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Germination ecology of cerejeira (*Amburana acreana* (Ducke) A. C. Sm.) seed as a function of temperature and photoperiod

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Abstract. The expansion of agricultural areas over the Amazon biome and illegal logging has caused a reduction in forest areas and the risk of extinction of several native species. Thus, cultivation in agroforestry or monoculture systems is essential for the economic and environmental sustainability of the sector. For this, it is necessary to understand the physiological parameters of seeds and establish protocols that help growers and nurseries during the seedling production phase. The objective of this work was to develop methods to evaluate the germination of *Amburana acreana* seeds at different temperatures and photoperiods. The seeds were submitted to germination tests, germination speed and average germination time at constant temperatures of 25 °C, 30 °C, 35 °C and 40 °C and two photoperiods, 12 and 24 hours of light. The temperature of 40°C inhibited germination. The germination process of *A. acreana* seeds is favored with a temperature of 30 °C under 24 h of light, promoting up to 100% germination.

Keywords: *Amburana acreana*, Amazon Biome, forest seedlings

Introduction

Brazil is one of the largest agricultural producers and exporters in the world (ZALLES *et al.*, 2019), and sectors such as livestock and grain production have a strong influence on the country's gross domestic product (IBGE, 2020). In recent decades, there has been strong growth in the sector, partly explained by the adoption of new

technologies, with increased productivity, and partly by the opening and expansion of new areas, mainly in the Cerrado and Amazon Biomes (DIAS *et al.*, 2016). This fact has raised concern among environmentalists and civil society, given the negative environmental impacts that this anthropic action has been causing.

In the Brazilian Amazon, in addition to the expansion of agricultural areas, illegal logging has negatively affected local biodiversity, with several native species at risk of extinction. Among these species, stands out the cerejeira *Amburana acreana* (Ducke) AC Sm., family Fabaceae, a tree native to the southwest of the Amazon, which has been much sought after and extracted from native forests by loggers in the region (FIGUEIREDO *et al.*, 2015; RAYOL *et al.*, 2017; PEREIRA *et al.*, 2018).

One of the strategies to reduce the pressure of forest exploitation and reduce the risk of extinction of several species is through planting in agroforestry systems, or in monoculture (OLIVEIRA *et al.*, 2017), which allows, in addition to the production of wood with economic potential (VIEIRA *et al.*, 2011), increase the sustainability of the sector, reducing the negative impacts that exploration causes.

However, the lack of knowledge about the ecology of these species limits their use as a planted forest, and threatens the conservation of their seeds in germplasm banks. In this sense, it is essential to understand the physiological processes associated with their seeds, as well as the procedures aimed at evaluating their germination potential, so that it is possible to establish protocols that help in the seedling production phase.

The germination test aims to determine the maximum physiological potential of seed lots, the result of which can be used to compare the quality of different lots and estimate their cultural value. During germination, a series of biochemical reactions are triggered, mainly influenced by temperature and light, since the efficiency of enzymatic systems is directly related to the quantity and intensity of these two factors (PACHECO JÚNIOR, 2010).

Temperature affects both the seed germination rate and the speed at which it occurs, as it is related to the water imbibition curve and regulation of various metabolic processes, such as respiration for example (BEWLEY *et al.*, 2013). The optimal temperature for germination can vary depending on the species, physiological condition and seed age, where young, newly harvested seeds require different moisture levels from aged seeds (ROWEDER *et al.*, 2020).

In addition to temperature, germination can be affected by the level of incident light. Biologically, seeds can be classified as positive photoblastic, which require light to trigger the germination process; negative photoblastic, which germinate in the dark, in addition to neutral or non-photoblastic, which are endowed with the ability to germinate in any environment. In addition, the amount and intensity of light can cause physiological and functional changes, which are related to plant growth and development (PERNÚS; SÁNCHEZ, 2017).

Table 1. Summary of statistical analysis of germination (G), germination speed index (IVG) and mean germination time (TMG) of cerejeira seeds as a function of temperature and photoperiod.

Thus, the objective of this work was to evaluate the influence of temperature and light on the germination of cerejeira (*Amburana acreana*) seeds under laboratory conditions.

Materials and Methods

The experiment was conducted at the Seed Laboratory of the Technology Foundation of Acre - Funtac, municipality of Rio Branco, AC, from september to november 2020. The experimental design was completely randomized, in a 4 x 2 factorial (temperature and light). Seeds of *Amburana acreana* were collected from matrix trees in the area of the Association of Small Agroforesters of the Reca Project, located in the district of Nova California, RO. After collection, the seeds were homogenized to obtain the pure seed fraction. The water content of the seeds was determined by the greenhouse method (BRASIL, 2009), showing average values of 10.7% in the analyzed lots.

The seeds were previously disinfested with sodium hypochlorite (2%) for five minutes and then washed in running water. Next, four subsamples of 25 seeds were placed on 19 g Germitest paper moistened with 57 mL of deionized water (three times its mass). After distribution, the seeds were kept in a BOD germinator, regulated to maintain constant temperatures of 25 °C, 30 °C, 35 °C and 40 °C, in two different photoperiods, 12 and 24 hours of light. The count of germinated seeds was performed daily for 30 days. The calculation of the percentage of emergence followed the model proposed by Labouriau e Valadares (1976).

The germination speed index was obtained for each sub-sample, adding the number of seedlings emerged each day, divided by the respective number of days elapsed since sowing (NAKAGAWA, 1999). At the end of the test, the emergence speed was calculated according to the formula proposed by Maguire (1962). The average germination time was calculated by the formula cited by Silva e Nakagawa (1995), based on the number of seeds germinated daily, during the thirty days of the germination test.

The procedures related to the statistical analysis of the results of the variables consisted of the initial verification of the presence of discrepant data, normality of the residues and homogeneity of the variances. After checking the assumptions, the analysis of variance was performed using the F test to verify the effects of the treatments, and noting differences, the qualitative data were compared using the Tukey test at 5% probability.

Results and discussion

Germination percentage (G), mean time (TMG) and velocity index (IVG) were influenced by the significant interaction between photoperiod and temperature (Table 1).

Source of variation	GL	G			IVG			TMG		
		Mean square								
Temperature (T)	1	21,13**	5,95**	100,82**						
Photoperiod (F)	3	2882,75**	12,95**	187,90**						
T x F	3	17,13*	0,84**	12,93**						
Erro	24	1,69	0,03	0,33						
CV (%)		7,93	9,90	8,31						

Nota: * significant at 5% probability. ** significant at 1% probability.

No germination occurred in seed lots subjected to a temperature of 40 °C regardless of the photoperiods (12 h and 24 h) studied (Table 2). Cerejeira seed death may be related to protein denaturation caused by heating (BEWLEY *et al.*, 2013). According to CARVALHO *et al.*, (2020) temperatures considered moderately high (35 to 42 °

C) can change the physicochemical properties and the functional organization of the cellular structures of seeds. As a result, seeds progressively deteriorate as a result of lipid peroxidation, damage to the cytoplasmic membrane and changes in the activity of antioxidant enzymes (WANG, 2015).

Table 2. Germination percentage (%), germination speed index, and average germination time of *A. acreana* at different temperatures and luminosity.

Feature	Photoperiod	Temperature (°C)			
		25	30	35	40
G (%)	12 h light	85 Aa	84 Ba	80 Aa	0 Ab
	24 h light	90 Aab	100 Aa	85 Ab	0 Ac
IVG	12 h light	1,61 Bb	1,97 Bab	2,23 Ba	0 Ac
	24 h light	2,82 Ab	3,45 Aa	2,98 Ab	0 Ab
TMG (days)	12 h light	13,90 Bc	11,32 Bb	9,58 Ba	0 Ad
	24 h light	8,60 Ab	5,87 Aa	6,15 Aa	0 Ad

Means followed by the same letter, uppercase in the column and lowercase in the row, within each factor, do not differ from each other ($p > 0.05$).

It observed a positive response for cerejeira tree germination in the range of 25 to 35 °C, this demonstrates that the seed germination process is favored by warmer environments and in relation to the photoperiod it obtained 100% germination for the period of 30 °C / 24 h light. The optimal temperatures reported here are in agreement with other studies carried out with seeds of the same genus, such as the cumaru-de-scent (*Amburana cearensis*) (GUEDES *et al.*, 2010; ALMEIDA *et al.*, 2017), and also with species from the same family, sombreiro (*Clitoria fairchildiana*) (ALVES *et al.*, 2011) and pay phone (*Enterolobium contortisiliquum*) (RAMOS, 2018). The optimal temperature for germination is a primordial factor that guarantees the action of seed reserves in the establishment of the species, being responsible for the increase in metabolism and for the translocation of these reserves to the embryonic axis (ALMEIDA *et al.*, 2017).

The results for the germination speed index at the studied temperatures and photoperiods are shown in Table 2. It can be seen that the IVG increased with a temperature of 30 °C and a photoperiod of 24 hours. Bewley *et al.* (2013) state that germination speed is more sensitive to variations in temperature and the data obtained are in accordance with those presented by Carvalho *et al.* (2020), who claim that the range from 25 to 30 °C is the optimum for braúna (*Schinopsis brasiliensis*) germination. According to Melo Junior *et al.* (2018),

the germination speed is a good indicator to assess the occupation of a species in a given environment, as the rapid establishment is strategic and can explain the ecology of the cerejeira, recognized as a pioneer tree (ARAÚJO; DANTAS, 2018), able to colonize regeneration gaps after openings in clearings due to falling trees or forms of environmental degradation (PIAZZA *et al.*, 2017) where they receive light directly and for longer periods.

Light is an ecological agent that influences germination (SILVA *et al.*, 2020), where phytochromes are responsible for capturing the light signals and converting them into biochemical signals, translating into different information according to quality, intensity and light exposure time. In the present study, the 24-hour photoperiod proved to be the most adequate, favoring germination, germination speed index and average germination time.

The mean germination time ranged from 6 to 14 days, with the lowest values ($p < 0.05$) observed in seed lots exposed to temperatures of 30 °C and 35 °C, both with 24 hours/light (Table 2). CARVALHO *et al.*, (2020) also found lower TMG at a temperature of 35 °C and 24 hours/light with mahogany (*Swietenia macrophylla*). The rise in temperature provided rapid root protrusion, which comes from the speed of imbibition and, consequently, acceleration of metabolic reactions during the seed germination process (GUEDES *et*

al., 2013). While, at a temperature of 25 °C/12 h light, there was a delay in the germination process, explained by the lower speed of germination, as the reduction in temperature can reduce water absorption, limiting several metabolic pathways (BEWLEY et al., 2013).

Conclusion

The temperature of 40 °C inhibits the germination of *A. acreana* seeds, regardless of the photoperiod. On the other hand, a constant temperature of 30 °C under 24 h of light favors germination and initial seedling growth.

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