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PRE-GERMINATION TREATMENTS IN BRAZILWOOD SEEDS AT SEEDLING EMERGENCE AND DEVELOPMENT

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Ednaldo Miranda de Oliveira[1], Anna Marcella da Silva Guimarães[2], Marcus Vinicius Sandoval Paixão[3], Hediberto Nei Matiello[4], Antônio Resende Fernandes[5] and Robson Celestino Meireles[6]

ABSTRACT

The brazilwood (Caesalpinia echinata) is a species of Atlantic Forest considered a national symbol of Brazil. The wood is heavy, smooth, and hard, and highly resistant to xylophagous organisms. Brazilwood seeds may present dormancy and initial germination difficulties. The objective of this study was to evaluate different methods for stimulating the emergence and development of brazilwood seedlings. The research was carried out in the seedling nursery of IFES-Campus Santa Teresa. The seeds were subjected to the following immersion treatments for 60 minutes: natural water (26°C) as a control; gibberellin solution at 1000 mg. L-1,2000 mg. L-1, 3000 mg. L-1 and 4000 mg. L-1, NaCl solution 9 g.L-1; KCl solution 50 g.L-1 and coconut water. They were then sown in 150 mL tubes containing commercial substrate. The experimental design was in randomized blocks with 8 treatments and four replications. After 30 days from the beginning of emergence, the percentage of emergence was evaluated, and after 90 days of emergence, the number of leaves was evaluated; plant height; stem diameter; root length; green mass of the aerial part; shoot dry mass; green root mass; dry root mass. Immersion in coconut water promoted the highest percentage of

[1] Dr. in Water and Environmental Resources
Federal Institute of Education, Science and Technology of Espírito Santo,
Email: ednaldo.oliveira@ifes.edu.br
ORCID: https://orcid.org/0000-0002-1182-7623
[2] Undergraduate student in Biology
Federal Institute of Education, Science and Technology of Espírito Santo,
Email: contato.annamarcella@outlook.com
ORCID: https://orcid.org/0009-0002-7925-4988
[3] Dr. in Plant Production, Dr. in Education,
Federal Institute of Education, Science and Technology of Espirito Santo,
Email: mvspaixao@gmail.com
ORCID: https://orcid.org/000-0003-3262-9404
[4] Dr. in Plant Science
Federal Institute of Education, Science and Technology of Espírito Santo,
Email: hedibertonm@ifes.edu.br
ORCID: https://orcid.org/ 0009-0003-7359-3660
[5] Dr. in Plant Production,
Federal Institute of Education, Science and Technology of Espirito Santo,
Email: aresendefernandes@gmail.com
ORCID: https://orcid.org/0000-0003-2651-6569
[6] Dr. in Plant Production,
Federal Institute of Education, Science and Technology of Espirito Santo,
E-mail: robsoncm@ifes.edu.br
ORCID: https://orcid.org/0000-0003-4806-812X

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seedling emergence. The dose is 4000 mg. L-1 of GA3, Solution of 9 g.L-1 of NaCl and 50 g.L-1 of KCL provided the highest values related to growth and higher production of leaf and root dry matter in brazilwood seedlings.

Keywords: Coconut water, Gibberellin, Dormancy, *Caesalpinia echinata*.

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INTRODUCTION

The brazilwood (*Caesalpinia echinata*) is a species native to the Brazilian tropical forests, present in the Atlantic Forest biome, extending from the coast of Rio Grande do Norte to Rio Grande do Sul, also known as ibirapitanga, paubrasilia, orabutã, brasileto, ibirapiranga, ibirapita, muirapiranga, pau-rosado, pau-de-pernambuco. Its height varies between 8 and 12m in height, and can be used in landscaping or cultivated in preservation areas. Brazilwood is the symbol species of Brazil and was the raw material of Brazil's first economic cycle. Extractivism lasted until 1875, with the export of brazilwood for the manufacture of dyes, shipbuilding and luxury carpentry. In 1605, just 105 years after the discovery, there were already claims for protective measures of the species, without effect. The red pigment of the wood was used in the process of dyeing fabrics in Europe. The wood has high density, smoothness, high hardness, and resistance to xylophagous organisms. The wood is excellent for the manufacture of musical instruments, with higheconomic value to the present day, considered of unique quality in the manufacture of violin bows (ROCHA, 2004).

Dormancy is a phenomenon by which seeds of a certain species, even if they are viable and present all the environmental conditions for germination, do not complete the process (CARVALHO; NAKAGAWA, 2000). The dormancy period can be temporary or extend for a long time until a certain special condition is met (TOLEDO, 1997).

To overcome dormancy, several methods can be used, with cutting of the distal region of the seed and immersion in water for 24 hours being the recommended treatments to increase the percentage of germination and speed without prejudice to the quality of the seedling (MENDONÇA et al., 2007). Immersion in water is an efficient method of overcoming for some forest species. Simple washing in running water is capable of breaking the dormancy of some species (TAVARES et. al., 2015).

During the germination process, gibberellins act in the synthesis of enzymes that cause the hydrolysis of the reserves to be used by the embryo, in addition to promoting the production of auxins (PAIXÃO, 2023). Gibberellin also promotes primary root elongation, while higher levels of auxins cause the seed coat to weaken and the embryonic plant to grow (POPIGINIS, 1985); (CARVALHO; NAKAGAWA, 2000). Species can reveal several mechanisms of seed dormancy, requiring specific techniques to overcome them (KHAN, 1977). Use of essential mineral elements, use of osmoconditioners and natural sources of

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hormones and mineral salts can be used to improve the emergence percentage and biometric characteristics of seedlings in early growth.

The objective of this study was to evaluate pre-germination treatments of brazilwood seeds at seedling emergence and development.

METHODOLOGY

Experiment was carried out in the Nursery Sector of the Federal Institute of Espírito Santo - Santa Teresa Campus - in a nursery structure of the mesh type, consisting of polyolefin mesh at 50% shading, ceiling height of 2.30 m, located in the central region of Espírito Santo, city of Santa Teresa-ES, district of São João de Petrópolis (Latitude: 19º56'12"S; Longitude: 40º35'28"W; Altitude:155 m). The climate of the region is characterized as Cwa, mesothermic, with a dry season in winter and heavy rainfall in summer (Köppen classification) (Alvares *et al*., 2013), with an average annual rainfall of 1,404.2 mm and an average annual temperature of 19.9 °C, with a maximum of 32.8 °C and a minimum of 10.6 °C (INCAPER, 2011).

The seeds were subjected to immersion for sixty minutes in natural water (26°C) as a control; gibberellin solution at 1000 mg. L-1,2000 mg. $^{L-1}$, 3000 mg. $^{L-1}$ and 4000 mg. L-1, solution at 9 g.L-1 of NaCl; solution at 50 g.L-1 of KCl, coconut water,. They were then sown in 150 mL polyethylene tubes containing commercial substrate. The experimental design was in randomized blocks with 8 treatments and four replications, with each experimental unit composed of 25 seeds.

Ninety days after the beginning of emergence, seedling emergence (E) was evaluated. To evaluate seedling development, five plants from each replication in the eight treatments were selected. The following were evaluated: Plant height (AP), Number of leaves (NF); Stem diameter (DC); Root length (CR); Green Leaf Mass (MVF); Dry leaf mass (MSF); Green Root Mass (MVR); Root dry mass (MSR). The evaluations were carried out as follows: Emergence (E) - counting the number of plants emerged in one hundred plants; Height of the plant (AP) - length from the base to the apex of the plant with a millimeter tape; Number of leaves (NF) - count all leaves of the plant; Stem diameter (DC)- measured with a caliper at the intersection between root and stem; Root length (CR) - determined from the level of the stem to the end of the root, with the help of a ruler graduated in centimeters; Leaf green mass (MVF) - removal and weighing of all leaves with the aid of a semi-analytical balance; Root green mass (MVR) - removal, washing and weighing of the

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roots with the aid of a semi-analytical balance; Dry mass of the leaves (MSF) - packaging of the sheets in paper bags, drying in a forced air circulation oven, at 70°C for 72 hours and weighing; Root dry mass (SRM) - the roots were separated from the aerial part, packed in paper bags and placed to dry in an oven with forced air circulation at 70°C for 72 hours.

The experimental data were submitted to analysis of variance and, according to the assumptions of the model by the Shapiro-Wilk test to verify normality, the means of the treatments were compared by Tukey's test at a level of 5% probability.

RESULTS AND DISCUSSION

Seedling emergence began at 30 days after sowing and ended sixty days after emergence began.

Treatment with coconut water stands out alone as the one with the highest percentage of emergence. The KCl solution, GA3 solution between 2000 and 4000 mg. $^{L-1}$ are treatments that have the second best result. Pure water, GA3 1000 mg $^{L-1}$ and KCl treatment form the group with the lowest effect on the percentage of emergence (Table 1).

Table 1 – Emergence in brazilwood seedlings in different pre-germination treatments

Treatment	Emergency (%)
Pure water (25°C)	47 f
GA3 1000 mg. L-1	52 EF
GA3 2000 mg. L-1	60 cd
GA3 3000 mg. L-1	66 BC
GA3 4000 mg. L-1	70 b
NaCl solution 9 g.L-1	70 b
Coconut water	78 to
KCl 50 g.L-1 solution	55
CV (%)	5,29

Means followed by the same letter in each column do not differ statistically at the level of 5% probability by Tukey's test.

Coconut water is rich in phytohormones that promote germination and potassium, which may have acted in the faster hydration of the seeds combined with the reduction of the effect of germination inhibitors. Potassium appears as the most abundant electrolyte in coconut water during fruit ripening, and also has sodium, calcium, magnesium, chloride, iron and copper (ARAGÃO et al., 2001; VIGLIAR et al., 2006). Coconut water is a natural product, an excellent hydroelectrolytic replenisher, similar to isotonic drinks and rich in mineral salts, a fact that may suggest the reason for the better emergence of seedlings (BRITO, 2004).

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Paixão et al. (2019) mention that coconut water has cytokinin and strong isotonic action, which increases the absorption capacity, and can inhibit any blocker that the seed may have. Tan, Yong and Ge (2014), using capillary electrophoresis (CE) coupled to mass spectrometry (MS), identified the presence of indole acetic acid, zeatin, gibberellin and abscisic acid in coconut water samples.

In the evaluation of seedling development, it is observed that the treatment with gibberellin at 4000 mg. L-1 and KCl solution 50 g.L-1 remained statistically isolated as treatments that provided the highest plant height, while coconut water was the one with the lowest plant height (Table 2).

For Number of leaves, the two highest doses of GA3 and the solution with KCL presented the best result, and for CD. The largest stem diameter was obtained through treatment with the highest dose of GA3 and the use of NaCl and KCl solutions (Table 2).

The treatment with NaCl solution stands out as the one that presented the lowest result in relation to root length . The other treatments were statistically superior to the treatment with NaCl (Table 2).

Table 2 – Growth of brazilwood seedlings in different pre-germination treatments

Treatment	AP	NF	Anno Domini	CR
Pure water (25°C)	11.07 b	15.2 b	2.24 d	14.38 to
GA3 1000 mg. L-1	10.33d	15.4 b	2.69 b	14.73 to
GA3 2000 mg. L-1	10.73 c	13.9 c	2.52 c	14.60 to
GA3 3000 mg. L-1	10.77 c	16.9 to	2.52 c	14.45 to
GA3 4000 mg. L-1	11.45 to	16.6 to	2.89 to	14.68 to
NaCl solution 9 g.L-1	10.11d	15.75 b	2.82 to	13.63 b
Coconut water	9.32 and	13.9 c	2.63 bc	14.48 to
KCl 50 g.L-1 solution	11.51 to	16.6 to	2.81 to	14.57 to
CV (%)	2,35	4,81	6,63	5,91

Averages followed by the same letters in the columns did not differ statistically by Tukey's test at 5% probability.
AP = seedling height (cm); NF = number of sheets; DC = diameter of the stem (cm); CR = root length (cm).

Studies on the development of native trees have been carried out to understand the response of several species subjected to different conditions, especially in seed treatment, and the efficiency in plant growth has been observed (SILVA et al., 2007).

The use of gibberellin in seed treatment showed better seedling development. Gibberellins act in breaking dormancy by inciting the synthesis of hydrolytic enzymes such as amylases and proteases, which degrade the nutritional reserves accumulated in the endosperm and make them available in a soluble form for the development of the embryo (TAIZ et al., 2017; BARBANTE, 2018). These actions within the seed activate and

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accelerate plant emergence, initiating the photosynthesis process earlier and causing greater initial seedling development.

Root length is usually affected by high sodium levels or when sodium is involved in reducing the osmotic potential of the medium. Dutra et al. (2017), when evaluating the effect of sodium concentration on germination, demonstrated an effect on the reduction in root length in seedlings of Canafístula (*Peltophorum dubium*) and Monkfish (*Enterolobium contortisiliquum*) and an increase in those of Pau-ant (*Triplaris americana* L.).

The dose is 4000 mg. L-1 of GA3 remained statistically isolated as the treatment that promoted the highest accumulation of green root and leaf weed (Table 3).

For dry mass of leaves and root, treatments with GA3 4000 mg. L-1, NaCl solution 9 g.L-1 and KCl solution 50 g.L-1 presented the best results, statistically superior to the other treatments and with no statistical difference between them (Table 3). Guangwu and Xuwen (2014) cite the beneficial effect of gibberellin on the germination of *Pinus massoniana*, raising auxin levels and reducing abscisic acid concentration. Seedlings of umbu treated with the dose of 337 mg. L-1 of GA3 via foliar showed plants of greater height, stem diameter, and biomass accumulation (PIRES et al. 2020). Osmotic compounds such as KCl and NaCl can promote a better supply of essential nutrients and, by altering the water potential of the seeds, promote greater water absorption, depending on the dose and species. Negative effects were observed in seeds of rapeseed varieties when subjected to increasing doses of KCl (SOLANGI et al., 2018). Corn seeds osmoconditioned in KCl solution showed better germination performance against medium salinization (ZAMAN et al. 2012). Pereira et al., (2021) mention that brachiaria seeds (*Urochloa humidicola*) showed efficient dormancy breaking when subjected to KNO3 doses.

The dose of 4000 mg L-1 of GA3 stands out for providing the highest values in all the variables evaluated. However, when analyzing the data related to the accumulation of dry matter in leaves and roots, the treatments with NaCl and KCl are added to the best results (Table 3). Such treatments also stand out in relation to the others for the biometric variables described in Table 2, which justifies the higher accumulation of dry matter in the seedlings. The strong effect of gibberellin on the acceleration of germination and cell elongation (TAIZ and ZEIGER, 2017, SALISBURY and ROSS, 2015), combined with the osmotic conditioning and supply of essential nutrients promoted by the treatment with NaCl and KCl, proved to be the condition for seedlings to achieve part of their photosynthetic self-sufficiency and obtain greater accumulation of dry matter in the time evaluated.

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Table 3 – Production of green and dry mass in brazilwood seedlings in different pre-germination treatments

TR	MVF	MVR	MSF	MSR
Pure water (25°C)	1.999 b	0.809 b	0.557 bc	0.196 b
GA3 1000 mg. L-1	1,766 cd	0.522 d	0.517 c	0.195 b
GA3 2000 mg. L-1	1,575	0.350 and	0.497 cd	0.203 b
GA3 3000 mg. L-1	1,405 and	0.309 and	0.516 c	0.194 b
GA3 4000 mg. L-1	2,293 to	0.946 to	0.597 to	0.230 to
Nacl Solution 9 g.L-1	1,839 BC	0.731 bc	0.599 to	0.240 to
Coconut water	1,765 cd	0.667 c	0.486 d	0.191 b
Kcl 50 g.L-1 solution	2,013 b	0.827 b	0.603 to	0.231 to
CV (%)	12,97	21,33	16,21	16,98

Averages followed by the same letters in the columns did not differ statistically by Tukey's test at 5% probability.
MVR = green root mass ($^{g.pl-1}$); MVF = green mass of leaves ($^{g.pl-1}$); MSR = dry root mass ($^{g.pl-1}$); MSF = dry mass of leaves ($^{g.pl-1}$).

CONCLUSION

- Immersion in coconut water promoted the highest percentage of seedling emergence;
- The dose is 4000 mg. L-1 of GA3, solution of 9 g.L-1 of NaCl and 50 g.L-1 ^{of} KCL provided the highest values related to growth and higher production of leaf and root dry matter in brazilwood seedlings.

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