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SEED BANK INDUCED WITH SPECIES NATIVE TO THE CAATINGA (FABACEAE) IN SÃO MAMEDE, PB

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ABSTRACT: To better understand the ecological dynamics of species *Mimosa tenuiflora* (MT), *Libidibia ferrea* (LF) and *Erythrina velutina* (EV) with respect to their ecological behavior with regard to their seedbank, it is necessary to better understand such ecological dynamics. Therefore, the aim of this research was to study such processes in the city of São Mamede-PB. Thus, seeds of these species were placed in containers (composed of shading screen material), which were placed in the soil in an area with Caatinga vegetation without litter and at depth of 5 cm. MT and LF seeds were incubated in mid-March and EV seeds in April, both in 2016. Seeds were monthly evaluated for their germination quality. The statistical design used was completely randomized (CRD), using ANAVA (treatments) and Tukey's test (means), both for $p<0.05$ and $p<0.01$. *M. tenuiflora, L. ferrea* and *E. velutina* seeds lost viability over the evaluation time, mainly around the third month of planting. Further studies on this theme, with related species, should be carried out in order to improve the understanding of such ecological demand.

KEYWORDS: Caatinga ecology, tegument dormancy, *Mimosa tenuiflora*, *Libidibia ferrea, Erythrina velutina*.

BANCO DE SEMENTES INDUZIDO COM ESPÉCIES NATIVAS DA CAATINGA (FABACEAE) EM SÃO MAMEDE, PB

RESUMO: Para melhor entender as dinâmicas ecológicas das espécies *Mimosa tenuiflora* (MT), *Libidibia ferrea* (LF) e *Erythrina velutina* (EV) com respeito ao seu comportamento ecológico no tocante ao seu banco de sementes fazem necessários para que melhor entender tal dinâmica ecológica. Portanto, o objetivo desta pesquisa foi estudar tais processos descritos no município de São Mamede-PB. Assim, foram colocadas sementes das espécies relatada em recipientes (compostos por material de telas de sombrite), estas foram colocadas no solo em área com Caatinga sem serapilheira e a 5 cm de profundidade. As sementes de MT e LF foram incubadas em meados de março e as de EV em abril, ambos no ano de 2016. Mensalmente foram avaliadas quanto a sua qualidade germinativa. O delineamento estatístico empregado foi o inteiramente casualizado (DIC), com uso da ANAVA (tratamentos) e teste de Tukey (médias), ambos para $p<0,05$ e $p<0,01$. As sementes de *M. tenuiflora, L. ferrea* e *E. velutina* perderam a viabilidade com passar do período de tempo mensurado, principalmente por volta do terceiro mês de plantio. Maiores estudos sobre esta temática, com as espécies relacionadas podem ser realizados a fim de melhorar o entendimento de tal demanda ecológica.

PALAVRAS CHAVE: Ecologia da Caatinga, dormência tegumentar, *Mimosa tenuiflora*, *Libidibia ferrea, Erythrina velutina.*

INTRODUCTION

The Caatinga biome presents heterogeneous vegetation, represented by xerophytic formations in different strata (herbaceous, shrubby and arboreal), rich in biodiversity and endemism and still with many species of deciduous character in the driest periods. Few studies have been carried out in this biome showing the (re)structuring of areas that were once deforested, important sources of knowledge for the construction of coherent and sustainable management of this biome (Costa and Araújo, 2003).

It is necessary to demonstrate that the Caatinga vegetation has been highly modified and damaged by human action and that such management has contributed to desertification (Araújo Filho, 2013). Thus, studies on the behavior of this vegetation, especially of pioneer species, can be a good source of information to better manage this fraction of the Caatinga vegetation, among them *Mimosa tenuiflora, Libidibia ferrea* and *Erythrina velutina*.

The species *Mimosa tenuiflora* (Willd) Poiret (Fabaceae: Mimosoideae), found in almost all areas of this biome (Araújo Filho, 2013), is a typical tree in the northeastern semiarid area, which presents fast growth, rusticity, and can survive in degraded areas, presenting characteristics that can be used for wood, medicinal and energy purposes and that can be used in restoration programs. *Libidibia ferrea* (Mart. ex Tul.) L.P. Queiroz (Fabaceae: Caesalpinoideae), can be used as energy source, civil construction and urban afforestation (Nogueira et al., 2010). *Erythrina velutina* (Willd) (Fabaceae: Faboideae), is a cosmopolitan plant in the biome, with diverse uses (Lorenzi, 2002).

An important work factor for the recovery of degraded areas would be the understanding of the possibilities of seedbanks present in these areas. The seedbank is a dynamic system composed of viable seeds at a given time and certain location, being affected by biotic and abiotic factors (Schorn et al., 2013), which can last and be viable for a certain period of time. Studies focused on forest species are still incipient (Costa and Araújo, 2003), especially for the Caatinga biome (Santos et al., 2010).

A coherent way of evaluating this bank is the germination test of seeds that in turn received biotic and abiotic factors, which can considerably influence the quality and vigor of these seeds (Kerbauy, 2013). Furthermore, this seedbank can be induced so that the dynamics that involve the presence and germination of certain plant species in relation to these factors are understood. Therefore, the aim of this research was to study the ecological dynamics occurring in a seedbank induced with species native to the Caatinga biome (FABACEAE), in the city of São Mamede-PB.

MATERIAL AND METHODS

Seed collection

M. tenuiflora (MT), *L. ferrea* (LF) and *E. velutina* (EV) seeds were used. Seeds were collected in areas of the municipalities of São Mamede and Patos, both in the state of Paraíba. The processing, cleaning, homogenization and division of groups of equal size were carried out at the Laboratory of Forest Seeds (LSF), Federal University of Campina Grande (UFCG), Campus de Patos - PB.

Seedbank incubation in the field

To carry out the seedbank incubation, seeds were placed in containers made from shading screens, with opening that did not allow their exit, with sufficient samples based on 13 collections for each species, originating from an area with Caatinga, in the municipality of São Mamede-PB. The number of 110 seeds was counted in each container.

In the Caatinga area, under the canopy of trees of species under study, these bags were incubated in the soil at about 5 cm in depth after the removal of litter. The depth of 5 cm was pre-defined because the largest amounts of seeds in the soil seedbank is found at this depth (Costa and Araújo, 2003). The locations of each container containing seeds were marked with paddocks of 40 cm in height. MT and LF seeds were incubated in March and EV seeds in April, both in 2016, aiming at evaluating the viability of seeds, for a period of eight months of incubation. Monthly, a container was removed, taken to the LSF (Laboratory of Forest Seeds), and germination test was carried out, within the period of February - November, 2016.

For LF seeds, the study was carried out with two matrices, separately, Matrix 1 (providing greater light input conditions due to its open canopy) and Matrix 2 (providing greater shading conditions due to its denser canopy), within the period of March - December, 2016.

Experiment conduction at the laboratory

At each collection month, seeds were characterized as viable (intact seeds) or dead (seeds predated by fauna). The determination of the number of intact seeds was carried out by counting the number of intact seeds and subtracting the result by the number of missing seeds. Live seeds were submitted to dormancy break, for the performance of the germination test: LF seeds were exposed to concentrated sulfuric acid for 20 minutes, MT seeds were submitted to thermal shock in immersion in water at 100 ºC for 2 minutes and EV seeds to scarification with # 20 sandpaper. Each collection consisted of a separate treatment, with non-cumulative effects (Brasil, 2009; Brasil, 2013).

To install the germination test, seeds were disinfected with sodium hypochlorite (1%) and washed with distilled water (Brasil, 2009; Brasil, 2013). After this procedure, seeds were sown in gerbox-type boxes containing vermiculite for MT and LF and sand for EV as substrates, with four replicates of 25 seeds. Gerboxes were taken to the germination chamber with 12-hour photo period and alternating temperature of 25-30 °C. The number of germinated seeds was daily counted. The duration of the germination test was 17 days for the three species. At the end of each germination test, during the 08 months of monitoring the viability and vigor of seeds in the soil, the percentage of germinated and dead seeds (predated by fauna) was evaluated, using four replicates of 25 seeds in each treatment. Data obtained as percentage were transformed into arcsine. When there were many values equal and zero, the constant 0.5 was added to data.

Treatments consisted of the control test or zero incubation time, with viability evaluated after seed collection (T0) and evaluation after permanence in the soil, carried out monthly, for eight months (T1 to T8), totaling 09 treatments.

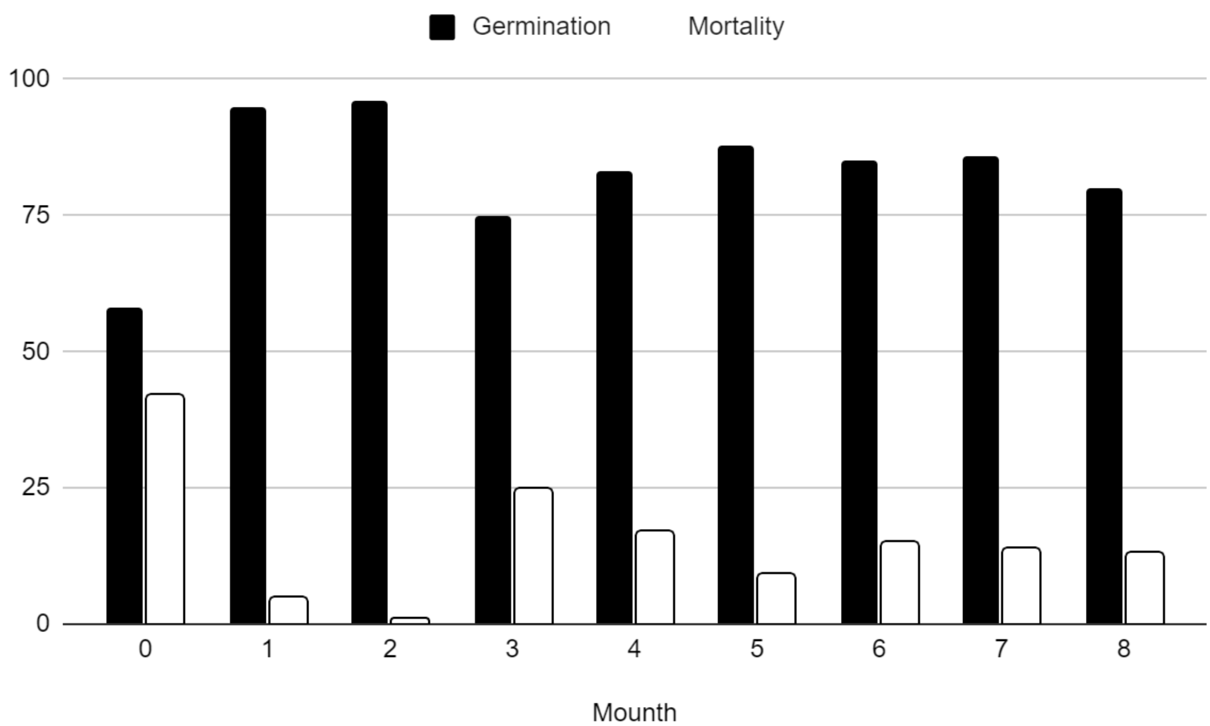
The statistical design used was completely randomized (CRD). Analysis of variance and comparison between treatment means was performed using the Tukey's test ($p<0.05$ and $p<0.01$), using the Assistat Version 7.5beta software (Silva and Azevedo, 2012).

RESULTS AND DISCUSSION

M. tenuiflora

The Analysis of Variance for the viability of MT seeds during the incubation period did not show significant differences between treatment means ($p<0.05$) (Figure 1). That is, the period of permanence of seeds in the soil did not affect the viability of seeds and positively influenced germination, with germination percentage above 75% after eight months of incubation of seeds in the soil. Regarding the seed mortality percentage, there were also no differences between treatments ($p<0.05$) (Figure 1), with the highest means observed in the third and eighth months of incubation. Probably, the action of soil fauna on the seed coat may have caused wear that allowed the embryo to deteriorate.

Figure 1. Mean germination and mortality percentages of *M. tenuiflora* during eight months of incubation in the soil.



* Means do not differ statistically from each other by the Tukey's test ($p<0.05$).

Percentage / months / Germination rate / mortality rate

For Lacerda (2007), seed mortality is associated with biotic and abiotic factors, which probably may have benefited *M. tenuiflora* seeds because germination in all months surveyed was higher than in month 0 (control). This energy expenditure, according to Salla (2015), can favor germination through access to natural resources that promote germination and, according to Costa and Araújo (2003), pioneer species have mechanisms such as tegument dormancy, which can be seen as a factor that positively influenced the results of this study. Biotic and abiotic factors that occurred in the site promoted dormancy overcoming, with higher mortality in control (42%), and over the incubation period, lower mortality (between 1–25%) and higher germination were observed (75 – 96%), although dormancy remains throughout the 8 months of incubation.

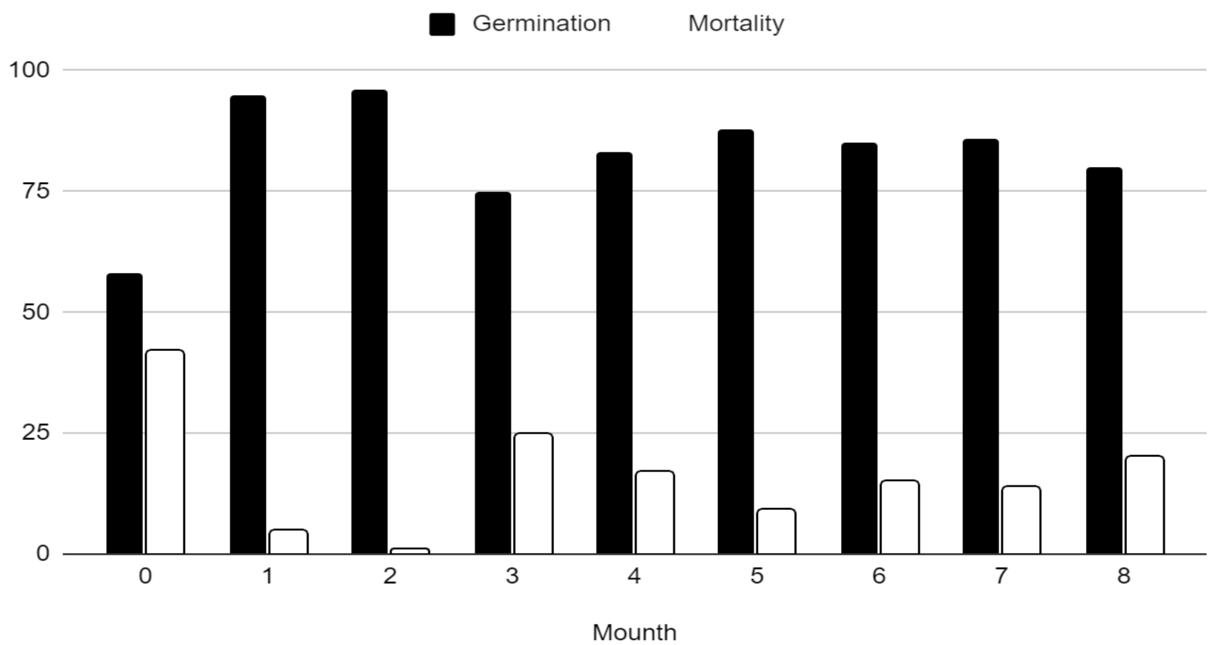
For Monquero and Christoffoleti (2005), abiotic conditions and sowing depth can influence seed germination, corroborating results of this work, where seed incubation occurred at the beginning of the rainy season in the study site, and even with high soil moisture, seeds remained viable and dormant. For Kerbauy (2013), dormancy is an important strategy capable of ensuring their survival over time, especially for pioneer species and in unfavorable environments. When analyzing the behavior of *Mimosa tenuiflora* seedbank, it is clear that the species was able to remain viable in the soil throughout the 8 months of study.

Affonso et al. (2014) studied the induced *Commiphora lepthophloeos* seedbank in a Caatinga area for 12 months and found increase in germination, which varied from 5% in the first month to 90% in the third month, 70% in the sixth and 20% in the twelfth month of incubation. These authors reported that germination is favored by the time seeds remain in the soil. Motta et al. (2006) analyzed the viability of *Guazuma ulmifolia* seeds sown at depth of up to 4 cm and with time of permanence of up to five months in the soil and observed that the viability of seeds remained above 70% until the fifth month, with higher germination rate in the group of seeds sown at 2 cm in depth.

L. ferrea (LF) - Matrices 1 and 2

The incubation conditions in Matrix 1 provided lower shading conditions, as the canopy was more open. In this matrix, the influence of the time of permanence of seeds in the soil was verified in relation to their viability, with differences between treatment means for the germination percentage ($p<0.05$). It was observed that seeds remained viable until the second month after their incubation in the soil, with total predation in some months and close to that in others, from the third month onwards (Figure 2).

Figure 2. Average germination and mortality percentages (predation by fauna) of *L. ferrea* seeds during eight months of incubation in the soil.

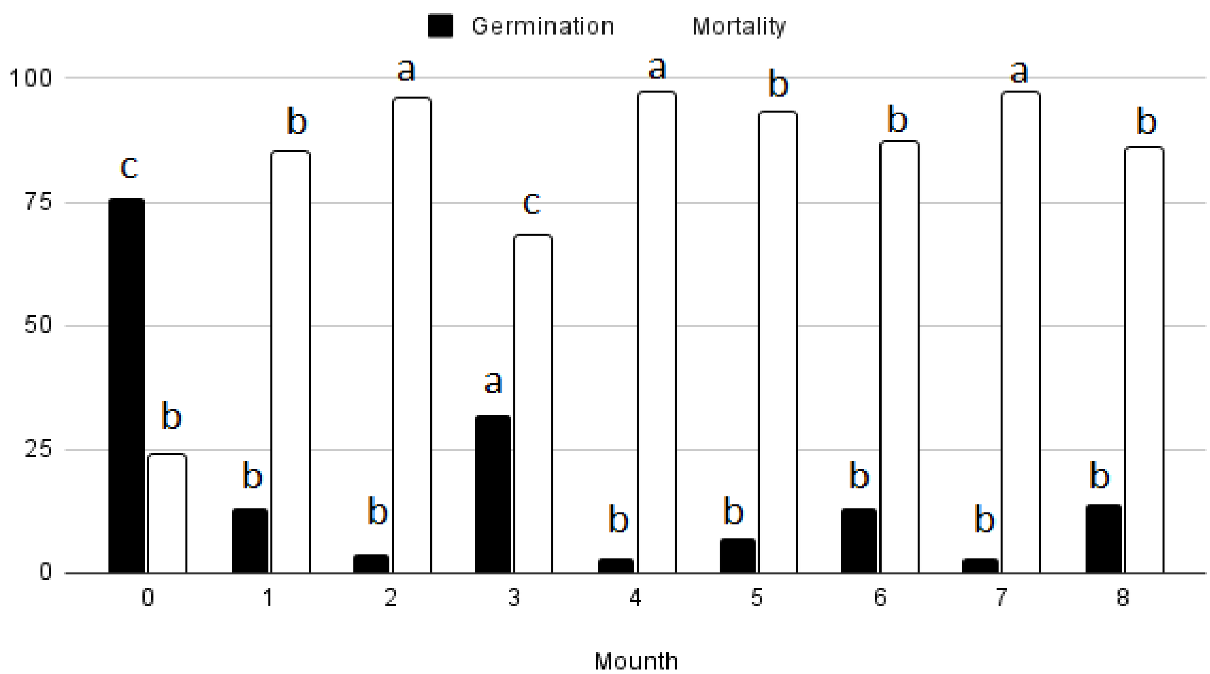


* Means followed by the same letter do not differ statistically from each other by Tukey's test ($p<0.05$).
Percentage / months / Germination rate / mortality rate

Lima et al. (2006) studied the effect of temperature and substrate on the germination of *L. ferrea* seeds and found that newly harvested seeds presented germination percentage of about 3% for non-scarified seeds. The authors also reported that the low germination percentage may be a consequence of the reduced water gain during imbibition caused by factors related to the tegument dormancy of seeds of this species.

Thus, the scarification of these seeds and their subsequent sowing in different substrates at temperatures of 25, 30 and 35°C allowed germination percentage above 95%, according to Lima et al. (2006). On the other hand, this research obtained results different from those of Crepaldi et al. (1998), who reported that seeds with tegument dormancy can remain viable in the soil for long periods of time. The result obtained in this research contradicts such information, in reference to Matrix 1. Seeds incubated under the canopy of Matrix 2 presented conditions of greater shading due to the higher canopy density. For this matrix, statistical differences ($P < 0.05$) between treatments were also observed, both for germination percentage and for dead/predated seeds (Figure 3). In this matrix, the loss of viability was faster than in the previous one, as in the second month, it reached 8%, with variations between 10 and 32% in the following months, unlike the previous matrix, with percentages of zero and close to it in subsequent months.

Figure 3. Average germination and mortality/predation percentages of *Libidibia ferrea* seeds during eight months of incubation in the soil.



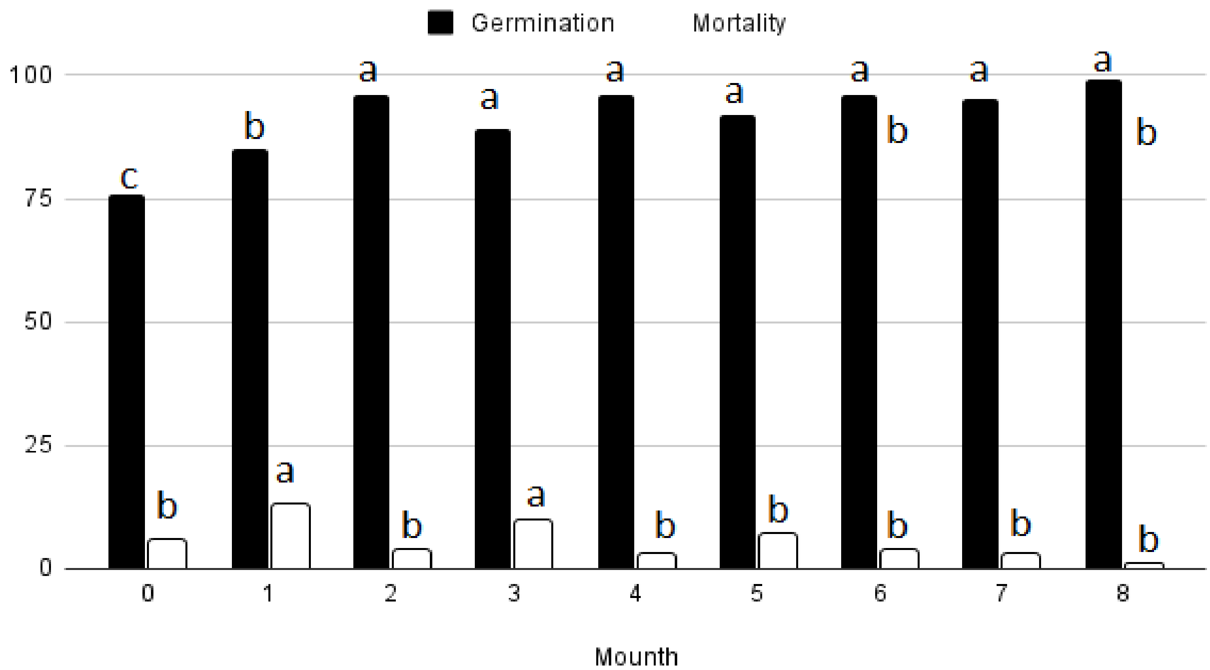
* Means followed by the same letter do not differ statistically from each other by Tukey's test ($p<0.05$).
Percentage / months / Germination rate / mortality rate

Overall, there was little change in the germination percentage from one matrix to another, as mortality rates were high for both. Matrix 1 was able to favor conditions for seeds to remain viable in the first and second months, with 33% and 51%, respectively, of viable seeds, and, in the subsequent months, germination percentages remained below 4%. The second matrix showed loss of viability after the second month of incubation, with germination percentage of about 50% in the first month and only about 8% in the second. This fact can be related to the period in which seeds were incubated, as it was the rainy season in the region, and soil moisture may have favored seed deterioration due to predation observed in the field. Predated seeds were common in the test, as described by Motta et al. (2006). The species was not able to maintain viability in the soil for the conditions under study, the severe dormancy of post-harvested seeds does not ensure their permanence with high viability in the soil for long periods.

E. velutina

E. velutina seeds incubated in soil showed rapid loss of viability, with statistically significant differences between treatments (p<0.05) (Figure 4). After the first month of incubation of the *Erythrina velutina* seedbank in the soil, germination occurred at the incubation site (Figure 4). This event can be explained by the fact that seed incubation began in May, when rain was already occurring at the study site, and the high soil moisture promoted water absorption, necessary for the germination process.

Figure 4. Average germination and mortality percentages (predation by fauna) of *E. velutina* seeds during eight months of incubation in the soil



* Means followed by the same letter do not differ statistically from each other by Tukey's test (p<0.05).
Percentage / months / Germination rate / mortality rate

For Kerbauy (2013), water is the main factor influencing germination, responsible for triggering metabolic processes necessary for the germination process. Santos et al. (2013) reported tegument dormancy for the species in post-harvest seeds. The authors found germination of about 17% in seeds without any treatment to overcome dormancy, and mechanically scarified seeds obtained average germination of 98%. EV seeds were incubated under the canopy of an individual of the species, and the area was also found to have considerable moisture.

In a study of induced *Genipa americana* seedbank in two distinct areas, hilltop and riparian forest, Salla (2015) observed that in the second month of the study, seeds incubated at the top of the hill presented about 60% of viability, and seeds disposed in the riparian forest exhibited only about 26% viability. In this study, incubation in the soil quickly overcame the tegument dormancy presented by the species, and promoted the germination of some seeds and the rapid deterioration of most of them, probably due to the action of the microbiota (Figure 4). Tegument dormancy is configured by primary mechanical dormancy in which the anatomical structure of the seed coat prevents or restricts water absorption (Loureiro et al., 2013) and requires treatments such as sandpaper to overcome it (Mantoan et al.., 2012). For Lacerda (2007), tegument dormancy can be overcome with the help of external factors.

M. tenuiflora, L. ferrea and *E. velutina* seeds lost viability after a period of time, mainly around the third month of planting. Further studies on this theme, with related species, should be carried out in order to improve the understanding of such ecological demand.

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