



## Effect of salt on seed germination and plant growth of *Anacardium occidentale*

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### ABSTRACT

In Cameroon, despite the increased growing of cashew in recent years, orchard yields remain low due to the quality of seed and unsuitable peasant farming practices. This work realized in the nursery at Wakwa aimed at evaluating the effect of different concentrations of salt on cashew germination and growth. The trial was conducted during the rainy season. The substrate was made up of a mixture of sand, black soil and cow manure respectively at 1/4, 1/2 and 1/4. Seeds were soaked in different proportions of salt solution (5%, 10% and 15%) for 24 hours. The experimental design was a complete randomized block comprising four treatments, each of which was replicated three times. Treatments consisted of different percentage of salt (5%, 10% and 15%) and the control without salt (0%). Salt concentration acted in different ways on germination, survey rate and plants growth. Germination inhibition by salt changed according to the salt concentration and time, being highest at the start of experiment and decrease over time. At 28DAS, 5% and 10% concentrations did not have an inhibitory effect, which made it possible to improve survey rate at this time. Conversely, 15% had a stimulating effect on the vigor and plants growth of cashew. This study showed that soaking cashew seeds in the salt after 24 hours at different concentration does not delay germination and concentration 15% allow to obtained well growth and more vigorous plants.

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**Keywords:** Salt, cashew, seed, pre-treatment, germination and growth.

### INTRODUCTION

The increased pressure on the natural resources and the natural ecosystems, in general heavily affects the biological diversity of forest ecosystems (Zammouri et al., 2010). It is characterized by the decrease, even the disappearance of certain species (Ganaba,

2008). However, the product provided by some species plays an important role valued by the African population (Maponmetsem et al., 2012). Therefore, the potential for regeneration of these species exists, but is often difficult due to the unavailability of the seed, quality and difficulty of preserving their germination

power (Ouedraogo et al., 2004; Thiombiano et al., 2010). The lack of the knowledge, bad farming practice and climatic fluctuations also make this regeneration uncertain (Sarr et al., 2013).

*Anacardium occidentale* is among the socio-economic plants valued by the populations of the Sudano-sahelian zone of Africa, native from Brazilian origin (Trevian et al., 2005). This plant plays an important socio economic role in many Africans countries, because it is often used in agroindustrial, in cosmetic, traditional medicine and in automobile industry (Aliyu, 2007). Cashew production is an important economic activity of many tropical countries (De Figueiredo et al., 2001). Global cashew production is estimated at more than 2 million tons of nuts in 2002, this production increased to 4152315 tons in 2012 (Dedehoue et al., 2015). The latest global cashew production is around 2.2 million tons of nuts per year (Monteiro et al., 2017)

In Cameroon, despite the increased growing interest in this crop in recent years, orchard yields remain low due to the quality of seed and unsuitable peasant farming practices (Hamida et al., 2020). The best condition of the germination of seed of this plant can allow their conservation and vulgarization. However, In Adamawa region of Cameroon, few studies have been carried out in this area, apart from the work done by Hamida et al. (2020) on Performance Evaluation of Different Accession of *Anacardium occidentale* L seed under various substrates. This study has identified the best substrate use to improve seed germination and plants growth of cashew, but did not shown if the pretreatment of seed before sowing in this substrate can improve or delay germination of this plant. This work aimed at evaluating the effect of different concentrations of salt on cashew germination and plant growth of cashew in the nursery.

## MATERIALS AND METHODS

### Study area

This study was carried out in Adamawa region of Cameroon; at Wakwa regional center of agriculture research. The site is located at 07°16.936 North latitude, at

013°30.092 East longitude and at 1130 m elevation (Figure 1). The climate of the area is of the Sudano-Guinean type, with two seasons: a long dry season (from November to March), rainy season (from April to October). Mean annual rainfall is about 1500 mm and mean annual temperature 23 °C (Humbel, 1971). The soil in majority is red ferralitic developed on old basalt. The dominant vegetation is woody and shrubby Savannas (Letouzey, 1968).

### Plant material

Plant material consisted of (a) *Anacardium occidentale* seeds local variety from Kismatari orchard, and the substrate mixture (of cow manure + sand + black soil respectively at 1/4, 1/4 and 1/2 ratio). (Figure 2). Table 1: shows the chemical composition of the substrate. This organic fertilizer (cow manure), appropriate to increase plant growth of *Anacardium occidentale* was chosen based on the previous work carried out in this research center (Hamida et al., 2020). Salt (c) was also used to stimulate seed germination.

### Experimental design and treatments

The trial was conducted during the rainy season. The substrate constitutes mixture of sand, black soil and cow manure respectively at 1/4, 1/2 and 1/4. Seeds were soaked was wetting in the salt at different proportion during 24 hours. The experimental design was a complete randomized block comprising four treatments, each of which was replicated three times. Forty seeds were soaked for each treatment, treatments consisted of different percentage of salt (5%, 10% and 15%) and the control was without salt (0%).

### Assessed parameters

The parameters measured for the experiment were rate of germination, the plant diameter, plant height, length and width of leaves, the number of leaves and leaf area. The plant diameter was measured using a Manutan A367504 calipers. Plant height, length and width of leaves were determined using a measuring tape; the number of leaves was counted manually. The measurements of germination parameter were carried out in all

the germinated seed available at in each time of evaluation and this measurement has been done 14DAS between two weeks and each two days. As concerning parameter growth, the measurements were carried out on ten plants chosen randomly from an experimental plot and this measure has been done 28 DAS. Rate of germination and leaf area were determinate by the following formula:

$$LA = 0.68 * (L * l) - 0.114 \quad (\text{Payne et al., 1997})$$

Where LA is the leaf area and L and l are respectively the length and width of leaf

$$RG = Ng * 100 / Ns$$

Where RG is the rate of germination, Ng and Ns are respectively the number of seed

germinated and the total number of seed sowing.

Inhibition effect of salt was determinate by using this formula:

$$Ig (\%) = (Gt - Ge / Ge) * 100 \quad (\text{Askri et al., 2007}).$$

Where Gt is the number of the seed germinated in the control plot and Ge, is the seed germinated in salt plot (5%, 10% or 15%).

### Data analysis

The collected data were subjected to the analysis of variance (ANOVA) using the STATGRAPHIC.5 software. The means were compared between treatments using the Duncan multiple range test. A P-value < 0.05 as considered significantly different.

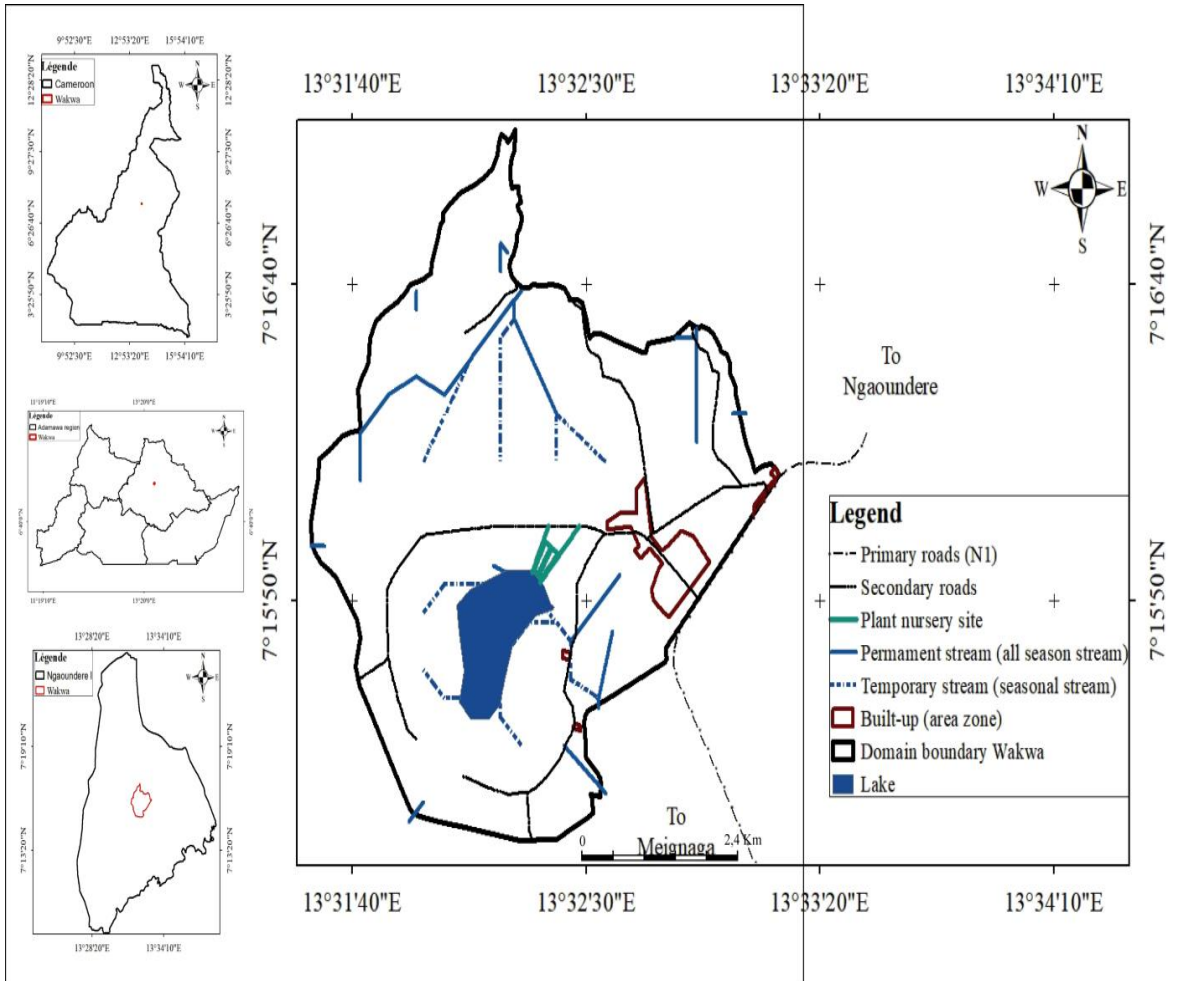
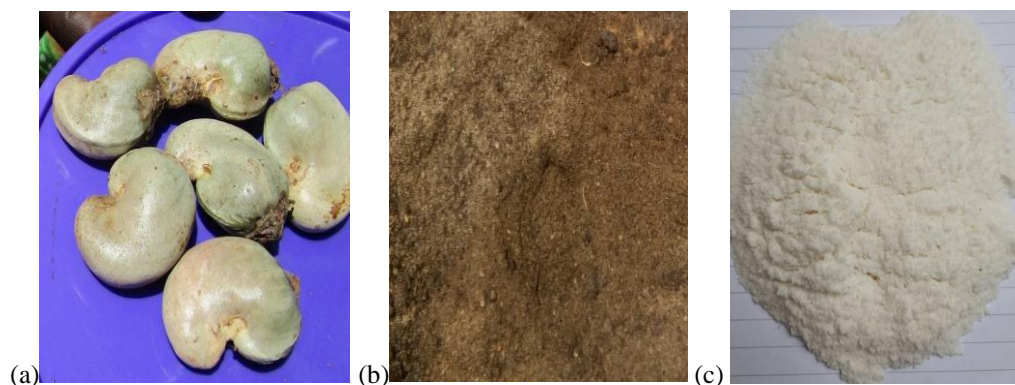


Figure 1: Map localization of the studied area.



**Figure 2:** (a): seed of cashew; (b): substrate and (c): salt.

**Table 1:** Chemical composition of the substrate.

PhWater	PhKCL	Ca(méq%)	K(méq%)	Mg(méq%)	Na(méq%)	CEC(méq%)	P(mg/kg)	CO(%)	N(g/kg)	C/N
7,3	6,5	23,2	0,25	14,48	0,46	50,08	178,2	6,10	3,40	17,9

## RESULTS

### Influence of salt concentration on the germination

Figure 3 shows the evolution of the survey rate from 14DAS (DAS= Day After Sowing) to 28DAS. The control rate (28.88%; 84.44%) was significantly higher than that of the 15% salt treatment (4.44%; 75.55%) at 14DAS and 28DAS respectively. Similarly, 14DAS the survey rate recorded for the salt treatments at 5% (6.44%) and 10% (4.44%) were lower than that of the control (28.88%), on the other hand at 28DAS these values were all equal for the three treatments (control, 5% and 10%). This means that the application of salt at the 5% and 10% concentration improved the survey rate compared to the 15% concentration.

### Inhibition effect of salt on germination

The values of the inhibition of germination of the different salt concentrations are shown in Table 2. It appears from this table that 14 DAS, the 5% salt concentration inhibited the germination of cashew at 3.33%, while application of the 10% and 15% concentrations inhibited germination at 5.55%. It is noted that for all the concentrations,

percentage inhibition decreases as a function of time from 14DAS until 18 DAS, then increases at 20DAS to decrease from 22DAS until canceling at 28DAS for the 5% and 10% doses. Whereas for the 15% dose, the inhibition of germination stabilizes from 24DAS. 28DAS the 5% and 10% concentration did not show an inhibitory effect, on the other hand the 15% concentration had an inhibitory effect of 0.12%.

### Effect of salt on plants growth

Table 3 shows the values of the growth parameters of cashew seedlings under the influence of the different treatments. The values of each parameter do not differ significantly between treatments; this means that the use of salt has no effect on improving the growth parameters measured.

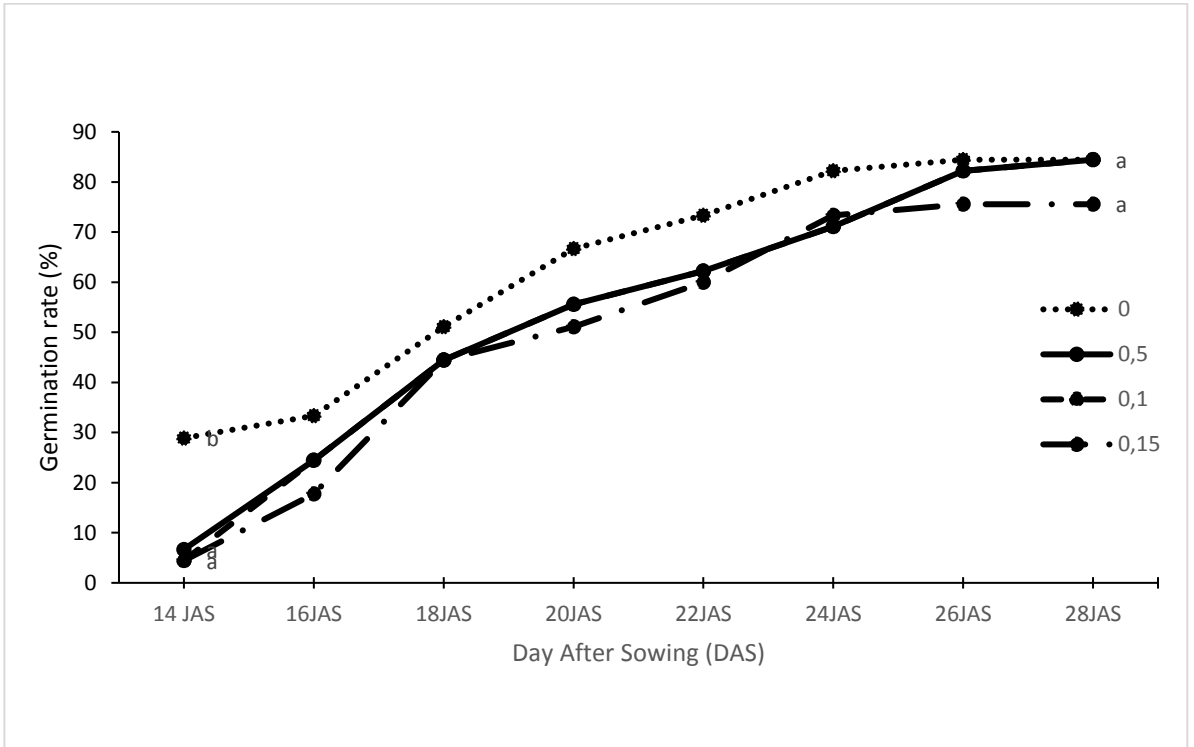
### Vigor Index

The plant vigor was greater with the salt concentration of 15% followed by 10%. The vigor index of the 5% concentration was lower than that of the control (Figure 4). Depending on the index values, the vigor index of concentrations can be classified as follows: 15% > 10% > 0% > 5%.

**Inhibition effect of salt on plant growth parameters**

The number of leaves and the diameter at the neck obtained for the 5% and 10% treatments showed an inhibitory effect of 0.12% and 0.24% respectively for the number of leaves parameter and of 0.03 and 0.02 for the diameter at the neck (Table 4). On the other hand, the 15% treatment rather had a stimulating effect on the number of leaves and

the diameter at the neck. In contrary, concerning plant height, all three salt treatments did not inhibit the height of the cashew plants, as their percent inhibition was all negative, which means that the use of all three salt concentrations helped stimulate the growth of the plants. The leaf surface was inhibited by the 5% salt treatment, while the 10% and 15% salt treatments rather had a stimulatory effect for this parameter



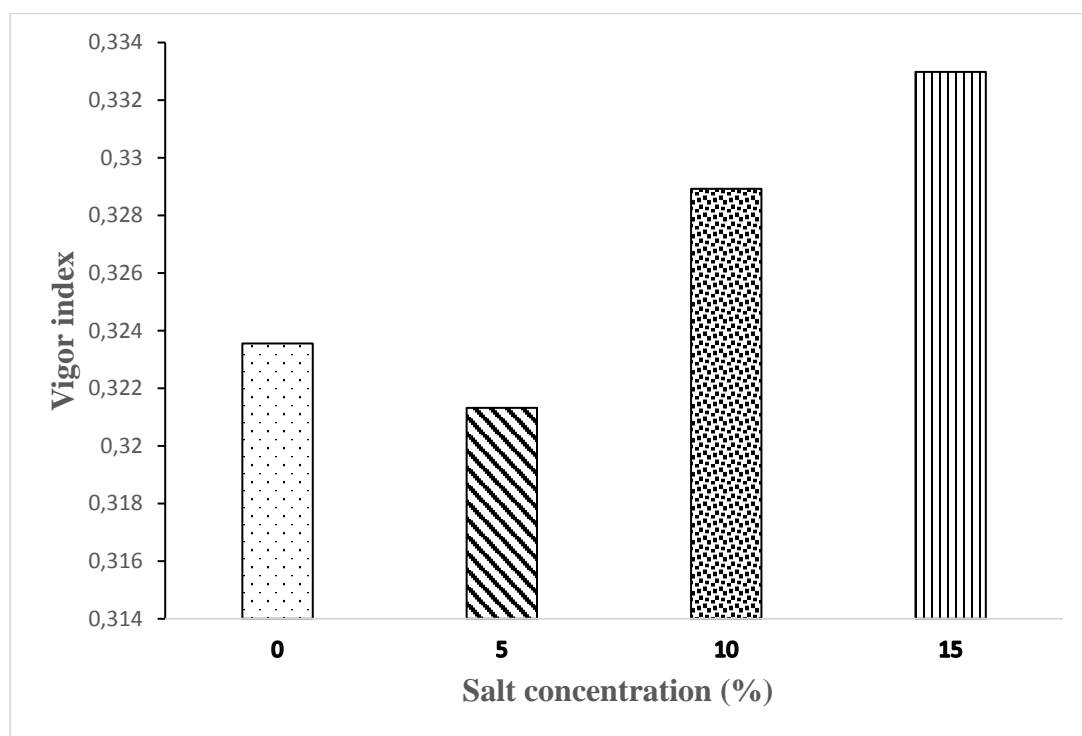
**Figure 3:** Evolution of the survey rate.

**Table 2:** Inhibition effect of salt on germination.

Concentration(%)	14 DAS	16DAS	18DAS	20DAS	22DAS	24DAS	26DAS	28DAS
5%	3.33	0.36	0.15	0.20	0.18	0.16	0.03	0
10%	5.50	0.36	0.15	0.20	0.18	0.16	0.03	0
15%	5.50	0.88	0.15	0.30	0.22	0.12	0.12	0.12

**Table 3:** Plant growth parameter of cashew.

Concentration(%)	Number of leaves	Height(cm)	Diameter (mm)	Area (cm <sup>2</sup> )
<b>0%</b>	9.11 ± 1.89a	19.26 ± 1.63a	7.81 ± 1.02a	29.94 ± 13.51a
<b>5%</b>	8.11 ± 0.19a	19.27 ± 3.51a	7.56 ± 1.18a	25.58 ± 4.40a
<b>10%</b>	7.33 ± 0.88a	23.57 ± 0,70 a	7.63 ± 0.83a	31.88 ± 1.93a
<b>15%</b>	9.33 ± 0.33a	23.93 ± 3.25a	8.03 ± 0.77a	34.69 ± 10.78a
<b>F-Ratio</b>	2.28	3.09	0.14	0.54
<b>P-value</b>	<b>0.1561</b>	<b>0.0897</b>	<b>0.9301</b>	<b>0.6658</b>



**Figure 4:** Vigor index of plant.

**Table 4:** Inhibition percentage of salt.

Concentration (%)	Number of leaf	Height	Diameter	Area
<b>5%</b>	0.12	-0.0005	0.03	0.17
<b>10%</b>	0.24	-0.18	0.02	-0.06
<b>15%</b>	-0.02	-0.19	-0.03	-0.14

## DISCUSSION

For all the doses of salt studied, the emergence of cashew plants begins fourteen days after sowing. This means that the salt does not delay the sprouting of cashew nuts. Ndiaye et al. (2014) also demonstrated that salt does not delay the germination of cotton seeds. However, 14JAS the seed survey rate obtained with the salt pretreatments are all lower than that of the control with the lowest value for the 15% pretreatment. Similarly, 28DAS the seed survey rate of the 15% salt pretreatments is lower than that of the control. On the other hand, the value of the survey rate of the 5% and 10% pretreatments does not differ from the control. This result means that a high salt concentration slows down the rate of germination of cashew seeds and thus inhibits the emergence of plants. This could be explained by a decrease in the osmotic potential due to a high concentration of salt as demonstrated by Mauromicale & Licandro (2002). Jaouadi et al. (2009) reported that the germination of *Acacia tortilis* seeds is inhibited as soon as the NaCl concentration reaches 9 g.l. Salt tolerant species are reported to have high osmotic potentials (Ndiaye et al., 2014). The reduction in germination rate would also be due to an osmotic dormancy process developed under these stressful conditions, thus representing an adaptation strategy with regard to environmental constraints (Prado et al., 2000)

The salt concentrations (5%, 10% and 15%) inhibited cashew germination throughout the study period except at 28DAS where there was an absence of inhibitory effect at the 5% and 10% concentration. However, the percentage inhibition decreases with time. The salt concentrations tested therefore make it possible to reduce the germination capacity of cashew nuts, but this reducing effect decreases over time. These results could be explained by the fact that salt can allow the alteration of enzymes and hormones found in the seed (Prado et al., 2000). The full understanding of this phenomenon requires additional studies to

follow the traceability of salt and locate its different target enzymes and hormones.

The results of this study also showed that the pre-treatment of cashew seeds with salt does not allow a significant improvement in the growth parameters studied (number of leaves, height and diameter at the neck, and leaf area). However, the results show a stimulating effect on the number of leaves and the diameter at the neck of cashew plants with the 15% concentration and an inhibiting effect on the number of leaves and the diameter with the 5% and 10% concentrations. The height of the plants on the other hand was stimulated by all the concentrations despite the absence of significant difference. For the leaf surface, an improving effect was observed with the 10% and 15% pretreatment, and an inhibitory effect with the 5% pretreatment. These results generally indicate that the pretreatment of cashew seeds at 15% salt is the pretreatment which stimulates the growth of the plants, whereas those at 5% and 10% lead to inhibition. This indicates that the saline soaking at low concentration negatively affected the growth (diameter, number of leaves and surface area) of cashew plants while the soaking at a high concentration (15%) rather improves growth. This improvement in growth with the 15% pretreatments may be due to the resistance of cashew seeds to the high concentration of salt. This means that there is a relationship between the high salt concentration and the tolerance of cashew nut, and this relationship needs further study to be understood. Cheikh et al. (2020) also showed that there is a relationship between high salt concentration and *Anacardium occidentale* plant tolerance. Some work on *Washingtonia filifera* L., date palm and citrus fruits has shown that salinity negatively affects plant growth (Rochdi et al., 2005; Sane et al., 2005; Daroui et al., 2012). On the other hand, some studies prove that the reaction of plants to salinity is very different depending on whether we are interested in the germination phase or

that of development (Ly et al., 2014; Labo et al., 2016; Ahamad et al., 2020).

The vigor of the plants was greater with the salt concentration of 15% and 10%, while the vigor of the cashew plants obtained with the 5% concentration was lower than the control. This result demonstrates that pretreatment at the 10% and 15% concentration results in more vigorous plants. This could be explained by the relationship between the high salt concentration and the tolerance of cashew nut.

### Conclusion

The goal of this work was to evaluate the effect of salt on seed germination and plant growth of Cashew. The study showed that all the salt concentration had an inhibitor effect during all the study period except at 28 DAS where we noted an absence of inhibitory effect for the concentration 5% and 10%. However, this absence of inhibition allowed an improvement of survey rate compared to the concentration 15%. These results show also that the use of salt as pretreatment does not allow a significant improvement of plant growth of cashew but concentration 15% is the best concentration that has shown a stimulatory effect on plant growth.

### COMPETING INTERESTS

The authors declare that they have no competing interests.

### AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration among all authors. Author MTJ and AH designed the study, wrote the protocol and the first draft of the manuscript. Author MTJ performed the statistical analysis. Authors SB designed the map and realized the chemical analysis. Authors AO, RD and VS managed data collection in the field. Author OPM managed the literature searches and supervised all the study.

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