the cattle population. These areas are continually decreasing, mostly due to conversion to cash crop lands. Presently, these areas are undergoing extensive degradation, due primarily to overgrazing and adverse climatic conditions. Overgrazing of the rangelands has led to accelerated soil erosion, reducing productivity and biodiversity of important forage plants and contributes to proliferation of non-palatable weeds.

As a way to overcome these problems, the use of stress tolerant, soil improver, high dry matter yielding and nutritive value trees or shrubs, like *Leucaena leucocephala* (hereafter is called Leucaena) may be one of the best method to develop sustainable grazing, increase productivity, and protect the biodiversity of rangelands. Ray *et al*. (1995) recommended the introduction of this plant into rangelands to improve their productivity.

Leucaena is fast growing multi-purpose plant. It is valuable soil improver because of its ability to fix high atmospheric N (74 – 584/year) (Anon.[1], 1977; Nutman, 1980). Leucaena is also well known because of its high biomass potential. Its dry matter yield can attain up to 30 tons dry matter/ha/year, depending on soil fertility and rainfall (Shelton and Brewbaker, 1998). Leucaena leaves are palatable to ruminant animals. They contain high protein (15 – 38%) and highly digestible (60 – 70%). Their crude protein has a high nutritional quality, comparable to those contained in soybean (U ter Meulen *et al*., 1985).Although the presence of high amounts of mimosine has limited use of this plant as animal feed, ruminants in certain parts of the world such as in Indonesia and Hawaii could tolerate higher dietary levels of Leucaena because of presence certain bacteria in their rumen that have ability to break down mimosine to un-poisonous compounds (Jones and Megarrity, 1983).

Despite its great importance and characteristics, establishment of Leucaena is difficult. One of the major constraints to its successful establishment is the high degree of hard seed due to impermeable seed coat that must be broken to allow water and oxygen to reach the embryo and start the germination process. Without scarification, only 10% of fresh Leucaena seed could germinate (Rusdy, 2016). The present study was carried out with the objective to evaluate effects of hot water, mechanical and acid scarifications on seedling emergence and early growth of Leucaena.

MATERIALS AND METHOD

This experiment was conducted in January 2016 at the Faculty of Animal Science Hasanuddin University, Makassar, Indonesia (5^{o}10’ S, 119^{o}20’ E). Seeds of Leucaena were collected from mature plants growing on the campus of Hasanuddin University. Seeds were selected by soaking the seeds in tap water for five minutes and only sunken seeds were selected for the experiment.

The experiment was arranged in completely randomized design with 15 treatments and three replicates. The treatments were as follows: Control (T1); Soaking of seeds in hot water (80^o C) for 2, 4, 6 and 8 minutes (T2, T3, T4 and T5); Immersing of seeds in concentrated sulfuric acid (96%) for 4, 8, 12, 16, 20, 24 and 28 minutes (T6, T7, T8, T9, T10, T11, and T12); and clipping of seed coats at 1 – 2 mm around micropyle (T13), 1 – 2 mm at distal end (T14) and sandpapering for 10 minutes (T15).

Twenty five scarified seeds were sown into pots (14 cm in height, bottom diameter of 12 cm and top diameter of 16 cm) that had been filled with soil to a depth of 2 cm.

The pots were watered as necessary. Seedling emergence was recorded daily until day 10 when no seedling emerged on the soil surface. Seedling were thinned to five plants per pot after full cotyledon extension stage was attained. The experiment was terminated at 22 days after sowing, when cotyledon began to yellow. Parameters measured were: percentage of emergence, emergence index, stem height, number of leaves, and biomass dry weight. Emergence index (EI) was calculated using the formula of Scott *et al*. (1984): EI = (TiNi/S), where Ti is the number of days after sowing, Ni is the number of seed germinated on day Ti and S is the total number of seeds sown.

RESULTS AND DISCUSSION

Different parameters related to seedling emergence and early seedling growth of Leucaena were significantly affected by applied treatments. In general, compared to control, all seed scarification methods had stimulatory effect (Table 1).

Hot water scarification

Hot water scarification had a positive effect on breaking dormancy in Leucaena (Table 1). The highest percentage of seedling emergence was recorded when the seeds soaked in hot water of 80^{o} C for two minutes. With the water temperature of 80^{o} C, the optimum length of soaking for breaking seed dormancy is varied. Teles *et al*. (2000) reported that at 80^{o} C, the best soaking duration to break seed dormany in Leucaena was five minutes. Furthermore, Akinola *et al*. (1999) reported that seed germination and emergence in Leucaena was the highest when the seeds immersed in hot water (80^{o} C) for 10 minutes. This might be due to differences in age of seeds used, where the seeds they used had been stored between 270 and 3955 days while in the current study, the new freshly seeds used. This is consistent with Anon. (2017) that as seeds age, the embryo will wither, decreasing the number of viable seeds. The optimum length of soaking the seeds in hot water is also influenced by water temperature. Villiers (1972) reported that soaking Leucaena seeds in 70^{o} for 20 minutes is effective treatment to break seed dormancy and enhanced germination of this species.

The success of overcoming hardseedness by hot water treatment has been reported in a number of species, including *Chrysophyllum albidum* (Aduradola et al., 2005), *Acacia senegal* (Nuhu *et al*., 2013) and *Vitex agnus castus* L. (Travios and Karamanos, 2007). Hot water treatment has been reported to enhance seed germination by affecting various factors, viz., seed coat permeability for gases and water exchange and release of inhibitor (Sharma *et al*., 2008).

Table 1. Effects of hot water, acid and mechanical scarifications on seedling emergence and early growth of Leucaena

Treatments	Percentage emergence (%)	Emergence Index	Plant height (cm)	Number of leaves (/plant)	Biomass dry wt. (g/pot)
T1	9.00	0.33	6.02	3.88	0.30
T2	49.0	3.51	6.49	4.00	0.36
T3	46.0	4.16	6.51	4.00	0.36
T4	40.0	6.41	6.30	3.93	0.33
T5	37.0	8.41	5.30	3.63	0.32
T6	50.0	3.34	7.27	4.33	0.35
T7	54.0	3.38	7.40	4.50	0.38
T8	58.0	3.45	7.45	4.60	0.40
T9	64.0	2.48	7.50	4.60	0.52
T10	66.0	2.44	7.54	4.80	0.54
T11	66.0	2.54	7.41	4.60	0.50
T12	60.0	2.50	6.33	4.10	0.49
T13	58.0	2.56	7.06	4.40	0.48
T14	54.0	2.28	6.80	4.20	0.48
T15	52.0	2.33	7.00	4.13	0.45
LSD 5%	7.43	1.05	1.28	1.80	0.08

Mechanical scarification

Mechanical scarification enhanced seedling emergence and seedling growth of Leucaena (Table 1). The results showed that mechanical scarification significantly enhanced seedling emergence and seedling growth of Leucaena. Highest percentage of seedling emergence and seedling biomass was found when seeds were clipped around micropyle. These results are in agreement with Maher *et al*. (2011) that blade scarification was very effective in breaking dormancy in Leucaena seeds and it was more effective than sandpaper scarification. The high seedling emergence as resulted from clipping around micropyle or distal end sides of seeds also reported by in *Spondias mombin* Linn (Oyebamiji *et al.*,2001), and in *Myrica esculenta* (Bhatt and Dar, 2000). Zubairu (2014) states that the opening into cotyledon of Leucaena seeds through micropyle or distal end of seeds allowed ready inbibition of water, which enhanced early germination. Besides, the enhanced rate of respiration may promote germination in mechanically scarified seeds.

Acid scarification

Acid scarification promoted seedling emergence and early growth of Leucaena.The highest percentage of seedling emergence, plant height, number of leaves, biomass dry weight the lowest emergence index was recorded when seeds treated with sulfuric acid for 20 and 24 minutes (Table 1). Comparison between the three types of seed scarification revealed that seedling emergence, plant height, number of leaves and dry biomass were significantly higher in seeds immersed in sulfuric acid compared to hot water, and mechanical scarification. This is in agree with Duguma *et al*.,(1998) that acid scarification is the most effective way of improving coat permeability in seeds of Leucaena.

The highest stimulatory effect of sulfuric acid pre-treatment on seed germination and seedling growth was also reported in other plants such as *Tamarindus indica* (Muhammad and Amusa, 2003), *Dacryodes edulis* (Agbokidi *et al*., 2007), *Prosopis koelziana* and *Prosopis juliflora* (Zare *et al*., 2011) and *Centrosema pubescens* (Rusdy, 2015).

The observed significant improvement of seed emergence, emergence index and seedling growth of Leucaena by acid scarification indicates that acid scarification stimulated prompt and uniform germination. This finding is in agree with Dachung and Verinumbe (2006) that acid treatment of seeds removed the waxy layer of seed coat by chemical composition of seed coat as that similar to breakdown process occurring during microbial attack. Sulfuric acid is thought to disrupt the seed coat and expose the lumens of the macrosclereids cell, permitting imbibition of water which triggers the release of simple sugar that could be readily used for protein synthesis, thereby encouraging germination (Jackson, 1994).

CONCLUSION

This study showed that hot water, sulfuric acid and mechanical scarification significantly induced seedling emergence and early growth of Leucaena. The best treatment was soaking the seeds in sulfuric acid for 20 and 24 minutes, because it produced the highest and the earliest seedling emergence, and the highest biomass dry weight.

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