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Phenology and production of traditional seeds of cowpea irrigated with saline water[1]

Fenologia e produção de sementes crioulas de feijão-caupi irrigado com água salina

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ABSTRACT - Cowpea suffers significant production losses when subjected to salt stress, but the response varies among genotypes. The objective of this study was to evaluate the phenology and production of traditional cowpea seeds under saline water irrigation. The experiment was conducted in two stages, the first one in a greenhouse to evaluate the phenology and production of cowpea genotypes and the second one in the laboratory to assess the viability and vigor of the seeds produced in the first stage. The treatments resulted from the combination of two salinity levels of the irrigation water (0.5 and 4.5 dS m^{-1}) and 14 traditional cowpea varieties (Boquinha, Ceará, Costela-de-vaca, Lisão, Canário, Pingo-de-ouro, Roxão, Branco, Canapum-branco, Canapum-miúdo, Baêta, Coruja, Paulistinha, and Sempre-verde) acquired from traditional farmers in the western region of Rio Grande do Norte, Brazil. Canário, Baêta, and Coruja varieties have a higher number of flowers per plant and earlier flowering. Salinity reduced the number of flowers per plant, increased abortion in all traditional varieties and reduced production in the early varieties Branco, Canapum-miúdo, Baêta, and Coruja. Cultivation under saline water irrigation did not affect the viability of the seeds from the second generation of cowpea, but reduced the vigor of the seeds of the varieties Lisão, Pingo-de-ouro, Roxão, Branco, Canapum-branco, Canapum-miúdo, Baêta and Coruja. The traditional varieties Boquinha, Ceará, Costela-de-vaca, Canário, Paulistinha and Sempre-verde are indicated for the production of cowpea seeds under irrigation with saline water.

Key words: *Vigna unguiculata* (L.) Walp. Salt stress. Family farming. Seed viability.

RESUMO - O feijão-caupi sofre perdas de produção significativas quando submetido ao estresse salino, porém esta ocorrência é variável entre os genótipos. Com isso, objetivou-se avaliar a fenologia e a produção de sementes crioulas de feijão-caupi irrigadas com água salina. A pesquisa foi conduzida em duas etapas, a primeira aconteceu em casa de vegetação para avaliar a fenologia e a produção dos genótipos de feijão-caupi. A segunda foi realizada em laboratório para avaliar a viabilidade e o vigor das sementes produzidas na primeira etapa. Os tratamentos constaram da combinação de dois níveis de salinidade da água de irrigação (0,5 e 4,5 dS m^{-1}) e 14 variedades crioulas de feijão-caupi (Boquinha, Ceará, Costela-de-vaca, Lisão, Canário, Pingo-de-ouro, Roxão, Branco, Canapum-branco, Canapum-miúdo, Baêta, Coruja, Paulistinha e Sempre-verde) adquiridas junto aos agricultores tradicionais da região Oeste do Rio Grande do Norte, Brasil. As variedades Canário, Baêta e Coruja resultaram com maior número de flores por planta e floração mais precoce. A salinidade diminuiu o número de flores por planta, aumentou o seu abortamento em todas as variedades crioulas e reduziu a produção para as precoces Branco, Canapum-miúdo, Baêta e Coruja. O cultivo irrigado com água salina não afetou a viabilidade das sementes da segunda geração do feijão-caupi, mas diminuiu o vigor das sementes das variedades Lisão, Pingo-de-ouro, Roxão, Branco, Canapum-branco, Canapum-miúdo, Baêta e Coruja. As variedades crioulas Boquinha, Ceará, Costela-de-vaca, Canário, Paulistinha e Sempre-verde foram indicadas para a produção de sementes de feijão-caupi irrigado com água salina.

Palavras-chave: *Vigna unguiculata* (L.) Walp. Estresse salino. Agricultura familiar. Viabilidade de sementes.

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INTRODUCTION

Irrigation is an important alternative for coping with rainfall irregularity in arid and semi-arid regions. However, the water available for this practice usually contains a high concentration of soluble salts that can affect soil and plant (DIAS *et al.*, 2021). This damage to plants caused by salinity is due to the water deficit induced by the high osmolarity of the soil solution, through ionic toxicity related to nutritional and metabolic disorders, whose factors lead to growth inhibition (HUANG, 2018).

Plant characteristics, including organ or tissue identity, developmental stage and variety, influence the response to stress, governed by mechanisms that confer resistance, whether via escape or via tolerance to salt stress (GUPTA; HUANG, 2014) . Therefore, an important factor for employing saline water without causing major losses is the use of varieties more tolerant to salinity (SÁ *et al*., 2016).

Cowpea (*Vigna unguiculata* (L.) Walp.) has great socioeconomic and food importance for the population of northeastern Brazil due to its protein content (TORRES *et al*., 2015). Given the importance of the crop and the predominance of saline waters in a large part of this region, the selection of salinity-tolerant varieties represents a great step towards improving the yield of plantations of this species in semi-arid regions (SÁ *et al*., 2017).

As for tolerance, cowpea is considered moderately tolerant to salinity of irrigation water (AYERS; WESTCOT, 1999). The increase of soil salinity due to irrigation with saline water can inhibit the development of plants, resulting in physiological and phenological changes in the species (SÁ *et al*., 2018). As a consequence, there may be a delay in flowering and an increase in flower abortion rate proportional to the increase in salinity (FURTADO *et al*., 2014). Usually, the degree of salinity tolerance in cowpea is variable according to genotype, and there may be changes in the partition of photoassimilates, germination and seedling growth under this condition (SÁ *et al.*, 2016, 2017). In addition, the synthesis of total proteins may also occur, making the study on salinity tolerance extremely important, as a support for the selection of varieties more suitable for the semi-arid region (DANTAS *et al*., 2002).

In traditional production systems there is a significant number of plant species that are used for various purposes. This vast number of varieties of cultivated species, such as maize, cassava, common bean and fava bean, has been maintained by family farmers as a production and coexistence strategy of communities impacted by climatic adversities (SANTOS; CURADO; TAVARES, 2019). For cowpea, little is known about the impact of salinity on its phenology and on the physiological quality of seeds produced in this environment.

The hypothesis of this study is that, among the varieties traditionally cultivated in the semi-arid region of northeastern Brazil, there are materials with high salinity tolerance potential, either by escape strategies or expression of mechanism against such stress. Thus, the objective was to evaluate the phenology and production of traditional seeds of cowpea irrigated with saline water.

MATERIAL AND METHODS

The research was carried out in two stages during 2019, at the Federal Rural University of the Semi-Arid Region (UFERSA), Mossoró, RN, Brazil (5°20’32”S, 37°32’38”W and altitude of 18 m). In the first stage, the phenology and production of traditional cowpea varieties were evaluated and, in the second stage, the viability and vigor of the seeds produced in the previous stage were assessed.

First stage: phenology and production

The experiment was conducted in a protected environment (greenhouse), in an experimental design of randomized blocks, arranged in a 2 x 14 factorial scheme. The treatments resulted from the combination of two salinity levels of irrigation water (S_1 - 0.5 dS m^{-1} and S_2 - 4.5 dS m^{-1}) and 14 cowpea varieties (V_1 - Boquinha, V_2 - Ceará, V_3 - Costela-de-vaca, V_4 - Lisão, V_5 - Canário, V_6 - Pingo-de-ouro, V_7 - Roxão, V_8 - Branco, V_9 - Canapum-branco, V_{10} - Canapum-miúdo, V_{11} - Baêta, V_{12} - Coruja, V_{13} - Paulistinha, V_{14} - Sempre-verde), with five repetitions, totaling 140 experimental units.

The seeds were acquired from collections belonging to the traditional seed guardians of the rural communities of Rio Grande do Norte. The untreated seeds, 2018 season, had been kept in hermetically sealed plastic bottles and stored in a dry and airy environment. The varieties used in this research were chosen based on preliminary studies in the initial stage of development (germination and initial growth) (PRAXEDES *et al*., 2020).

The soil used in the experiment was an Oxisol with sandy loam texture and came from an uncultivated area, located at the Rafael Fernandes Experimental Farm of UFERSA, District of Alagoinha, Mossoró, RN, Brazil. The soil was collected from the 0-30 cm layer, dried at ambient temperature, pounded to break up clods, sieved through a 4.0-mm mesh and characterized for chemical and physical attributes (Table 1), according to the methodology proposed by Teixeira *et al*. (2017).

The soil was placed in pots with capacity of 12 dm^3, with 10 dm^3 of soil and 1 dm^3 of crushed stone. The crushed stone layer was arranged at the bottom of the pots and covered with a screen to prevent soil loss and facilitate drainage.

Soil acidity was corrected with calcium hydroxide ($Ca(OH)_2$), with 54% calcium. The soil was corrected to increase base saturation to 90%. After 15 days, fertilization was performed in pots in protected cultivation according to the recommendations of Novais, Neves and Barros (1991). 100 mg of N, 300 mg of $P_2O_5^-$ and 150 mg of K_2O per dm^3 of soil were applied through fertigation, using urea (45% of N), monoammonium phosphate (MAP = 12% of N and 50% of $P_2O_5^-$) and potassium chloride (KCl = 60% of K_2O), respectively. Fertilization with micronutrients was performed by foliar applications at pre-flowering and at 15 days after flowering, using the foliar fertilizer Liqui-Plex Fruit®, in the proportion of 3 mL L^{-1} of solution, following the manufacturer's recommendation (Table 2).

After filling the pots, irrigation was carried out to leave the substrate at field capacity, uniformizing soil moisture in each pot. Irrigation management was based on the drainage lysimetry method, so as to leave the soil with moisture content close to the maximum holding capacity, through irrigations performed once a day, with a leaching fraction (LF) of 15% added to the applied depth every seven days. The volume applied (Va) per pot was obtained by the difference between the previous depth applied (Lp) minus the mean drainage (D), divided by the number of pots (n), as indicated in Equation 1:

$$Va = \frac{Lp - D}{n(1 - LF)} \quad (1)$$

The irrigation system was composed of a Metalcorte/Eberle self-venting circulation motor-pump set, driven by a single-phase motor, with 210 V voltage and 60 Hz frequency, installed in a reservoir with capacity for 50 L, and 16-mm-diameter hoses with pressure-compensating drippers with flow rate of 1.3 L h^{-1}.

Irrigation was performed using public-supply water in treatment 01 (S_1) and a solution with electrical conductivity of 4.5 dS m^{-1}, prepared from the dilution of reject brine (9.5 dS m^{-1}) and public-supply water, in treatment 02 (S_2). The desalination reject brine was obtained at the Jurema Settlement, Mossoró, RN (Table 3).

Table 1 - Chemical and physical attributes of the soil used in the cultivation of traditional cowpea varieties

pH	OM	P	K^+	Na^+	Ca^{2+}	Mg^{2+}	Al^{3+}	H+Al	SB	T	CEC	V	ESP
	(%)	------- (mg dm^{-3}) ---------			--------------------------- ($cmol_c$ dm^{-3}) ----------------------------							------ % --------	
5.30	1.67	2.1	54.2	21.6	2.70	0.90	0.05	1.82	3.83	3.88	5.65	68	2.0
ECse dS m^{-1}	BD kg dm^{-3}	Sand				Silt				Clay			
		-- (g kg^{-1}) --											
0.58	1.60	820				30				150			

OM - Organic matter; ECse - electrical conductivity of soil saturation extract; BD - Bulk density

Table 2 - Chemical characterization of the foliar fertilizer Liqui-Plex Fruit® used in the cultivation of traditional cowpea varieties

N	Ca	S	B	Cu	Mn	Mo	Zn^-	OC
-- g L^{-1} --								----- % ------
73.50	14.70	78.63	14.17	0.74	73.50	1.47	73.50	2.45

OC - organic carbon

Table 3 – Physical-chemical characterization of the water sources used in the cultivation of traditional cowpea varieties

	pH	EC	K^+	Na^+	Mg^{2+}	Ca^{2+}	Cl^-	CO_3^{2-}	HCO_3^-	SAR
	H_2O	dS m^{-1}	--- $mmol_c$ L^{-1} ---							
PSW	7.57	0.50	0.31	3.74	1.20	0.83	2.40	0.60	3.20	2.62
DRB	7.10	9.50	0.83	54.13	24.20	37.80	116.00	0.00	3.40	9.70

PSW - public-supply water; DRB - desalination reject brine; pH (H_2O) – Hydrogen potential in water; EC - Electrical conductivity; K^+ - Potassium; Na^+ - Sodium; Mg^{2+} - Magnesium; Ca^{2+} - Calcium; Cl^- - Chlorine; CO_3^{2-} - Carbonate; HCO_3^- - Bicarbonate; SAR - Sodium adsorption ratio

At the end of the experiment, the electrical conductivity of the soil saturation extract (ECse) of each pot was analyzed (Table 4). ECse was estimated according to the methodology of Ayers and Westcot (1999), for soils of medium texture. For this, at 80 days after sowing, another leaching depth was applied (15%), the drained volume was collected, and the electrical conductivity of the drainage water (ECd) was determined using a benchtop conductivity meter, with the data expressed in dS m^{-1}, adjusted to the temperature of 25 ºC. Then, ECse was calculated according to Equation 2:

$$ECse = \frac{ECd}{2} \tag{2}$$

Weed control was performed manually. When necessary, insecticide and fungicide registered for the crop were used to control silverleaf whitefly (*Bemisia tabaci*), angular leaf spot (*Pseudocercospora griseola*) and common bean scab (*Colletotrichum dematium f. truncata*).

In the phenological analysis of cowpea varieties, the following parameters were determined:

Days to Flowering (DF): estimated by counting the days between sowing and opening of the first flowers per plant;

Days to Pod Maturity (DM): estimated by counting the days between anthesis and the harvest of the pods, with light yellow or brown color; and

Cycle: determined as the time in days from the date of sowing to the date of the last harvest, which culminated in the removal of the plants from the pots.

In the analysis of cowpea production, the following parameters were determined:

Number of Flowers per Plant (NFP): obtained by counting the total number of flowers produced during the cycle;

Flower Abortion Percentage: estimated by the relationship between the total number of fertilized flowers and the total number of flowers produced per plant;

Number of Pods per Plant (NPP): obtained by counting the number of pods harvested from each plant;

Number of Locules per Pod (NLP): determined by counting the number of locules of each pod;

Number of Seeds per Pod (NSPO): obtained by counting the seeds in each pod per plant, with results expressed in number of seeds per fruit;

Number of Seeds per Plant (NSPL): obtained by counting the total seeds produced in each plant;

Seed Weight per Plant (SWP): obtained by weighing the seeds derived from each repetition on precision analytical scale;

Average Seed Weight (ASW): obtained by the relationship between seed weight per plant and the number of seeds per plant; and

Seed Length, Thickness and Width: 10 seeds of each replicate were measured, totaling 2800. The measurements were taken with a digital caliper and the results were expressed in mm.

Second stage: physiological quality of seeds

The seeds from the replicates of each treatment of the first stage (variety and salinity) were mixed and homogenized. The experimental design used was completely randomized in a 2 x 14 factorial scheme with four replicates of 25 seeds. The treatments resulted from the seeds produced by the 14 cowpea varieties used in the first stage and irrigated with saline waters (S_1 – 0.5 dS m^{-1} and S_2 – 4.5 dS m^{-1}).

Seed moisture content was determined by the oven method at 105 ºC for 24 hours, following the methodology described in the Rules for Seed Analysis (BRASIL, 2009), with two subsamples of 10 seeds.

The seeds were placed to germinate in an air-conditioned room at a temperature of 25 ºC and relative humidity of 75%, in aluminum trays (40 × 27 × 4.5 cm), containing washed sand sterilized at 105 ºC as substrate. Two replicates of 25 seeds were sown in each tray. The first germination count (FGC) and the final germination count (G) were performed on the fifth and eighth day after sowing, respectively (BRASIL, 2009).

Table 4 - Electrical conductivity of the saturation extract (ECse) of the soil used in the experiment at the end of the cultivation of traditional cowpea varieties

	ECse (dS m^{-1})													
	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	V14
S1	1.3	1.1	1.4	1.5	1.4	1.4	1.7	1.4	1.5	1.3	1.9	1.3	1.4	1.4
S2	7.8	7.3	6.7	6.5	9.7	7.8	8.4	7.8	7.4	6.7	7.2	7.0	6.3	7.5

V_1 - Boquinha, V_2 - Ceará, V_3 - Costela-de-vaca, V_4 - Lisão, V_5 - Canário, V_6 - Pingo-de-ouro, V_7 - Roxão, V_8 - Branco, V_9 - Canapum-branco, V_{10} - Canapum-miúdo, V_{11} - Baêta, V_{12} - Coruja, V_{13} - Paulistinha, V_{14} - Sempre-verde. S_1 - 0.5 dS m^{-1}, S_2 - 4.5 dS m^{-1}

Length (LNG) and dry matter (DMS) of seedlings were determined after the final germination count. For this, the seedlings of each experimental unit were measured with a graduated ruler and the data were expressed in cm seedling^{-1}. Subsequently, the seedlings were placed in paper bags, dried in a forced circulation oven (65 °C) until reaching constant weight and weighed on analytical scale (0.0001 g), with data expressed in mg seedling^{-1}.

Statistical analysis

The obtained data were subjected to analysis of variance using the F test. In the cases of significance, the Scott-Knott test of means was performed for the variety factor and Student's t-test was applied to the salinity factor, at 5% significance level, using the statistical program SISVAR® (FERREIRA, 2014). Phenology and production data were subjected to standardization, with mean zero ($\bar{x} = 0$) and variance one ($S^2 = 1$). Subsequently, cluster analysis was performed using Ward's minimum variance hierarchical method, with Euclidean distance as a measure of dissimilarity (HAIR *et al*., 2009). PAST 3 free software was used for the multivariate statistical analysis.

RESULTS AND DISCUSSION

Phenology and production

The variety and salinity factors had single effects ($p < 0.01$) on the variables Days to Flowering (DF) and Number of Flowers per Plant (NFP). For the cycle variable, there was a significant effect only of the variety factor ($p < 0.05$), while the abortion percentage was influenced only by salinity ($p < 0.01$). Days to Maturity (DM) was not influenced by the studied factors (Table 5).

The cowpea varieties started flowering between 38 and 48 days after sowing, and Boquinha (V_1), Lisão (V_4), Canário (V_5), Branco (V_8), Baêta (V_{11}), Coruja (V_{12}) and Paulistinha (V_{13}) were the earliest, while Costela-de-vaca (V_3) was the latest (Table 6). However, only the varieties Branco (V_8), Baêta (V_{11}) and Paulistinha (V_{13}) had early cycle, between 62 and 64 days (Table 5).

For plants grown under the high-salinity condition (4.5 dS m^{-1}), the time to flowering (DF) was delayed by three days on average compared to those grown under the low-salinity condition (0.5 dS m^{-1}) (Table 5).

The number of flowers per plant (NFP) varied between 11 and 25, with the varieties Canário (V_5), Baêta (V_{11}) and Coruja (V_{12}) producing more flowers. Despite the variability in the number of flowers, their abortion percentage was similar by the Scott-Knott test (Table 5). However, cowpea plants cultivated under high salinity (4.5 dS m^{-1}) showed a 19% reduction in NFP and a 17%

Table 5 - Mean values for Days to Flowering (DF), Days to Maturity (DM), Cycle, Number of Flowers per Plant (NFP) and Flower Abortion of traditional cowpea varieties subjected to different salinity levels of irrigation water

Variety (V)	DF	DM	Cycle (days)	NFP	Abortion (%)
1 - Boquinha	43 c	20 a	67 a	18.5 b	74.4 a
2 - Ceará	44 b	20 a	78 a	13.5 c	68.1 a
3 - Costela-de-vaca	48 a	19 a	75 a	17.9 b	80.2 a
4 - Lisão	43 c	19 a	69 a	15.4 c	76.0 a
5 - Canário	41 c	19 a	69 a	21.3 a	80.8 a
6 - Pingo-de-ouro	44 b	20 a	70 a	14.2 c	71.9 a
7 - Roxão	45 b	21 a	73 a	19.5 b	77.6 a
8 - Branco	41 c	19 a	64 b	17.6 b	60.6 a
9 - Canapum-branco	44 b	18 a	70 a	13.4 c	63.0 a
10 - Canapum-miúdo	44 b	18 a	69 a	15.1 c	66.0 a
11 - Baêta	39 c	19 a	62 b	22.1 a	71.0 a
12 - Coruja	42 c	20 a	69 a	24.7 a	75.5 a
13 - Paulistinha	40 c	20 a	64 b	18.7 b	70.6 a
14 - Sempre-verde	44 b	20 a	71 a	11.5 c	72.6 a
Salinity					
0.5 dS m^{-1}	41 B	19 A	68 A	19.2 A	63.5 B
4.5 dS m^{-1}	44 A	19 A	70 A	15.6 B	80.5 A

Equal uppercase and lowercase letters in the columns do not differ by Student's t-test and Scott-Knott test at 5% probability level, respectively increase in flower abortion, regardless of the variety. Studies conducted by Furtado *et al*. (2014) with the variety BRS Pajeú showed that NFP is sensitive to the effects of salinity and that, under salt stress conditions, there is usually an increase in the abortion of flowers in cowpea.

Studies indicate that salinity interferes in plant development, as verified here. Such interferences occur due to ionic toxicity and/or nutritional imbalance, mainly caused by the excess of Na^+ and Cl^- ions in plant tissues (SYVERTSEN; GARCIA-SANCHEZ, 2014; VOLKOV; BEILBY, 2017). These ions modify the Na^+/K^+, Na^+/Ca^{2+}, Na^+/Mg^{2+} and Cl^-/NO_3^- ratios, affecting photophosphorylation, respiratory chain, assimilation of nutrients and metabolism of proteins, among other organic compounds (GUPTA; HUANG, 2014). As a consequence, the metabolism and development of plants are hampered (HUANG, 2018).

The interaction between variety and salinity was significant ($p < 0.05$) for the Number of Pods per Plant (NPP), Number of Locules per Pod (NLP), Number of Seeds per Pod (NSPO) and Number of Seeds per Plant (NSPL) (Table 6).

The varieties Branco (V_8), Baêta (V_{11}), Coruja (V_{12}) and Paulistinha (V_{13}) under the control treatment (0.5 dS m^{-1}) obtained higher NPP, while Ceará (V_2), Costela-de-vaca (V_3), Lisão (V_4), Pingo-de-ouro (V_6) and Sempre-verde (V_{14}) obtained the lowest NPP. Under salt stress conditions (4.5 dS m^{-1}), there was no difference among the varieties for NPP. However, the NPP values of Costela-de-vaca (V_3) and Sempre-verde (V_{14}) were not reduced under salinity conditions compared to the control treatment (Table 6).

NLP was similar among the varieties between the control and salt stress treatments. However, the NLP values of Canário (V_5) and Baêta (V_{11}) were reduced by 30.2 and 17%, respectively, under salt stress compared to the control (Table 6). Despite the similarity between control and salt stress for NLP, there was a difference in NSPO between the control treatment and the salt stress condition.

The NSPO of the variety Boquinha (V_1) increased under salt stress, while for Canário (V_5), Roxão (V_7) and Coruja (V_{12}) there was a reduction in NSPO compared to the control treatment. For the other cowpea varieties studied, no differences were observed in this variable (Table 6).

The control treatment resulted in lower NSPL for the varieties Boquinha (V_1), Costela-de-vaca (V_3), Lisão (V_4), Branco (V_8) and Sempre-verde (V_{14}); under salt stress, the lowest values of NSPL were verified for Costela-de-vaca (V_3), Canário (V_5), Roxão (V_7) and Branco (V_8) (Table 6).

The control treatment (0.5 dS m^{-1}) led to the highest numbers of seeds per plant (NSPL) for the varieties Baêta (V_{11}), Coruja (V_{12}) and Paulistinha (V_{13}), and to the lowest NSPL for Ceará (V_2), Costela-de-vaca (V_3), Lisão (V_4) and Sempre-verde (V_{14}). However, under salt stress (4.5 dS m^{-1}) there were no differences between the varieties for this variable (Table 6). Only Ceará (V_2), Costela-de-vaca (V_3) and Sempre-verde (V_{14}) showed no reduction in the number of seeds under salinity conditions compared to the control (Table 6).

Table 6 - Mean values for Number of Pods per Plant (NPP), Number of Locules per Pod (NLP), Number of Seeds per Pod (NSPO) and Number of Seeds per Plant (NSPL) of traditional cowpea varieties subjected to different salinity levels of irrigation water

Variety (V)	NPP		NLP	
	0.5 dS m^{-1}	4.5 dS m^{-1}	0.5 dS m^{-1}	4.5 dS m^{-1}
1 - Boquinha	6.8 Ab	2.8 Ba	14.9 Aa	16.1 Aa
2 - Ceará	4.8 Ac	2.6 Ba	15.4 Aa	15.8 Aa
3 - Costela-de-vaca	4.2 Ac	3.0 Aa	15.4 Aa	13.7 Aa
4 - Lisão	4.8 Ac	2.2 Ba	14.7 Aa	15.7 Aa
5 - Canário	6.0 Ab	2.4 Ba	16.2 Aa	11.3 Ba
6 - Pingo-de-ouro	5.2 Ac	2.4 Ba	15.3 Aa	14.1 Aa
7 - Roxão	6.2 Ab	2.2 Ba	15.7 Aa	13.4 Aa
8 - Branco	9.2 Aa	3.6 Ba	14.5 Aa	13.4 Aa
9 - Canapum-branco	6.0 Ab	3.0 Ba	15.8 Aa	15.4 Aa
10 - Canapum-miúdo	6.6 Ab	3.0 Ba	16.5 Aa	14.4 Aa
11 - Baêta	8.6 Aa	3.6 Ba	17.8 Aa	14.8 Ba
12 - Coruja	8.0 Aa	4.0 Ba	16.4 Aa	14.0 Aa
13 - Paulistinha	9.0 Aa	2.8 Ba	17.2 Aa	14.7 Aa
14 - Sempre-verde	3.6 Ac	2.0 Aa	13.7 Aa	15.0 Aa

Continuation Table 6

Variety (V)	NSPO		NSPL	
	0.5 dS m^{-1}	4.5 dS m^{-1}	0.5 dS m^{-1}	4.5 dS m^{-1}
1 - Boquinha	11.6 Bb	15.3 Aa	80.5 Ab	42.3 Ba
2 - Ceará	13.4 Aa	15.0 Aa	63.4 Ac	38.5 Aa
3 - Costela-de-vaca	9.9 Ab	9.3 Ab	42.0 Ac	26.8 Aa
4 - Lisão	11.9 Ab	13.6 Aa	56.8 Ac	28.3 Ba
5 - Canário	14.3 Aa	10.0 Bb	83.7 Ab	24.2 Ba
6 - Pingo-de-ouro	13.9 Aa	14.1 Aa	74.2 Ab	33.6 Ba
7 - Roxão	13.5 Aa	10.5 Bb	82.2 Ab	23.9 Ba
8 - Branco	10.5 Ab	10.1 Ab	91.4 Ab	36.3 Ba
9 - Canapum-branco	13.9 Aa	14.0 Aa	78.6 Ab	36.3 Ba
10 - Canapum-miúdo	14.7 Aa	12.6 Aa	96.8 Ab	37.7 Ba
11 - Baêta	13.3 Aa	12.9 Aa	113.8 Aa	45.7 Ba
12 - Coruja	15.1 Aa	12.1 Ba	121.0 Aa	50.0 Ba
13 - Paulistinha	14.1 Aa	13.0 Aa	126.6 Aa	35.5 Ba
14 - Sempre-verde	11.8 Ab	13.9 Aa	43.0 Ac	28.0 Aa

Equal uppercase letters in the rows and lowercase letters in the columns do not differ by Student's t-test and Scott-Knott test at 5% probability level, respectively

Salt stress reduced the seed production of all cowpea varieties, except for Ceará (V_2), Costela-de-vaca (V_3) and Sempre-verde (V_{14}). For the others, the reduction in the number of pods per plant was the main cause for reduction in NSPL, as well as lower production of flowers and higher abortion rate, especially under salt stress. Only the varieties Baêta (V_{11}) and Coruja (V_{12}) had reduction in NSPO with no decrease in NLP. This indicates that, for these varieties, in addition to the reduction of NPP, pod filling was deficient. These facts may be related to low pollen viability and nutritional disorders caused by high salinity (SILVA *et al*., 2021).

The osmotic and ionic effects of salinity cause physiological and morphological changes that reduce plant yield. Sá *et al*. (2018) found morphophysiological changes in cowpea plants, with reduction in their photosynthetic rate, due to stomatal restrictions and damage to the photosynthetic apparatus. Thus, the production of photoassimilates directly influences the production performance of cowpea (TAGLIAFERRE *et al*., 2018).

Water salinity negatively interferes with cowpea yield. Brito *et al.* (2015) verified this negative effect in five varieties of this species irrigated with water of 4.8 dS m^{-1}, whose reduction in the number of seeds per plant was up to 88%. Similarly, Oliveira *et al.* (2015) found that the production of pods per cowpea plant under salt stress was reduced by 50% and that the number of seeds per pod (NSPO) decreased by 1.5 seeds per pod, for each unit increase in the electrical conductivity of irrigation water. According to Tagliaferre *et al*. (2018), each unit increase in the electrical conductivity of irrigation water above the salinity threshold (3.3 dS m^{-1}) lead to reductions of up to 25% in grain yield. Despite that, there is divergence in the reduction of cowpea production as a function of salt stress, caused by the different degrees of tolerance between varieties (DANTAS *et al*., 2002).

The interaction between variety and salinity was significant ($p < 0.05$) for Seed Weight per Plant (SWP) and Average Seed Weight (ASW) (Table 7).

The varieties Ceará (V_2), Costela-de-vaca (V_3), Canário (V_5), Pingo-de-ouro (V_6) and Sempre-verde (V_{14}) obtained lower values of ASW in the control treatment (Table 7). For ASW, the varieties Boquinha (V_1), Costela-de-vaca (V_3), Lisão (V_4), Roxão (V_7) and Sempre-verde (V_{14}) were superior to the others in the control treatment (Table 7).

Salt stress reduced the SWP of all cowpea varieties compared to the control, except for Ceará (V_2), Costela-de-vaca (V_3), Pingo-de-ouro (V_5) and Sempre-verde (V_{14}) (Table 7). When irrigated with high-salinity water, the varieties Costela-de-vaca (V_3), Lisão (V_4), Pingo-de-ouro (V_6), Roxão (V_7), Canapum-branco (V_9) and Sempre-verde (V_{14}) obtained higher ASW. Among these varieties, only Pingo-de-ouro (V_6) had ASW increased compared to the control (Table 7).

The SWP of the cowpea varieties was lower under salt stress due to the decrease in NSPL, since ASW was not influenced. Exception occurred for Pingo-de-ouro (V_6), which had a significant increase in ASW, promoting a SWP value similar to that obtained in the control treatment.

Table 7 - Mean values for Seed Weight per Plant (SWP) and Average Seed Weight (ASW) of traditional cowpea varieties subjected to different salinity levels of irrigation water

Variety	SWP (g)		ASW (g)	
	0.5 dS m^{-1}	4.5 dS m^{-1}	0.5 dS m^{-1}	4.5 dS m^{-1}
1 - Boquinha	16.7 Aa	9.8 Ba	0.25 Aa	0.25 Ab
2 - Ceará	11.2 Ab	7.4 Aa	0.18 Ab	0.20 Ab
3 - Costela-de-vaca	10.5 Ab	7.2 Aa	0.31 Aa	0.27 Aa
4 - Lisão	15.5 Aa	7.5 Ba	0.27 Aa	0.30 Aa
5 - Canário	12.9 Ab	5.6 Ba	0.15 Ab	0.24 Ab
6 - Pingo-de-ouro	12.5 Ab	9.9 Aa	0.18 Bb	0.31 Aa
7 - Roxão	19.1 Aa	7.4 Ba	0.24 Aa	0.32 Aa
8 - Branco	16.9 Aa	8.1 Ba	0.19 Ab	0.23 Ab
9 - Canapum-branco	16.3 Aa	7.1 Ba	0.22 Ab	0.32 Aa
10 - Canapum-miúdo	17.9 Aa	7.3 Ba	0.19 Ab	0.21 Ab
11 - Baêta	20.1 Aa	9.2 Ba	0.18 Ab	0.20 Ab
12 - Coruja	18.7 Aa	10.2 Ba	0.16 Ab	0.22 Ab
13 - Paulistinha	15.7 Aa	7.5 Ba	0.13 Ab	0.22 Ab
14 - Sempre-verde	12.1 Ab	8.3 Aa	0.32 Aa	0.35 Aa

Equal uppercase letters in the rows and lowercase in the columns do not differ by Student's t-test and Scott-Knott test at 5% probability level, respectively

The varieties Canário (V_5), Branco (V_8), Canapum-branco (V_9), Baêta (V_{11}), Coruja (V_{12}) and Paulistinha (V_{13}) showed alterations in the biometric characteristics of their seeds under salt stress. The increments in seed length and thickness did not influence the average seed weight and, therefore, was not enough to reduce the impact of stress on seed weight per plant (SWP).

Cowpea seed weight is a stress-sensitive variable, as observed in this study. Oliveira *et al* (2015) also verified reductions in the number and weight of seeds of this species as a function of salt stress. In addition, the authors found that this reduction occurs when irrigation water with salinity greater than 2.0 dS m^{-1} is used.

The interaction between variety and salinity was significant ($p < 0.05$) for seed biometrics (Table 8).

As for SL, under the control condition the varieties Costela-de-vaca (V_3), Sempre-verde (V_{14}), Boquinha (V_1), Lisão (V_4), Pingo-de-ouro (V_6), Roxão (V_7) and Canapum-branco (V_9) obtained the highest means. However, under the salt stress condition, the highest SL values were verified in the varieties Costela-de-vaca (V_3), Pingo-de-ouro (V_6), Roxão (V_7), Branco (V_8), Canapum-branco (V_9), Coruja (V_{12}) and Paulistinha (V_{13}) (Table 8). Under the salt stress condition, the varieties Canário (V_5), Pingo-de-ouro (V_6), Branco (V_8), Canapum-branco (V_9), Canapum-miúdo (V_{10}), Baêta (V_{11}), Coruja (V12) and Paulistinha (V13) produced longer seeds, compared to those in the control treatment, with no significant differences for the other varieties (Table 8).

Greater seed width (SW) was obtained by the varieties Lisão (V_4), Roxão (V_7) and Sempre-verde (V_{14}) in the control treatment (0.5 dS m^{-1}) and by the varieties Pingo-de-ouro (V_6), Roxão (V_7), Branco (V_8), Canapum-branco (V_9), Coruja (V_{12}) and Sempre-verde (V_{14}) under salt stress (4.5 dS m^{-1}). Under this stress condition, the SW values of the varieties Canário (V_5), Pingo-de-ouro (V_6), Branco (V_8), Coruja (V_{12}) and Paulistinha (V_{13}) were higher than those found in the control treatment (Table 8).

In the control treatment, as observed for SL and SW, the highest values of ST were verified in the varieties Lisão (V_4) and Sempre-verde (V_{14}). Under salt stress, the varieties Canário (V_5), Pingo-de-ouro (V_6), Roxão (V_7), Canapum-branco (V_9), Baêta (V_{11}), Coruja (V_{12}) and Paulistinha (V_{13}) produced seeds with greater thickness compared to the values obtained in the control treatment (Table 8).

In the control treatment, there is variability regarding the production components. Varieties that produce higher number of seeds such as Baêta (V_{11}), Coruja (V_{12}) and Paulistinha (V_{13}) resulted in smaller and lighter seeds. Costela-de-vaca (V_3), Lisão (V_4) and Sempre-verde (V_{14}) produce fewer seeds per plant, but these seeds are larger and heavier. Nevertheless, the varieties Costela-de-vaca (V_3), Canário (V_5), Pingo-de-ouro (V_6) and Sempre-verde (V_{14}) had lower production compared to the others.

Table 8 - Mean values for seed length (SL), seed width (SW) and seed thickness (ST) of traditional cowpea varieties subjected to different salinity levels of irrigation water

Varieties	SL (mm)		SW (mm)		ST (mm)	
	0.5 dS m^{-1}	4.5 dS m^{-1}	0.5 dS m^{-1}	4.5 dS m^{-1}	0.5 dS m^{-1}	4.5 dS m^{-1}
1 - Boquinha	9.4 Ac	9.2 Ab	6.9 Ab	9.4 Ac	9.2 Ab	6.9 Ab
2 - Ceará	8.7 Ad	9.4 Ab	6.3 Ac	8.7 Ad	9.4 Ab	6.3 Ac
3 - Costela-de-vaca	11.4 Aa	11.1 Aa	7.2 Ab	11.4 Aa	11.1 Aa	7.2 Ab
4 - Lisão	9.4 Ac	9.8 Ab	7.6 Aa	9.4 Ac	9.8 Ab	7.6 Aa
5 - Canário	8.5 Bd	9.7 Ab	6.5 Bc	8.5 Bd	9.7 Ab	6.5 Bc
6 - Pingo-de-ouro	9.1 Bc	10.7 Aa	7.0 Bb	9.1 Bc	10.7 Aa	7.0 Bb
7 - Roxão	9.6 Ac	10.5 Aa	7.9 Aa	9.6 Ac	10.5 Aa	7.9 Aa
8 - Branco	8.8 Bd	10.1 Aa	6.3 Bc	8.8 Bd	10.1 Aa	6.3 Bc
9 - Canapum-branco	9.3 Bc	10.5 Aa	7.3 Ab	9.3 Bc	10.5 Aa	7.3 Ab
10 - Canapum-miúdo	8.4 Bd	9.3 Ab	7.4 Ab	8.4 Bd	9.3 Ab	7.4 Ab
11 - Baêta	8.9 Bd	10.0 Ab	6.0 Ac	8.9 Bd	10.0 Ab	6.0 Ac
12 - Coruja	8.8 Bd	10.7 Aa	6.9 Bb	8.8 Bd	10.7 Aa	6.9 Bb
13 - Paulistinha	7.9 Bd	10.3 Aa	6.2 Bc	7.9 Ad	10.3 Aa	6.2 Bc
14 - Sempre-verde	10.1 Ab	9.8 Ab	8.1 Aa	10.1 Ab	9.8 Ab	8.1 Aa

Equal uppercase letters in the rows and lowercase letters in the columns do not differ by Student's t-test and Scott-Knott test at 5% probability level, respectively

Reductions in seed size and weight occur due to changes in the partition of photoassimilates resulting from the effects of salinity (NEVES *et al*., 2008; OLIVEIRA *et al*., 2015; SÁ *et al*., 2018). Thus, plants grown under high salinity produce a smaller amount of photoassimilates, which are divided among a lower number of seeds, resulting in larger seeds, as verified here.

Dissimilarity

In the cluster analysis, based on the Euclidean Distance of 4.4, under low salinity, there was the formation of two groups of cowpea varieties (Figure 1A). The first one (I) consists of the varieties Branco (V_8), Canapum-miúdo (V_{10}), Baêta (V_{11}), Coruja (V_{12}) and Paulistinha (V_{13}). Group II comprised the varieties Boquinha (V_1), Ceará (V_2), Costela-de-vaca (V_3), Lisão (V_4), Canário (V_5), Pingo-de-ouro (V_6), Roxão (V_7), Canapum-branco (V_9) and Sempre-verde (V_{14}).

Four groups were formed under salt stress (Figure 1B). The first one (I) comprised the variety Canário (V_5), and the second one (II) was formed by Costela-de-vaca (V_3) and Roxão (V_7). The third group (III) contained the varieties Boquinha (V_1), Ceará (V_2), Lisão (V_4), Pingo-de-ouro (V_6), Canapum-branco (V_9), Paulistinha (V_{13}) and Sempre-verde (V_{14}). The fourth group (IV) was composed of Branco (V_8), Canapum-miúdo (V_{10}), Baêta (V_{11}) and Coruja (V_{12}).

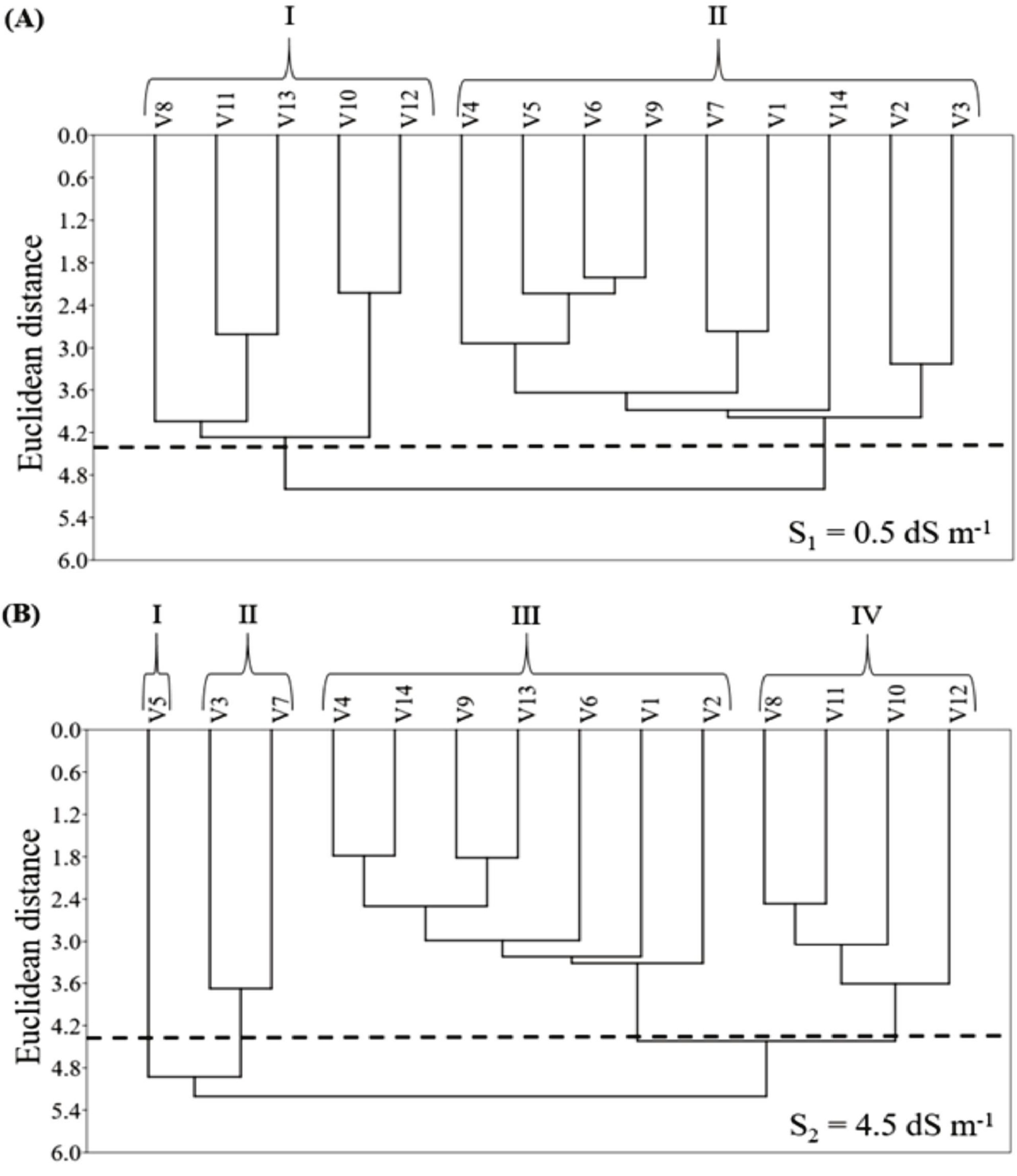
Under low-salinity condition, the first group (I) corresponded to the varieties with short cycle, which produce a higher number of seeds and with greater seed weight, while the second group comprise varieties with long cycle and lower production. Under high salinity, there was greater stratification of groups, with the first two containing the varieties with production least affected by salinity, such as Canário (V_5), Costela-de-vaca (V_3) and Roxão (V_7), all of which with long cycle, as verified under the low-salinity condition.

The third group contained varieties with long cycle and lower production loss, except for Paulistinha (V_{13}), which is short cycle. The fourth group consists of short-cycle varieties, such as Branco (V_8), Canapum-miúdo (V_{10}), Baêta (V_{11}) and Coruja (V_{12}), which had the highest losses in seed production. In general, it was found in the present study that early varieties are the most affected by salt stress.

It is worth pointing out that some varieties, even after being exposed to salt stress, showed high similarity, such as Costela-de-vaca (V_3) and Roxão (V_7); Branco (V_8), Canapum-miúdo (V_{10}), Baêta (V_{11}) and Coruja (V_{12}); and Boquinha (V_1), Ceará (V_2), Lisão (V_4), Pingo-de-ouro (V_6), Canapum-branco (V_9) and Sempre-verde (V_{14}).

The varieties Costela-de-vaca (V_3) and Roxão (V_7) were similar in relation to the long cycle, late flowering, intermediate production of flowers, and production of large and heavy seeds. The varieties Branco (V_8), Canapum-miúdo (V_{10}), Baêta (V_{11}) and Coruja (V_{12}) have short cycle, early flowering, high production of flowers, and high production of pods and seeds, but have reduced seed weight and size. On the other hand, the varieties Boquinha (V_1), Ceará (V_2), Lisão (V_4), Pingo-de-ouro (V_6), Canapum-branco (V_9) and Sempre-verde (V_{14}) are characterized by long cycle, early flowering, large number of seeds per pod and per plant under control conditions (except for Sempre-verde), with a marked decrease in the number of seeds and increase in their size under salt stress conditions.

Figure 1 - Dissimilarity dendrogram of the groups formed by the combination of salinity levels (S) and traditional cowpea varieties (V)



Viability and vigor of seeds

The initial moisture content of the seeds ranged from 8.0 to 10.8% for those produced with water of 0.5 dS m^{-1} and from 9.4 to 10.3% for those produced with water of 4.5 dS m^{-1}. Moisture content is important for both conducting vigor tests and maintaining seed quality, and the values obtained are within the acceptable range for orthodox seeds (MARCOS-FILHO, 2015).

The First Germination Count (FGC) was significantly affected ($p < 0.05$) by the variety factor. The same occurred for seedling length (LNG) with the single factors variety and salinity (Table 9).

The lowest FGC values occurred for the varieties Costela-de-vaca (V_3) and Pingo-de-ouro (V_6), Canapum-branco (V_9) and Sempre-verde (V_{14}). However, regardless of the salinity under which the seeds were produced, the FGC was higher than 90% in all varieties, indicating good vigor performance (ARAÚJO NETO *et al.*, 2020; NUNES *et al.*, 2019; SÁ *et al.*, 2017).

The varieties Lisão (V_4) and Canapum-miúdo (V_{10}) obtained the highest values of seedling length, with no difference among the others (Table 9). Seeds produced under high-salinity condition had a 15% greater length compared to those produced under low-salinity condition (Table 9).

The interaction between variety and salinity significantly affected ($p < 0.05$) Germination (G) and Dry Matter of Seedlings (DMS) (Table 10).

The seeds of the varieties Lisão (V_4) and Pingo-de-ouro (V_6) had the lowest values of germination (G) when plants were grown under low-salinity condition (93%). For the others, germination varied from 98 to 100% (Table 9). Under the high-salinity condition, there was no difference among the varieties for germination. However, the germination of Costela-de-vaca (V_3) seeds decreased by 6% when compared to seeds produced under low salinity (Table 10). According to Araújo Neto *et al.* (2020), salinity reduces the germination performance of cowpea seeds and increases the occurrence of abnormalities in the formation of its seedlings.

Germination is a critical stage for all species and can be affected by several factors, such as water, light and salinity conditions (FERREIRA *et al.*, 2017; PAIVA *et al.*, 2018). Studies indicate that salinity negatively affects the germination (G) of cowpea seeds (FERREIRA *et al.*, 2017; SÁ *et al.*, 2016, 2017). However, the present study found that cultivation under salt stress conditions did not affect the germination of the second generation of traditional cowpea varieties, except for Costela-de-vaca (V_3). Germination results were equal to or greater than 94%, an acceptable value for most agricultural crops, including cowpea.

Table 9 - Mean values for First Germination Count (FGC) and Seedling Length (LNG) of traditional cowpea varieties subjected to different salinity levels of irrigation water

Variety (V)	FGC (%)	LNG (cm seedling^{-1})
1 - Boquinha	99 a	23.2 b
2 - Ceará	98 a	23.9 b
3 - Costela-de-vaca	90 b	24.5 b
4 - Lisão	95 a	27.9 a
5 - Canário	98 a	24.1 b
6 - Pingo-de-ouro	90 b	22.2 b
7 - Roxão	97 a	22.1 b
8 - Branco	99 a	24.2 b
9 - Canapum-branco	94 b	22.3 b
10 - Canapum-miúdo	97 a	27.8 a
11 - Baêta	98 a	22.5 b
12 - Coruja	98 a	24.5 b
13 - Paulistinha	99 a	23.6 b
14 - Sempre-verde	92 b	24.9 b
	Salinity	
0.5 dS m^{-1}	95 A	22.5 B
4.5 dS m^{-1}	96 A	25.8 A

Equal uppercase and lowercase letters in the columns do not differ by Student’s t-test and Scott-Knott test at 5% probability level, respectively

Table 10 - Mean values for Germination (G) and Dry Matter of Seedlings (DMS) of traditional cowpea varieties subjected to different salinity levels of irrigation water

Varieties	G (%)		DMS (mg seedling^{-1})	
	0.5 dS m^{-1}	4.5 dS m^{-1}	0.5 dS m^{-1}	4.5 dS m^{-1}
1 - Boquinha	100 Aa	99 Aa	252.6 Ac	262.2 Ab
2 - Ceará	100 Aa	99 Aa	247.4 Ac	232.5 Ac
3 - Costela-de-vaca	100 Aa	94 Ba	281.4 Ac	301.9 Aa
4 - Lisão	93 Bb	99 Aa	320.6 Aa	270.5 Bb
5 - Canário	99 Aa	100 Aa	217.8 Bd	270.4 Ab
6 - Pingo-de-ouro	93 Bb	100 Aa	298.2 Ab	227.3 Bc
7 - Roxão	100 Aa	99 Aa	263.3 Ac	223.7 Bc
8 - Branco	100 Aa	100 Aa	265.4 Ac	225.9 Bc
9 - Canapum-branco	99 Aa	100 Aa	270.3 Ac	228.7 Bc
10 - Canapum-miúdo	100 Aa	99 Aa	264.4 Ac	214.3 Bc
11 - Baêta	100 Aa	100 Aa	294.9 Ac	219.9 Bc
12 - Coruja	100 Aa	100 Aa	281.2 Ab	224.9 Bc
13 - Paulistinha	100 Aa	98 Aa	264.1 Ac	253.2 Ab
14 - Sempre-verde	98 Aa	100 Aa	330.2 Aa	257.1 Ab

Equal uppercase letters in the rows and lowercase letters in the columns do not differ by Student's t-test and Scott-Knott test at 5% probability level, respectively

The varieties Lisão (V_4) and Pingo-de-ouro (V_6) obtained higher values of germination (G) when cultivated under high salinity (Table 10). This behavior was also observed for the length of seedlings of the cowpea varieties studied (Table 9). Probably, seeds produced under stressful conditions, for being acclimated to these conditions, when exposed to optimal germination conditions, intensify growth as a stress-escape strategy. However, due to the higher germination and growth, there was greater expenditure of seed reserves, compromising the accumulation of dry matter of seedlings in most of the varieties (Table 10), except for Boquinha (V_5), Ceará (V_2), Costela-de-vaca (V_3), Canário (V_5) and Paulistinha (V_{13}), which were more efficient in the utilization of reserves.

Under the low-salinity condition, four groups were formed for dry matter of seedlings (DMS), and the varieties Sempre-verde (V_{14}) and Lisão (V_4) stood out with the highest DMS, while Canário (V_5) had the lowest DMS (Table 10).

Under the high-salinity condition, three groups were formed for dry matter of seedlings, the first two composed of the varieties Costela-de-vaca (V_3), Boquinha (V_1), Lisão (V_4), Canário (V_5), Paulistinha (V_{13}) and Sempre-verde (V_{14}), with the highest DMS values (Table 10).

When comparing the seeds produced under the two salinity levels, it was found that the dry matter accumulation of seedlings (DMS) of the second generation of the varieties Lisão (V_4), Pingo-de-ouro (V_6), Roxão (V_7), Branco (V_8), Canapum-branco (V_9), Canapum-miúdo (V_{10}), Baêta (V_{11}) and Coruja (V_{12}) was reduced with saline water irrigation (4.5 dS m^{-1}).

As it is the only vigor variable with significant interaction between the studied factors, the dry matter of seedlings was used as the main indication of vigor of cowpea seeds. This physiological attribute was not reduced in the second generation of the varieties Boquinha (V_1), Ceará (V_2), Costela-de-vaca (V_3), Canário (V_5), Paulistinha (V_{13}) and Sempre-verde (V_{14}) irrigated with saline water. However, for most varieties this quality indicator was reduced. According to Neves *et al*. (2008), NaCl accumulation occurs in cowpea seeds produced under salt stress conditions. The increase in Na^+ and Cl^- concentrations in reproductive organs such as fruits and seeds causes reductions in K^+ and Ca^{2+} contents, which are fundamental for plant metabolism and dry matter production in stress situations (NEVES *et al*., 2008; SILVA *et al.*, 2021).

Seeds from plants irrigated with high-salinity water usually result in second-generation seedlings with lower vigor and lower capacity of dry matter accumulation, compared to those produced with low-salinity water. This fact has been verified in cherry tomatoes grown with saline water (SILVA *et al*., 2021). Salt stress causes ionic disturbances that affect nutrient distribution and increased accumulation of reactive oxygen species (ROS) (HUANG, 2018; TURAN; TRIPATHY, 2013). These changes in plant metabolism are clearly transferred to the offspring, a result confirmed for the varieties Lisão (V_4), Pingo-de-ouro (V_6), Roxão (V_7), Branco (V_8), Canapum-branco (V_9), Canapum-miúdo (V_{10}), Baêta (V_{11}) and Coruja (V_{12}), which obtained less vigorous seedlings.

CONCLUSIONS

1. The varieties Canário, Baêta and Coruja have higher number of flowers per plant and earlier flowering;
2. Salinity reduces the number of flowers per plant, increases their abortion in all traditional varieties, and reduces the production of the early varieties Branco, Canapum-miúdo, Baêta and Coruja;
3. Cultivation under irrigation with saline water (4.5 dS m^{-1}) does not compromise the viability of second-generation seeds of traditional cowpea varieties, but reduces the vigor of seeds of Lisão, Pingo-de-ouro, Roxão, Branco, Canapum-branco, Canapum-miúdo, Baêta and Coruja;
4. The traditional varieties Boquinha, Ceará, Costela-de-vaca, Canário, Paulistinha and Sempre-verde are indicated for the production of cowpea seeds under irrigation with saline water.

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