EFFECTS OF SALT STRESS ON VEGETATIVE PROPAGATION OF *Pterocarpus santalinoides* L'Hérit. ex DC.

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ABSTRACT

The influence of salt stress on sprout length, collar diameter, leaf and branch production, and survival rate of *Pterocarpus santalinoides* stem cuttings was assessed. In a completely randomized design with five treatments: (0, 5, 10, 15 and 20 grams of salt), 20 cuttings were exposed to each of the five salt solutions. Data were analyzed using descriptive and inferential statistics. There were significant differences in the growth variables across treatments. However, sprout length at six weeks, did not significantly differ. Growth variables decreased with increase in salt stress, with control and 20 g displaying the highest and lowest growth attributes, respectively. Seedlings in control treatments had the highest sprout length (20.65 mm, 28.30 mm, 32.15 mm and 40.35 mm) at 6, 8, 10 and 12 weeks, respectively, while 20 g treatment had the least (15.95 mm, 17.78 mm, 19.80 mm and 25.80 mm). Number of leaves (13.25, 18.75, 22.13 and 36.13), branches (3.50, 4.88, 7.50 and 9.25) and collar diameter (3.50 mm, 4.88 mm, 7.50 mm and 9.25 mm) were highest for control over the 6, 8, 10 and 12 weeks. Stem cuttings of *Pterocarpus santalinoides* may not thrive well in saline soils, because of the negative effects of salt on seedlings.

Keywords: *Pterocarpus santalinoides,* Salt stress, Macro propagation, Cuttings

INTRODUCTION

Pterocarpus santalinoides commonly known as "Red sandal wood" is a multipurpose leguminous species from the family Fabaceae (Anowi *et al*., 2012). It is locally known as gaydar kurmi or gunduru in Hausa, Nturukpa in Igbo and gbengbe in Yoruba (Orwa *et al.*, 2009). This shade tree is frequently found along riverine forests in the tropics (Osuagwu, 2008). The tree can reach a height of 9–12 m and 1 m in diameter at breast height. It grows at altitude 200–500 m, with an annual mean temperature of 26°C and 1600 mm of rainfall (Orwa *et al.*, 2009). The species has great potential in plantation and agroforestry systems, because of its inherent ability to fix nitrogen and improve soil fertility (Eze *et al.*, 2012).

The bark is used for making pepper soup, and the tender leaves are used as vegetables (Eze *et al.*, 2012). The herbs are useful in the treatment of rheumatism, dysentery, diarrhoea, cough, asthma, diabetes, malaria, elephantiasis, colds, and other ailments (Okwu and Ekeke, 2003). The leaves or bark of the stem are used to cure gastroenteritis in traditional medicine (Ayéna, 2021). The leaves of *Pterocarpus santalinoides* is also used for treating skin diseases and infections like candidiasis (Igoli *et al*., 2005). Ngwuli, *et al*. (2019) noted that the species can be multiplied through vegetative propagation techniques such as stem cuttings, which is a useful strategy for maintaining a distinctive feature of plants (Hartman *et al*., 2002; Okunlola, 2013). However, the ability of a stem cutting to take root is dependent on factors such as the cuttings' placement on the shoots, type of rooting medium, the time of year the cuttings were made, and the physical

and environmental circumstances (Ali and El-Tigani, 2003).

Environmental stress such as soil salinity affect plant productivity. The buildup of salt in soil and water threatens the survival and growth of tree species (Qureshi *et al*., 2005; El Naim *et al*., 2012; Shahriari, 2012). Elevated salinity levels can be detrimental to soil structure, plant development and water quality (Berrichi *et al*., 2010; El Naim *et al*., 2012).

Excess salt in the soil creates osmotic stress and an ionic imbalance in plants. These have negative impacts on the biomass, morphology and biochemical activities of the plants (Gharsallah *et al*., 2016; Kumar *et al*., 2021). Unfortunately, it is predicted that by the middle of the twenty-first century, 50% of arable land would disappear due to increase in salinity, unsatisfactory farming methods and climate change (Islam *et al*., 2019).

Pterocarpus santalinoides is a tree species, of interest with limited information on the response of its stem cuttings to soil salinity in Nigeria. Hence, this study assessed the growth performance of stem cuttings of *Pterocarpus santalinoides* under varying salt concentrations.

MATERIALS AND METHODS

Experimental Site

The study was conducted at the arboretum of the Forestry and Wildlife Management division, Faculty of Agriculture, University of Port Harcourt, Rivers State. The arboretum is situated along latitude of 04º52´30´´N and 04°55´0´´N and longitude 6°54´0´´E and 6°55´30´´E.

Collection and Preparation of Cuttings

Leafy stem cuttings (10 cm) were randomly obtained from healthy trees of *Pterocarpus santalinoides*. The collection of cuttings was done in the morning, utilizing secateurs and a cutlass. Subsequently, they were placed in plastic bags, in order to minimize heat stress on the cuttings, until the time of planting. The base of each cutting was shaped into a circular form to facilitate a uniform distribution of roots, while the upper portion was slanted to improve water runoff during watering.

Experimental Design

The experiment was conducted using a completely randomized design, incorporating five distinct treatments (0 (control), 5, 10, 15, and 20 g of NaCl. One hundred (100) cuttings were used as the experimental units (i.e. 20 cuttings exposed to each of the five salt solutions). These cuttings were subsequently placed in polybags filled with topsoil and allowed to grow, undisturbed for 2 weeks prior to the application of the designated salt treatments. Each seedling received a daily dose of 50 ml of the salt solution for 3 months. Regular weeding was done during the study.

Data Collection and Analysis

Data collection commenced one month after the application of treatments (i.e. 6 weeks after planting) and was done bi-weekly for 3 months. The number of leaves and branches, collar diameter, length of sprouts, and survival rate were assessed. The number of leaves and branches were ascertained by counting, length of the sprouts was determined using a meter rule, and collar diameter was measured with a veneer

calliper. Survival rate was calculated using the equation below.

$$Survival\ Rate\ (SR) = \frac{Number\ of\ cuttings\ that\ survived}{Number\ of\ cuttings\ planted}\ x\ 100$$

Data were subjected to one-way analysis of variance, at $p<0.05$ level of significance. The Duncan multiple range test was used to separate significantly different means.

RESULTS

There were significant variations in length of sprouts, which decreased with increase in salt stress, across treatments (Table 1). The control treatment had the highest sprout length, while 20 g salt treatment had the least. The number of leaves varied significantly across treatments, with the mean varying from 5.75 (6 weeks) to 36.13 (12 weeks). The control treatment had the highest number of leaves, while 20 g salt treatment had the least (Table 1).

The number of branches significantly differed across treatments, ranging from 1.25 (6 weeks) to 9.25 (12 weeks). Number of branches was highest in control and lowest in the 20 g salt treatment (Table 1).

Similarly, collar diameter significantly varied at all stages, across treatments (Table 1). The mean collar diameter ranged from 2.51 mm (6 weeks) to 6.20 mm (12 weeks).

The number of sprouts of *P. santalinoides* indicated that control treatment had the highest, while 20 g salt treatment had the least (Figure 1). In addition, the survival rate varied from 20% in 20 g salt treatment to 80% in control treatment (Figure 2).

DISCUSSION

Pterocarpus santalinoides stem cuttings exhibited a decrease in the length of sprouts due to an increase in salinity. A similar pattern was observed for collar diameter, survival rate, number of leaves, and number of branches, with the control treatment displaying the most favourable growth variables. These findings aligned with those of Dantus *et al*. (2005), who noted that a salinity level of zero (control) led to an increase in plant height, while higher concentrations of salt caused reductions in the growth of *Vigna unguiculata* and *Brassica campestris*. Carpici *et al*. (2009) documented a negative correlation between vegetative growth indices and increasing salinity. Similarly, Ali *et al*. (2014) and Chima *et al.* (2019) reported that higher levels of salinity affected seed germination and growth of pearl millet and *Annona muricata* seedlings, respectively. Plant growth and yield are adversely affected by salinity in the root zone, with reductions in water and nutrients' absorption, resulting in ionic or osmotic stress (Hannin *et al.*, 2016; Zhao *et al.*, 2017; Minhas *et al.*, 2020).

The negative effect of salinity was more pronounced in 20 g salt treatment, with yellowing of leaves, withering and eventual death of the cuttings as observed by Karimi and Nasrotahpour-Moghadam (2016). The excessive absorption of salt by plants can lead to an accumulation of ions at toxic levels through transpiration. This not only inhibits growth but also causes premature senescence and abscission (Parida and Das 2005; Munns 2011; Shrivasta and Kumar 2015; Sandhu *et al*., 2017; Negrao *et al*., 2017; Li *et al*., 2017).

Table 1. Effects of different salt levels on growth variables of stem cuttings of *Pterocarpus santalinoides* (μ±SE).

	Sprout Length (Weeks)			
Salt levels	**6**	**8**	**10**	**12**
0 g	20.65±1.28a	28.30±2.88a	32.15±2.31a	40.35±2.88a
5 g	19.59±2.25a	27.11±2.28a	29.51±2.58a	35.70±1.64ab
10 g	18.33±0.94a	25.84±2.03a	28.01±2.24a	32.30±3.06bc
15 g	17.35±2.04a	22.46±1.12ab	27.94±1.80a	31.81±2.59bc
20 g	15.95±0.25a	17.78±0.54b	19.80±1.03b	25.80±1.08c
Mean	18.37±0.70	24.30±1.03	27.48±1.10	33.19±1.27
P	0.024	0.004	0.003	0.002
	Number of leaves (Weeks)			
Salt levels	**6**	**8**	**10**	**12**
0 g	13.25±0.70a	18.75±1.69a	22.13±2.60a	36.13±2.83a
5 g	12.38±0.80a	15.38±1.57ab	21.25±2.23a	29.38±1.72b
10 g	9.25±1.31b	13.63±1.67abc	16.75±1.21a	22.13±2.41c
15 g	7.13±0.99bc	12.88±2.59bc	16.13±2.43a	21.63±2.19c
20 g	5.75±1.00c	8.75±0.62c	10.00±0.93b	12.75±0.31d
Mean	9.55±0.62	13.88±0.91	17.25±1.09	24.40±1.54
P	0.000	0.006	0.001	0.000
	Number of branches (Weeks)			
Salt levels	**6**	**8**	**10**	**12**
0 g	3.50±0.27a	4.88±0.52a	7.50±0.71a	9.25±1.03a
5 g	2.38±.26b	4.63±0.60a	6.00±0.57ab	8.50±0.96a
10 g	2.13±.30b	3.38±0.18b	5.25±0.53bc	7.50±0.66ab
15 g	2.00±.00b	2.88±0.13bc	4.25±0.49cd	6.00±0.63bc
20 g	1.25±0.16c	2.00±0.27c	3.50±0.19d	4.00±0.00c
Mean	2.25±0.15	3.55±0.24	5.30±0.32	7.05±0.44
P	0.000	0.000	0.000	0.000
	Collar Diameter (Weeks)			
Salt levels	**6**	**8**	**10**	**12**
0 g	4.20±0.26a	5.06±0.22a	5.73±0.36a	6.20±0.35a
5 g	3.89±0.16a	4.70±0.24a	4.96±0.32ab	6.04±0.33a
10 g	3.14±0.24b	3.73±0.21b	4.70±0.21bc	5.73±0.33ab
15 g	3.10±0.22b	3.59±0.23b	4.35±0.24bc	5.15±0.12bc
20 g	2.51±0.23b	3.10±0.22b	3.94±0.27c	4.64±0.19c
Mean	2.25±0.14	4.04±0.15	4.74±0.15	5.55±0.15
P	0.000	0.000	0.001	0.002

Values in the same column with the same letters were not significantly different at $p<0.05$.

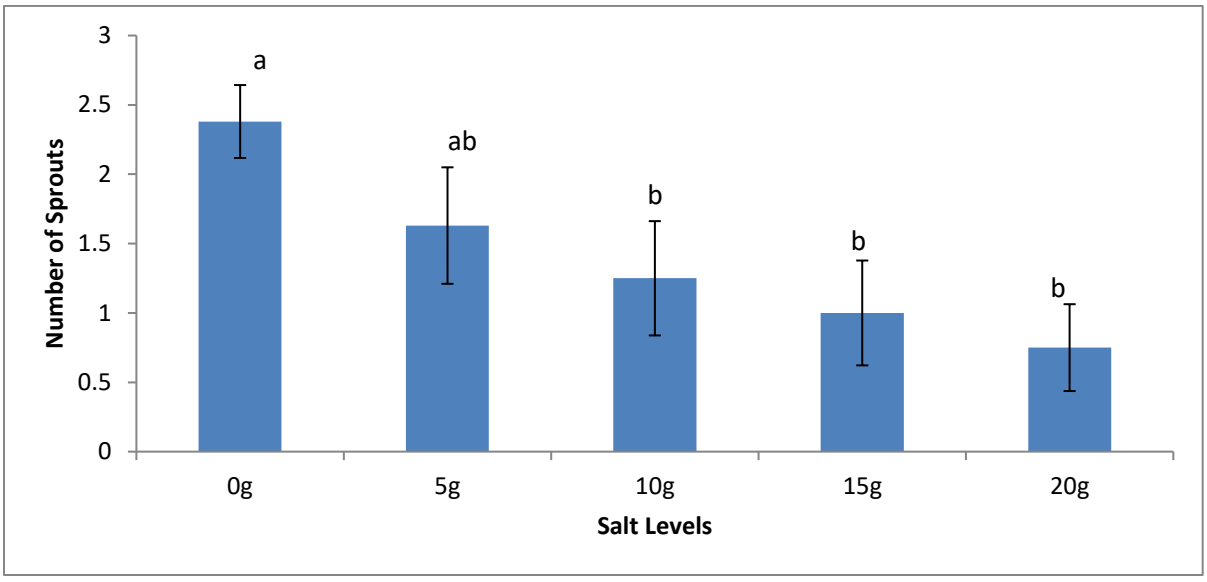

Figure 1. Effects of salt stress on number of sprouts from stem cuttings of *Pterocarpus santalinoides.* Bars with the same letter (s) do not significantly differ at $p<0.05$.

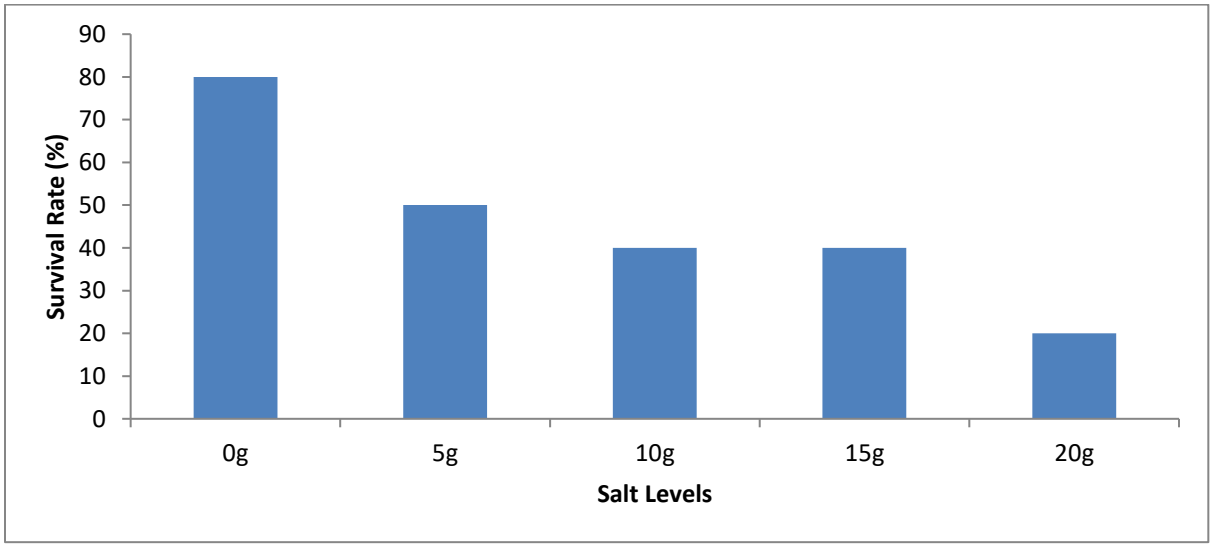

Figure 2. Effects of salt stress on survival rate of stem cuttings of *Pterocarpus santalinoides*

CONCLUSION

The study revealed that increasing salt levels resulted in growth inhibition and mortality of *P. santalinoides* cuttings. Hence, stem cuttings of *Pterocarpous santalinoides* may not thrive well in saline soils. The species may not be able to withstand high levels of salt stress.

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