Brazilian Journal of Biological Sciences, 2017, v. 4, No. 7, p. 103-111.
ISSN 2358-2731
https://dx.doi.org/10.21472/bjbs.040711

Hydrothermal treatments for overcoming dormancy in seeds of *Mimosa ophthalmocentra* Mart. *ex* Benth. (Fabaceae: Mimosoideae)

Azenate Campos Gomes[1], Alecksandra Vieira de Lacerda[2], Riselane Lucena de Alcântara Bruno[3], Edna Ursulino Alves[3], Carina Seixas Maia Dornelas[2], Iracy Amelia Pereira Lopes[4], Adriano Salviano Lopes[4] and Francisca Maria Barbosa[2]

[1]Programa de Pós-Graduação em Agronomia. Centro de Ciências Agrárias. Universidade Federal da Paraíba. Rodovia BR 079, km 12. Areia-PB. Brazil (CEP 58397-000).
[2]Centro de Desenvolvimento Sustentável do Semiárido. Universidade Federal de Campina Grande. Sumé-PB. Brazil (CEP 58540-000). Email alecvieira@yahoo.com.br.
[3]Centro de Ciências Agrárias. Universidade Federal da Paraíba. Rodovia BR 079, km 12. Areia-PB. Brazil (CEP 58397-000).
[4]Curso Superior de Tecnologia em Agroecologia. Centro de Desenvolvimento Sustentável do Semiárido. Universidade Federal de Campina Grande. Sumé-PB. Brazil (CEP 58540-000).

Abstract. The efficiency in the production of seedlings is decisive for the final result of their applicability. Therefore, strategies to ensure a rapid and uniform emergence are necessary, especially when it is associated with sustainable methods. The aim of this study was to evaluate the influence of different water temperatures as overcoming seed dormancy in *Mimosa ophthalmocentra* Mart. *ex* Benth., simply and economically, in the Brazilian Semiarid Region. The experimental design was completely randomized with four replications, each one consisting of 50 seeds, which were subjected to six treatments: intact seeds (T1/control) and seeds immersed in water at 55, 65, 75, 85, and 95 °C (T2, T3, T4, T5, and T6, respectively). Sowing was performed in trays under environmental conditions and evaluations were performed daily for 28 days. The emergence percentage, emergence speed index (ESI), and length and dry mass of seedlings were evaluated. Data were subjected to analysis of variance, and the means were compared by Tukey test ($p < 0.05$). *M. ophthalmocentra* has tegumentary dormancy, and its emergence was influenced by water temperature. Immersion of seeds in water at 75 ºC for 1 min provided the best result with 60% of emergence, ESI of 2.68, and seedlings with longer lengths and higher dry mass.

Keywords: *Mimosa ophthalmocentra*; Emergency; Vigor; Seedling production.

Received
June 12, 2017

Accepted
June 29, 2017

Released
June 30, 2017

Open Acess
Full Text Article

ORCID
0000-0001-6184-3114
Azenate Campos Gomes
0000-0002-9703-3997
Alecksandra Vieira de Lacerda

0000-0002-4206-6417
Riselane Lucena de Alcântara Bruno
0000-0002-7709-3204
Edna Ursulino Alves
0000-0003-0602-7979
Carina Seixas Maia Dornelas
0000-0003-1641-6214
Iracy Amelia Pereira Lopes
0000-0002-3182-3478
Adriano Salviano Lopes
0000-0002-6273-0979
Francisca Maria Barbosa

Introduction

The Caatinga is the predominant biome in the semiarid region of Brazil and occupies about 11% of the national territory (MMA, 2015). Despite its high biodiversity with a unique potential for conservation of environmental services associated with the sustainable use of its resources, several authors such as Pereira and Carvalho (2008) have reported an increased degradation in this region.

It is considered the least known biome of South America, regarding biodiversity, this fact may have significantly contributed to its current state of degradation. In this sense, studies which contribute to the conservation of its native species are necessary, as well as the development of sustainable methods of coexistence to preserve its resources, given that this biome is decisive for the development of the semiarid region and progress of the country (MMA, 2015).

Among the promising species that compose the Caatinga, *Mimosa ophthalmocentra* Mart. *ex* Benth. stands out; it belongs to the Family Fabaceae and Subfamily Mimosoideae, and it is endemic to this region, found in the list of medicinal species that are under study (Giulietti et al., 2002), also standing out for its timber and energy potential (Silva et al., 2011).

In this way, studies aimed to investigate the emergence of seeds and therefore the production of seedlings are of great importance as a form of conservation of the species since there are few studies on this process.

The delay in the germination of seeds, until adequate environmental conditions for their establishment and survival, is one of the difficulties encountered in the seedling production process (Pio et al., 2008). This characteristic is undesirable when a rapid germination and uniform growth is necessary (Carvalho, 1994).

Various methodologies have been developed aiming at a brief and standardized process of seedling emergence. Among the most common methods, we can highlight chemical or mechanical scarification, immersion in solvents (hot water, alcohol, acetone and others), quick cooling, high-temperature exposure, increase in oxygen tension, shocks, and mechanical scarification through impacts against hard surface to overcome dormancy caused by impermeability and mechanical restrictions (Carvalho; Nakagawa, 2012).

Regarding the technology of seeds of *M. ophthalmocentra*, there is only one study on seed dormancy overcoming, carried out by Brito et al. (2014), who obtained the best result using sulfuric acid, which, besides not being accessible to small farmers, it can cause severe damage to the environment.

Some authors such as Smiderle and Schwengber (2011) concluded that the use

of hot water had been a practical, simple and efficient method to overcome the dormancy of seeds of *Leucaena leucocephala* (Lam.) Wit and *Bowdichia virgilioides* Kunth. However, this method may also be studied for other species, with the aim of obtaining rapid and uniform production of seedlings without damage the environment.

Given the above, this study aimed to evaluate the influence of different water temperatures on seed dormancy overcoming in *Mimosa ophthalmocentra* Mart. *ex* Benth., simply and economically, in the Brazilian Semiarid Region.

Material and methods

The seeds of *Mimosa ophthalmocentra* Mart. ex Benth. were collected in an experimental area reserved for ecology and dynamic studies of the Caatinga, located in Western Cariri in the state of Paraíba, specifically in the municipality of Sumé. The collection was authorized by SISBIO 79457917.

The experimental design was completely randomized with four replications, each one consisting of 50 seeds, which were processed and subjected to six treatments: intact seeds (T1/control), and seeds immersed in water at 55, 65, 75, 85, and 95 °C (T2, T3, T4, T5, T6, respectively). The seeds were sown in trays containing sand as substrate, previously sifted, washed, and sterilized by autoclaving at 120 °C for 1 h.

The experiment was conducted under environmental conditions, and the evaluations were performed daily for 28 days. Seedlings with cotyledons above the substrate surface were considered emerged seedlings.

The emergence was evaluated as suggested by Carvalho and Nakagawa (2012) and emergence speed index (ESI) as proposed by Maguire (1962), using the following formula:

$$\text{Emergence (E)} = (N/A) \times 100$$

where:
N = number of seedlings in the final test, and
A = number of seeds sown.

$$\text{Emergence Speed Index (ESI)} = E1/N1 + E2/N2 + \ldots + E_n/N_n$$

where:
E1, E2, E_n = number of seeds emerged computed for each count, and
N1, N2, N_n = number of days from the sowing date.

The seedling length was determined at 28 days of the experiment, when the normal seedlings from each repetition, i.e., those that had perfect essential structures, were measured with the aid of a graduated ruler, being the results expressed in centimeters per seedling. After length measurement, the seedlings were dried in an oven at 80 °C for 24 h, weighed on a 0.001 g precision scale to obtain the dry weight of the seedlings as recommended by Carvalho and Nakagawa (2012). The results were expressed as g per plant.

The data were subjected to variance analysis, and the means were performed by Tukey test ($p < 0.05$) when F test was significant. The SISVAR software, version 4.3, developed by the Federal University of Lavras, was used.

Results and Discussion

The data showed that *Mimosa ophthalmocentra* Mart. ex Benth. has tegumentary dormancy, since in the treatment of intact seeds (T1) only 4.5% of the seedlings emerged. The tegumentary dormancy has been quite common in the family Fabaceae.

In particular, it has been described in the literature that species of the *Mimosa* genus have tegumentary dormancy characterized by the impermeability of the integument or pericarp to water and

oxygen, such as *Mimosa caesalpiniifolia* Benth. (Bruno et al., 2001), *Mimosa flocculosa* Burkart (*S*hibata et al., 2014), and *Mimosa bimucronata* (DC.) O. Kuntze (Ribas et al., 1996).

According to Busatto et al. (2013), the dormancy in Leguminosae is caused by the physical blockage promoted by a resistant and impermeable integument, which impedes aqueous transit and gaseous exchanges, neither allowing seed imbibition nor the embryo oxygenation, remaining in a latent state.

Regarding the emergence (Figure 1), the immersion in water at 75 °C for 1 min (T4) was the best treatment, providing 60% of emergence, significantly differing ($p<0.05$) from the other treatments. The immersion in water at 85 °C during 1 min was the second best treatment, only differing ($p<0.05$) from T4 and f control (T1).

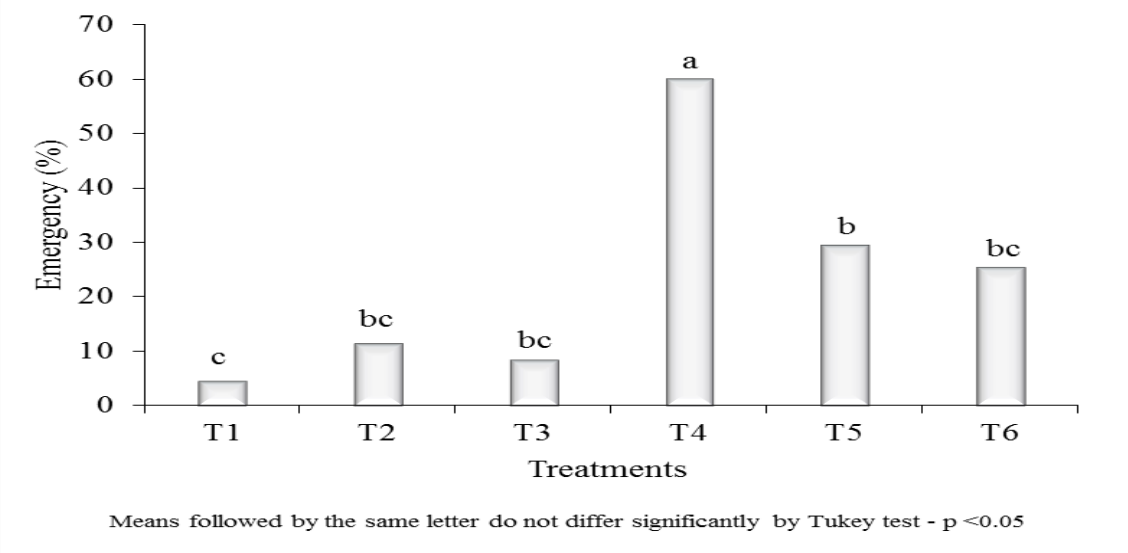

Figure 1. Percentage of emergence of seeds of *Mimosa ophthalmocentra* Mart. *ex* Benth. subjected to different treatments: T1 (control), and T2, T3, T4, T5, and T6 - immersion in water at 55, 65, 75, 85 and 95°C, respectively.

Brito et al. (2014), analyzing water immersion treatments at ambient temperature for 12 h, such as immersion in commercial bleach for 6 h, immersion in 20% caustic soda for 10 min, and immersion in H_2SO_4 for 5 and 10 min, observed that these last two treatments had shown the best results for *M*. *ophthalmocentra*.

Although the use of scarification with sulfuric acid and caustic soda has presented positive interactions for the results of emergence and vigor of seeds, it endangers human integrity. Moreover, its use requires trained people, and its acquisition requires certain criteria, making essential the use of sustainable techniques.

According to Shibata et al. (2014), for seeds of *M*. *flocculosa*, the immersion in water for 18 h at 65 °C provided the highest germination rate (74%). Leal et al. (2008) concluded that seed of *M. caesalpiniifolia*, sown without craspedium, immersed in water at 90 ºC and 100 ºC for 1 min, and then subjected to thermal shock and immersion in hot water at 80 and 90 ºC until total cooling, had higher germination percentages.

For the ESI, the best result was obtained in seeds immersed in water at

75 °C, differing from the other treatments, followed by seeds immersed in water at 85 °C (Figure 2). These results were like those found by Ribas (1996) for *M. bimucronata*, who found that the immersion of seeds in water at 80 °C for 1 and 5 min and, also for 24 h, provided a higher germination speed index.

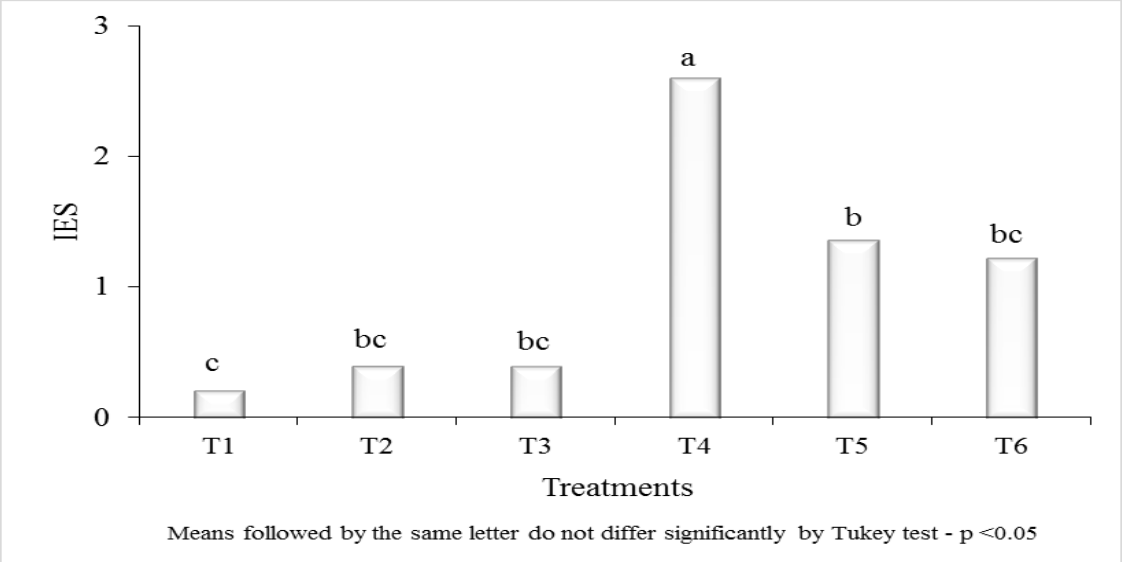

Figure 2. Emergence speed index (ESI) for *Mimosa ophthalmocentra* Mart. ex Benth. subjected to different treatments, T1 (control), and T2, T3, T4, T5, and T6 - immersion in water at 55, 65, 75, 85, and 95 °C, respectively.

Sperandio et al. (2013) also obtained good results in the germination speed index for *Mimosa setosa* Benth. at temperatures of 70 °C and 80 °C during 1, 3 and 5 min. Leal et al. (2008) observed that seeds of *M. caesalpiniifolia* placed to germinate at 25 and 30 °C achieved the best ESI when they were immersed in 80 °C and 100 °C, respectively. Also regarding this species, Bruno et al. (2001) found that immersion at 100 °C for 1 min provided higher values, compared to the same immersion temperature for 2 min.

The immersion in water at 55 and 65 °C for one minute resulted in a low ESI regarding the overcoming of tegumentary dormancy of *M. ophthalmocentra* seeds, similar to the result obtained at 85 and 95 ºC. However, the result obtained at 85 and 95 ºC is related to the reduction in the level of seedling vigor caused by the beginning of seed dehydration, so increasing the average time needed to root protrusion and thus contributing to the uneven emergence.

According to Bello et al. (2008), high temperatures cause seed deterioration, as observed in *Amburana acreana* (Ducke) A. C. Sm., in which the thermal stress retards the development of the germination process and can suppress it in quiescent seeds or in seeds that had already initiated the germination.

With regards to the seedling length, there was no statistical difference between the treatments (Figure 3). Consequently, there was neither influence of the tested temperatures nor of the intact seeds, in the seedling growth, which varied between 9.5 and 12.7 cm. These results were higher than those reported by Brito et al. (2014), who found that mechanical and chemical scarification treatments resulted in values lower than 9.5 cm, thus showing the high efficacy of this method in seedling development.

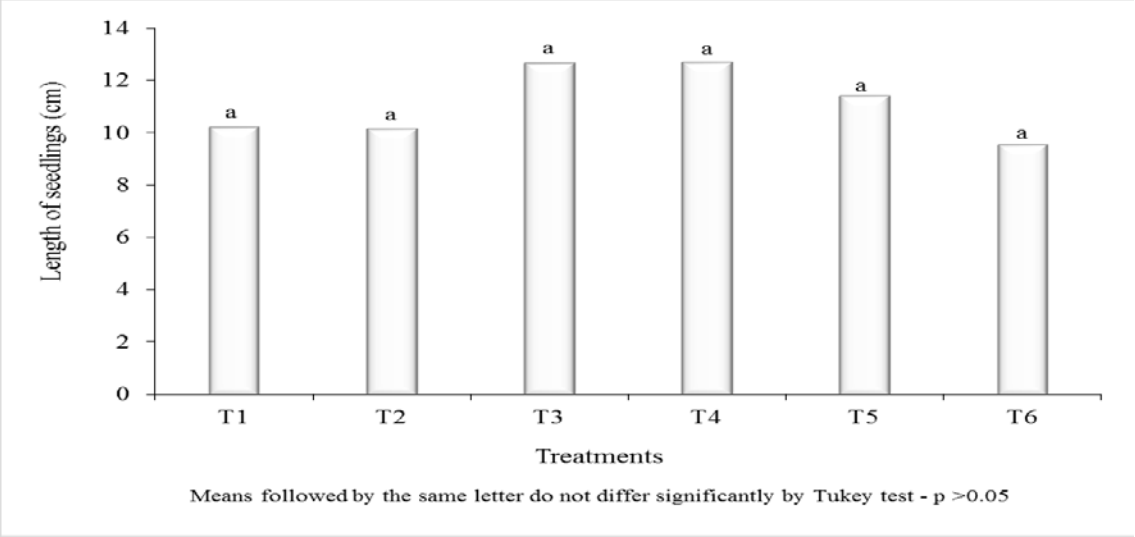

Figure 3. Seedling length of *Mimosa ophthalmocentra* Mart. ex Benth. subjected to different treatments: T1 (control), and T2, T3, T4, T5 and T6, immersion in water at 55, 65, 75, 85, and 95 °C, respectively.

For species of the subfamily Mimosoideae, some studies have evidenced the efficiency of the immersion of seeds in water heated at different temperatures since the seeds of these species, subjected to this method, originated seedlings with significant lengths, without differing from the other treatments used. As an example, we can cite the study carried out by Farias et al. (2013), who, evaluating the coating cutting on the opposite side of the hilum, immersion in hot water (100 °C) for 1, 2 and 3 min, and immersion in sulfuric acid for 10, 13, and 15 min, in the overcoming of seed dormancy in *Piptadenia stipulacea* (Benth.) Ducke, observed that these treatments did not differ statistically regarding the results of seedling length.

The data for seedling length were similar to those reported by Lima and Garcia (1996) for *Acacia mangium* Willd., who obtained higher values of this variable when the seeds were immersed in water at 80 °C.

Regarding the dry mass, only the immersion in water at 75 °C during 1 min differed from the other treatments, which were too affected by the temperatures, especially at 85 °C and 95 °C (Figure 4), which may have been caused by seed dehydration, resulting in the embryo cell damage and consequently in the low development of seedlings.

Moreira et al. (2007) observed that the scarification with sulfuric acid significantly reduced the dry mass of seedlings of *Luffa cylindrica* M. Roem. Alves et al. (2004), observed that the highest values of dry matter mass in seedlings of *Bauhinia divaricata* L. were obtained from seeds subjected to coating cutting on the opposite side of the micropyle and to the immersion in water at a temperature of 70 °C.

Costa et al. (2010) demonstrating that in seeds of *Adenanthera pavonina* L., the immersion in water at a temperature of 95 °C, significantly reflected on the emergence and dry mass of the seedlings due to the considerable weakening of the embryo. For seeds of *M. caesalpiniifolia*, Bruno et al. (2001), analyzing the immersion in boiling water for 2 min, obtained the lowest values of dry mass in the seedlings.

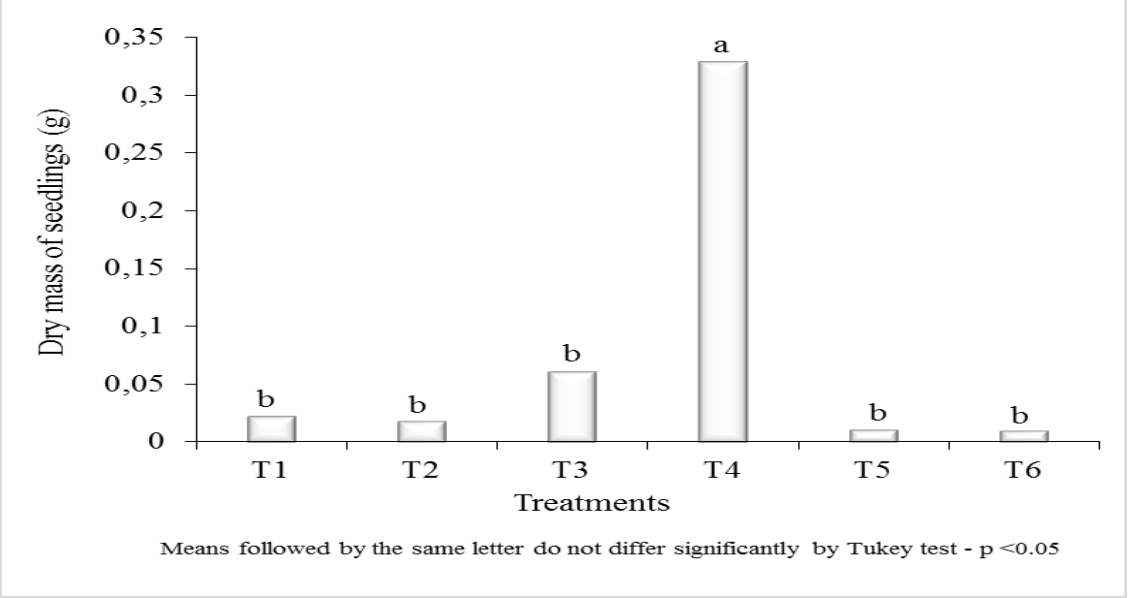

Figure 4. Dry mass of seedlings of *Mimosa ophthalmocentra* Mart. ex Benth. subjected to different treatments: T1 (control), and T2, T3, T4, T5, and T6, immersion in water at 55, 65, 75, 85 and 95 °C, respectively.

For seed of *Schizolobium amazonicum* Huber *ex* Ducke, Shimizu et al. (2011) observed that the scarification with sandpaper generated the best results in the dormancy overcoming of this species, as well as, higher values of length and dry mass of seedlings compared to those seeds immersed in water at 100 °C for 2 min. Araújo (2014) obtained dry mass values similar to those obtained for *Macroptilium martii* (Benth.) Maréchal & Baudet, in which the lowest values were obtained when the seeds were immersed in water at 80 °C for 12 min. The appropriate treatment for dormancy overcoming is extremely important since according to Menezes et al. (2006), conditions that compromise the process of germination favor the development of more vigorous seedlings, in such a way that there is a direct relationship between the initial and final development.

Conclusion

Thus, it was evidenced the influence of hydrothermal treatment on the emergence of seedlings of *Mimosa ophthalmocentra* Mart. *ex* Benth. and that, among the studied temperatures, heating at 75 °C provides the highest values of seed emergence and vigor.

Conflicts of interest

Authors declare that they have no conflict of interests.

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