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Organizadores

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APRESENTAÇÃO

Com o objetivo de promover a recuperação de áreas degradadas, o Ministério do Meio Ambiente, por intermédio do Departamento de Florestas (DFLOR) e do Departamento de Revitalização de Bacias Hidrográficas (DRB), e o Ministério da Integração Nacional (MI), por meio da Companhia de Desenvolvimento dos Vales do São Francisco e do Parnaíba (CODEVASF), no âmbito do Programa de Revitalização da Bacia Hidrográfica do Rio São Francisco (PRSF), criaram os Centros de Referência em Recuperação de Áreas Degradadas (CRADs).

Os objetivos dos CRADS estão ligados ao desenvolvimento de modelos de recuperação de áreas degradadas em áreas demonstrativas, à definição e documentação de procedimentos para facilitar a replicação de ações de recuperação de áreas degradadas e à promoção de cursos de capacitação para a formação de recursos humanos (coleta de sementes, produção de mudas, plantio, tratos silviculturais).

Atualmente, existem cinco CRADs instalados na Bacia Hidrográfica do Rio São Francisco, sendo um deles o CRAD/Mata Seca, com sede na UNIMONTES (Universidade Estadual de Montes Claros), Campus de Janaúba (MG), em parceria com a UFMG (Universidade Federal de Minas Gerais) e UFVJM (Universidade Federal dos Vales do Jequitinhonha e Mucuri).

Além da parte administrativa faz parte da estrutura do CRAD/Mata Seca o Viveiro Escola, coordenado pelo Professor DSc. Luiz Henrique Arimura Figueiredo e tendo como Diretor Técnico João Edáclio Escobar Neto. E, em 2019 foi criado o Laboratório de Ecologia Florestal, coordenado pela Professora DSc. Cristiane A. Fogaça. Fazem ainda parte da equipe, acadêmicos do Curso de Agronomia, como bolsistas de Iniciação Científica, estagiários e orientados de Trabalhos de Conclusão de Curso.

Na parte administrativa são realizados encontros e palestras relacionados à Recuperação de Áreas Degradadas, tendo como público alvo produtores rurais, alunos do ensino fundamental, médio e superior.

Com relação ao Viveiro Escola, o mesmo tem como objetivo a produção de mudas de espécies nativas da região para a doação a comunidades, produtores rurais e prefeituras da região, visando em especial à recuperação de áreas degradadas e/ou sujeitas à degradação. A capacidade do Viveiro Escola é de 10.000 mudas.ano-1. Além da produção e doação de mudas são recebidos no local, alunos de ensino fundamental e médio, onde são apresentadas as espécies produzidas e a importância das mesmas, demonstrando a necessidade de recuperar áreas degradadas e ainda, a importância da arborização tanto na área rural como urbana.

Com o intuito de reduzir as perdas de sementes coletadas na região e possibilitar maior conhecimento sobre o comportamento germinativo e a morfologia de espécies florestais criou-se no local o Laboratório de Ecologia Florestal, onde além do beneficiamento e armazenamento de sementes, desenvolve pesquisas sobre a morfologia de sementes, plântulas e da germinação; métodos de superação da dormência; padronização de testes rápidos para a avaliação da viabilidade de sementes, entre outros.

Assim, o presente E-book CRAD/Mata Seca – Coletânea I apresenta oito capítulos de pesquisas desenvolvidas sobre tecnologia de sementes e produção de mudas florestais.

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Sumário

Capítulo VIII

Study os seeed dormancy of *Enterolobium timbouva* Mart.

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INTRODUCTION

The species *Enterolobium timbouva* Mart., commonly known as "timburí" or "tamboril", has its occurrence in the Brazilian territory of the Region of the Lower Amazon towards the south by Mato Grosso and Goiás to Minas Gerais, in the northwest of São Paulo and Mato Grosso in the semideciduous forest and in the "cerradão". This species can be used in rural landscaping and due to its rapid growth and rusticity is also recommended for the composition of reforestation for preservation purposes. Its seeds present dormancy and it is necessary to use methods of overcoming this to promote germination (Lorenzi, 2002).

When seeds of a certain species stop germinating even though they are viable and having all the environmental conditions to do so, we receive the name of dormancy. The phenomenon of dormancy is considered as a resource of great importance, by which nature distributes seed germination over time (Carvalho et al., 2012), that is, it is an evolutionary method that seeks to protect the species' perpetuation (Piña-Rodrigues et al. (2012). This phenomenon not only guarantees the potential of regeneration of the seed bank even in environmental conditions that are adverse to survival, but also contributes to the species being distributed over time through the dependence of its overcoming by environmental factors.

Dormancy can be divided into two categories: embryonic or endogenous and tegumentary or exogenous. In the first category, dormancy occurs due to the immature embryo, or presence of a physiological inhibition mechanism that prevents it from developing. In the second category, the seed is dormant because the tissues that surround it exert an impediment that can not be overcome, being known

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as dormancy imposed by the integument. This is the most common category of dormancy, and is related to the impermeability of the integument or pericarp to water and oxygen, with the presence of chemical inhibitors in the integument or pericarp, such as coumarin or parathoric acid, or with the mechanical resistance of the tegument or the pericarp to embryo growth (Fowler et al., 2000).

In the natural state, the seeds overcome the dormancy when the moment is propitious by mechanisms of the seed itself or the environment, finishing its cycle (Maguire, 1962). The fungi and bacteria present in the soil under forest conditions can minimize this type of dormancy by degrading the seed coat (Fowler et al., 2000).

However, in commercial nurseries or conservationists waiting for the natural process may require long periods for lot of seeds to overcome dormancy and a uniform emergence is gotten, which makes the activity impracticable. Thus, ways were developed to accelerate the germination process known as dormancy breaking techniques. Such techniques have been developed following species research in nature and continue to be improved as information is spread (Piña-Rodrigues et al., 2012).

There are several methods of overcoming or breaking dormancy, whose objective is to accelerate the process, increase and standardize the germination, of which can be cited: mechanical or chemical scarification, in which the seed is submitted to a tegumentary wear; the stratification, in which it assists the seed in the process of maturation of the embryo, by means of gas exchanges and in water soaking; the immersion in cold or hot water, where the seeds are immersed and remain a variable period of time, according to the species. The application and efficiency of these treatments depends on the cause and degree of dormancy, which is quite variable among the species (Scremin-Dias et al., 2006).

Thus, the objectives of this work were to verify the occurrence of integument dormancy in *Enterolobium timbouva* Mart. seeds and identify the best treatment for overcoming it under nursery conditions, aiming to accelerate and standardize the emergence process.

MATERIAL AND METHODS

The present work was conducted at the Forest Ecology Laboratory of the Center of Reference for the Recovery of Degraded Areas (CRAD / Dry Forest) of the Departament of Agricultural Sciences of the State University of Montes Claros (UNIMONTES), Janaúba, MG, Brazil.

The lot of *Enterolobium timbouva* seeds was collected in May 2017, in Janaúba, MG, located in the northern region of Minas Gerais, with a geographical coordinate of latitude 15°47'50"S and longitude 43°18'31"W, with approximately 516 m of altitude (Prefeitura Municipal de Janaúba, 2013). The climate according to Koppen's classification is "AW" (rainy tropical with dry winter), with annual average rainfall of 900 mm, average annual temperature of 25 °C and average relative air humidity of 65% (Ometto, 1981).

In order to characterize the seed lot, the weight of one thousand seeds and the water content were determined according to the requirements of the Rules for Seed Analysis (Brasil, 2009).

In the determination of the weight of one thousand seeds, 8 replicates of 100 seeds were weighed in an analytical balance with an accuracy of 0.001 grams (g). The result was calculated by multiplying the mean weight of 100 seeds by 10 and expressed in g to one decimal place.

The water content of seeds was determined using four replicates of a whole seed sample. The replicates were weighed and conditioned in metallic containers of known tare. The weighings were performed in an analytical balance with an accuracy of 0.001g. The samples were kept in an chamber at 105 ±3 ºC for 24 hours. The calculation was done in terms of wet basis and the results expressed as a percentage.

To verify the occurrence of integument dormancy the impregnation curves of intact and scarified seeds were determined. For this, four replicates of 20 seeds of each class were used, intact and mechanically scarified with sandpaper nº 80 on the side opposite the embryo until the cotyledons were exposed. The seeds were placed in plastic containers (200 mL) with distilled water enough to cover them, and kept in a laboratory environment, at average temperature of 26 ºC, for 120 hours.

The seeds were weighed before immersion in distilled water, and then at regular intervals of two hours until the first 12 hours, and sequentially every 12 hours up to 48 hours and ending every 24 hours to complete 120 hours.

Seeds corresponding to each class were removed from the water and dried on filter paper to remove excess water. The results were expressed as percentage of fresh mass increment, calculated from the equation, % Fresh Mass Increase = [(Pf - Pi) / Pf] x 100, where: Pi = initial seed weight; Pf = final weight of the seeds at each time (Nery, 2008).

The curves were graphically represented by their mean values and with polynomial equation elevated to the degree that best adjust the standard model proposed by Carvalho et al. (2012) for the process of water absorption by seeds, by means of the Assistat software version 7.7 (Silva et al., 2016).

After the occurrence of integument dormancy, the seeds were submitted to the following treatments: Control - seed without previous treatment; Intact seeds soaked in cold water for 24 and 48 hours at ambient temperature; Mechanical scarification - the seed was scarified manually with sandpaper nº 80, on the side opposite the embryo until the exposure of the cotyledons; Seeds mechanically scarified and soaked in cold water for 24 and 48 hours at ambient temperature.

After the treatments, the seeds were placed between washed and autoclaved sand in plastic trays and kept under nursery conditions. The irrigations are carried out manually and daily as needed.

The counts were made from the moment the seedlings presented all the structures formed, occurring on the seventh day after sowing and extending until the sixteenth day after sowing, computing the number of normal seedlings. And at the last count it was counted the number of hard seeds. Both results are expressed as a percentage.

Two vigor tests were applied to better evidence the results of the treatments. One of them was the first count test, in which the number of normal seedlings was determinated on the first day of counting. The result was expressed as a percentage according to the Rules for Seed Analysis (Brasil, 2009). The other, index of emergence speed (IES) was determined by the sum of the number of normal seedlings that emerged daily divided by the number of days elapsed between sowing and emergence (Maguire, 1962).

The experimental design was in randomized blocks, with the results submitted to analysis of variance and the means compared by the Tukey test, at 5% probability. Statistical analyzes were performed using ASSISTAT software version 7.7 (Silva et al., 2016).

RESULTS AND DISCUSSION

The water content of *E. timbouva* seeds was 9% and the weight of one thousand seeds was 554.8g.

From the analysis of the results obtained by the soaking curve (Figure 1), it was observed that the scarified seeds showed an increase in the fresh mass much higher than the intact seeds, evidencing that the intact integument prevented water entry.

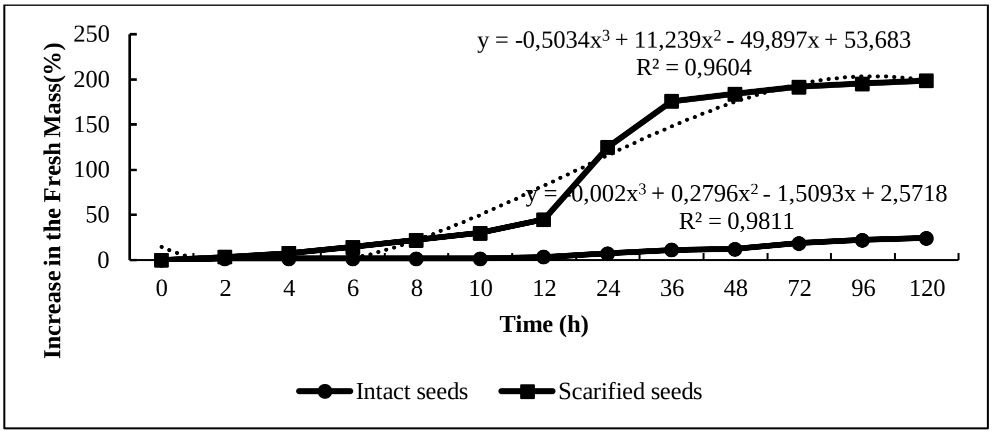

Figure 1. *Enterolobium timbouva* seed soaking curve. Source: The Authors.

The water absorption by the seeds obeys a three-phase pattern. Phase I, called soaking, is a consequence of the matrix potential and, therefore, it is a physical process occurring regardless of seed viability or dormancy, since it is not a tegument dormancy causing impediment of water entry. Phase II, called stationary, occurs as a function of the balance between the osmotic potential and the pressure potential. In this phase, the seed absorbs water slowly and the embryonic axis can not grow yet. Finally, phase III is characterized by the continuation of water absorption, culminating with the emission of the primary root (Carvalho et al., 2012).

In the scarified seeds, the soaking curve showed linear growth up to 36 hours (phase I) with an increase of approximately 176% and reached approximately 199% with 120 hours of soaking (phase II). On the other hand, with the seeds intact the increase of fresh mass was approximately 24% at 120 hours.

In spite of the increase in fresh mass observed in the scarified seeds, it was not possible to observe phase III, when the growth of the embryonic axis becomes visible as a result of the primary root emission.

Similar behaviors were observed by studying the impregnation curves of *Enterolobium contortisiliquum* Vell. Morong. (Fogaça et al., 2004) and *Enterolobium maximum* Ducke (Farias, 2014), where the authors verified a higher increase of fresh mass of scarified seeds in relation to intact seeds, indicating the occurrence of integument dormancy in both species. Also, they did not observe the occurrence of phase III, which culminates with the radicular protrusion.

Based on the results presented in Table 1, it was verified that the evaluated seed lot showed a variation of the degree of impermeability of the tegument, since in the control it was observed an emergence of 7.0%, which was statistically similar to the treatments that submitted intact seeds to soaking by 24 hours (3.0%) and 48 hours (5.0%).

Table 1. Mean values of first count (FC), index of emergence speed (IES), emergence (E) and hard seeds (HS) of *Enterolobium timbouva* submitted to different treatments of dormancy overcoming, under nursery conditions. Source: The Authors.

Treatment	FC (%)[1]	IES	E (%)	HS (%)
Control	0,0 b	0,2 c	7,0 c	92,0 a
Intact seeds soaked for 24 hours	0,0 b	0,0 c	3,0 c	94,0 a
Intact seeds soaked for 48 hours	0,0 b	0,2 c	5,0 c	86,0 a
Seeds mechanically scarified	0,0 b	2,4 a	83,0 a	2,0 b
Scarified seeds soaked for 24 hours	38,0 a	2,9 a	88,0 a	0,0 b
Scarified seeds soaked for 48 hours	30,0 a	1,4 b	43,0 b	0,0 b
CV (%)	12,9	11,2	22,7	9,6

[1] Means followed by the same letter, in the column, do not differ by Tukey test, at 5%. CV (%) - coefficient of variation.

Seeds of the same genus, *E. contortisiliquum* without previous treatment also presented germination of 5% in work that evaluated different treatments to overcome seed dormancy of this species (Santos et al., 2011). In other works, the germination of *E. contortisiliquum* seeds without previous treatment was not verified (Alexandre et al., 2009; Silva et al., 2009; Cuz-Silva et al., 2011).

This variation observed in the permeability of the tegument is justifiable, because genetic and environmental factors during the production (Rolston, 1978; Argel et al., 1983), the stage of development of the seeds at the moment of drying and the type of drying can affect the permeability of the tegument, determining the percentage and the intensity of dormancy (Marcos-Filho, 2005; Nakagawa et al., 2005).

The treatments that resulted in lower percentages of emergence (control, intact seeds soaked for 24 and 48 hours) and that were statistically inferior to the others, also presented the highest values of hard seeds. This showed that the degree of hydration of the seed tissues did not allow the increase of the respiratory activities to a level capable of sustaining the embryo growth, with sufficient supply of energy and organic substances.

The inefficacy of these treatments was confirmed by the mean values obtained in the two vigor tests, first counting and IES, which were statistically inferior to the other treatments.

It was verified that the treatment with mechanical scarification followed by soaking for 24 hours was efficient to promote 88% of emergence and with index of emergence speed of 2.9, but did not differ statistically from the treatment in which the seeds were only scarified mechanically with 83% of seedlings formed and 2.4 of IES.

Similar results were obtained by other researchers studying the efficiency of different treatments for the dormancy overcoming of *E. contortisiliquum* seeds, where they verified that mechanical scarification with sandpaper (Alexandre et al., 2009; Cruz-Silva et al., 2011), mechanical scarification followed by water soaking by 12 hours (Alexandre et al., 2009) and mechanical scarification followed by immersion in water for 24 hours (Silva et al., 2009) provided the best germination and germination speed index.

This variation of results observed by different researchers is due to the degree of impermeability of the integument of the evaluated seeds, which can be affected by genetic and environmental factors during the production (Rolston, 1978; Argel et al., 1983).

The treatments that resulted in the best emergence and IES results, were those whose seeds were subjected to mechanical scarification followed by soaking for 24 hours since allowed the acceleration of the emergence process. This result was verified by the average value of first counts of 38%, superior and statistically different from that one obtained when the seeds were only submitted to scarification (0%).

When the seeds were submitted to mechanical scarification and the soaking period of 48 hours, the percentage of emergence and IES were reduced to 43% and 1.4, respectively. Possibly, the reduction of the values of these variables occurred due to the deterioration suffered by the seeds exposed to a longer soaking period. Since, in a study carried out on different treatments for the dormancy overcoming of seeds of *Enterolobium* species, the authors verified that periods of soaking over 24 hours, resulted in deterioration of the seeds (Alexandre et al., 2009).

CONCLUSIONS

Enterolobium timbouva seeds present integumentary dormancy.

It recommends the mechanical scarification of the seeds followed by soaking for 24 hours as the most efficient method to overcome the dormancy of *E. timbouva* under nursery conditions.

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ÍNDICE REMISSIVO

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