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Effect of saline stress, and nitrogen and potassium fertilization on morphophysiology of *Passiflora edulis* Sims. f. *flavicarpa* Dreg.

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ABSTRACT: In Brazil semi-arid regions, excess of soluble salts is a limiting factor for the success of agricultural crops. An adequate supply of nutrients can cause positive responses in plant species under salt stress. The objective of this study was to analyze the effect of nitrogen and potassium on the morphophysiology of passion fruit (*Passiflora edulis*) seedlings subjected to saline stress. The design was a randomized blocks design, with treatments generated by the Box Central Composite Design matrix. Five electrical conductivities of irrigation water (ECw = 0.5, 0.98, 2.15, 3.32, and 3.80 dS m^{-1}), five doses of nitrogen (N) and potassium (K) (0.0, 29.08, 100.0, 170.92, and 200.0%), in four replications. The combination of 200% NK stimulated the synthesis of chlorophyll *a*, and total chlorophyll under low salinity conditions (0.5 dS m^{-1}). The chlorophyll *a*/*b* ratio was higher at ECw of 3.8 dS m^{-1} and under a concentration of 20.23% NK. The increase in water salinity from of 0.5 dS m^{-1} caused deleterious effects on the growth of passion fruit seedlings. The doses of NK between 100% and 120% improved the absolute growth rates of plant height and stem diameter, chlorophyll *b*, aerial dry matter, and total dry matter. The 200% dose of NK improved the leaf mass ratio. The combination of N and K applied foliar proved to be efficient in reducing the effects of salinity on the synthesis of photosynthetic pigments, providing better growth conditions for yellow passion fruit seedlings.

Key words: fertilizing; photosynthetic pigments; salinity; vegetative growth

Efeito do estresse salino e da adubação nitrogenada e potássica na morfofisiologia do maracujazeiro-amarelo

RESUMO: Na região semiárida brasileira, o excesso de sais solúveis é um fator limitante para o sucesso das culturas agrícolas. Um fornecimento adequado de nutrientes pode causar respostas positivas em espécies de plantas sob estresse salino. O objetivo deste estudo foi analisar o efeito do nitrogênio e do potássio na morfofisiologia de mudas de maracujá (*Passiflora edulis*) submetidas ao estresse salino. O delineamento utilizado foi em blocos casualizados, com tratamentos gerados pela matriz de Composto Central de Box. Cinco condutividades elétricas da água de irrigação (CEa = 0,5, 0,98, 2,15, 3,32 e 3,80 dS m^{-1}), cinco doses de nitrogênio (N) e potássio (K) (0,0, 29,08, 100,0, 170,92 e 200,0%), com quatro repetições. A combinação de 200% de NK estimulou a síntese de clorofila *a* e clorofila total sob condições de baixa salinidade (0,5 dS m^{-1}). A relação clorofila *a*/*b* foi maior na CEa de 3,8 dS m^{-1} e sob a concentração de 20,23% de NK. O aumento da salinidade da água a partir de 0,5 dS m^{-1} causou efeitos deletérios no crescimento de mudas de maracujazeiro. As doses de NK entre 100% e 120% melhoraram as taxas de crescimento absoluto da altura das plantas e diâmetro do caule, clorofila *b*, matéria seca aérea e matéria seca total. A dose de 200% de NK melhorou a relação massa foliar. A combinação de N e K aplicado via foliar se mostrou eficiente em reduzir os efeitos da salinidade sobre a síntese de pigmentos fotossintéticos, proporcionando melhores condições de crescimento das mudas de maracujazeiro amarelo.

Palavras-chave: fertilização; pigmentos fotossintéticos; salinidade; crescimento vegetativo

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Introduction

Brazil is the world largest producer of yellow passion fruit (*Passiflora edulis* Sims. f. *flavicarpa* Deg.) and reached a production of 697,859 tons in 2022 in a cultivated area of 45,602 ha. The Northeast region of Brazil accounted for 69.8% of the total production. However, the national productivity is still low, with an average of 15.303 t ha^{-1} $year^{-1}$ (IBGE, 2022).

The specie is an important socioeconomic component of the Brazilian agricultural sector and is cultivated throughout the territory, due to the favorable edaphoclimatic conditions and the high demand for fresh consumption of fruit and processed juice (Souto et al., 2023).

The disparity between the current average productivity and the potential passion fruit production is due to several biotic and abiotic factors. In the Northeast, semi-arid region, where climatic instability and water insufficiency occur due to the high rate of evaporation and irregularity of precipitation, one of the factors limiting the success of cultivation is the excess of soluble salts found in water sources for irrigation, which is an abiotic stress that limits the development of plants worldwide (Nóbrega et al., 2022).

The use of saline water for irrigation causes deleterious effects on crops because when there is a reduction in the osmotic potential of the soil, there is a decrease in the availability of water for plants, promoting stomatal closure and compromising transpiration and photosynthesis (Pereira et al., 2022; Silva Filho et al., 2024). The excess of salts has an ionic effect, promoting nutritional imbalance in plants exposed to these conditions. This causes, *inter alia*, changes in the assimilation of nitrogen and the metabolism of proteins. The latter is due to the inhibition of the synthesis of 5-aminolevulinate acid, which is the precursor of chlorophyll and changes the functional state of the chloroplast thylakoid membranes, and the characteristics of the chlorophyll fluorescence signals in the leaves (Nigam et al., 2022).

Nutrition supply with nutrients that elicit a positive response to salt stress has been studied to mitigate the harmful effects of salt concentration in irrigation water on plants. Nitrogen (N) and potassium (K) are essential macronutrients that have several important functions in plants. N constitutes several vital organic compounds, such as amino acids, proteins, nucleic acids, chlorophyll, and proline pigments, among other organic assimilates, while K promotes the control of cell turgidity, activation of enzymes involved in respiration and photosynthesis, regulation of stoma opening and closing processes, carbohydrate transport, and transpiration (Mulet et al., 2023). With an adequate supply of these compounds, it is possible to increase the osmotic adjustment capacity of the plant to salinity, and the tolerance of the cultures to salt stress, further promoting the restoration of nutritional balance and decreasing the toxic effects of sodium (Figueiredo et al., 2023).

The objective of this study was to analyze the effect of nitrogen and potassium on the morphophysiology of passion fruit (*Passiflora edulis*) seedlings subjected to saline stress.

Materials and Methods

The experiment was performed from April to June 2018 in a controlled environment facility at the Centro de Ciências Agrárias, Universidade Federal da Paraíba, municipality of Areia, Paraíba, Brazil (latitude 6° 58' S, longitude 35° 41' W, and altitude of 575 m). The climate of the region, according to the Köppen classification, is of the 'As'' type, which means a dry and hot summer and rain in the winter.

The passion fruit seedlings were grown in 1.15 L polyethylene bags filled with substrate composed of 85% soil, 10% fine sand, and 5% dried bovine manure. The substrate was analyzed for physical and chemical characteristics for fertility and salinity, following the methods of Teixeira et al. (2017) (Table 1).

Three seeds of yellow passion fruit variety (*Passiflora edulis* Sims. f. *flavicarpa* Deg.) were used per polyethylene bag, which was close to field capacity of seeds, until germination was established.

The randomized blocks design had four replications and two plants per plot, with five levels of electrical conductivity of irrigation water ECw, and five doses of the combination of nitrogen and potassium (D), totaling nine combinations, which were generated through the central box compound matrix. The combinations of ECw (dS m^{-1}) and D (%) were: T1 = 0.98 and 29.08; T2 = 0.98 and 170.92; T3 = 3.32 and 29.08;

Table 1. Physical and chemical composition of the substrate components used in the experiment.

Physics	Value	Fertility	Value	Salinity	Value
Sand (g kg^{-1})	639	pH in water (1: 2.5)	7.00	pH	7.30
Silte (g kg^{-1})	227	P (mg dm^{-3})	146.32	ECw (dS m^{-1})	2.73
Clay (g kg^{-1})	134	K^+ (mg dm^{-3})	633.29	$SO4^{2-}$ ($mmol_c$ L^{-1})	1.02
Textural class	Franco	Na^+ ($cmol_c$ dm^{-3})	0.27	Ca^{2+} ($mmol_c$ L^{-1})	16.00
	Sandy	Al^{3+} ($cmol_c$ dm^{-3})	0.00	Mg^{2+} ($mmol_c$ L^{-1})	16.75
		H^++Al^{3+} ($cmol_c$ dm^{-3})	2.84	K^+ ($mmol_c$ L^{-1})	6.90
		Ca^{2+} ($cmol_c$ dm^{-3})	5.53	CO_3^{2+} ($mmol_c$ L^{-1})	0.00
		Mg^{2+} ($cmol_c$ dm^{-3})	1.70	HCO_3^{2+} ($mmol_c$ L^{-1})	40.00
		SB ($cmol_c$ dm^{-3})	9.12	Cl^- ($mmol_c$ L^{-1})	30.00
		CTC ($cmol_c$ dm^{-3})	11.96	RAS ($mmol_c$ L^{-1})	0.94
		MO ($cmol_c$ dm^{-3})	26.69	PST (%)	0.13
				Classification	Saline

T4 = 3.32 and 170.92; T5 = 0.50 and 100; T6 = 3.80 and 100; T7 = 2.15 and 200; T8 = 2.15 and 0; and, T9 = 2.15 and 100, respectively, in each of the nine treatments.

The electrical conductivity of the irrigation water ECw was obtained by diluting a strongly saline (14.6 dS m^{-1}) with non-saline water (0.5 dS m^{-1}), with the aid of a portable conductivity meter. Saline levels were chosen based on Oliveira et al. (2015), who reported inhibition of growth in passion fruit seedlings with an ECw of 1.5 dS m^{-1}.

The NK compound was obtained by combining two commercial products to meet the need for potassium and nitrogen, as proposed by Novais et al. (1991) for vessels, at 150 mg dm^{-3} of K and 300 mg dm^{-3} of N, which corresponded to a combination of 100% in this study. The other doses used were: 29.08% (43.62 mg dm^{-3} K and 87.24 mg dm^{-3} N); 170.92% (256.38 mg dm^{-3} K and 512.76 mg dm^{-3} N); and 200% (300 mg dm^{-3} K and 600 mg dm^{-3} N). The first product contained 100 g kg^{-1} N and 100 g kg^{-1} K_2O to meet the requirement for K, and the second product contained 99 g kg^{-1} N and was used to supplement N.

At 20 days after sowing (DAS), the application of saline water started, with daily irrigation by hand, according to the need of the plant, which is determined by the water balance method. which consists of replacing the evapotranspiration volume daily. For this purpose, collectors were placed in 10 containers, and water capacity was determined as the difference between the volume applied and the volume drained from the previous irrigation. Every 15 days, a 15% leach fraction was applied, based on the volume applied in that period, to reduce the accumulation of substrate salts, determined by Equation 1:

$$\mathrm{VI} = \frac{(\mathrm{Va} - \mathrm{Vd})}{(1 - \mathrm{LF})} \tag{1}$$

where: VI - volume of water to be used in the irrigation event (mL); Va - volume applied in the previous irrigation event (mL); Vd - volume drained in the previous irrigation event (mL); and, LF - leaching fraction of 0.15, applied every 15 days.

Fertilization with the compost also started at 20 DAS and was divided into seven equal applications, performed weekly in the late afternoon. The quantities of potassium and nitrogen were determined and then diluted in distilled water to reaching the volume of the water requirement during the application period.

Growth evaluations were performed at 30 and 75 DAS to determine the absolute growth rate of the stem diameter (AGRsd) and plant height (AGRph), as proposed by Hunt et al. (2002), as calculated by Equation 2:

$$\mathrm{AGR} = \frac{(\mathrm{A}_2 - \mathrm{A}_1)}{(\mathrm{t}_2 - \mathrm{t}_1)} \tag{2}$$

where: AGR - absolute growth rate; A_2 - plant growth at time t_2; A_1 - increase in plant growth at time t_1; and, t_2 - t_1 is the time difference between samples.

At 75 DAS, the chlorophyll *a, b,* and total chlorophyll were determined by the non-destructive method, using a portable chlorophyll meter (ClorofiLOG®, model CFL 1030, Porto Alegre, RS, Brazil) to determine a Falker chlorophyll index (FCI). Immediately afterwards, destructive evaluation was performed to determine the dry shoot phytomass (DSP) and total dry phytomass (TDP). For this purpose, the material was stored in individually marked paper bags and placed in an air draught oven at 65 °C for 72 hours. After the material achieved a constant weight, samples were weighed on a 0.01 g precision scale. Phytomass values were used to determine the leaf mass ratio (LMR) as described by Dutra et al. (2012), according to Equation 3:

$$\mathrm{LMR} = \frac{(\mathrm{DSP})}{(\mathrm{TDP})} \tag{3}$$

where: LMR - leaf mass ratio; DSP - dry shoot phytomass; and, TDP - total dry phytomass.

The data obtained were subjected to the normality test (Shapiro Wilk), and then to analysis of variance using the F test ($p \leq 0.05$). In cases of significant effect, polynomial regression analysis was performed for the factors studied, with prepared response surfaces for the variables in which the interaction was significant. For data analysis, the statistical program R was used (R Core Team, 2021).

Results

The effect of the electrical conductivity of irrigation water (ECw) and nitrogen and potassium (NK) doses on the content of pigments and the morphology of passion fruit seedlings are shown in Table 2. The levels of chlorophyll *a*, chlorophyll *a/b* and total chlorophyll were influenced by the interaction between ECw and NK doses, while for chlorophyll *b*, absolute growth rate in plant height and stem diameter, leaf mass ratio, dry shoot phytomass, and total dry phytomass, was a significant main effect.

Chlorophyll levels reduced as saline levels increase, with the highest values being obtained in plants subjected to a lower ECw of 0.5 dS m^{-1}, with values of 41.78 and 56.21 for chlorophyll *a* and total, at doses of 200 and 198.73% NK, respectively (Figures 1A and 1B). The lowest values obtained (29.5 and 37.2) in plants subjected to ECw of 3.45 and 2.66 dS m^{-1} and doses of 200 and 96.5% of NK, resulting in reductions of 29.4 and 33.8% in chlorophyll *a* and total contents, respectively, when compared with the maximum values obtained.

Contrary to the results obtained for chlorophyll *a* and total chlorophyll, the ratio of chlorophyll *a/b* (Figure 1C) increased with salinity, with a maximum ECw of 3.8 dS m^{-1} and 1.38% NK, 20.23% higher than the minimum value ECw of 0.5 dS m^{-1} at a dose of 1.03 NK.

The salinity of the irrigation water and the dose of the NK compound individually affected chlorophyll *b*, where a linear reduction in chlorophyll *b* occurred with an increase

Table 2. Summary of the analysis of variance for the variables Chlorophyll *a* (Chl*a*), chlorophyll *b* (Chl*b*), and total chlorophyll (Chlt), chlorophyll *a*/*b* ratio (Chl*a*/*b*), absolute growth rate for plant height (AGRph), stem diameter (AGRsd), leaf mass ratio (LMR), dry shoot phytomass (DSP), and total dry phytomass (TDP) in passion fruit seedlings subjected to different electrical conductivities of irrigation water and doses of nitrogen and potassium at 75 days after sowing.

Variation sources	GL	Medium square								
		Chl*a*	Chl*b*	Chlt	Chl*a*/*b*	AGR_{PH}	AGR_{SD}	LMR	DSP	TDP
Blocks	3	1.39^{ns}	8.77^{ns}	6.02^{ns}	0.05^{ns}	0.05^{ns}	1.8×10^{-4ns}	$6.9\times10^{-4*}$	0.08^{ns}	0.07^{ns}
Treatments	8	38.04^{**}	25.55^{**}	98.99^{**}	2.25^{**}	0.68^{**}	$6.3\times10^{-4*}$	$3.6\times10^{-3**}$	13.55^{**}	27.47^{**}
Doses (L)	1	5.76^{**}	2.15^{**}	9.21^{**}	0.23^{*}	0.35^{*}	0.019^{*}	0.035^{**}	2.82^{**}	4.75^{**}
Doses (Q)	1	3.55^{**}	3.28^{**}	7.01^{**}	0.16^{ns}	0.93^{**}	0.024^{**}	0.010^{ns}	3.21^{**}	4.47^{**}
ECw (L)	1	1.16^{ns}	2.06^{**}	2.75^{ns}	0.05^{ns}	0.18^{ns}	0.014^{ns}	0.059^{**}	1.80^{*}	1.50^{ns}
ECw (Q)	1	1.75^{ns}	1.60^{*}	3.69^{*}	0.19^{**}	0.56^{**}	0.020^{**}	0.025^{**}	1.34^{ns}	2.42^{*}
Doses × ECw	1	0.77^{*}	0.26^{ns}	1.08^{*}	0.07^{**}	0.02^{ns}	6.7×10^{-4ns}	0.002^{ns}	0.31^{ns}	0.37^{ns}
CV		5.80	5.50	6.50	4.30	19.10	15.70	3.50	14.40	14.20

^{ns}, *, ** non-significant, p ≤ 0.05, and p ≤ 0.01 results, respectively.

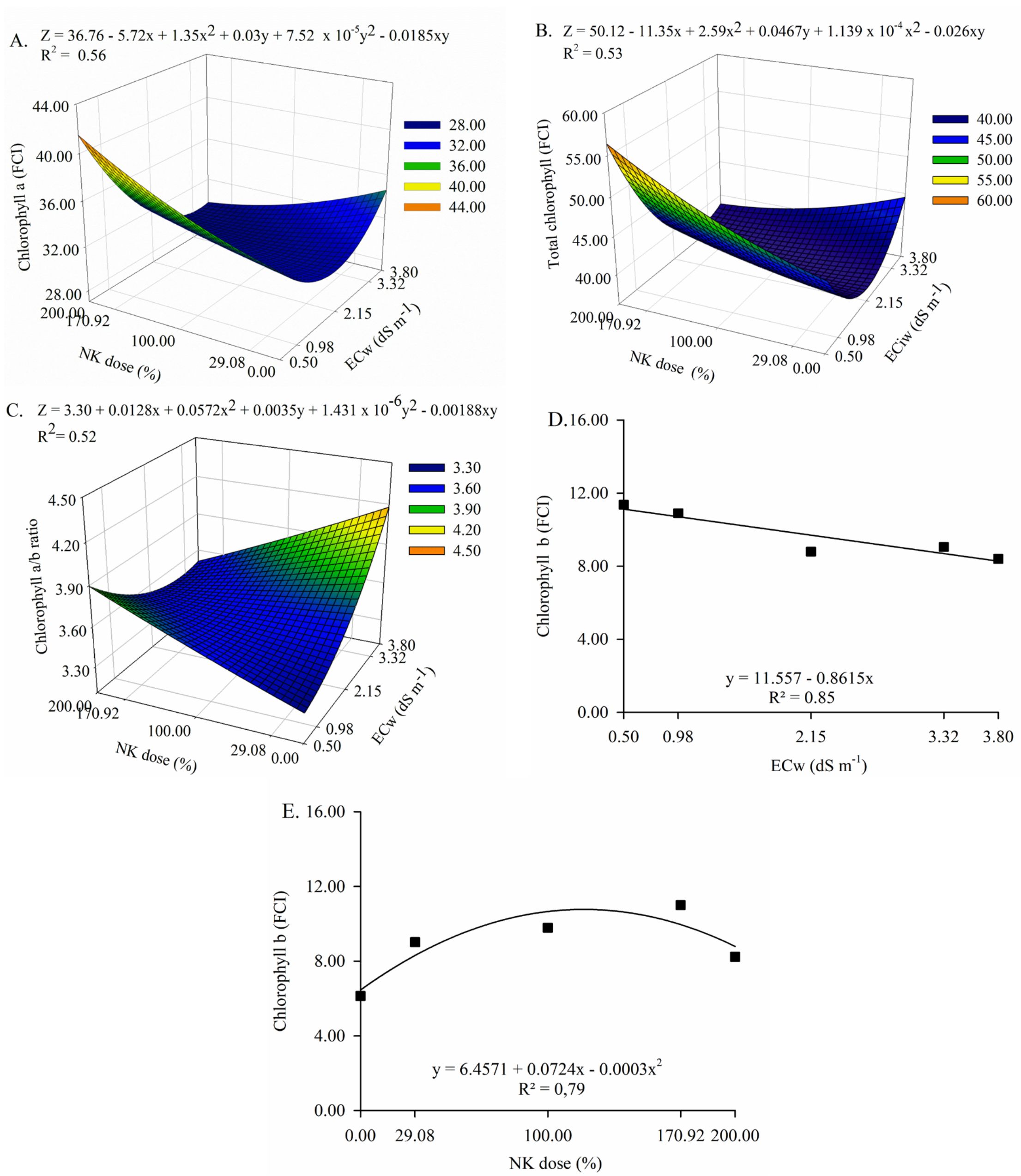

Figure 1. Chlorophyll *a* (A), total chlorophyll (B), chlorophyll *a*/*b* ratio (C), and chlorophyll *b* (D and E) in passion fruit seedlings subjected to different electrical conductivities of irrigation water and doses of nitrogen and potassium at 75 days after sowing.

in the electrical conductivity of the irrigation water, with a value of 11.13 and 8.28 in the ECw of 0.5 and 3.8 dS m^{-1}, respectively, representing a reduction in 25.60% (Figure 1D). A quadratic response to nitrogen and potassium dose was observed, with the highest chlorophyll *b* (10.82) at a dose of 120.17% NK (Figure 1E).

Absolute growth rate of plant height (AGRph) and stem diameter (AGRsd) reduced up to a ECw of 3.8 dS m^{-1}, with results varying between 1.67 and 1.24 cm^2 day^{-1} for AGRph (Figure 2A) and between 0.0746 and 0.0948 mm^2 day^{-1} for AGRsd (Figure 2B), when compared to the control treatment (0.5 dS m^{-1}), which corresponds to a reduction of 25.74% and 21.30% in AGRph and AGRsd, respectively.

Regarding the effect of nitrogen and potassium doses, there was a quadratic response for the variables AGRph and AGRsd, with the largest increment of 61.85% being recorded for AGRph at a dose of 111.87%, and 20.50% for AGRsd at a dose of 100% (Figures 2C and 2D).

The electrical conductivity of irrigation water up to 3.8 dS m^{-1} increased the leaf mass ratio (LMR), with a maximum of 0.37 under this salinity, exceeding by 9.29% the RMF of 0.33 under a conductivity of 0.5 dS m^{-1} (Figure 3A). LMR was also linearly stimulated by the application of NK (Figure 3B). The values increased from 0.30 to 0.40, with an increment of 24.77% in plants that did not receive fertilization and those that received up to 200% of the recommended dose.

As for dry shoot phytomass (DSP), and total dry phytomass (TDP) a linear decrease was observed with increasing salinity of the irrigation water up to 3.8 dS m^{-1}. A decrease of 10.23 g to 6.93 g was identified for DSP, and from 14.53 to 9.48 g for TDP, corresponding to a significant loss of 32.25 and 34.75%, respectively (Figures 3C and 3D).

A dose of 110.5% of the recommended amount of nitrogen and potassium provided the best results for DSP (9.07 g) and TDP (13.07 g), with gains of 34.21 and 37.36%, respectively, when compared to the control (Figures 3E and 3F).

Discussion

Fertilization with the combination of N and K proved to be efficient to stimulate the synthesis of photosynthetic pigments in passion fruit seedlings, under low salinity

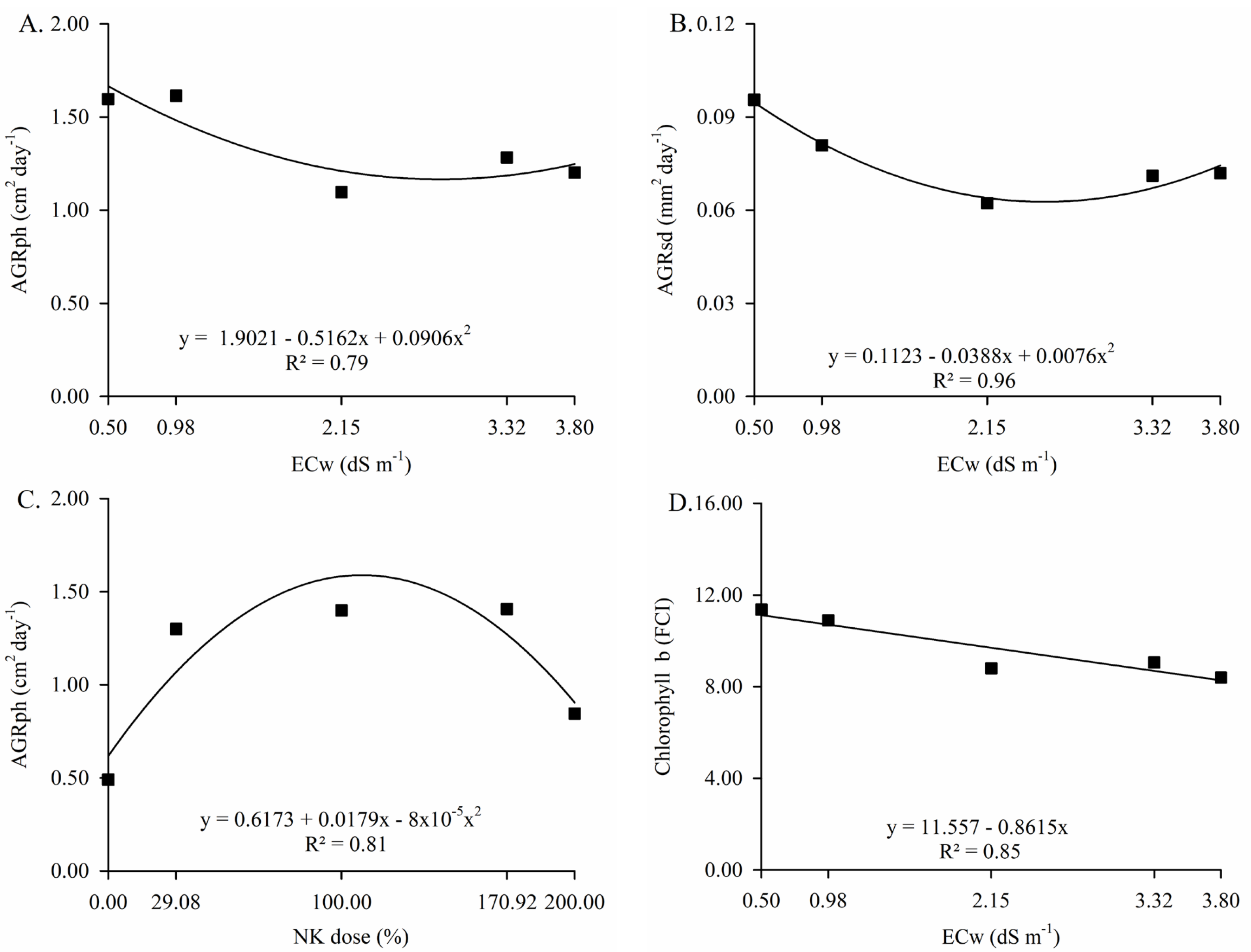

Figure 2. Absolute growth rate for plant height (AGRph) (A and C) and absolute growth rate of stem diameter (AGRsd) (B and D) of passion fruit seedlings, subjected to different electrical conductivities of irrigation water and doses of nitrogen and potassium at 75 days after sowing.

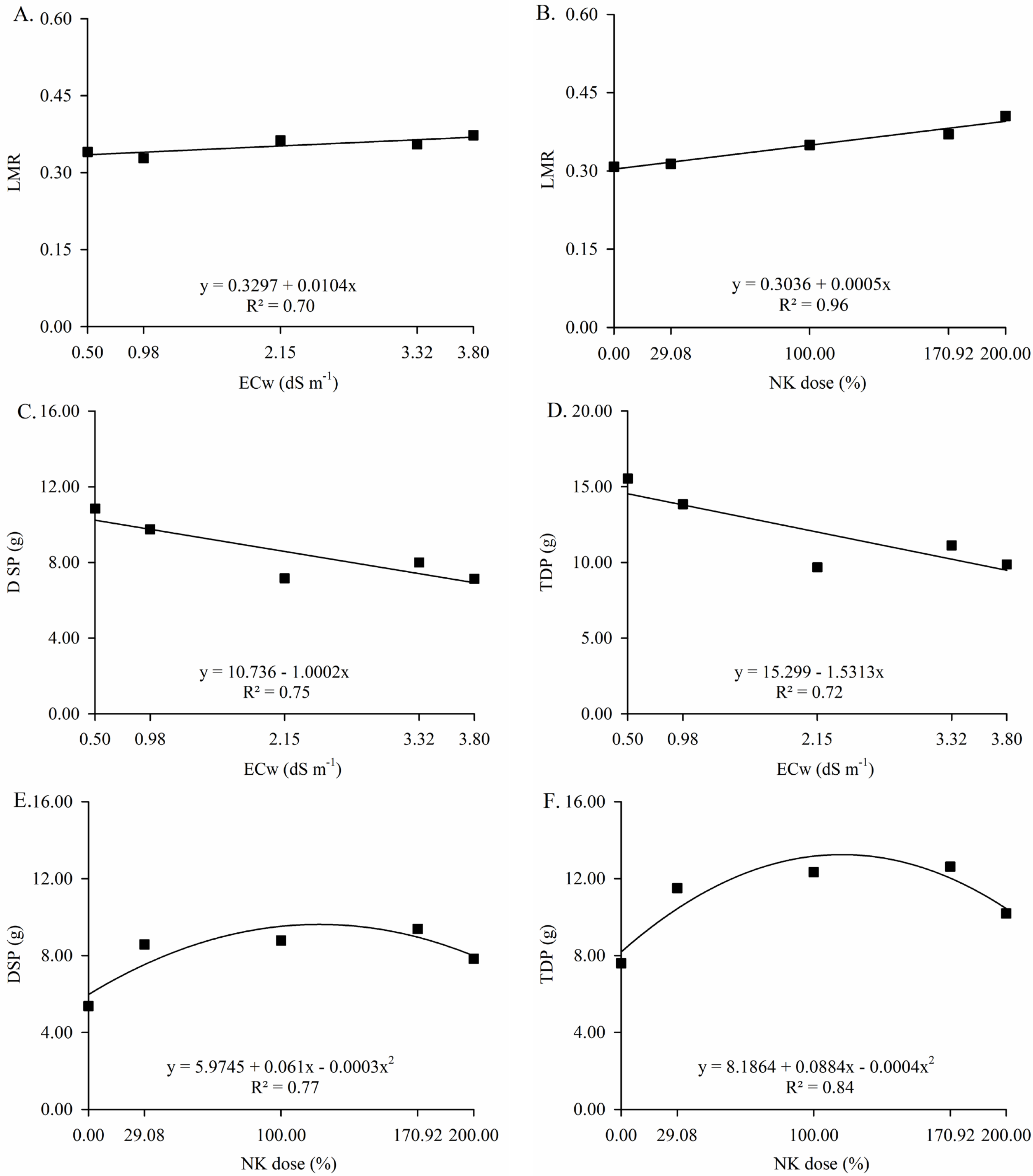

Figure 3. The leaf mass ratio - LMR (A and B), dry shoot phytomass - DSP (C and E) and total dry phytomass - TDP (D and F) of passion fruit seedlings, subjected to different electrical conductivities of irrigation water and doses of nitrogen and potassium at 75 days after sowing

conditions, this effect being associated with the interaction to the synergistic action of these two elements on photosynthetic activity. Nitrogen plays an important role in osmotic balance, in addition to being a constituent of chlorophyll amino acids, and proteins (Figueiredo et al., 2023), participates in antioxidant activities and relieves ionic toxicity (Fátima et al., 2022). Potassium promotes the activation of enzymes involved in respiration and photosynthesis, increases photosynthetic rate, and improves water balance (Papadakis et al., 2023).

Salinity compromised the synthesis of photosynthetic pigments, where the increased salinity levels in irrigation water lead to the degradation and reduction of photosynthetic pigment levels and the growth of passion fruit seedlings. This can be explained by the fact that salt stress limits or decreases the synthesis of chlorophyll or due to the activity of the enzyme chlorophylase, which acts to degrade chlorophyll molecules (Nigam et al., 2022).

Consistent with the results of the present study, the reduction of photosynthetic pigment content was observed in different species grown under salt stress conditions, such as *Malpighia emarginata* D. C. (Dias et al., 2021), *Annona squamosa* L. (Fátima et al., 2022), and *Passiflora edulis* Sims. (Galvão Sobrinho et al., 2023).

On the other hand, the increase in the chlorophyll *a*/*b* ratio may indicates that passion fruit plants developed a defense mechanism to resist damage from saline stress, stimulated by the application of low concentrations of N and K, which favored the recovery of chlorophyll *a* content at higher salinity and the constant drop in chlorophyll *b*. This reaction occurs through an increase in the number of thylakoids, or an increase in the number of chloroplasts to protect the plants photosynthetic system (García-Valenzuela et al., 2005). The elements may be directly involved in the increase in photosynthetic pigments, since N is directly involved in the composition of the chlorophyll molecule (Fátima et al., 2022), and K is directly involved in cellular osmoregulation, so that plants can carry out the synthesis of photosynthetic pigments (Papadakis et al., 2023). Thus, the combination of these elements in the fertilization of passion fruit plants provides improvements in chlorophyll synthesis, increasing the photosynthetic capacity of plants under saline conditions.

This reduction in growth rates is due to osmotic stress induced by salinity, which induces stomatal closure and reduces gas exchange, and consequently, limits the ability of plants to absorb water and nutrients, resulting in less growth a reduction of water absorption by the plant (Souto et al., 2023).

Similar results to the current study were reported by Pereira et al. (2022), who analyzed the height of the passion fruit plants and observed a reduction of 57.6% with an increase in the salinity of the irrigation water from 0.5 to 2,1 dS m^{-1}. Figueiredo et al. (2023) found a 37.9% reduction in growth in stem diameter of pomegranate seedlings when they were subjected to an ECw of 5.0 dS m^{-1}. There was a 46.6% reduction in the growth branches of West India cv North, presented by Silva Filho et al. (2024) when subjected to an ECw of 4.0 dS m^{-1}.

On the other hand, N and K fertilization stimulated the production of pigments and plant growth, this effect being attributed to the role of potassium in nitrogen metabolism. Potassium is not included in the structure of chlorophyll molecules or any organic compound, but plays an important role in nitrogen metabolism, which requires adequate amounts of K in the cytoplasm to synthesize this pigment (Viana & Kiehl, 2010). These increments can be explained by the fact that nitrogen and potassium participate in vital structures and processes in plants, which are essential for plant growth and development (Jiaying et al., 2022).

The increase in salinity stimulated the LMR, which may be an indication that the plants were able to direct the photoassimilates in the leaves to form new assimilation organs. Considering that 90% of the assimilates are produced in the leaf, and from there transferred to other parts of the plant, the LMR expresses the fraction of dry mass not exported from the leaves to the other organs of the plant (Costa et al., 2020). Based on this context, the increase in LMR observed in this work can be explained by the greater fraction of material retained in the leaves, i.e., the lower export of photoassimilates from the leaves to the other parts of the plant (Silva et al., 2021). The increase in LMR under increasing levels of saline water was described by Silva et al. (2023) for *Ocimum basilicum* L., and under doses of nitrogen and potassium by Figueiredo et al. (2020) for *Passiflora edulis.*

The deleterious effect of saline stress on growth was also seen on the biomass production observed by DSP and TDP, causing reductions with increasing saline levels. Saline stress affects the accumulation of phytomass, limiting the absorption of water and essential nutrients, with immediate effects on cell growth and expansion (Nóbrega et al., 2022). Figueiredo et al. (2020) observed the influence of high salinity on dry phytomass in passion fruit plants.

On the other hand, supplying a combination of 110% N and K provides maximum performance of DSP and TDP, indicating that they stimulate the production of phytomass in passion fruit plants. This effect is due to the fact that N and K are essential nutrients for the development of the plant, being directly involved in the photosynthetic process, through the fixation and diffusion of CO_2, generating the production of photoassimilates, and consequently, the accumulation of biomass (Xu et al., 2020). With respect to nitrogen fertilization (Figueiredo et al., 2020) and potassium (Miyake et al., 2016), it was found that the application of adequate doses of these nutrients favors the accumulation of biomass in passion fruit.

Conclusion

The application of nitrogen and potassium reduced the harmful effects of irrigation water salinity on the levels of chlorophyll *a*, total chlorophyll, and the chlorophyll *a/b* ratio.

The increase in electrical conductivity of irrigation water causes deleterious effects on the morphology of passion fruit seedlings.

Doses of NK between 100 and 120% improved the absolute growth rate of plant height and stem diameter, chlorophyll *b*, aerial dry matter, and total dry matter.

The 200% dose of NK generated a greater accumulation in the leaf dry mass ratio, at 75 days after sowing.

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Compliance With Ethical Standards

Author contributions: Conceptualization: JSN, JESR; Funding acquisition: GSL, LAAS; Investigation: MBP, MFQL, JTAF, RTF, FRAF; Methodology: WEP; Project administration: JSN, JESR; Resources: FRAF; Supervision: JSN, JESR, GLS; Validation: GSL, LAAS, FRAF; Visualization: WEP; Writing - original draft: MBP, MFQL, JTAF; RTF; JSN, JESR; Writing - review & editing: JSN, JESR GSL LAAS, WEP.

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