Original Research Article

Assessment of The Effect of Cutting Length on Sprout and Growth of *Pterocarpus Santalinoides* L'hérit. Ex Dc

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ABSTRACT

Aims: This study evaluated the effect of cutting lengths on sprouts and seedling growth of *P. santalinoides.*

Study design: The experiments were laid out in a Completely Randomised Design (CRD).

Place and Duration of Study: The study was carried out at the Department of Forestry and Wildlife Management Nursery, University of Port Harcourt, Rivers State, Nigeria, between April 2019 and March 2020.

Methodology: Ten (10) cuttings per cutting length were planted in a polybag filled with forest topsoil. The treatments are; 13, 20, 25 and 33 cm cutting lengths. Five seedlings per treatment were randomly selected and dried for biomass. Emergence of sprouts, number of leaves and branches, survival rate, number of cuttings that sprouted, sprout length, root length and biomass were determined and subjected to analysis of variance.

Results: Sprouts emergence occurred earliest in 25 cm cuttings (7 days) and latest in 5 and 8cm cuttings (12 days). There were significant differences ($P \leq 0.05$) in leaf number at month 1, number of branches at months 1, 3, 5 and 9, cutting length at month 2 and root to shoot ratio and non-significant differences ($P > 0.05$) in leaf number at months 3,5,7,9 and 11, number of branches at months 7 and 11, number of sprouts, cutting length at month 12, root length, shoot biomass, root biomass, total fresh and dry weight. 10cm long cutting enhanced sprout parameters while 33 cm long cutting enhanced root parameters.

Conclusion: The result showed that 25 and 33 cm long cuttings are most suitable cutting lengths and are therefore recommended for growth of the species.

Keywords: Pterocarpus santalinoides, cutting length, sprout emergence, growth, biomass, survival rate

1. INTRODUCTION

Pterocarpus santalinoides DC. also known as Red Sandal Wood in English [1] is a significant leguminous species that belongs to the Fabaceae family [2]. According to Eze et al. [3], it is a shade tolerant tree usually seen in Africa along the riverine forest. Most indigenous plants in Nigeria including *Pterocarpus santalinoides* are medicinal and are used as food [4]. The bark of the stem is used for the preparation of pepper soup and the leaves are used for soup making [3]. Various components of plants are included to treat various disorders, including asthma, rheumatism, dysentery, elephantiasis, cough, diabetes, cold, diarrhea and malaria [5; 6]. The leaves can be used as folder, the wood which is termite-resistant is a good source of timber, the stem exudes a gum red in colour while the bark has tannins and dyes used for dyeing [2].

The ability of seeds to be viable depends on environmental conditions [7]. Seeds can lose their viability after 15 months of storage or after five months if stored in an ambient room condition (Bambang, 2014). According to Ngwuli et al. [8], Pterocarpus species can be propagated by seeds or vegetative means. However, the seeds are scarce due to some factors ranging from seasonality of fruiting to reduction in the population of mature fruit bearing trees. Vegetative propagation techniques play important role in tree improvement and are extensively used for the propagation of many species of economic importance [8]. Okunlola [9] stated that "propagation by stem cuttings is the most popular and extensively used method of vegetative propagation". According to Hartmann et al. [10], it is a practical means of preserving a unique trait of plants. Cuttings are relevant because plants grow from them easily [9]. One major problem with cuttings is its inability to produce good roots.

Length of cutting is also a crucial factor that can cause variations in shoot and root growth [12]. Length of cuttings may significantly affect adventitious root and shoot formation and plant establishment; and can influence sprouting, callus formation and rooting [13]. Cutting length used may have an effect on percentage of rooting [11]. Determination of appropriate cutting length for a species becomes important since using very long cutting is wastage of valuable material with reduced benefit in growth; and short cutting may result in improper growth and development of the species which may be due to insufficient reserves for storage [11]. Studies on the effect of cutting length have been reported by several researchers including [9; 11; 14; 15; 16; 17 and 18]. Identifying the appropriate cutting length for the propagation of *P. santalinoides* cuttings will aid in obtaining optimum yield of the species. The objective of this study was to assess the effect of stem cutting length on sprouting and growth of *P. santalinoides* sprouts.

2. MATERIAL AND METHODS

2.1 Study location

The study was carried out at the Department of Forestry and Wildlife Management Nursery, University of Port Harcourt, Rivers State, Nigeria. The University of Port Harcourt is located within Latitude 04°52´30´´N and 04°55´0´´N and longitude 6°54´0´´E and 6°55´30´´. The nursery is located at the Choba Campus of the University. The total annual rainfall is about 2400 mm and temperature ranges from 25^{o}C to 38^{o}C in the dry season [19].

2.2 Collection and Preparation of Cuttings

Mature cuttings of *P. santalinoides* for this study were collected from healthy mother trees in Eziama Ntigha Autonomous Community in Isiala Ngwa North Local Government Area, Abia State. The top of each cutting was cut just above a leaf bud and the bottom cut just below another one with the top cut slanted and the bottom cut square. Cuttings were leafless. Measurements of cutting lengths were done using meter rule.

2.3 Experimental design

The experiment was laid out in a complete randomized design (CRD) consisting of 40 selected cuttings (i.e. 10 cuttings * 4 cutting lengths = 40 experimental units), each cuttings was sown in a polybag filled with forest topsoil. The treatments are; 13, 20, 25 and 33 cm cutting lengths. A polybag was taken as a replicate of its own.

2.4 Biomass determination

At the end of the experiment, five seedlings per treatment were randomly selected and carefully removed from the pots and the root system exposed by carefully washing off the growth media from the roots, absorbent paper was used for blotting excess moisture from the plants. Seedlings were then separated into shoot and root components by cutting at the collar. The root length, fresh weight of shoot (including the leaves) and root were taken and then placed in a paper bag for drying. The shoot and the root samples were oven dried at 70°C for three days (72 hours).

2.5 Data collection

The following parameters were measured: emergence of sprouts, number of leaves and branches, survival rate, number of cuttings that sprouted, sprout length, root length and biomass. Data collection for growth was done one month after planting (MAP) and bi-monthly thereafter for 11 months (Plate 11). Number of sprouts, leaves and branches were obtained by counting while length of sprouts and roots were measured using meter rule. At the end of the experiment, the cuttings were uprooted and washed to remove growth media from the roots, absorbent paper was used for blotting excess moisture.

The length of the roots were determined using meter rule after which it was separated from the cuttings oven dried to determine the root dry weight. Five sprouts of uniform heart for each treatment were also dried to determine sprout weight. The cuttings were said to have sprouted when the bud exceeds 0.5 cm in length. Emergence of sprouts and survival rate were determined as follow;

Sprout emergence (SE) =Time to sprout after planting.

Survival Rate (SR) = (Number of cuttings that survived)/(Number of cuttings planted)

The seedlings were weighed using a digital weighing scale calibrated in grams (g) to determine root and sprout fresh and dry weights, while moisture content (MC), total weight (TW) and root to sprout ratio (RSR) were calculated using the following equation;

Moisture Content (MC) = Fresh weight – dry weight

Total Weight (TW) = Shoot weight + root weight

Root to Sprout Ratio (RSR) = Root weight ÷ sprout weight

2.6 Data analysis

Data collected on sprouts and growth were analysed using the Analysis of Variance (ANOVA) in SPSS statistical software (SPSS version 21.0, SPSS Inc.) to determine the variation among treatments and *P* value was significant at $P \leq 0.05$. Mean separation was done using the Duncan Multiple Range Test (DMRT). Microsoft Excel 2010 was used to plot the graphs presented

3. RESULTS

3.1 Effects of Cutting Length on Emergence of Sprouts

The effect of the cutting lengths on the emergence of *P. santalinoides* sprouts is shown in Figure 1. Sprouts emergence occurred earliest in 25 cm cuttings, followed by 33 cm and latest in 13 and 20 cm cuttings.

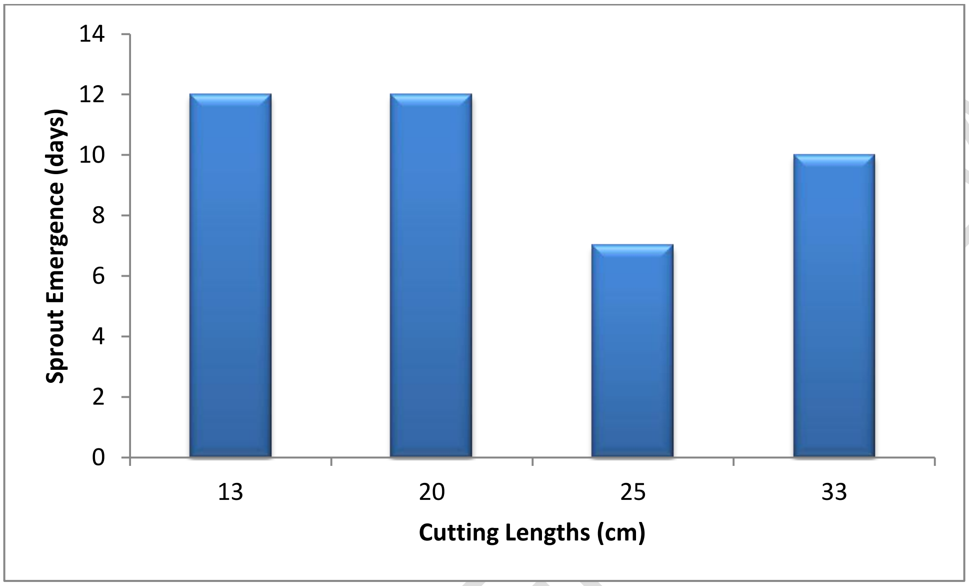

Figure 1. Sprouts emergence of *P. santalinoides* cuttings of different length

3.2 Effects of Cutting Length on leaf number

The result from the study indicated that there were considerable variations ($P \leq 0.05$) in leaf number in month 1 and non-significant differences ($P > 0.05$) at months 3,5,7,9 and 11. Mean seedling leaf number ranged from 7.85 in month 1 to 40.06 at month 11. Mean seedling leaf number was highest in 25 cm cutting length at month 1 to 11 (13.40, 22.80, 32.80, 33.20, 42.25 and 55.80 respectively) and lowest in 20 cm length at month 1 (3.00) and 13 cm at months 3 to 11 (8.25, 18.0, 22.33, 23.67 and 30.67 respectively) (Table 1).

Table 1. Leaf number of *P. santalinoides* sprouts of different cutting length (μ±SE)

Cutting Length (cm)	Sprout Leaf Number (Months)					
	1	3	5	7	9	11
13	4.00±1.00b	8.25±2.06b	18.00±1.53a	22.33±2.91a	23.67±1.86a	30.67±7.06a
20	3.00±0.71b	12.80±2.63ab	20.60±5.63a	24.75±5.11a	32.25±5.63a	34.50±7.03a
25	13.40±2.56a	22.80±1.83a	32.80±1.83a	33.80±2.71a	38.00±6.14a	55.80±11.29a
33	7.50±0.50ab	16.60±5.60ab	26.60±7.30a	29.20±3.58a	33.60±7.47a	38.00±8.24a
Mean	7.85±1.64	15.47±2.03	26.33±2.83	26.53±2.00	35.18±3.23	40.06±5.03
P	.016	.067	.200	.190	.335	.216

Values in the same column with the same subscript letter do not vary significantly ($P > 0.05$).

3.3 Effects of Cutting Length on number of Branches

The result from the study showed that there were significant variations ($P \leq 0.05$) in number of branches at months 1, 3, 5 and 9 and non-significant differences ($P > 0.05$) at months 7 and 11. Overall mean number of branches ranged from 1.75 at month 1 to 14 at month 11. Mean number of branches was highest in 25 cm cutting length at month 1 to 11 (2.40, 7.00, 8.80, 8.80, 12.20 and 20.20 respectively) and lowest in 33 cm length at month 1 (1.00) and 13 cm at months 3 to 11 (2.40, 3.60, 5.00, 7.00 and 9.00 respectively). This information is presented in Table 2.

Table 2. Branch number of *P. santalinoides* sprouts of different cutting length (μ±SE)

Cutting Length (cm)	Sprout Branch Number (Months)					
	1	3	5	7	9	11
13	1.50±0.50ab	2.40±0.25c	3.60±0.40b	5.00±0.58b	7.00±0.58b	9.00±1.16b
20	1.50±0.50ab	4.20±0.37b	6.60±0.51ab	8.25±1.11a	9.25±1.11ab	11.00±1.47ab
25	2.40±0.25a	7.00±0.63a	8.80±1.32a	8.20±0.37a	12.20±1.16a	20.20±3.93a
33	1.00±0.00b	3.60±0.51bc	7.00±1.52a	8.80±1.07a	11.60±1.33a	13.00±1.83ab
Mean	1.75±0.22	4.30±0.44	6.50±0.65	7.82±0.52	10.41±0.72	14.00±1.70
P	.032	<.001	.023	.065	.047	.062

Values in the same column with the same subscript letter do not vary significantly ($P > 0.05$).

3.4 Effects of Cutting Length on number of sprouts

The effect of the various cutting length on number of sprouts of *P. santalinoides* is shown in Figure 2. The result from the research showed that there were no significant variations ($P > 0.05$) in number of sprouts due to cutting length although number of sprout was highest in 33 cm, followed by 25, 20 and 13 cm lengths respectively.

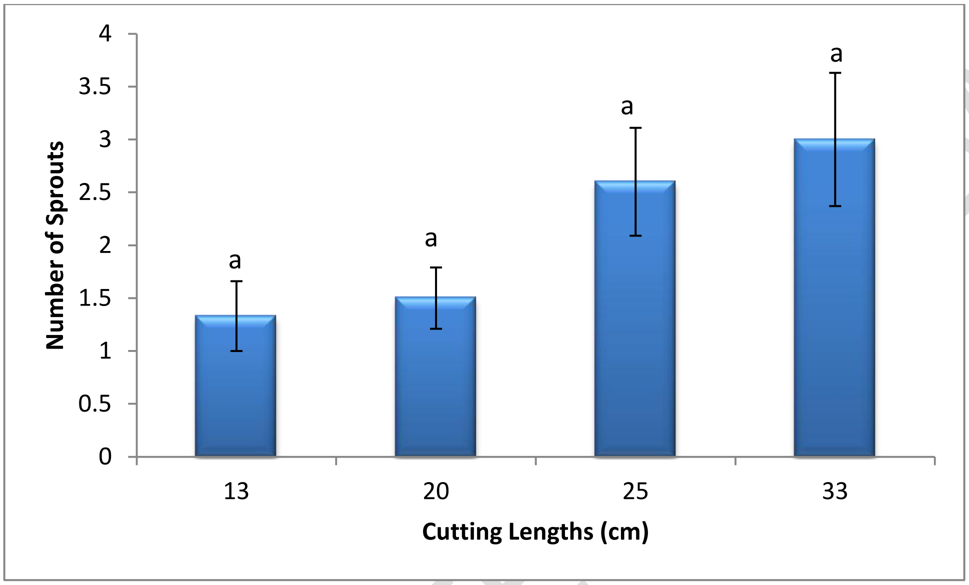

Figure 2. Effects of cutting length on number of sprout of *P. santalinoides* cuttings. Bars with the same letter (s) do not vary significantly ($P > 0.05$).

3.5 Effects of Cutting Length on Sprout Length

The average sprout length of *P. santalinoides* at different cutting lengths, 2 and 11 months after planting, is shown in Figure 3. The result from the research showed that there were significant variations ($P \leq 0.05$) among cutting length at month 2 and non-significant difference at month 12. Sprout length increased with increase in cutting length but decreased at 33 cm at 2 and 11 months after planting although 33 cm cutting length had higher shoot length than 8 and 13 cm at month 2 and 13 cm in month 11.

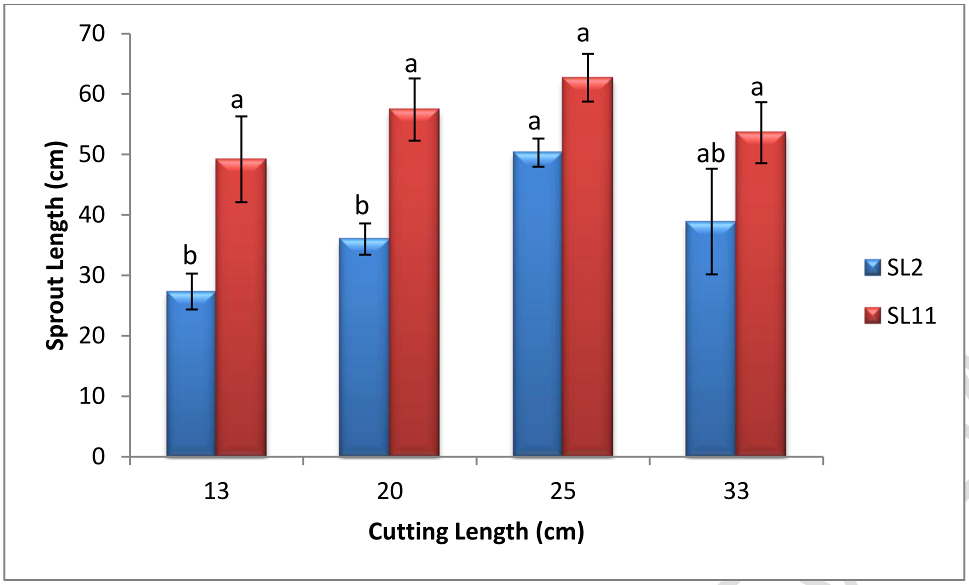

Figure 3. Effects of cutting length on sprout length of *P. santalinoides.* Bars with the same letter (s) do not vary significantly (*P* > 0.05). Where SL 2 and 11 are sprout lengths at months 2 and 11.

3.6 Effects of Cutting Length on Root Length

Results on seedling root length of *P. santalinoides* from various cutting lengths are presented in Figure 4. Root length was not significantly (*P* > 0.05) affected by cutting length. Mean root length varied from 26.83 cm in 13 cm cutting length to 42.05 cm in 33 cm cutting length. Root length was observed to have increased with increase in cutting length.

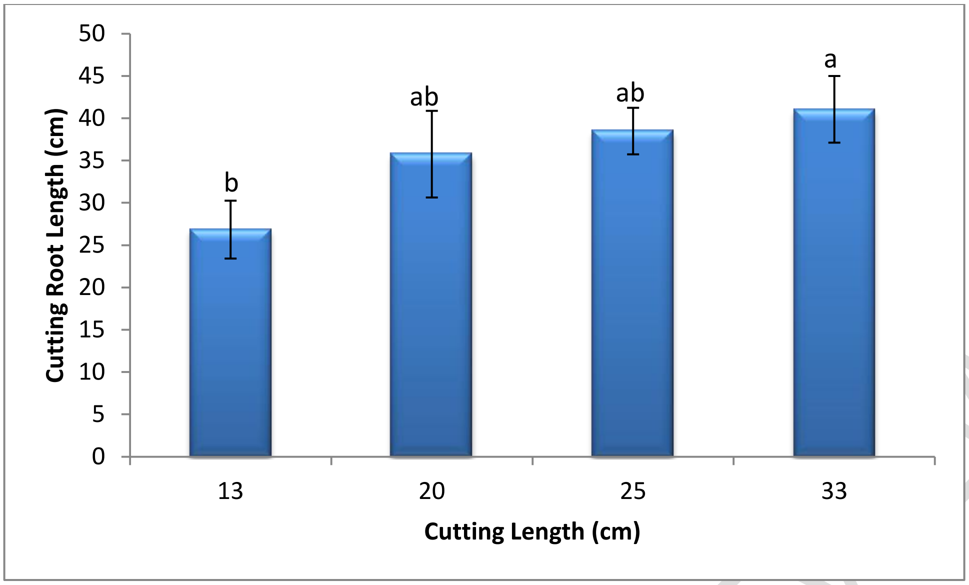

Figure 4. Effects of cutting length on the root length of *P. santalinoides* cuttings. Bars with the same letter (s) do not vary significantly (*P* > 0.05).

3.7 Effects of Cutting Length on Biomass

Seedlings of *P. santalinoides* from various cutting lengths showed non-significant variations ($P \leq 0.05$) in their shoot biomass although highest shoot fresh and dry weight were observed at 10cm cutting length, while lowest shoot fresh and dry weight was observed at 13cm cutting length. Shoot moisture content was highest at 25 cm and lowest at 33 cm cutting length (Table 3).

Seedlings of *P. santalinoides* from various cutting lengths showed non-significant differences ($P \leq 0.05$) in their root biomass. Highest root fresh and dry weight was observed at 33 cm cutting length while the lowest root fresh and dry weight was observed at 13 cm cutting length. Root moisture content was highest at 33 cm cutting length and lowest at 20 cm cutting length as shown in Table 3.

Seedlings of *P. santalinoides* from various cutting lengths showed non-significant differences ($P \leq 0.05$) in total fresh and dry weight although highest total fresh and dry weight was noticed at 25 cm cutting length followed by 20 cm while lowest total fresh and dry weight were found in 13 cm cutting length (Table 3).

Cutting length significantly affected ($P \leq 0.05$) root to shoot ratio. Highest root to shoot ratio for both fresh and dry weight was observed at 33 cm cutting length, while lowest root to shoot ratio for fresh weight was observed at 25 cm cutting length and dry weight at 13 cm cutting length (Table 3).

Table 3. Biomass accumulation of *P. santalinoides* sprouts and roots at different cutting lengths (μ±SE)

	Cutting Length (cm)				
Biomass (g)	13	20	25	33	*P*
Sprout Fresh Weight	8.83±2.89^{a}	11.23±2.71^{a}	13.54±1.49^{a}	8.98±2.32^{a}	.411
Sprout Dry weight	3.73±0.94^{a}	4.40±1.09^{a}	5.42±0.77^{a}	3.90±0.99^{a}	.574
Sprout Moisture Content	5.10±1.97^{a}	6.83±1.82^{a}	8.12±0.76^{a}	5.08±1.64^{a}	.413
Root Fresh Weight	2.57±1.33 ^{a}	3.10±0.99^{a}	3.46±0.77^{a}	4.43±1.39^{a}	.713
Root Dry weight	0.70±0.15^{a}	1.45±0.50^{a}	1.46±0.20^{a}	1.53±0.38^{a}	.407
Root Moisture Content	1.87±1.17^{a}	1.65±0.56^{a}	2.00±0.60^{a}	2.90±1.01^{a}	.719
Total Fresh Weight	11.40±4.21a	14.33±3.67a	17.00±2.16a	13.40±3.61a	.688
Total Dry Weight	4.43±1.09a	5.83±1.57a	6.88±0.91a	5.43±1.31a	.598
Fresh Root to Sprout Ratio	0.26±0.50^{b}	0.27±0.03^{b}	0.25±0.04^{b}	0.47±0.05^{a}	.006
Dry Root to Sprout Ratio	0.19±0.01^{b}	0.31±0.04^{ab}	0.28±0.03^{b}	0.41±0.05^{a}	.020

Values in the same column with the same subscript letter do not vary significantly ($P > 0.05$).

4. DISCUSSION

The earliest sprout emergence observed in cutting length of 25 cm indicated that emergence of sprouts is not dependent on the length of the cutting. While cutting length influenced sprout length, number of leaves and branches at some stages of growth, it did not at others. Non-significant difference observed in number of leaves at month 3 to 11 disagree with the findings of Duut [20] who reported significant influence of cutting length on leaves of *Jatropha curcas* although the difference between cutting length used in their study is greater than that used in this study. Highest sprout length, number of leaves and branches observed in 25 cm cuttings is an indication that growth in sprout length, number of leaves and branches of cutting sprout does not depend on the length of the cutting. According to Hartman et al. [10], "cuttings depend on stored food supplies to nourish their developing shoot and root until the plant becomes self-sustaining". This is buttressed by Antwi-Boasiako and Enninful [21] who opined that excessive growth (number of sprouts) "reduced the food reserves of long cuttings which then reduced the opportunity for further growth of the shoots". This explains why 25 cm cutting displayed better growth of the shoots including shoot biomass (shoot fresh weight, dry weight and moisture content) since highest number of sprout was observed in 33 cm cuttings and decreased with a decrease in cutting lengths although number of sprout was not significantly influenced by cutting length. Highest number of sprouts observed in 33 cm long cuttings could be due to the higher number of nodes compared to other cutting lengths (25, 20 and 13 cm). Highest number of sprouts observed in 33 cm long cuttings confirms the findings of [20] who noted that longer cuttings have more nodes than shorter cuttings, hence will have more sprouts.

Cutting length significantly influenced root length while root biomass (root fresh weight, dry weight and moisture content) was not influenced. The significant difference observed in root length does not agree with the results of [22] and [23] who noticed lack of significant differences in root length of *Micromeria fruticulosa* stem cuttings and Olive cuttings respectively. Cutting length of 33 cm exhibited highest root parameters including root length and biomass. Duut [20] also observed that longer cuttings (40cm) performed better in terms of all rooting parameter and noted that the more vigorous roots by 40cm cuttings could be due to higher amount of accumulated carbohydrate in the 40cm cuttings. This disagrees with the findings of [23] who observed maximum root length in 15 cm cuttings and minimum root length in 25 cm cuttings. Longer cuttings had more sprouts which could have influenced rooting. According to [24], more nodes on the 30 cm cuttings buried at planting led to more root initiation for better establishment. The number of buds grows as the number of nodes increases, providing a source of growth for roots and sprouting [24].This agrees with the observations of [20] that presence of buds influence rooting of cuttings. Reduced growth performance observed in 13 cm long cuttings is an indication that this cutting length is not suitable for the propagation of *P. santalinoides.*

5. CONCLUSION

Propagation through cuttings appears to be the best alternative method of producing more vigorous plants in less period of time. Stem-cutting length significantly affected some growth parameters (sprout length at month 2, leaf number at month 1, root to shoot ratio etc.) and did not affect others (number of sprouts, sprout length at month 12, number of branches, biomass etc.) in the early growth performance of *P. santalinoides*. The result showed that 25 cm long cutting enhanced sprout parameters while 33cm long cutting enhanced root parameters. Longer cuttings probably have higher food reserves and are more successful in vegetative propagation. This implies that for 25 and 33cm long cuttings are more suitable for the growth of this species asexually by stem cutting. These results may be useful as a guide for carrying out some nursery operations and also silvicultural technique of the species to boost afforestation and reforestation programmes.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist.

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