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Foliar application of auxin on forage grasses subjected to salt stress

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Gilmara Matias de Sousa
PhD student at PMBqBM of the Federal University of Cariri - UFCA.

Juan Carlos Alvarez-Pizarro
Professor at the Federal University of Cariri – UFCA

ABSTRACT
Urochloa brizantha and Megathyrsus maximus grasses are species that are not very tolerant to salinity and that plant hormones are fundamental for the adaptation of plants to salinity, as they mediate several adaptive responses; the present work aims to evaluate the effect of auxin, indoleacetic acid, on the mechanisms of adaptation to salt stress. On the day of collection, the groups of plants were divided into leaves, stems and roots to estimate the contents of Na+ and K+ ions. The quantification of ions in these samples was done by flame photometry. Treatment with auxin did not stimulate the regulatory mechanisms of Na+ homeostasis in U species. brizantha and M. maximus.

Keywords: Auxin, Salt stress, Salinity tolerance.

1 INTRODUCTION

Abiotic stresses are harmful to plants by interfering with plant metabolism and compromising the biochemical and physiological functions of the body. Among the abiotic stresses, saline is caused by the excess of salts in the medium, being quantified through the electrical conductivity in the saturation extract (LEITE et al. 2019).

The excess of sodium, calcium, carbonates, chlorides and other salts in the environment generate an area of low water potential and restricts the roots to absorb water, in addition, it promotes toxicity in plant metabolism, leading plants to a state of ionic imbalance, by absorbing high concentrations of sodium ions (Na+) and chlorides (Cl^-) to the detriment of low concentrations of important ions, such as potassium (K+), which interferes with productivity and can even lead to the death of the plant (JIANG et al. 2010).

Some plants have been able to develop adaptation mechanisms that support life in environments with excess salts, but most plant species are glycophytes, that is, they do not support life in saline environments. Among these organisms are species belonging to the Poaceae family (GAMALERO et al. 2020).

Forage grasses are monocot species, of the Poaceae family, native to the African continent and have considerable importance in the agricultural sector, as they have a high forage cover capacity, and represent a nutritious and low-cost food for the animal (SILVA, 2019).

However, grasses are species that show variations in sensitivity to salt stress. As an example, the cultivar Piatã from the species *Urochloa brizantha* is categorized as sensitive to salinity , and the cultivar Tanzania from the species *Megathyrsus maximus* is identified as moderately tolerant to salinity, as this cultivar can survive in environments with low salt concentrations (SOUSA et al, 2022; FERREIRA, 2019; PRAXEDES et al. 2019; ALVAREZ-PIZARRO et al. 2019; ALVES and COSTA, 2018).

In view of the above, this work aims to investigate whether auxin (3-indoleacetic acid - IAA) stimulates the cultivars Piatã and Tanzania to develop adaptation mechanisms in an environment with excess sodium chloride (NaCl), since auxin is a plant hormone that promotes the growth and elongation of tissues, and that 3-indoleacetic acid is the most present and important auxin for plant tissues. as well as, because plant hormones can boost mechanisms of adaptation to abiotic stresses in plants (TAIZ et al. 2017).

2 METHODOLOGY

The work was conducted at the Plant Biochemistry and Physiology Laboratory at the Federal University of Cariri (UFCA). 20 seeds of the Piatã cultivar and 20 seeds of the Tanzania cultivar were selected and treated with 3% sodium hypochlorite (NaClO) for 5 minutes, and then rinsed with running water. Sowing was done in cups with a capacity of 180 ml and filled with vermiculite, 10 seeds per cup were sown, and moistened with 10 ml of 0.5 mM Calcium Chloride.

After 10 days of sowing, the plants were transferred to containers containing Hoagland's nutrient solution with pH of 5.8, the plants remained in this container for another 10 days, and the nutrient solution was changed on the fifth day.

On the twentieth day, the plants were transferred to pots containing nutrient solution and divided into treatment groups (control, saline, auxin, saline + auxin), NaCl was applied in three plots, each at a concentration of 40 mM, totaling 120 mM.

Auxin (IAA) with a concentration of 5 μM was applied by sprinkling on the leaves and in two plots, on the third and fifth day after the salt stress was applied to the plants.

On the ninth day of stress, stomatal conductance was measured with the aid of a leaf porometer. And on the tenth day, the collection took place, where the plants were separated by plant tissue; leaf, stem and root, measured to measure the length and weighed to later be packaged by treatment and stored in a freezer.

The concentrations of $Na+$ and $K+$ ions in the three plant tissues (leaf, stem and root) were calculated using a flame photometer, and expressed in μmol. $^{g-1}$ of fresh mass.

The data obtained were analyzed using analysis of variance ANOVA and with Tukey's test significance ($p \leq 0.05$), with the aid of the Jamovi software, version 2.3.21.

3 RESULTS AND DISCUSSION

Auxin stands out for having been the first plant hormone to be investigated as a growth promoter in plants, many researches explore the use of auxin in the mechanisms of cell elongation and development of vascular tissues. Figueiredo et al. (2014) used auxin to stimulate the germination of the *Urochloa brizantha*, Filho et al. (2017) and Meneguzzi et al. (2015) used auxin to promote the rooting of dicotyledonous species, Oliveira et al. (2017) used a combination of plant hormones, including auxin to stimulate cowpea to survive under irrigation with saline water, as well as Sá et al. (2020) who noticed the beneficial effects of auxin (IAA) in the species of *Charge papaya* tolerance to salt stress at low NaCl concentrations.

Despite the various beneficial effects promoted by EIA and reported in research, the application of 5μM of EIA in this study (figure 01) was not sufficient for the species of *Urocloa brizantha* (cultivar Piatã) and *Megathyrsus maximus* (cultivar Tanzania) recovered the tissue length and fresh mass lagged during salt stress.

It is observed that the cultivar Tanzânia has a higher growth and more accumulation of fresh mass in the leaf, compared to Piatã, in the control groups (figure 01), but in relation to the saline treatments the length remained or decreased. Akbari et al. (2007) demonstrated that using exogenous IAA application they were able to boost wheat growth when exposed to salinity, but Sá et al. (2020) point out that the use of exogenous IAA will only be efficient at low salt concentrations.

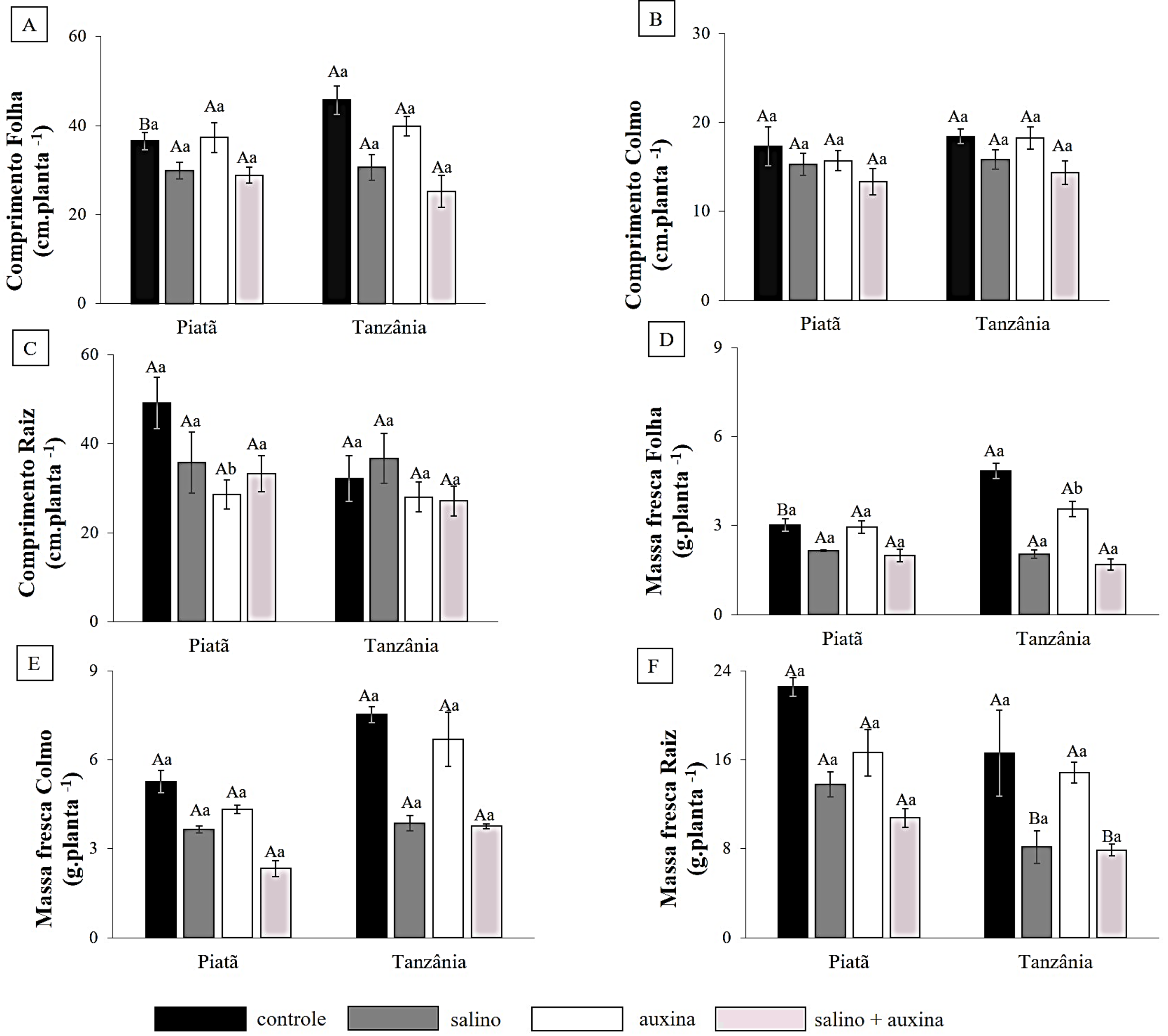
Salinity affects the growth of plant tissues by causing morphological damage, especially in the shoots, Praxedes et al. (2019) demonstrated that high salt concentrations caused a reduction in the length of the Tanzania cultivar, and Maia et al (2015) associated the reduction in the growth of the Tanzania cultivar under salt stress to a deficiency in nitrogen absorption.

Salt stress negatively interferes with stomatal conductivity, by decreasing water absorption by plants, promoting delays and imbalance in plant metabolism, driving plants with a lower growth rate to a stomatal closure, thus, the absorption of carbon dioxide (CO2) is impaired (SOUZA, 2018).

In Figure 02, it can be observed that the exogenous application of EIA promoted a significantly important recovery of transpiration in the Tanzania cultivar. On the other hand, the same result was not observed in the Piatã cultivar, remaining stable in relation to salinity.

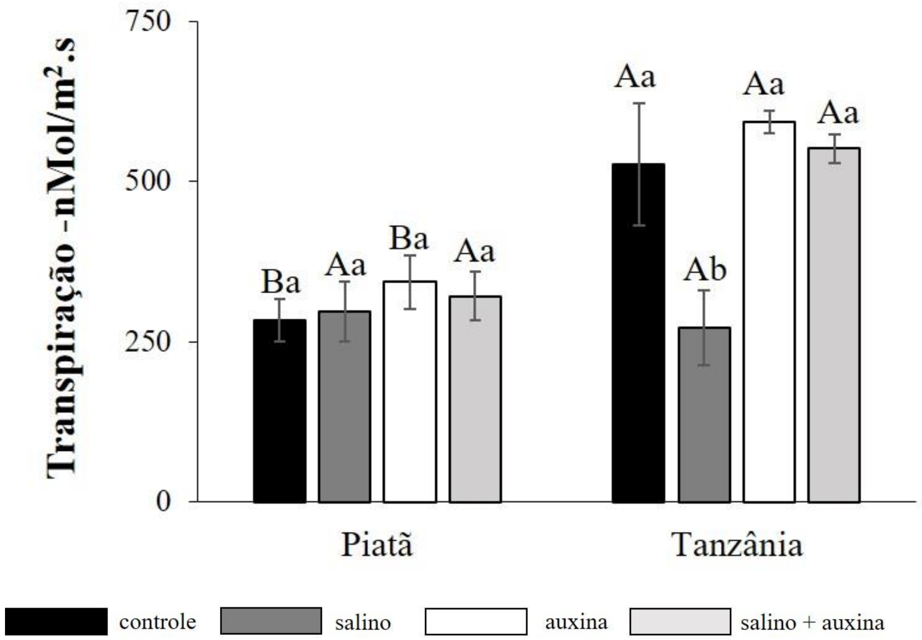
The result of perspiration (figure 02) is relevant to the extent that studies (SOUSA et al. 2022, FERREIRA, 2019; PRAXEDES et al. 2019; ALVAREZ-PIZARRO et al. 2019; ALVES and COSTA, 2018) consider the Tanzania cultivar to be more tolerant to salinity compared to the Piatã cultivar, emphasizing that Tanzania is able to survive and adapt to low salt levels in the environment.

Figure 01 - Data of length (A, B, C) and fresh mass (C, D, E) of *Urochloa brizantha* (Piatã cultivar) and *Megathyrsus maximus* (Tanzania cultivar) submitted to 120 mM NaCl. The uppercase letters (A, B) over the bars of the graph compares the species *U. brizantha* (Piatã) and *M. maximus* (Tanzania) in the same treatment, and the lowercase letters (a, b) compares the treatments (control and auxin/saline and saline + auxin) within the same species



Source: The author.

Figure 02 - Stomatal conductance data of *Urochloa brizantha* (Piatã cultivar) and *Megathyrsus maximus* (Tanzania cultivar) submitted to 120mM NaCl. The uppercase letters (A, B) over the bars of the graph compares the species *U. brizantha* (Piatã) and *M. maximus* (Tanzania) in the same treatment, and the lowercase letters (a, b) compares the treatments (control and auxin/saline and saline + auxin) within the same species



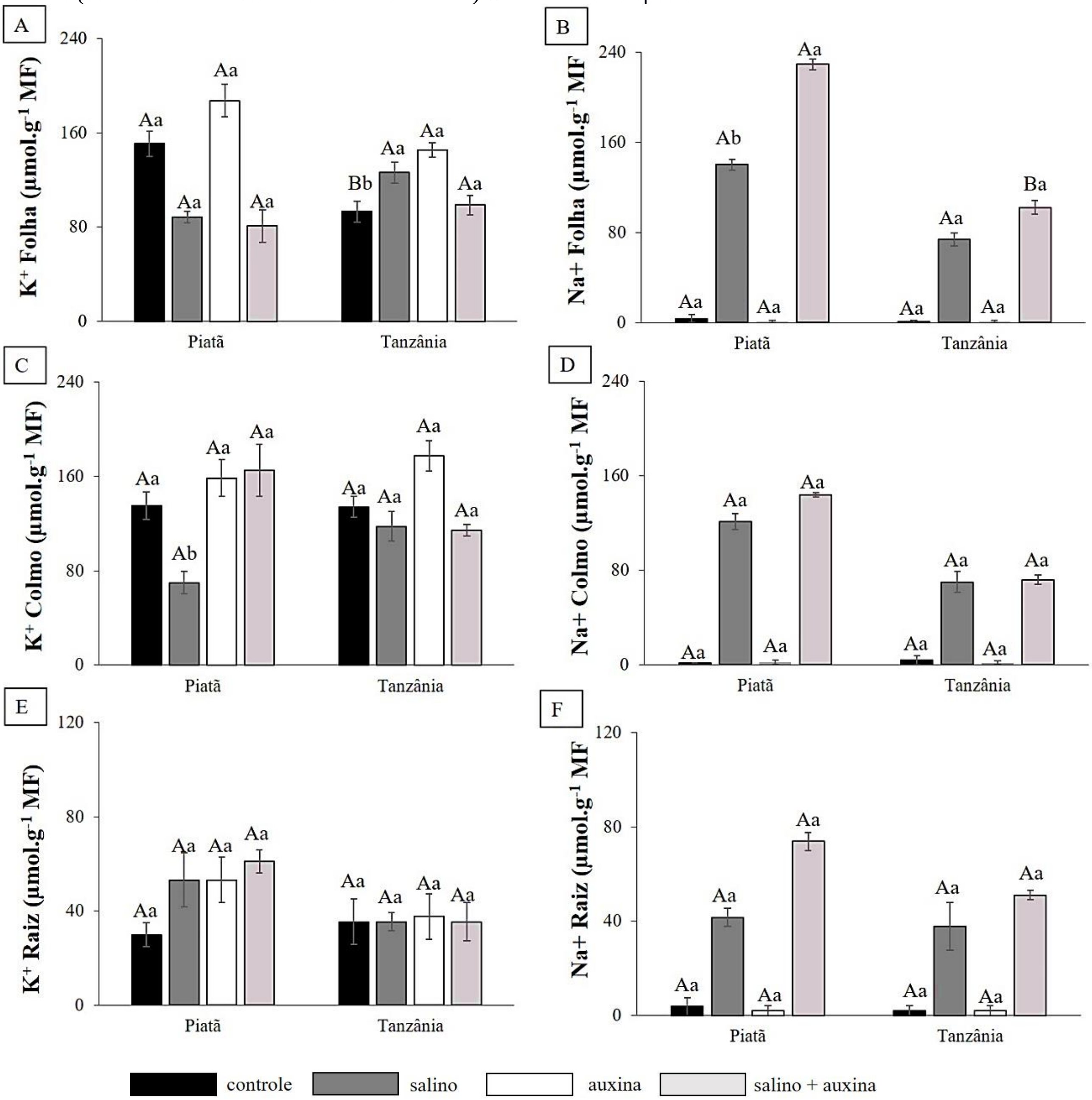
Source: The author.

The most harmful effect of salt stress on plants is characterized by an imbalance in plant nutrition, causing an undesired ionic effect, in which Na+ and Cl^- ions accumulate in tissues and lead to deficiency of other ions, such as K+, and excess Na+ causes competition with K+ transporters. Therefore, high concentrations of Na+ can trigger enzymatic inhibition and impair protein synthesis (BASSIL, et al. 2012; KETEHOULI et al. 2019).

It can be seen in figure 03 (A, C) that the application of IAA promoted an increase in the levels of K+ in the leaves and stems of the two cultivars studied when comparing the controls, and in the stem of the Piatã cultivar the application of EIA promoted a significant effect by doubling the accumulation of K+ in this tissue with salt stress. The K^+ it is important for the plant as it cooperates with various metabolic processes, such as membrane transport, enzyme activation, pH balance, and photosynthesis (KETEHOULI et al. 2019).

Lafet et al. 2021, by using exogenous IAA in the bean under salt stress, achieved a marked reduction in Na^+ contents, showing that the IAA led the plant to attenuate the damage caused by the ionic imbalance. This fact was not found in the referred study, because the application of 5μM IAA was not effective in reducing the levels of Na+ in the tissues studied. However, the Piatã cultivar accumulated more Na^+ in the tissues than Tanzania.

Figure 03 - K+ and Na+ contents in *Urochloa brizantha* (Piatã cultivar) and *Megathyrsus maximus* (Tanzania cultivar) species submitted to 120mM NaCl. The uppercase letters (A, B) over the bars of the graph compares the species *U. brizantha* (Piatã) and *M. maximus* (Tanzania) in the same treatment, and the lowercase letters (a, b) compares the treatments (control and auxin/saline and saline + auxin) within the same species



Source: The author.

4 CONCLUSION

This research opens spaces for a more detailed investigation of the role of auxin as a salt stress attenuating agent in grasses. Further study is needed to establish an ideal concentration of IAA to be used in grasses, as well as to investigate which adaptive mechanisms can be potentiated with the use of exogenous IAA in glycophyte plants.

REFERENCES

AKBARI, G. et al. Effect of Auxin and Salt Stress (NaCl) on Seed Germination of Wheat Cultivars (Triticum aestivum L.). Pakistan Journal of Biological Sciences, 2007.

ALVAREZ-PIZARRO, J. C. et al. Osmolyte accumulation in leaves and Na+ exclusion by roots in two salt–treated forage grasses. Grassland Science, p. 1-7, 2019.

ALVES, A. B.; COSTA, CLÁUDIO. Efeito do estresse salino em sementes de brachiaria, variedades brizantha, piatâ, decumbens, marandú e ruziziensis. Funcamp Agro, 2018.

BASSIL, E.; COKU, A.; BLUMWALD, E. cellular ion homeostasis: emerging roles of intracellular NHX Na+ /H+ antiporters in plant growth and development. Journal of Experimental Botany, v. 63, n. 16, p. 5727-5740, 2012.

FERREIRA, I. G. et al. Mecanismo de regulação da homeostase ionica em espécie de capim braquiaria submetidas a salinidade. PDVAgro, 2019.

FILHO, R. S. L. C. et al. efeito das auxinas ácido indolbutírico (aib), ácido indolacético (aia) e ácido naftalenoacético (ana) no enraizamento in vitro de Myracrodruon urundeuva. Anais Seminário de Iniciação Científica, 2017.

GAMALERO, E. et al. Saline and Arid Soils: Impact on Bacteria, Plants, and Their Interaction. Biology, v. 9, n. 6, Jun 2020.

JIANG, X.; LEIDI, E. O.; PARDO, J. M. How do vacuolar NHX exchangers function in plant salt tolerance? Plant Signaling & Behavior, v. 5, p. 792-795, 2010.

KETEHOULI, T. et al. Adaptation of Plants to Salt Stress: Characterization of Na+ and K+ Transporters and Role of CBL Gene Family in Regulating Salt Stress Response. Agronomy, v. 9, n. 11, 2019.

LAFET, A. A. H.; AKTER, A.; ARIF, M. T. Foliar application of auxin or cytokinin may confer tolerance to salinity stress in Vicia faba. agronomy, 2021.

LEITE, R. D. S. et al. Effect of salinity on the growth of Brachiaria. Tordesillas, revista de investigación multidisciplinar, 2019.

MENEGUZZI, A. et al. Ácido indolacético influencia no enraizamento de estacas de Pittosporum tobira. Revista de Ciências Agroveterinárias, Lages, v. 14, n. 1, p. 24-28, 2015.

OLIVEIRA, F. D. A. D. et al. Estresse salino e biorregulador vegetal em feijão caupi. Irriga, Botucatu, v. 22, n. 2, p. 314-329, abril-junho 2017.

PRAXEDES, S. S. C. et al. Desempenho do Capim Tanzânia Irrigado com água salobra aplicada via aspersão e gotejamento. IRRIGA, v. 24, n. 2, p. 236-253, 2019.

SÁ, F. V. D. S. et al. Exogenous application of phytohormones mitigates the effect of salt stress on Carica papaya plants. Revista Brasileira de Engenharia Agrícola e Ambiental, v. 24, n. 3, p. 170-175, 2020.

SILVA, D. A. S. Agronomia: elo da cadeia produtiva. Ponta Grossa: Atena Editora, 2019., v. 5, 2019.

SOUSA, G. M. D. et al. Germinação, Crescimento e equilíbrio iônico em duas espécies de gramíneas forrageiras submetidas a diferentes níveis de salinidade do solo. In: Meio Ambiente e Sustentabilidade: Pesquisas reflexões e dialógos emergentes. Ampla, v. III, 2022. p. 389-399

SOUZA, M. W. D. L. Bioestimulante como atenuador de estresse salino na cultura da abobrinha italiana (cucurbita pepo l.). Universidade Federal Rural do Semi- Árido. mossoró-RN, p. 98. 2018.

TAIZ, L. et al. Fisiologia e desenvolvimento vegetal. 6. ed. Porto Alegre: Artmed, 2017.