**Effect of seed priming with NaCl on the induction of salinity tolerance in Myracrodruon urundeuva Allemão in vitro**

Efeito do seed priming com NaCl na indução de tolerância à salinidade em Myracrodruon urundeuva Allemão in vitro

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**ABSTRACT**

Soil salinization is an environmental factor that frequently occurs in semi-arid regions around the world and seed priming technique is one of the alternatives to obtain the greatest establishment of seedlings in the field, through the induction of tolerance to environmental stresses. This research aimed to evaluate the effect of seed priming with NaCl on the induction of salinity tolerance in Myracrodruon urundeuva Allemão in vitro. The research was carried out at the Center for Strategic Technologies of the Northeast, in Recife / PE-Brazil. M. urundeuva seeds were disinfected and submitted to two treatments: water (control) or NaCl (2mM), and inoculated in WPM medium at three saline concentrations (0.0; 25.0 and 50.0 mM NaCl) for 45 days. Plant height, number of leaves, fresh biomass (total, shoot, and root), shoot/root ratio, sodium and potassium and Na/K ratio, antioxidant enzyme activity, and peroxide content were evaluated malondialdehyde hydrogen. The data were subjected to variance analysis and the results were compared using the Student-Newman-Keuls test at 5% probability, using the R software. Seed priming with NaCl promoted a beneficial effect on the height of seedlings exposed to salinity. On the other hand, height was inversely proportional to saline concentrations, regardless of seed priming. The shoot/root ratio was also lower in seedlings cultivated under 25 and 50 mM NaCl. Despite being favorable for most growth variables, seed priming with NaCl induced an increase in lipid peroxidation in seedlings that were not exposed to salinity, which is linked to a decrease in the activity of antioxidant enzymes. The antagonistic response to NaCl stimulation between growth parameters and plant defense observed in the present research raises the need for further complementary studies that make it possible to delineate the metabolic alterations of M. urundeuva against a chemical stimulus to induce tolerance to a given stress.

**Keywords:** Caatinga; Tree; Soil salinization; Antioxidant enzymes
RESUMO

A salinização do solo é um fator ambiental que ocorre frequentemente em regiões semi-áridas ao redor do mundo e a técnica de seed priming é uma das alternativas para se obter o maior estabelecimento de mudas no campo, através da indução de tolerância aos estresses ambientais. Este trabalho objetivou avaliar o efeito do seed priming com NaCl na indução da tolerância à salinidade em *Myracrodruon urundeuva* Allemão in vitro. A pesquisa foi realizada no Centro de Tecnologias Estratégicas do Nordeste, em Recife / PE-Brasil. Sementes de *M. urundeuva* foram desinfestadas e submetidas a dois tratamentos: água (controle) ou NaCl (2mM), e inoculadas em meio WPM em três concentrações salinas (0.0; 25.0 and 50.0 mM NaCl) por 45 dias. Foi avaliada a altura, número de folhas, biomassa fresca (total, parte aérea e raiz), razão parte aérea / raiz, sódio, potássio, razão Na / K, atividade de enzimas antioxidantes, teores de peróxido de hidrogênio e malondialdeído. Os dados foram submetidos à análise de variância e os resultados comparados pelo teste Student-Newman-Keuls a 5% de probabilidade, utilizando o software R. O priming com NaCl promoveu efeito benéfico na altura de mudas expostas à salinidade. Todavia, a altura foi inversamente proporcional às concentrações salinas, independentemente do priming. A razão parte aérea / raiz foi menor nas mudas cultivadas sob NaCl 25 e 50 mM. Apesar de ser favorável para a maioria das variáveis de crescimento, o seed priming com NaCl induziu aumento na peroxidação lipídica em mudas não expostas à salinidade, o que está relacionado à diminuição da atividade de enzimas antioxidantes. A resposta antagônica à estimulação do NaCl entre parâmetros de crescimento e defesa das plantas na presente pesquisa levanta a necessidade de novos estudos complementares que possibilitem delinear as alterações metabólicas de *M. urundeuva* frente a um estímulo químico para induzir tolerância a um determinado estresse.

Palavras-chave: Caatinga; Árvore; Salinização do solo; Enzimas antioxidantes

1 INTRODUCTION

The Caatinga ecogeographic domain is exclusive to the Brazilian territory, predominantly in the northeast region of the country, and represents about 13% of the national territory, occupying an area of 912,000 km² rich in biodiversity (BARROS et al., 2021). The main characteristic of Caatinga environment is the poorly developed soils, with an intense dry period, with almost no rain for 8 to 10 months throughout the year (AQUINO et al., 2021). Due to anthropogenic exploration as well as the edaphoclimatic characteristics of the semi-arid region, the Caatinga is in a condition of vulnerability, highly threatened in the scenario of rising global temperatures, putting this region on alert (NOBRE, 2011) due to the risks of desertification and salinization of soils (OLIVEIRA et al., 2013; NOBRE, 2011).
The process of soil salinization is a frequent environmental factor in semi-arid regions around the world, caused by low rainfall and high evaporation rate, being aggravated by the inadequate use of the soil in production processes. Even native species, which are more adapted to the environment, may have the germination process and/or seedling survival impeded in more extreme conditions of soil salinity (RIBEIRO et al., 2017). This fact can make programs unfeasible to recover degraded areas with saline soils, especially when natural regeneration techniques are used through the dispersion of propagules in the environment or even the direct seeding of forest species (GONÇALVES et al., 2020).

Among the alternatives to obtain the greater establishment of seedlings in the field, the seed priming technique can provide tolerance to various environmental stresses through the induction of cellular memory, which accompanies specific epigenetic changes as well as plant physiology (REHMAN et al., 2014). On occasion, seed priming establishes a long-term somatic memory accompanied by specific changes in the epigenome that comprise differences in chromatin states, transcriptional responsiveness, as well as the physiology of the whole plant. Thus, this technique can promote increases in the activities of several enzymes, as well as physiological adjustments that allow plants to survive a given stress condition (ACHARYA et al., 2020). Allied to this, there is an easier water absorption by the seed, which activates the pre-germinative metabolism from DNA repair processes and modulations in the redox system, promoting the induction of tolerance to abiotic stresses during germination (NÔBREGA et al., 2021).

One of the most used chemical agents in inducing tolerance to abiotic stresses is sodium chloride (NaCl), which can induce tolerance and increase the percentage of seed germination under salinity conditions when used in seed priming (STASSINOS et al., 2021).
In the Caatinga restoration of native forests, the proper choice of species is essential to obtain good results. Popularly known as aroeira, Myracrodruon urundeuva Allemão is among the options of native trees from the Caatinga to be used in reforestation processes (DRUMOND et al., 2016). Seedlings are obtained from seed germination. However, areas with saline soils can limit the establishment and maintenance of seedlings in the field.

*M. urundeuva* is a native tree of Brazil with distribution in the North, Northeast, Midwest, Southeast, and South of the country and occurs in Caatinga vegetation, Cerrado, and Atlantic Forest. It is widely used in the reforestation of native forests. However, its wood is economically exploited due to its physical-mechanical qualities and can be used for the production of stakes, beams, slats, rafters, floor battens, firewood, and charcoal. In addition to its use in the wood industry, this species has wide application in folk medicine in the treatment of inflammation, stomach ulcers, colds, rheumatism, among other diseases (PAREYN et al., 2018), as well as in the commercial production of herbal products, is widely used by local populations in an exploratory and non-renewable manner. However, these activities, mostly predatory, are resulting in rapid loss of species, elimination of ecological processes and formation of extensive desertification nuclei in various locations region (SILVA et al., 2012). *M. urundeuva* has multiple uses, being considered a reference tree species in studies with plants under environmental stress (CAPO et al., 2022).

Considering the problem of soil salinization in the semiarid region, as well as species conservation and restoration of degraded areas, this research aimed to evaluate the effect of *seed priming* with NaCl in inducing in vitro salinity tolerance in *M. urundeuva* Allemão. Initially, the following questions were asked: 1) Does *seed priming* have a beneficial action on the growth of *M. urundeuva* under salinity conditions? 2) *Seed priming* with NaCl is effective in inducing salt stress tolerance and activating the enzymatic antioxidant defense system in *M. urundeuva* seedlings?
2 MATERIAL AND METHODS

The study was carried out at the Laboratory of Research Applied to the Biofactory of the Northeast Strategic Technologies Center (CETENE), located in Recife-PE-Brazil. Diaspores of *Myracrodruon urundeuva* were collected at the José Nilson de Melo Experimental Station belonging to the IPA (Agronomic Institute of Pernambuco), in the municipality of Caruaru (PE), under geographic coordinates 8 ° 14’ and 35 ° 55’ in December 2015.

Diaspores were used as explants, which were disinfected in alcohol (70%) for one minute and then in sodium hypochlorite (2.5%) for 15 minutes. Then, the explants were washed three times in sterile distilled water.

2.1 Priming application

After rinsing, the seeds were soaked in the following solutions: sterile distilled water or 2 mM NaCl solution, where they remained for 1 h under gentle agitation.

Then, the seeds were inoculated in test tubes containing 10 ml of Woody Plant Medium (WPM) (LLOYD; MCCOWN, 1981), plus 0.1 g. inositol L⁻¹, 30 g. L⁻¹ sucrose and 5.5 g. L⁻¹ of agar. The saline concentrations tested were: 0.0; 25.0 and 50.0 mM NaCl. After inoculation, the test tubes containing the diaspires were kept in a growth room at 25 ± 2°C in the dark for 45 days. After emergence, the seedlings were transferred to shelves with white LED lamps, with a light intensity of 42 µmol m² s⁻¹. The seedlings were kept under these conditions for 45 days.

2.2 Development and growth parameters

2.2.1 Biochemical Analysis

The seedling height was considered from the largest root to the shoot, fresh biomass (total, shoot and root) was obtained using a precision scale and the number of leaves/plant was obtained by counting (transformed data √x+1).
Enzymatic activities of superoxide dismutase (SOD, EC 1.15.1.1), ascorbate peroxidase (APX, EC 1.11.1.1), and catalase (CAT, EC 1.11.1.6) were analyzed at 45 days. For this, 0.2 g of *M. urundeuva* leaves were macerated in liquid nitrogen, and then 2 mL of extraction buffer (pH 7.0) containing potassium phosphate, 1,4-dithiothreitol, and ethylene diaminetetraacetic acid were added. Subsequently, the macerate was centrifuged at 10,000 g 4 °C for 20 minutes and the supernatant was used for the analysis of enzymatic activities.

The enzymatic activity of SOD was performed according to Giannopolitis and Reis (1977). A mixture of the reagents (1765 µl 85 mM sodium phosphate buffer, 780 µl 50 mM methionine, 225 µl 1 mM nitroblue tetrazolium, 30 µl 10 mM EDTA, and 150 µl 0.1 mM riboflavin was added to 50 µL of sample extract in test tubes. The tubes were exposed to lighting with fluorescent lamps (30 watts) for 5 minutes. Afterward, the tubes were kept in the dark until the moment of reading, which was performed in a spectrophotometer at 560 nm, and the results were expressed in U.SOD g⁻¹ fresh mass (FM). APX activity was performed as described by Nakano and Asada (1981). An aliquot (75 µL) of the extract received 1335 µL of buffer (0.05 M potassium phosphate, 0.001 M EDTA, pH 6.0), 75 µL (0.01 M) ascorbate and 15 µL of hydrogen peroxide (0.1M). Readings were performed in a spectrophotometer at 290 nm. The activities were calculated from the molar extinction coefficient for ascorbate (2.8 mM⁻¹cm⁻¹) and expressed in µmol AsA g⁻¹ of fresh biomass per minute.

The CAT activity followed the methodology proposed by Berris and Sizer (1952). To the sample extracts (50 µL) were added 1390 µL of monobasic potassium phosphate buffer (50 mM - pH 7.0) and 60 µL of hydrogen peroxide (500 mM). Readings were performed in a spectrophotometer at 240 nm. The enzymatic activity was expressed in nmol H₂O₂ g⁻¹ of fresh mass per minute and for the calculation of the activities, 36 mM⁻¹ cm⁻¹ was considered as molar extinction coefficient.

Measurements of malondialdehyde (MDA) and hydrogen peroxide (H₂O₂) contents were performed with the same extract, which was prepared with 0.2 g
of macerated leaves and homogenized in 2.0 ml of trichloroacetic acid (1%) and subsequently centrifuged at 2000 xg for 10 minutes at 4°C. The MDA analysis was performed according to Heath and Packer (1968). Approximately 250 μL of the extract was added to cryogenic tubes containing 1 mL of thiobarbituric acid (0.5%) and trichloroacetic acid (20%) solution. The tubes were kept in a dry bath for 30 minutes at 95°C and then cooled in an ice bath and centrifuged again for 10 minutes at 2000 g. Readings were performed at 535 and 600 nm and results were expressed in nmol·g⁻¹ of fresh biomass. The H₂O₂ content was determined according to the method by Loreto and Velikova (2001). An aliquot of the extract (75 μL) was added to 1.75 mL of potassium phosphate buffer (10 mM, pH 7.0) and 1.5 mL of potassium iodide (1M). The H₂O₂ content was measured at 390 nm in a spectrophotometer and expressed in μmol·g⁻¹ of fresh biomass.

2.2.2 Na and K content

The seedlings of *Myracrodruon urundeuva* were dried in forced aeration ovens at 60 ºC until constant weight. Then, the material was crushed and submitted to digestion in sulfuric acid and hydrogen peroxide in a digester block at 350ºC, according to the methodology proposed by Thomas *et al.* (1967). For the quantification of sodium and potassium contents, flame spectroscopy was used (EMBRAPA, 2009), and the results were expressed in mg·g·fresh mass⁻¹.

2.2.3 Statistical analysis

The experimental design was completely randomized, consisting of a 2x3 factorial scheme, 2 seed priming concentrations (control and 2M NaCl), and 3 saline levels (0.0; 25.0 and 50.0 mM NaCl), totaling 6 treatments with 24 reps. The data were subjected to analysis of variance (ANOVA), respecting the prerequisites (normality and homogeneity), and the means were compared using the Student-Newman-Keuls (SNK) test at a 5% probability level. Person correlation, principal component analysis (PCA), and cluster analysis were performed, all performed with the aid of the R software.
3 RESULTS AND DISCUSSION

Among the chemical agents widely used in seed priming, NaCl is the most common, being able to induce tolerance under salinity conditions (STASSINOS et al., 2021). Seedling height was inversely proportional to saline concentration in both priming groups. The seedlings that received the conditioning with 0mM NaCl showed greater height than the untreated seedlings. (Figure 1A).

Figure 1 – Effect of seed priming on height (A), total fresh biomass (Total FB) (B), shoot fresh biomass (SFB) (C) and root fresh biomass (RFB) (D) of Myracrodruon urundeuva Allemão seedlings submitted to three levels of salinity (0.0; 25.0 and 50.0 mM NaCl) in vitro for 45 days

Source: Authors (2021)

Studying the initial growth of Cereus jamacaru seedlings, Nobrega et al. (2021) also observed that pre-treatment of seeds with eliciting substances can increase seedling growth. The total fresh biomass (TFB) of the seedlings decreased in the saline treatment with 50.0 mM NaCl in the group that did not receive the seed priming, while
the seedlings from the pre-treated seeds maintained the total fresh biomass even in the highest salt concentration (Figure 1B). Seed priming also favored the increase in shoot fresh biomass (SFB), while seedlings from treatment without priming showed a decrease in the mean of this variable when subjected to a saline concentration of 50.0 mM NaCl (Figure 1C). Root fresh biomass (RFB) was reduced in saline concentrations of 25.0 and 50.0 mM of NaCl, regardless of priming application (Figure 1D). Assessing the physiological behavior of Myracrodruon urundeuva under salinity conditions, Oliveira et al. (2019) suggest that the use of this species in saline soils is limited. The authors tested different osmotic potentials with polyethylene glycol (PEG) and NaCl. The authors found that the osmotic threshold for germination of *M. urundeuva* seeds in NaCl was 0.43 MPa. Therefore, more studies are needed.

The *seed priming* technique is a viable and low-cost technology that makes it possible to reduce the adverse effects of salinity on the physiological and biochemical aspects of plants (KHAN et al., 2021). The beneficial effects of *seed conditioning* with NaCl were demonstrated by Abol-Hasani et al. (2020), by decreasing the harmful effects of salinity in *Dracocephalum moldavica* plants. The authors emphasized the increase in biomass production, decrease in membrane damage, electrolyte leakage, and increase in leaf area. Preconditioning with NaCl favored the maintenance of biomass production in sugarcane plants and induction of tolerance when they were exposed to salinity (MELO et al., 2014).

In the case of *M. urundeuva* in the present research, the excess of salts was not favorable to the accumulation of fresh root biomass, which is probably linked to the osmotic effect of the saline media solutions, caused by the decrease in the free energy of water, directly influencing the cellular water status (AMANIFAR; TOGHranegar, 2020). Despite the eliciting effect of the $H_2O_2$ in attenuating the harmful effects of salinity, a decrease in seedling growth of *M. urundeuva* under salinity conditions was observed (RODRIGUES et al., 2020). The seedlings from the *seed priming* treatment kept the mean leaves number (LN) similar regardless of the saline concentration (Figure
On the other hand, in seeds that did not receive priming, the seedlings presented a reduction in the number of leaves when submitted to 50.0 mM of NaCl. The shoot/root ratio (SRR) was reduced in seedlings cultivated with 25.0 and 50.0 mM of NaCl, regardless of seed priming application (Figure 2B).

Figure 2 – Effect of seed priming on the number of leaves (LN) (A) and shoot/root ratio (S/R) (B) in Myracrodruon urundeuva Allemão seedlings submitted to three levels of salinity (0.0; 25.0 and 50.0 mM NaCl) in vitro for 45 days

The effect of NaCl on growth is one of the most studied topics in plant physiology. The growth inhibition and the plant production reduction could be a result of solution changes in osmotic potential, caused by excess salts and/or their toxic effect (ISAYENKOV; MAATHUIS, 2019). Thus, the decrease in plant growth, in addition to being linked to the cytotoxic effect of sodium, is closely linked to drastic changes in the water status of the plant, which can be considered the primary cause of productivity losses, directly affecting the basic processes of cell division and expansion (HERNÁNDEZ, 2019). Sodium levels increased at the expense of saline concentrations in the culture medium, where the highest average was found in plants subjected to 50.0 mM NaCl and receiving seed priming (Figure 3A). Regarding potassium contents, the highest averages were verified in plants submitted to 25.0 mM of NaCl regardless of priming treatment (Figure 3B). The Na / K ratio was higher in pretreated plants that were subjected to 50.0 mM NaCl (Figure 3C).
Figure 3 – Effect of seed priming on sodium (Na) content [mg. g. fresh mass$^{-1}$] (A), potassium (K) [mg. g. fresh mass$^{-1}$] (B) and Na / K ratio (C) in *Myracrodruon urundeuva* Allemão seedlings submitted to three levels of salinity (0.0; 25.0 and 50.0 mM NaCl) *in vitro* for 45 days

Source: Authors (2021)
Under salinity conditions, sodium can reduce the absorption of nutrients such as potassium (OLIVEIRA et al., 2018). In the present research, it was found that *M. urundeuva* seedlings were not able to promote an efficient ionic adjustment, which allowed greater absorption of sodium at the expense of potassium.

The total soluble protein (TSP) content was altered as a function of priming treatments and saline concentrations in the culture medium (Figure 4A). The application of *seed priming* with NaCl favored the increase in the content of total soluble proteins in seedlings subjected to 50.0 mM of NaCl. However, seedlings from seeds that did not receive priming and that were subjected to the same saline concentration showed a decrease in the mean values for this variable (Figure 4A). Under conditions of salt stress, several nitrogenous compounds can be accumulated among the main ones are proteins, a multigenic trait of tolerance to salt stress (HERNÁNDEZ, 2019).

Figure 4 – Effect of *seed priming* on total soluble protein content (TSP) (A), on the activity of superoxide dismutase enzymes (SOD) (B), ascorbate peroxidase (APX) (C) and catalase (CAT) in *Myracrodruon urundeuva* Allemão seedlings submitted to three levels of salinity (0.0; 25.0 and 50.0 mM NaCl) *in vitro* for 45 days

![Figure 4](image-url)

Source: Authors (2021)
Proteins play several roles in plant survival, including the defense function, and these represent the main changes in the total soluble protein content in plants (KOSOVÁ et al., 2018). The response in the protein content of plants under salinity conditions can vary greatly according to the degree of tolerance that each species presents (gene expression), even suggesting the participation of some polypeptides in the cellular osmotic adjustment (HERNÁNDEZ, 2019).

In adverse environmental conditions, plants use antioxidant defense systems (enzymatic and non-enzymatic) to prevent severe damage caused by oxidants in their cell structures. Among the main enzymes that make up the enzymatic antioxidant defense system are superoxide dismutase (SOD), ascorbate peroxidase (APX) and catalase (CAT) which act on the front line of plant defense, mitigating the adverse effects of stress as well as preventing oxidative stress (SOUZA et al., 2020).

The SOD activity in seedlings showed an inversely proportional relationship with salinity, regardless of priming treatment, that is, the higher the salinity, the lower the activity of this enzyme. However, seedlings from seeds that were priming with NaCl showed a marked decrease in the activity of this enzyme (Figure 4B). APX activity was more expressive in the group that did not receive seed priming with NaCl, especially in the saline control. On the other hand, the CAT activity in this same treatment was lower, indicating a more effective and joint action of SOD and APX (Figure 4B, C and D). The CAT activity did not show differences between the seedlings of saline treatments that received priming with NaCl (Figure 4D).

Tolerance to environmental stresses has been associated with efficient antioxidant defense (SOUZA et al., 2020), through the upregulation of the activity of antioxidant enzymes (SOD, CAT, POD, GR, etc.), where each enzyme performs a specific function in the detoxification of reactive oxygen species (ROS) (ABOGADALLAH, 2010). Although SOD catalyzes the conversion of the superoxide anion (O$_2^-$) to H$_2$O$_2$, in the present study this enzyme did not present a strong or significant correlation with the H$_2$O$_2$ contents ($r= 0.19$). On the other hand, H$_2$O$_2$ showed a strong and positive
correlation (0.78, 0.77, 0.67 and 0.66) with the growth parameters. This might suggest that this molecule had most of its origin in the apoplast region through NADPH-dependent oxidases and some cell wall peroxidases. This region is where the loosening of the wall for cell expansion occurs (SILVEIRA et al., 2017). Salinity caused by excess NaCl commonly causes physiological stress, contributing to an imbalance in the redox system and leading to an increase in ROS content, increasing damage to biological membranes (MORAIS et al., 2019). However, in the present research, it was observed that the contents of \( \ce{H_2O_2} \) and MDA had the highest means in the saline control in the group of seeds that were primed with NaCl (Figures 5A, 5B).

Figure 5 – Effect of seed priming on hydrogen peroxide content (\( \ce{H_2O_2} \)) (A) and malondialdehyde (MDA) (B) in *Myracrodruon urundeuva* Allemão seedlings submitted to three levels of salinity (0.0; 25.0 and 50.0 mM NaCl) *in vitro* for 45 days

Source: Authors (2021)

The increase in the amount of salts level in the substrate solution can trigger an imbalance in the plant’s redox system, causing stress, which in turn can damage plant growth and development (MORAIS et al., 2019). However, the answers obtained in the present research show us that priming with NaCl was not effective in activating the enzymatic antioxidant defense system in seedlings that were not subjected to subsequent stress, not showing the desired signaling effect. On the contrary, it favored stress on seedlings that were not cultivated in a saline medium.
The principal components analysis (PCA) considering the two main axes, explain 71% of the variations presented in this study. Within the analyzed parameters, it is observed that dimension 1 explains 50.11% of the results (Figure 6A).

Figure 6 – Principal Component Analysis (PCA) in Myracrodruon urundeuva Allemão seedlings submitted to three levels of salinity in vitro for 45 days

Source: Authors (2021)

In where: Principal Component Analysis (PCA): Effect of seed priming on height, total fresh biomass (TFB), fresh shoot biomass (FSB), fresh root biomass (FRB), number of leaves (NL), sodium (Na) content, potassium (K) content, total soluble protein content (TSP), on the activity of superoxide dismutase enzymes (SOD), ascorbate peroxidase (APX) and catalase (CAT), on hydrogen peroxide content (H$_2$O$_2$) and malondialdehyde (MDA) in Myracrodruon urundeuva Allemão seedlings submitted to three levels of salinity (0.0; 25.0 and 50.0 mM NaCl) in vitro for 45 days.

The groupings observed in the PCA were important for a better understanding of the seedling responses to the imposed factors. The variables were grouped according to the correlation with the evaluated treatments and, thus, it is observed that salinity was the main factor with the distribution of variables within the quadrants (Figure 6B). In general, salinity negatively affected growth parameters and some biochemical variables, such as enzymatic activity of SOD and APX, as observed in the upper quadrants. The analysis shows the inversely proportional relationship
between the soluble protein contents and the activity of SOD and APX enzymes, confirming that the total protein contents may vary as a function of the enzymatic activity. It also shows us the positive correlation between the H$_2$O$_2$ contents with most of the growth parameters in the upper right quadrant, as well as the positive correlation between the H$_2$O$_2$ and MDA contents, confirming that the increase in lipid peroxidation in this treatment was due to the increased concentrations of this ROS. The vectors position indicates that salinity had a detrimental effect on the seedling root system. The results clearly show that seed priming with NaCl caused a decrease in the activity of SOD and APX enzymes. Seedlings grown under salinity, regardless of priming, showed a positive correlation with Na and K contents, as well as with protein contents and CAT activity (Figures 6A, 6B).

4 CONCLUSION

Despite *Myracrodruon urundeuva* not tolerating environments with high salinity, this study proved some tolerance plasticity within the saline concentrations tested could be obtained. Seed priming with NaCl, despite being favorable when considering most growth and development variables, induced an increase in lipid peroxidation in seedlings that were not exposed to salinity, which is linked to a decrease in the activity of antioxidant enzymes. This antagonistic response to NaCl stimulation between growth parameters and plant defense raises the need for further studies to complement this one, with a broader framework of analyzes in order to delineate *M. urundeuva* strategies in a more integral way when a chemical stimulus is directed to the embryo.

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How to quote this article
Souza, L. M.; Conceição, E. M.; Barbosa, M. R.; Palhares Neto, L.; Santos, A. M. M.; Souza, R. A.; Houllou, L. M. Effect of seed priming with NaCl on the induction of salinity tolerance in Myracrodruon urundeuva Allemão in vitro. Ciência Florestal, Santa Maria, v. 32, n. 4, p. 2199-2218, 2022. DOI 10.5902/198050986700. Available from: https://doi.org/10.5902/198050986700.