Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 11, Issue, 02, pp.1495-1499, February, 2019

DOI: https://doi.org/10.24941/ijcr.34394.02.2019

ISSN: 0975-833X

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

GERMINATION ANALYSIS OF PTEROCARPUS ROHRII VAHL UNDER DIFFERENT SOWING TECHNIQUES

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ARTICLE INFO

Article History:
Received 10th November, 2018
Received in revised form
24th December, 2018
Accepted 20th January, 2019
Published online 28th February, 2019

Key Words:
Fabaceae; Seedling production; *Pterocarpus violaceus*; Aldrago; Forestry seeds.

ABSTRACT

Brazilian's native forestry species usually present a slow development. The demand for commercial production of seedlings from those species is rising due to its use on afforestation programs. Making necessary the development of techniques that reduce the time required to seedling production. *Pterocarpus rohrii* is an important Brazilian native species with some potential economic uses, but with rare publications about its technologic or biological characterization. Thereby, this study aimed to evaluate germination pattern associated with different sowing techniques of *Pterocarpus rohrii.* One thousand and eight hundred fruits from each population evenly distributed between two replicas of each treatment. Control treatment consisted of direct fruit sowing, while in the second treatment all fruits had their wings removed with scissors. Synchronization indexes were not significantly different between treatments or seed origin. Removal of the seed wing did not affect the time associated with the germination process but provided better germination rates. Germination pattern and responses between treatments and germination rates are dependent on population characteristics. Being responsible for a great variation on time required to germination of a seed lot. Besides that, wind removal seems to be an important procedure, since it promotes higher germination rates. Propitiating a better exploitation of a seed lot.

***Citation: REGNIER, Leonardo de Lima Pereira.* 2019.** "Germination analysis of *Pterocarpus rohrii* vahl under different sowing techniques", *International Journal of Current Research*, 11, (02), 1495-1499.

INTRODUCTION

About one hundred million Brazilians live in Atlantic rainforest, but the original vegetation was reduced to 7.3% (da, 2011). The constant destruction of native forests generates environmental problems and create the necessity of restoration of degraded areas, what sired the interest of development of native species (de S. Carvalho Filho, 2003). Slow development is the major problem found on the seedling production of Brazilian native species, especially of late successional groups or climax (Ferraz, 2011). Due to the long period required to seedling production, most simple sowing methods have not been capable to properly fulfill the demand of afforestation programs (de, 2003 and Ferraz, 2011).Promoting the application of strategies that accelerate the production process, without losing seedling qualities (Lorenzi, 2002). *Pterocarpus rohrii* is an arboreous Brazilian's species of Fabaceae family, popularly known as Aldrago or Pau-Sangue. It has a large occurrence in pluvial Atlantic rainforest since the south of Bahia and Minas Gerais states until Paraná state. This tree reaches between 8 and 14 meters tall, presents complex leaves presenting between 5 and 7 glabrous leaflets (Lorenzi, 2002).

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Fabaceae family presents a vast number of economically relevant species in Angiosperms, but usually, this family has limited information about the germination process (Ferraz, 2011). *Pterocarpus rohrii* is used on fence and boxes production also presents a potential use on particleboards (Farrapo, 2013), and decorative uses. Although the main use of this is species is associated with ornamentation, due to its bright leaves and exuberant bloom, what promoted the usage of this species in urban afforestation on São Paulo state (Lorenzi, 2002). Besides that, the easy propagation, high resistance against sun exposure and fast-growing makes this species very propitious to reforestation programs (Castanho, 2009). However, scientific publications about the biological, technological or potential uses are rare. At the same time, the very few information disposable is conflicting about seeds processing or germination data. Some authors indicate that the samara fruits must have their wings removed before sowing (Nogueira, 2016), while other authors assert that no seed processing is necessary, and the fruit can be directly forwarded to planting (Lorenzi, 2002). Thus, this study aimed to evaluate the possible impact in germination process between two populations of *Pterocarpus rohrii,* with different sowing techniques associated with the removal of fruits wings on germination process, focusing on commercial seedling production.

MATERIAL AND METHODS

This study was conducted in Harry Blossfeld plant nursery of São Paulo, situated in Cotia (23°36'30.0"S 46°50'48.9"W). The region presents Cwa, altitude tropical climate, according to Köppen climate classification (SMA, 2018). Presenting concentered rains during summer, dry winter, and the highest mean temperature above 22°C. Plant material was collected in South and East region of São Paulo city at the end of April and November 2018 respectively. Fruits from the tree and fallen were collected and kept at plastic bags at room temperature about 15 days until sowing. Before the beginning of experiments, one sample of four thousand fruits was used to the estimation of mean weigh of fruits with Filizola Mf weighing scale. The study consisted ofone thousand and eight hundred fruits from each population evenly distributed between two replicas of each treatment. Control treatment consisted of direct fruit sowing, while in the second treatment all fruits had their wings removed with scissors. After that, fruits were planted in white trays containing vermiculite as substrate and kept at greenhouse with white plastic covering and fogging watering system with periodic activation every 35 minutes. Plant emergence was recorded through 75 days after seeding, with measurements nearly every 7 days. The evaluation consisted in the use of indexes as mean germination time, also known as mean length of incubation time [10], and the standard deviation was calculated as proposed by Haberlandt in 1875[11]. Defined as:

$$T_m = \frac{N_{g1}T_1 + N_{g2}T_2 + \cdots + N_{gn}T_n}{N_{g1} + N_{g2} + \cdots + N_{gn}}$$

$T_m$is the mean germination time, the measurement of the mean time required to one seed germination, or the average length of time required for maximum germination of a seed lot. N_{g1}, N_{g2} e N_{gn} values are the quantities, non-cumulative, of germinated seeds during specific times T_1, T_2e T_n, respectively. In this study, time was always presented in days. Respectively standard deviation (s) noted as:

$$s = \sqrt{\frac{N_{g1}(T_1 - T_m)^2 + N_{g2}(T_2 - T_m)^2 + \cdots + N_{gn}(T_n - T_m)^2}{(N_{g1} - 1) + (N_{g2} - 1) + \cdots + (N_{gn} - 1)}}$$

Mean time to stabilize germination (T_{me}), also, its standard deviation, were calculated using the same rules for mean germination time. However, using cumulative germination data. Aiming to determinate the mean time required to germination and death rate reach the same mount, providing a stable seedling number on a seed lot. Synchronization index is associated with the distribution of the relative frequency of germination, as presented in Ranal e Santana (2006), the frequency of germination of k time is described as:

$$f_k = \frac{N_{gk}}{N_{g1} + N_{g2} + \cdots + N_{gn}}$$

In addition, the synchronization index (Ē)can be obtained by:

$$\bar{E} = (-f_1 log_2 f_1) + (-f_2\, log_2 f_2) + \cdots + (-f_n log_2 f_n)$$

All data were compiled to Excel component of Microsoft Corporation Office pack and represented through graphics and tables. All the statistical tests were executed with individual data of the replicas. Statistical tests were performed using Bioestat 5.0 software. The results were tested by ANOVA and in sequence submitted to Tukey test with a critical p-value of 5% ($p<0.05$).

RESULTS AND DISCUSSION

We obtained a mean weight of 0.587g per fruit or 1705 fruits per kilogram. Estimation of seeds/kg is very important since forestry seeds are usually sold per kilo. Our results were relatively close to Lorenzi (2002) estimation of 1530 seeds per kilogram but were very far from Nogueira and Brancalion (2016) estimation of 1100 seeds per kilo. No significant differences between the weight of fruits from the east or south population were found. Germination rate, mean time to reach 50% of germination, mean germination time and mean time to stabilize germination were statistically disparate according to seed population origin (Table 1) comparing control treatments. Besides that, the synchronization index was not significantly different. Indicating that even though the variations on time required to germination process occur on these two populations, these differences are not associated with the general pattern of synchronization of the germination process. Time for 50% of germination ($t_{1/2}$), as described by Ranal& Santana (2006), presents the required time to reach half of the germination of a seed lot. Pointing out how fast germination process of some species can be. What we found is that different populations present great variations on seed germination speed. Mean germination time and mean time do stabilize germination are important indexes sincemean germination time or mean length of germination time, demonstrates the required period to one seed of a species to germinate, indicating how much it is necessary to reach themaximum germination of a seed lot (Ranal, 2006). Mean time to stabilize germination is an important index to seedling producers since it indicates the time required to reach the maximum stable values of germination, designating the adequate waiting time between seeding and seedling transplant procedures.

During the seedling production process, differences of 7 days can be considered relevant, but not necessarily drastic. We found that to *Pterocarpus rohrii,* choosing the parent population can be an important aspect to pay attention since it can provide relevant variations of germination. It is already recognized that tropical trees present high genetic variations compared to non-woody plants, presenting greater regional variations (Hamrick, 2002 and Piña-rodrigues et al.2007) also emphasize that those variations can affect directly scientific research since some results are only applicable to the specific ecologic region of the study. Because most of the researches are conducted with one single population, providing a restricted seed sample. What we tried to overcome and to conflict with available data, gathering from two distinct city regions. Parent plants from east origin presented about 13 days of delay of germination process (Figure 1). Species that did not suffer the domestication process, as many of forest species, presents great disparities between populations since the dynamics of evolutionary processes keep actively acting over these species. What can results on differences on many levels, including seed dormancy (Piña-Rodrigues, 2007; Cruz, 2001) and seed germination. For the south region, seeds submitted to wing cut procedure presented faster germination than the control group, but after 58 days of analysis, there is a turn over point (Figure 1), when control group starts to presents a greater mean germination rate between replicas.

Table 1. Mean time, in days, for the first germination ($t0$), to reach 50% of germination ($t1/2$), to stabilize germination (Tme) and mean germination time (Tm) according to seed origin. Percentage of germination rate and the synchronization index (Ē) were also presented

Indexes / Seedorigin	t_0	$t_{1/2}$	T_m±s	T_{me} ±s	Germination rate (%)	Ē
South region	33	45.54*	49.68* ±7.7	59.97* ±8	93.2±0.1*	2.4
East region	46	67.00*	62.86* ±4.8	66.95* ±9.8	54.91±0.03*	1.95

(*) Statistically significant difference (p<0.05)

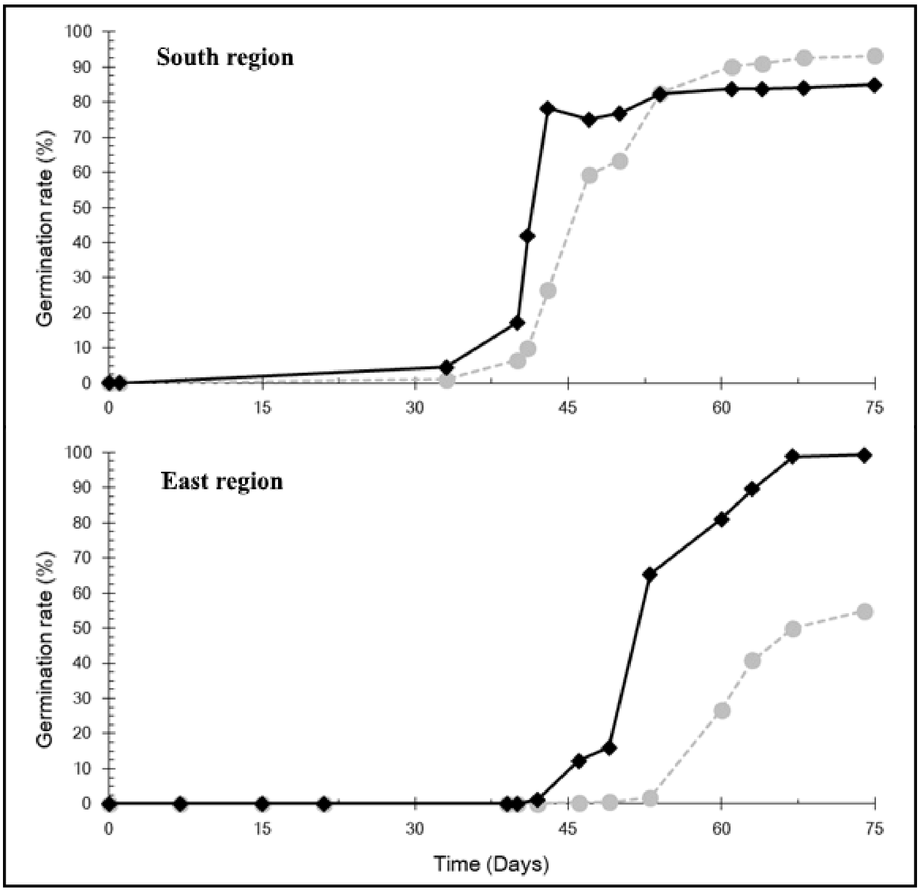

Figure 1. Mean cumulative germination of *Pterocarpusrohrii* seedlings according to seed population origin and submitted to wing cut (♦) and control (●) treatments during 75 days of the experiment

Table 2. Mean time, in days, for the first germination ($t0$), to reach 50% of germination ($t1/2$), to stabilize germination (Tme) and mean germination time (Tm) according to seed treatment. Percentage of germination rate and the synchronization index (Ē) were also presented.

Indexes / Treatment	t_0	$t_{1/2}$	T_m±s	T_{me} ±s	Germination rate (%)	Ē
Control	39.50	56.27	56.27±6.2	63.46 ±8.9	74.06±0.23	2.18
Wing removal	37.50	46.61	49.31±22.3	59.93±9.0	92.14±0.1*	2.15

(*) Statistically significant difference (p<0.05) compared to control group

This stands out the importance of time in seed germination since short-term evaluations could let to the conclusion that cutting seed wings always provide higher germination rates. What is inconsistent with the long-term evaluation data for south region seeds. Removal of the seed wing did not affect the time associated with the germination process (Table 2). Time for first germination, mean time to stabilize and to reach 50% of germination was not consistently affected. Mean germination time was also very slightly different. Besides that, the germination rate obtained during the experiment was statistically significant. What indicates that removing the wing with scissors propitiate a greater number of seeds to germinate. These results are consistent with the information found in Nogueira and Brancalion (2016), wichemphasize the importance wing removal in *P. rohrii* to better exploitation of a seed lot. A relevant aspect of seedling production. During the development of *Pterocarpus rohrii* fruits, there is a lignification of pericarp (Nakamura, 2005), what possibly hampers seed contact with water. Wing cut procedure probably favors water inflow, propitiating imbibition process and consequently the resumption of embryo development. Inducing the germination of a greater number of seeds. Germination rate obtained at this study is very discrepant from the rate obtained by Nogueira e Brancalion (2016) and Lorenzi (2002). These first authors found that *P. rohrii* presented germination rate lesser than 20%, while the last author affirms that germination rate reaches more than 40%. An important aspect to take a better look is the time used in germination rate estimation.

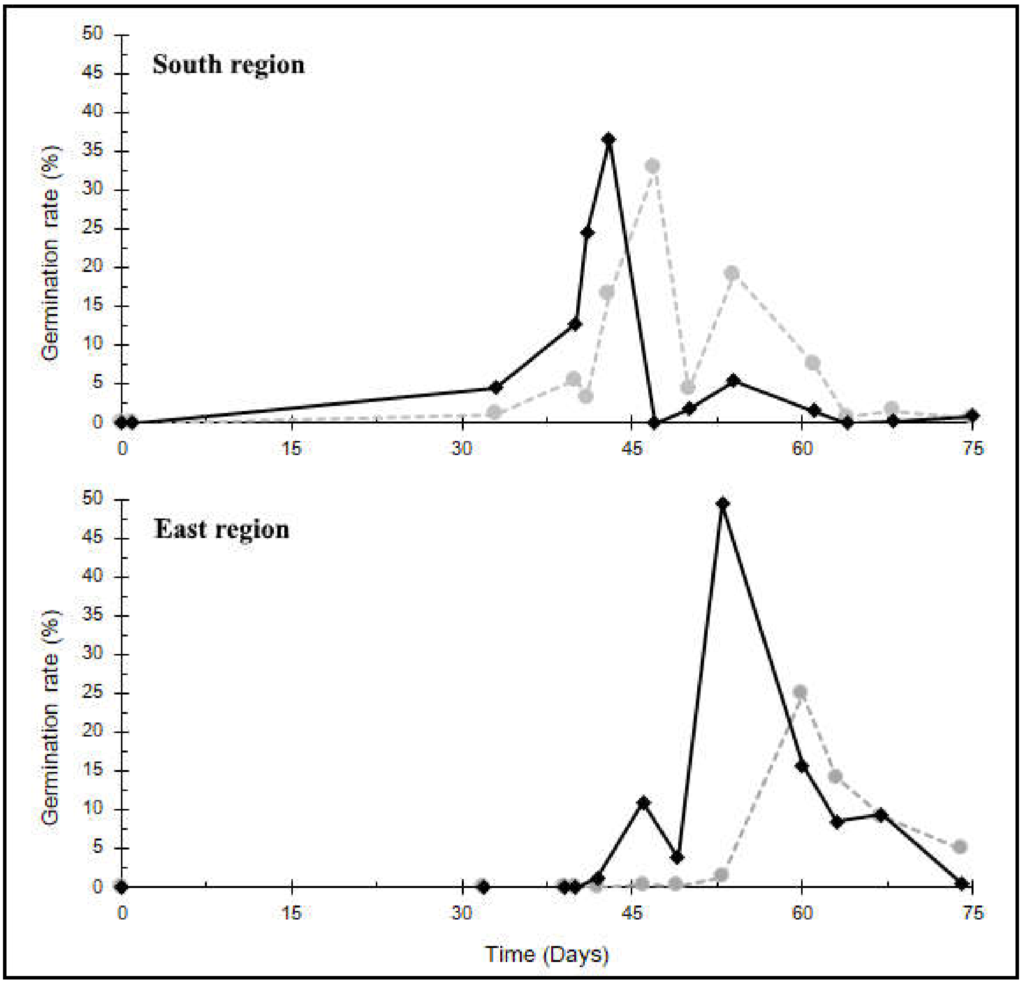

Figure 2. Mean non-cumulative germination of *Pterocarpusrohrii* seedlings according to seed population origin and submitted to wing cut (♦) and control (●) treatments during 75 days of the experiment

If those authors measured germination before germination stabilization, the value could be underestimated and can present a great range of variations. Besides that, we found closer results of germination rate found in Lorenzi (2002). Synchronization index was barely influenced by the treatments, what means that the process of wing removal does not promote interferences on synchrony of seed germination. What is consistent with the non-cumulative pattern (Figure 2), that demonstrates a short period of highly active germination. It is also important to notice that the wing removal promoted only a slight reduction of time of germination. Seeds with wing cut from south region presented a bland rise of non-cumulative germination values, while wing removal of seeds that come from the eastern region had higher values of non-cumulative germination. Besides the great number of seeds used in this study can apparently provide some reasonable confidence, these indexes must be carefully used. As we showed, there are local influences, were seed population origin promotes different patterns of response. Disparities also can be found according to the environment of germination were the study is conducted. Lorenzi (2002) also mentioned that germination rates are affected by the developments stage of fruits.

Conclusion

We found that germination pattern and responses between treatments and germination rates are dependent on population characteristics, affecting time indexes associated with it germination. Besides that, wind removal seems to be an important procedure, since it promotes higher germination rates. Propitiating a better exploitation of a seed lot.

Acknowledgments

Secretaria do Verde e MeioAmbiente, of São Paulo due to its trainee programs, that propitiate experience and opportunities. In addition, the workgroup of Harry Blossfeld Municipal plant nursery, especially my trainee co-workers and Mr. Claudionor. My bosses Leila Borges Proença and GuilhermeBrandão do Amaral for making this idea possible, which can make Brazilian's native plant production better. Also Rafaela C. Perez and Juliana de Lemos due to their consistent scientific support.

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