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Organomineral fertilization and salt stress on the agronomic performance of peanut crop

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ABSTRACT: Salt stress is one of the main abiotic stresses that negatively affect agricultural production and sustainable development worldwide. Thus, there is a search for management strategies to reduce the deleterious effects of salts on plants. In view of the above, the objective was to evaluate the effects of irrigation with brackish water and different forms of organomineral fertilization on the agronomic performance of the peanut crop. The study was conducted in a greenhouse in a completely randomized design (5 × 2 factorial scheme) with five forms of fertilization (F1 = 100% mineral; F2 = 100% bovine biofertilizer; F3 = 100% vegetal ash; F4 = 50% mineral + 50% bovine biofertilizer; and F5 = 50% mineral + 50% vegetal ash), two levels of electrical conductivity of the irrigation water (ECw) (1.0 and 5.0 dS m^{-1}), and five replicates. The fertilization composed only by vegetable ash 100% associated with irrigation water with higher concentration of salts (5.0 dS m^{-1}) caused negative effects on the number of pods, pod mass, pod shell dry mass and yield. Although brackish water (5.0 dS m^{-1}) reduces peanut yield components and productivity, fertilization made with 100% biofertilizer provided the highest productivity among all treatments.

Key words: *Arachis hypogaea* L.; plant nutrition; salinity; vegetables production

Adubação organomineral e estresse salino no desempenho agronômico da cultura do amendoim

RESUMO: O estresse salino é um dos principais estresses abióticos que afetam negativamente a produção agrícola e o desenvolvimento sustentável no mundo. Desta forma, existe uma busca por estratégias de manejo para diminuir os efeitos deletérios dos sais nas plantas. Neste sentido, objetivou-se avaliar os efeitos da irrigação com águas salobras e diferentes formas de adubação organomineral no desempenho agronômico da cultura do amendoim. O experimento foi conduzido em casa de vegetação em delineamento inteiramente casualizado, esquema fatorial 5 × 2, com cinco formas de adubação (F1 = 100% mineral; F2 = 100% biofertilizante bovino; F3 = 100% cinza vegetal; F4 = 50% mineral + 50% de biofertilizante bovino e F5 = 50% mineral + 50% cinza vegetal), dois níveis de condutividade elétrica da água de irrigação (CEa) (1,0 e 5,0 dS m^{-1}), e cinco repetições. A adubação composta apenas por cinza vegetal 100% associada à água de irrigação com maior concentração de sais (5,0 dS m^{-1}) causou efeitos negativos sobre o número de vagens, massa de vagens, massa seca de casca e produtividade. Embora a água salobra (5,0 dS m^{-1}) reduza os componentes do rendimento e a produtividade do amendoim, a adubação feita com 100% de biofertilizante proporcionou a maior produtividade entre todos os tratamentos.

Palavras-chave: *Arachis hypogaea* L.; nutrição de plantas; salinidade; produção vegetal

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Introduction

Peanut (*Arachis hypogaea* L.) is considered one of the most cultivated oilseeds in the world, with China as the largest producer, accounting for 40% of global production; however, in planting area China is behind India, accounting for 19% of the global planting area (Liu et al., 2023). Brazil reached a production in the 2022/2023 crop of 893 thousand tons, representing a variation to the previous crop of 19.6% (Conab, 2023).

Despite being an important alternative for irrigation in agriculture practiced in the Brazilian northeastern semi-arid region, the use of brackish water triggers molecular, biochemical, and physiological changes in plants, encompassing plant toxicity and decreased plant growth and productive efficiency (Garcia et al., 2019; Ribeiro et al., 2022). Lima et al. (2020) report that this abiotic stress causes reduction in both carbon assimilation and metabolism and in the accumulation of sugars, affecting mainly the productivity and quality of the fruits.

Thus, the search for management strategies to reduce the deleterious effects of salts on plants. If properly applied, organomineral fertilization can help mitigate the deleterious effects of salinity on plants, allowing an osmotic adjustment and improvements in the physical and chemical qualities of the soil (Sousa et al., 2018).

However, the existing salts in irrigation water, the sources used, and the concentration of chemical and organic fertilizers bring complexity in plant responses in saline environments, especially when it comes to crop production (Sousa et al., 2021).

In view of the above, the objective was to evaluate the effects of irrigation with brackish water and different forms of organo-mineral fertilization on the agronomic performance of the peanut crop.

Materials and Methods

The study was conducted in a greenhouse in the experimental area of the Auroras Seedling Production Unit (UPMA), belonging to the Universidade da Integração Internacional da Lusofonia Afro-Brasileira (UNILAB), Redenção, Ceará, Brazil (latitude 04º13’33” S, longitude 38º43’50” W, with an average altitude of 88 m). The climate of the region is classified as (Aw’) tropical rainy, very hot, with rain predominantly in the summer to autumn seasons, according to the Köppen classification system (Köppen, 1923).

The climatic variables observed in the experimental area, containing maximum and minimum temperature; and maximum and minimum relative humidity, were collected daily during the experimental period (Figure 1).

The experimental design used was completely randomized, in a 5 × 2 factorial arrangement, with five replicates and two plants per plot. The first factor corresponded to the different forms of fertilization: F1 = 100% mineral; F2 = 100% bovine biofertilizer; F3 = 100% vegetal ash; F4 = 50% mineral + 50% bovine biofertilizer; and F5 = 50% mineral + 50% vegetal ash) and two values of electrical conductivity of the irrigation water (ECw) (1.0 and 5.0 dS m^{-1}).

To evaluate the chemical attributes of the soil, a sample was collected before treatment and sent to the Soil and Water Laboratory of the Soil Sciences Department at the Universidade Federal do Ceará (UFC). The results are presented in Table 1.

The sowing of the peanut crop cultivar BR-1 was performed in plastic pots with a volume of 8 L, containing the substrate composed of a mixture of loose soil, sand and cattle manure in a ratio of 4:3:1, respectively. Thinning was performed 10 days after sowing (DAS), leaving only the most vigorous plant.

The biofertilizer was prepared from a mixture of fresh bovine manure and water in a 1:1 ratio. It was stored in plastic pots with a capacity of 100 L for aerobic fermentation over a period of 30 days. The vegetable ash used came from burning sugar cane, from Fazenda Douradinha, in the municipality of Redenção, Ceará, Brazil. The results of the chemical analysis of the organic fertilizers are presented in Table 2.

The need for fertilization of the peanut plants was based on the amount of nutrients in the substrate (Table 1) and

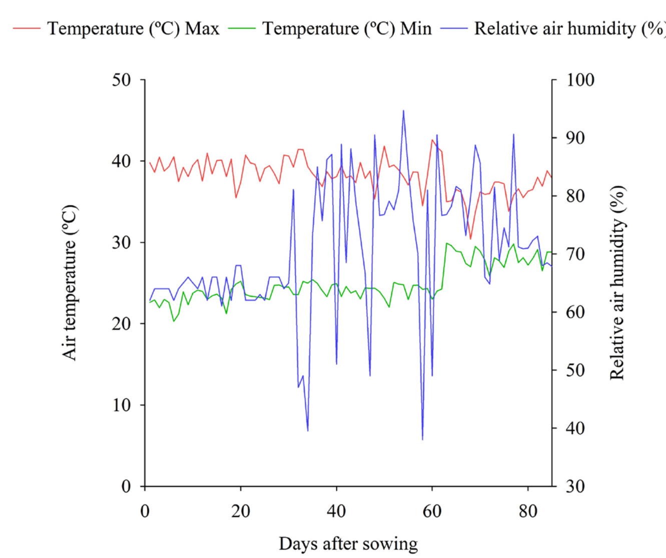

Figure 1. Mean values of temperature and relative air humidity during the experimental period

Table 1. Chemical attributes of the substrate used for growing peanuts before applying treatments

Chemical attributes									
OM	N	P	K	Ca	Mg	Na	pH	ESP	EC
(g kg^{-1})								(%)	(dS m^{-1})
4.34	0.26	0.065	0.25	0.24	0.15	0.08	6.2	7	1.19

OM - Organic matter; ESP - Exchangeable sodium percentage; EC - Electrical conductivity

Table 2. Chemical attributes of bovine biofertilizer and vegetal ash

Organic fertilizers	Chemical attributes								
	N	P	K	Ca	Mg	Fe	Cu	Zn	Mn
	($g L^{-1}$)					($mg L^{-1}$)			
Biofertilizer	0.82	1.4	1	2.5	0.75	141.6	1.92	68.2	14.72
	($g kg^{-1}$)					($g kg^{-1}$)			
Vegetal ash	0.4	1.13	54.4	28.7	13.9	7819.1	10.5	37.8	240.8

the maximum recommendation for chemical fertilization suggested by Fernandes (1993), which comprises 15 kg ha^{-1} of N, 62.5 kg ha^{-1} of P_2O_5 and 50 kg ha^{-1} of K_2O. With a stand of 10,000 plants ha^{-1}, the maximum dosage per $plant^{-1}$ in the estimated cycle was: 1.8 g N; 7.5 g P_2O_5 and 6.0 g K_2O.

To designate the fraction of nutrients in the substrate, the density of the substrate (1.3 g dm^{-3}) was multiplied by the volume of substrate placed in each pot (8 L). Subsequently, the value found (10.4 kg^{-1}) was multiplied by the amounts of N, P and K obtained in the substrate analysis (Table 3).

By means of the supply estimates (Table 3), at 8 DAS fertilizations were initiated, carried out manually once a week, following the proportions according to the treatments: mineral 100% (F1), with 1.8 g $plant^{-1}$ N; 6.3 g $plant^{-1}$ P_2O_5; and 6.0 g $plant^{-1}$ K_2O. For the organo-mineral fertilizations (F4 and F5), the following proportions were used: 0.9 g $plant^{-1}$ N; 3.7 g $plant^{-1}$ P_2O_5; and 3.0 g $plant^{-1}$ K_2O.

According to the need of nutritional complementation presented in Table 3 and with the quantity of NPK present in Table 2, 5.0 L $plant^{-1}$ of bovine biofertilizer was applied for the 100% dose (F1) and 2.5 L $plant^{-1}$ for the 50% dose (F4). For the vegetable ash, 1.5 kg $plant^{-1}$ was used for the 100% dose (F3) and 0.75 kg $plant^{-1}$ for the 50% dose (F5). The fertilizers were divided during the experimental cycle and applied manually.

The irrigation water was prepared by diluting the soluble salts (NaCl, $CaCl_2.2H_2O$ and $MgCl_2.6H_2O$), following the methodology of Rhoades et al. (2000), to obtain an equivalent ratio of 7:2:1 for Na:Ca:Mg, through the relationship between ECw and its concentration ($mmol_c$ L^{-1} = EC × 10). Irrigation was manually applied daily from 8 DAS, using 15% leaching. Calculations were performed according to the lysimeter principle of drainage (Bernardo et al., 2019), represented by two vessels of each treatment, maintaining

Table 3. Estimation of nutrient supply by the substrate and needs for mineral nutritional supplementation, of cattle manure and vegetal ash

Fertilization strategies	Nutrients		
	N	P	K
Recommendation (g $plant^{-1}$)	1.8	7.5	6.0
Substrate (g kg^{-1})	0.26	0.065	0.25
Total nutrient contribution per pot ##	2.70	0.67	2.6
Mineral complementation requirement (per plant)	0	6.83	3.4
Requirement for organic supplementation			
Biofertilizer (L $plant^{-1}$)	0	5.0	0
Vegetal ash (g $plant^{-1}$)	0	1.50	0

Substrate density (1.3 g dm^{-3}) multiplied by the volume of the substrate per pot

the soil at field capacity. The water volume applied to the plants was determined using Equation 1.

$$VI = \frac{(Vp - Vd)}{(1 - LF)} \quad (1)$$

where: VI - volume of water to be applied in the irrigation event (mL); Vp - volume of water applied in the previous irrigation event (mL); Vd - volume of water drained (mL); LF - leaching fraction of 0.15.

At 85 DAS, the experiment was finalized by uprooting the plants and harvesting the pods. The pods were then identified, separated, and stored by treatment in a covered greenhouse for eight days for pod drying, to homogenize the humidity. The following variables were analyzed: pod length (cm pod^{-1}) and pod diameter (mm pod^{-1}) were measured with a pachymeter, respectively. For pod number count, commercial pods were counted. Semi-analytical balance with 0.01 g precision was used for pod and pod shell dry mass. The yield was obtained through the mass of grains (in grams), later transformed into g pot^{-1}.

To evaluate the normality of the data, the variables were submitted to the Kolmogorov-Smirnov test ($p \leq 0.05$). The data were then submitted to analysis of variance, and Tukey test for comparison of means ($p \leq 0.05$) was performed in the ASSISTAT 7.7 BETA program (Silva & Azevedo, 2016).

Results and Discussion

The variables number of pods, length of pods, diameter of pods, mass of pods, dry mass of pod husk and productivity were influenced by the interaction between the salinity levels of irrigation water and type of fertilization (Table 4).

When analyzing the interaction between different electrical conductivities of irrigation water and sources of organo-mineral fertilization (Table 5) for the number of pods (NP), it was found that fertilizations did not show significant difference in low salinity water (1.0 dS m^{-1}). However, there was a significant difference in the number of pods in high salinity water (5.0 dS m^{-1}) and an expressive reduction of 66.66% when comparing the number of pods fertilized with 100% vegetal ash in relation to low salinity water.

The significant reduction of the number of pods in peanut plants irrigated with brackish water and fertilized with 100% vegetal ash may be associated with the depressing effects of salts on the plants and the chemical composition of this fertilization (Table 2). That is, the high concentration of K^+

Table 4. Summary of the analysis of variance for the effects of electrical conductivity of irrigation water and different types of fertilization on number of pods (NP), length of pods (LP), diameter of pods (DP), mass of pods (MP), dry mass of pod husk (DMPOH) and productivity (PRO)

Variation sources	DF	Mean square					
		NP	LP	DP	MP	DMPOH	PRO
Treatments	9	32.03 **	40.84 **	12.12 **	29.17 **	1.55 **	9711.75 **
Type of fertilization (TF)	4	26.09 **	23.58 ns	5.16 ns	16.44 **	0.70 ns	6011.57 **
Saline levels (SL)	1	0.63 ns	72.33 *	38.71 **	136.24**	6.02 **	42105.67 **
TF x SL	4	45.81 **	50.24 **	12.44 **	15.13 **	1.29 **	5313.46 **
Residue	30	4.26	10.18	2.67	0.83	0.42	155.68
Total	39						
CV (%)		23.65	22.66	27.54	16.99	20.91	15.46

DF - Degrees of freedom; CV - Coefficient of variation; * - Significant by the F test at p ≤ 0.05; ** Significant by the F test at p ≤ 0.01; ns - Not significant

Table 5. Average number of pods (NP) values of peanut plants subjected to different fertilization and ECw treatment

Fertilization	NP (pod^{-1})	
	1.0 dS m^{-1}	5.0 dS m^{-1}
F1 - NPK 100%	9.25 aA	6.75 aA
F2 - Biofertilizer 100%	7.50 aA	6.50 aAB
F3 - Vegetal ash 100%	9.00 aA	3.00 bB
F4 - NPK 50% + Bio 50%	7.75 aA	7.40 aA
F5 - NPK 50% + Ash 50%	10.7 aA	8.25 aA
MSD column		2.61
MSD line		3.72

MSD - Minimum significant difference. ** Means followed by the same letter, uppercase in the column and lowercase in the row, did not differ significantly, based on Tukey test (p ≥ 0.05)

added with the salts, may have contributed to the increase in salinity; consequently, it caused an imbalance in the translocation of carbohydrates, such as sucrose, for pod formation (Tränkner et al., 2018).

Opposite results to the present study were found by Seleiman & Kheir (2018), where they found that application of vegetable bagasse ash in saline soils increased the number of spikelets in wheat crops. Khan et al. (2019) studied foliar and soil applied salicylic acid application and addition of bagasse compost to soil in wheat crop and found that the use of bagasse alone did not reduce the deleterious effects of salinity on grain yield, however, when associated foliar salicylic acid application obtained higher yield.

Table 6 shows the values of pod length (LP) under different electrical conductivities of irrigation water and fertilizer sources. The plants fertilized with 100% NPK was superior to the other forms of fertilization, but did not differ statistically from the vegetable ash 100%, NPK 50% + Bio 50% in water of lower salinity; and NPK 100%, Biofertilizer 100% and NPK 50% + Bio 50% in water of higher salinity.

Plant mineral nutrition plays an indispensable role in plant development and production, as well as, in optimizing a tolerance and decrease of abiotic stresses in agricultural plants, which encompasses salt stress (El-Mageed et al., 2022). In the case of treatments with biofertilizer and vegetable ash, the amount of P present in these materials may have contributed to the better performance of these plants in terms of pod length, since this macronutrient acts in regulating physiological responses and increasing tolerance to abiotic stresses. (Khan et al., 2023). Similar results were observed by Guilherme et al. (2021) when analyzing the use of saline water and phosphate fertilization in peanut crop and found that higher doses of P, increased the length of pods of peanut plants when subjected to irrigation with saline water.

Regarding the diameter of the pod (Table 7), it was observed that the plants fertilized with NPK 100%, Biofertilizer 100% and Vegetal ash 100% in water with ECw of 5.0 dS m^{-1} expressed approximate results and did not differ statistically from those irrigated with low salinity water. However, the use of NPK 50% + ash 50% in water of higher salinity, affected the diameter of the pod with a reduction of approximately 20% in relation to plants irrigated with water of low electrical conductivity.

This result may be related to a possible increase in soil osmotic effects, impairing water relations, physiological and

Table 6. Average length of pods (LP) values of peanut plants subjected to different fertilization and ECw treatment

Fertilization	LP (cm pod^{-1})	
	1.0 dS m^{-1}	5.0 dS m^{-1}
F1 - NPK 100%	15.82 aA	12.32 aA
F2 - Biofertilizer 100%	11.38 aB	11.85 aA
F3 - Vegetal ash 100%	12.37 aA	11.10 aB
F4 - NPK 50% + Bio 50%	12.35 aA	13.92 aA
F5 - NPK 50% + Ash 50%	11.77 aB	10.55 aB
MSD column		1.61
MSD line		2.29

MSD - Minimum significant difference. ** Means followed by the same letter, uppercase in the column and lowercase in the row, did not differ significantly, based on Tukey test (p ≥ 0.05)

Table 7. Average diameter of pods (DP) values of peanut plants subjected to different fertilization and ECw treatment

Fertilization	DP (cm pod^{-1})	
	1.0 dS m^{-1}	5.0 dS m^{-1}
F1 - NPK 100%	5.03 aA	5.11 aA
F2 - Biofertilizer 100%	4.37 aAB	5.93 aA
F3 - Vegetal ash 100%	5.62 aA	5.07 aA
F4 - NPK 50% + Bio 50%	5.85 aA	4.59 bB
F5 - NPK 50% + Ash 50%	4.95 bB	3.95 bB
MSD column		1.57
MSD line		2.23

MSD - Minimum significant difference. ** Means followed by the same letter, uppercase in the column and lowercase in the row, did not differ significantly, based on Tukey test (p ≥ 0.05) nutrient metabolism; due to the increased concentration of salts coming from irrigation water (Lacerda et al., 2022; Taiz et al., 2017) associated with the salinity in KCl and the high concentration of K^+ in the chemical composition of vegetable ash. In line with this result, Lima et al. (2020) warn that the fruits of plants in saline environments tend to delay the natural development mediated by the low translocation of photoassimilates from the leaves, due to the energy expenditure to block Na uptake and regulate cellular osmotic adjustment.

In a study by Silva et al. (2020), when analyzing the fruit quality of acerola irrigated with brackish water under combinations of nitrogen/potassium fertilization (70% N + 50% K_2O; and 100% N + 75% K_2O); they verified reductions of 2.86 and 2.63% in fruit diameter with increasing salinity of irrigation water.

The pod mass (MP) was also influenced by the interaction between irrigation water and fertilizer forms. When analyzing the mean comparison test (Table 8), it was found that the plants fertilized with NPK 50% + Ash 50% and NPK 100% had higher values for pod mass in relation to the other sources of fertilization in water with lower salinity, although not statistically different from plants fertilized with Biofertilizer 100% in water with higher salinity.

The gain in pod mass when fertilized with NPK 50% + Ash 50% and NPK 100% is a result of the essential nutrients present in the fertilization forms. N when supplied in the proper concentration can act in metabolic pathways, such as the assimilation of amino acids that will be synthesized in the leaves or roots, subsequently distributed and allocated to N needs of crops (Yang et al., 2020; Taiz et al., 2017). As well as N supplied in the proper concentration, P has as one of its main functions the action of energy transport of the cell in the form of adenosine triphosphate (ATP) (Guilherme et al., 2021). K, on the other hand, acts in the processes of transpiration and photosynthesis, distribution of carbohydrates, photoassimilates and phytohormones (Ferreira et al., 2020; Silva et al., 2020).

On the other hand, the reduction of the deleterious effects of salts on the pod mass caused by the use of bovine biofertilizer in high salinity water (Table 8), may possibly be linked to the increase in organic matter, generating improvements in the physicochemical characteristics of the soil, such as soil porosity; since the increase in total porosity may contribute to a greater exchangeable Na^+ leaching, consequently, a decrease in soil salinity will occur (Sousa et al., 2018).

It is noteworthy that the fact that the plants adjust osmotically with fertilization aid, generates a decrease in the effects of salinity on the pod mass that will contribute to the filling of the pods and better seed development, which will directly affect productivity.

Similarly, Freire et al. (2022) when studying organic fertilization and salt stress on the agronomic performance of maize crop found that there was an increase in the dry mass of ears with straw when using the combination of cow manure + goat biofertilizer when compared with other forms of fertilization in water with higher salinity.

Similar to the results achieved in pod dry mass (MP), pod husk dry mass (DMPOH) was also significantly affected with increasing salinity of irrigation water (Table 9), the forms of fertilization showed a reduction of 60.80, 31.53, 46.54, 30.87 and 54.34% compared to plants that were irrigated with low salinity water and fertilized with F1 to F5, respectively. The highest DMPOH was obtained in pod of peanut plants that received 100% NPK fertilization (2.73 pod^{-1}) when irrigated with low salinity water. This result was higher than the other types of fertilization at the same ECw and did not differ statistically from the other forms of adduction.

As previously reported, the reduction of the production components of the peanut crop due to the increase of the electrical conductivity of the irrigation water is linked to osmotic impacts, ionic unbalance added to nutritional unbalance (for example the vegetable ash (Table 10), due to its high concentration of K (Table 2) added to the salts present in the irrigation water); forming an environment with a high concentration of salts (Silva et al., 2020).

However, the use of certain types of organic fertilizer in saline environments, such as bovine biofertilizer in this study (Table 10), may have contributed to the occurrence of an osmotic adjustment and improvements in the physicochemical qualities of the soil (Sousa et al., 2018), thus contributing to a sufficient translocation of photoassimilates from the leaves to the peanut pod shell.

Table 8. Average mass of pods (MP) values of peanut plants subjected to different fertilization and ECw treatment

Fertilization	MP (pod^{-1})	
	1.0 dS m^{-1}	5.0 dS m^{-1}
F1 - NPK 100%	9.28 aA	3.97 aB
F2 - Biofertilizer 100%	6.53 aB	6.41 aA
F3 - Vegetal ash 100%	5.54 aB	0.99 bB
F4 - NPK 50% + Bio 50%	5.35 aB	3.70 aB
F5 - NPK 50% + Ash 50%	9.33 aA	2.49 aB
MSD column		1.31
MSD line		1.87

MSD - Minimum significant difference. ** Means followed by the same letter, uppercase in the column and lowercase in the row, did not differ significantly, based on Tukey test (p ≥ 0.05)

Table 9. Average dry mass of pod husk (DMPOH) values of peanut plants subjected to different fertilization and ECw treatment

Fertilization	DMPOH (pod^{-1})	
	1.0 dS m^{-1}	5.0 dS m^{-1}
F1 - NPK 100%	2.73 aA	1.07 bB
F2 - Biofertilizer 100%	2.22 aA	1.52 aA
F3 - Vegetal ash 100%	1.59 aA	0.85 bB
F4 - NPK 50% + Bio 50%	2.17 aA	1.50 aB
F5 - NPK 50% + Ash 50%	2.30 aA	1.05 bA
MSD column		0.94
MSD line		1.34

MSD - Minimum significant difference. ** Means followed by the same letter, uppercase in the column and lowercase in the row, did not differ significantly, based on Tukey test (p ≥ 0.05)

Table 10. Average productivity (PRO) values of peanut plants subjected to different fertilization and ECw treatment

Fertilization	PROD (g pot^{-1})	
	1.0 dS m^{-1}	5.0 dS m^{-1}
F1 - NPK 100%	145.44 aA	64.75 bB
F2 - Biofertilizer 100%	95.61 aB	93.78 aA
F3 - Vegetal ash 100%	87.61 aB	3.11 bD
F4 - NPK 50% + Bio 50%	81.00 aB	33.83 bC
F5 - NPK 50% + Ash 50%	156.06 aA	31.22 bC
MSD column		17.14
MSD line		24.37

MSD - Minimum significant difference. ** Means followed by the same letter, uppercase in the column and lowercase in the row, did not differ significantly, based on Tukey test ($p \geq 0.05$)

Khafagy et al. (2019) described that biofertilizers can reduce soil salinity by reducing mineral fertilizer application, improving soil fertility, and solubilize the rhizosphere region of soil phosphate and produce plant growth in saline soil conditions.

The yield (PRO) of peanut crop (Table 10) was significantly influenced by the SL × TF interaction. The peanut plants fertilized with NPK 50% + Ash 50% and irrigated with low salinity water (1.0 dS m^{-1}) showed higher productivity (156.06 g pot^{-1}), without statistically different from those that received NPK 100% (145.44 g pot^{-1}) in the same electrical conductivity of the irrigation water.

These results may be justified by a possible balance in the nutritional balance of the fertilizers because the main macronutrients such as N, P and K exist in their compositions (Silva et al., 2020).

Corroborating these data, Guilherme et al. (2021) irrigated the peanut crop with saline water and different doses of phosphorus and obtained higher productivity (6.2 g pot^{-1}) when using 100% of the recommended dose of phosphorus. Sousa et al. (2022) worked with maize crop and found that the yield of the crop in low salinity water associated with all the nitrogen recommendations was statistically superior to high salinity water (0% = 71.14; 50% = 393.55 and 100% = 286.08 g pot^{-1}).

On the other hand, with increasing water ECw from 1.0 to 5.0 dS m^{-1} reduced peanut productivity in all forms of fertilization, where the highest productivity was achieved when using biofertilizer 100% (93.78 g pot^{-1}) which represents a difference of 96.68% of plants fertilized with vegetable ash 100% (3.11 g pot^{-1}).

Freire et al. (2022) describe that one of the main effects of salinity on crops is nutritional imbalance, generating antagonism in the absorption of important nutrients, such as nitrogen and potassium, and reducing their productivity, which can be enhanced by the composition of fertilizers; as what is observed in plants that received 100% vegetal ash. Seleiman & Kheir (2018) found that the highest grain and straw yields of wheat grown in different saline soils and environments were obtained from the plots that received a combination of bagasse ash and thiourea.

Conclusions

The fertilization composed only by vegetable ash 100% associated with irrigation water with higher concentration of salts (5.0 dS m^{-1}) caused negative effects on the number of pods, pod mass, pod shell dry mass and yield.

Fertilization with NPK 100%, vegetable ash 100%, biofertilizer 100%, and the combination NPK 50% + vegetable ash 50% increased pod number, pod mass, pod shell dry mass, and yield of peanut under salinity of irrigation water 1.0 dS m^{-1}.

Although brackish water (5.0 dS m^{-1}) reduces the yield and productivity components of peanuts, fertilization made with 100% biofertilizer provided the highest productivity among all treatments.

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Compliance with Ethical Standards

Author contributions: Conceptualization: GGS, TVAV; Data curation: TVAV; Formal analysis: JTMS; Investigation: EBS, JTMS, JMPL, JRSS; Project administration: GGS; Supervision: GGS; Writing - original draft: EBS, JTMS, JMPL, JRSS; Writing - review and editing: GGS, TVAV.

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