

## **SURVIVAL RATE OF ROOT PRUNED WIDLINGS AND COPPICE SHOOTS GROWTH IN STUMPED *Garcinia kola* (Heckel) SAPLINGS IN RIVERS STATE, NIGERIA**

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### **Abstract**

*Study of survival rate of root pruned wildlings and coppice shoots growth in *Garcinia* (*G.*) *kola* was conducted in FRIN. *G. kola* wildlings were collected under 28-year-old plantation, and classified into six treatments, namely: two leaves ( $T_1$ ), four leaves ( $T_2$ ), six leaves ( $T_3$ ) eight leaves ( $T_4$ ), wildlings with branch ( $T_5$ ) and untreated wildlings (control) ( $T_6$ ). Root pruning was carried out in all treatments except the control, completely randomized design (CRD) was adopted. Growth characteristics: survival rates, height, collar diameter and leaf number were assessed monthly for four months. 120 saplings of *G. kola* aged sixteen months were cut at four different stump heights, growth attributes: inception of coppice, shoot number, shoots height, number of leaves, shoot diameter and stump diameter were monitored for four months and (CRD) was used. Results showed significant differences among the root pruned wildlings treatments in height and collar diameter; no significant differences in survival rates and leaf number among various treatments. Results showed that inception of coppice, shoot number, coppice shoot and stump diameters were significantly different among the stumped *G. kola* saplings; however, no significant difference in shoot height, leaf number and coppice branch among various treatments. Root pruning influenced seedling height and collar diameter growth more than it influenced the survival rates and leaf production in *G. kola* wildling. The study revealed that *G. kola* saplings have capacity to coppice at the stump heights investigated; however, stump height significantly influenced the growth of coppice shoots.*

**Key Words:** *Garcinia kola*, Wildling, Coppice, Sapling, Growth attribute

### **Introduction**

*Garcinia kola* belongs to the family Guttiferaeae/Clusiaceae (Okonkwo *et al.*, 2014). It is a medium-sized tree that grows up to 12 metres in height within 8 years in moist forest through-out West and Central Africa (Isawumi, 1993). At maturity the plant can reach about 20 metres to 30 metres in height under favourable weather and environmental conditions. It is a slow

growing tree found in the rain forest of the humid lowlands of West and Central Africa between Sierra Leone and the Democratic Republic of Congo (Keay *et al.*, 1964 and Adeola, 2015). Though the plant can do well in most African countries, but Nigeria and Cameroon remain the main hotspots of the species. This species occurs mostly in homegardens as an upper storey plant at

the fringes of such homegardens (Okafor and Fernandez, 1987 and Adeola, 2015).

*G. kola* nuts are freely eaten and it generates a seasonal trade for small holder farmers in the Eastern and Western Nigeria. *G. kola* is one of the indigenous fruit trees that have great economic potential for poverty alleviation because of its contribution to food security, medicinal value and its economic multiplier effects (Yakubu *et al.*, 2014). Most tropical forest fruit trees have been known to produce more fruits based on corresponding canopy formation. *G. Kola* has been ranked five and sixth most values species priority in Ghana and Nigeria respectively by the farmers (Adeola, 2015).

The seed has a bitter taste and hence the species is commonly called bitter kola. It is an economically significant and highly valued tree, used extensively in African folk/traditional medicine. Due to enormous potentials accrued from the species, researchers from accredited institutions had find out the possible healing attributes of the *G. kola* popularly known as bitter kola. Here are some of the incredible health benefits of *G. kola*: (a) It improves sexual performance, especially among men. *G. kola* does not only increase sex drive, it also improves and guarantees optimum sexual performance of men who consume it, mostly few minutes before the exercise (CTA, 2007). (b) Remedy for osteoarthritis - researchers at Obafemi Awolowo University in Nigeria tested the effects of bitter kola against arthritis symptoms and the result concluded that bitter kola significantly reduced inflammation and pain (CTA, 2007). It also increased joint movement in patients that had osteoarthritis symptoms. (c) It combats sexually transmitted diseases (STDs). Results have shown that

seed and leaf of bitter kola have antibacterial activity on clinical isolates of *Staphylococcus aureus*, *Escherichia coli*, *Salmonella typhi* and *Streptococcus pyrogens*. (d) It improves the function of the lungs: *G. kola* commonly called bitter kola when consumed regularly aids in strengthening fibres and lung tissues of human and it also stabilizes any other counter effect (CTA, 2007). *G. kola* also helps in the maintenance of good respiratory tract as well as treating chest cold. (e) It improves the immune system: bitter kola has a high amount of antioxidant. This high amount of antioxidants found in bitter kola does not only help fight bacteria and other illnesses, it also helps the body to increase its immunity levels. And when the immunity level of the body is increased, it becomes strong enough to fight against any foreign contaminant. (f) It is anti-malaria agent: research had revealed that *G. kola* has anti-malarial properties; these make herbalists to always prescribed bitter kola for the treatment of malaria infections. The parts often used are: the stem, bark, and seeds which are used to treat acute fever, inflammation of the respiratory tract and throat infections. (g) It fights glaucoma: according to a Lagos University Teaching Hospital journal, when bitter kola is eaten, at least twice a day, it could successfully reduce the eye pressure (CTA, 2007). *G. kola* has been found to be an amazing remedy for eye related issues. Bitter kola is commonly used in Akwa Ibom State of Nigeria as anti-poison, which could be through food or drink poisoning.

Despite economic, medicinal and cultural values of the species, it remains one of the neglected plants in Nigeria and Africa in terms of plantation establishment as a result of seed

dormancy. Most of the fruits are collected from the wild and some from homegarden. Due to population pressure, they are fast disappearance in the natural ecosystem. Nigeria forest and savanna wood lands have been witnessing enormous pressures (Igboanugo, 2008 and Nsien *et al.*, 2017). *G. kola* plays important role in food security and the well-being of rural populations due to its contribution to the income and nutrition of many local populations, as well as herbal medicine. The study was therefore designed to assess the survival rate of root pruned wildlings and coppice shoot growth of *G. kola* saplings in the nursery. This is with a view of understanding the influence of root pruning on the survival of wild collected seedlings and to assess the dynamics of coppice shoot growth in stumped saplings for production of juvenile cuttings for mass propagation and genetic selection in the nursery. This study was equally designed in other to enhance sustainable

development and sustainability of *G. kola* plantations within Nigeria and beyond Africa continent.

## **Materials and Methods**

### ***Study Area***

The study of survival rate of root pruned wildlings and coppices shoot growth of saplings in *G. kola* was conducted in the Nursery unit, Swamp Forest Research Station (SFRS), Onne, Eleme - Rivers State, Nigeria (Figure1). Onne is located on Latitude 4°50'N and Longitude 7°03'E with an elevation of 40 m above the sea level (Anegbeh, 1997). It has annual rainfall of 2500mm with a mean value of 75% relative humidity in February and 80% in July (Okonkwo *et al.*, 2014). The mean minimum temperature is 25°C (ICRAF/IITA, 1994). The general feature of the landform is one of long connecting, slopes with gentle gradient (Koyejo, 2002). The soil is an Ultisols derived from coastal sediments.

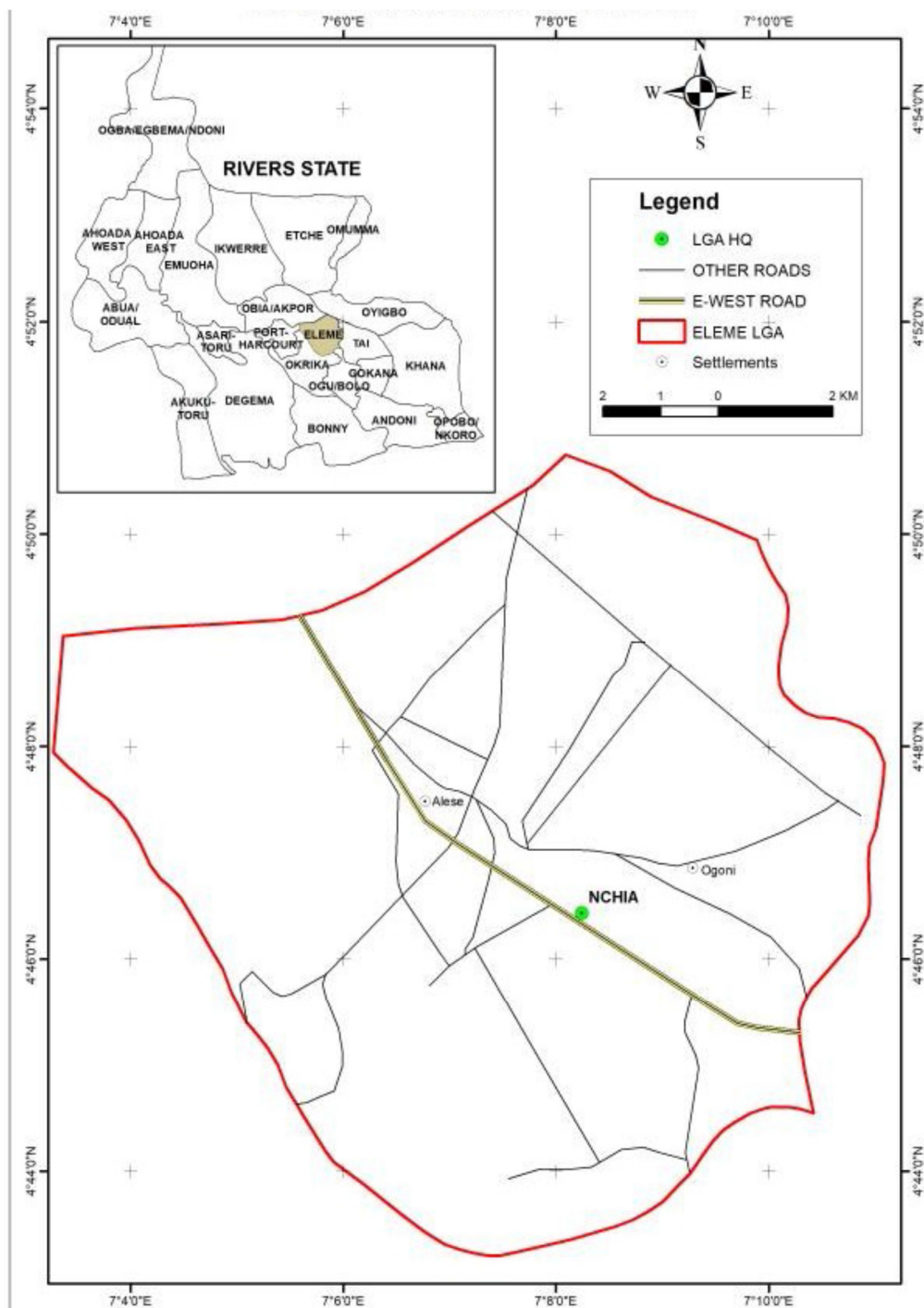


Fig. 1: Map of Rivers State showing the location of Eleme Local Government Area  
Source: Eric *et al.* (2020)

**Wildlings Collection and Root Pruning**

Wildlings of *G. kola* were collected under 28 year old plantation of the species

within SFRS-Onne, Rivers State, Nigeria. They were classified into six categories, namely: two leaves ( $T_1$ ), four leaves ( $T_2$ ),

six leaves (T<sub>3</sub>) eight leaves (T<sub>4</sub>), wildlings with branch (T<sub>5</sub>) and untreated wildlings (control) (T<sub>6</sub>). Root pruning was carried out on all treatments except the control. Polythene bags of size 20 cm x 9 cm were filled with top soil and weighed 2.5kg each. There were twenty wildlings per treatment replicated three times and the lay out was a completely randomized design (CRD) and watering was carried out daily. The following growth characteristics were assessed every four weeks for a period of four months: survival rates of wildling were counted, height (cm) was measured with a ruler, collar diameter (mm) with a vernier calliper, and leaf number were counted.

#### **Coppice Shoot Growth Experiment**

Sixteen (16) months old saplings of *G. Kola* were stumped and monitored for a period of four months at SFRS-Onne, Rivers State, Nigeria. Saplings were cut at four (4) different stump heights and there were ten saplings per treatment. The four (4) sapling stump heights were as follows measured from the collar of the saplings in the polypot: (1) 25cm, (2) 35cm, (3) 45cm and (4) 55cm. Each of the treatment was replicated three times to make a total of 120 plants in a CRD layout.

#### **Data Collection**

The following growth attributes were assessed monthly: (a) Inception of coppice: this was the time of first sight of coppice growth on the stump, (b) shoot number: this was a count of the number of coppice shoots per stump, (c) shoots height: coppice shoot height was measured from the base of the stump with a measuring tape to the highest point on the individual shoot, (d) number of leaf: number of leaf was counted per coppice shoot, (e) shoot diameter: collar diameter of coppice shoot was measured at the basal attachment of the shoot to the stump

with a vernier calliper, (f) stump diameter: stump shoot diameter was measured at the collar of the stumped sapling using a vernier calliper.

#### **Data Analysis**

Data analysis was carried out using analysis of variance (ANOVA), and Fisher's Least Significant Difference (F-LSD) used for mean separation and simple linear regression ( $Y = a + bx$ ) was used to evaluate relationship between the growth parameters. Where: Y = stump height, X = measurement variables, a = slope and b = intercept.

### **Results**

#### **Survival Rates of Root Pruned Wildlings of *G. kola***

Table 1 and figure 2 showed that there was no significant different ( $p \leq 0.05$ ) among various treatments {wildlings with two leaves (T<sub>1</sub>), wildlings with four leaves (T<sub>2</sub>), wildlings with six leaves (T<sub>3</sub>) wildlings with eight leaves (T<sub>4</sub>), wildlings with branch (T<sub>5</sub>) and untreated wildlings (control) (T<sub>6</sub>)} on the effects of root pruning on *G. kola* wildlings on survival rates. However, wildling with eight leaves showed greater number of survival than other treatments. Table 1 and figure 2 showed that there was significant different ( $p \leq 0.05$ ) among the various treatments of wildlings height (cm) of *G. kola*. However, wildlings with branch (T<sub>5</sub>) had highest height, while wildlings with four leaves (T<sub>2</sub>) had the least of wildlings height (cm) of *G. kola*. Wildlings of *G. kola* with T<sub>1</sub>, T<sub>3</sub> and T<sub>6</sub> were statistically similar. Table 1 and figure 1 showed that the Collar diameter (mm) of *G. kola* on wildlings/seedlings were significantly different ( $p \leq 0.05$ ) from each other. Thus, wildlings with branch (T<sub>5</sub>) had highest collar diameter (mm), while wildlings with four leaves (T<sub>2</sub>) had the least of

seedling/wildlings collar diameter (mm) of *G. kola*. Table 1 and figure 1 showed that there was no significant different ( $P \geq 0.05$ ) among various treatments on the effects of root pruning on *G. kola* wildlings on leaf number.

**Coppice Shoots Growth in *Garcinia kola***

Table 2 and figure 3a showed that inception of coppice was significantly different ( $p \leq 0.05$ ) among the various treatments (stump heights) on *G. kola*. Coppice inception from stump heights at 35cm (T<sub>2</sub>) had highest value while stump height at 45cm (T<sub>3</sub>) had the least value. Table 2 and figure 3a showed that shoot number of coppice was significantly different ( $p \leq 0.05$ ) among the four treatments (stump heights) on *G. kola*. However, treatments (T<sub>1</sub> and T<sub>2</sub>) at stump height 25cm and 35cm were significantly similar, while treatments T<sub>3</sub> and T<sub>4</sub> at the height 45cm and 55cm were statistically

similar. Table 2 and figure 3a showed that coppice branch was not significant difference ( $P \geq 0.05$ ) among different stump heights (treatments). Table 2 and figure 3a showed that leaf number of coppice was not significantly different from each other. Table 2 and figure 3b showed that shoot height was not significant different ( $P \geq 0.05$ ) among the various treatments. Table 2 and figure 3b also showed that coppice shoot diameter was significantly different ( $p \leq 0.05$ ) from each other. Treatment four (T<sub>1</sub>) with stump height 25cm had the highest value and treatment one (T<sub>1</sub>) with stump height 55cm had the least value. Table 2 and figure 3b showed that stump diameter was significantly different ( $p \leq 0.05$ ) from each other. However, treatment four (T<sub>4</sub>) with stump height 55cm had the highest value, while treatment one (T<sub>1</sub>) with stump height 25cm had the least value.

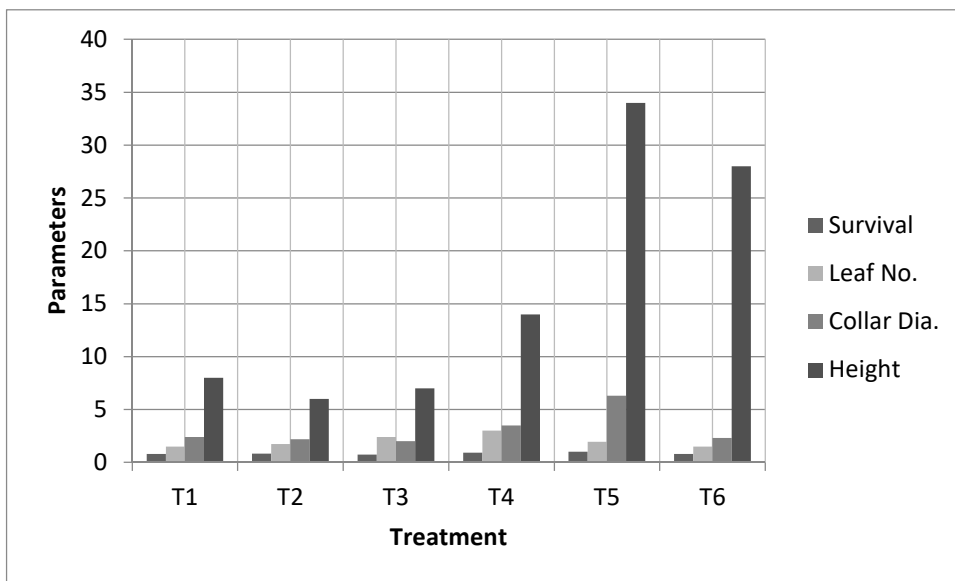


Fig. 2: showed survival rate and growth parameters on *Garcinia kola* wildlings

Table 1: ANOVA for survival rate of root pruned wildlings of *Garcinia kola*

SOV	SS	DF	MS	F-Ratio	P-Value
<b>Survival rates</b>					
Between treatments	0.920078	5	0.184016	2.061578	0.118 <sup>ns</sup>
Within treatments	1.606672	18	6.463056		
Total	2.52675	23			
<b>Height (cm)</b>					
Between groups	33.72834	5	6.745669	138.6263	0.000*
Within groups	0.875894	18	0.048661		
Total	34.60423	23			
<b>Leaf Number</b>					
Between groups	23.94833	5	4.789887	0.741084	0.603 <sup>ns</sup>
Within groups	116.335	18	6.463056		
Total	140.2833	23			
<b>Collar Diameter (mm)</b>					
Between groups	77.01083	5	15.40217	5754831	0.00*
Within groups	4.8175	18	0.267639		
Total	81.82833	23			

\*= significantly different, ns = numbers significantly different.

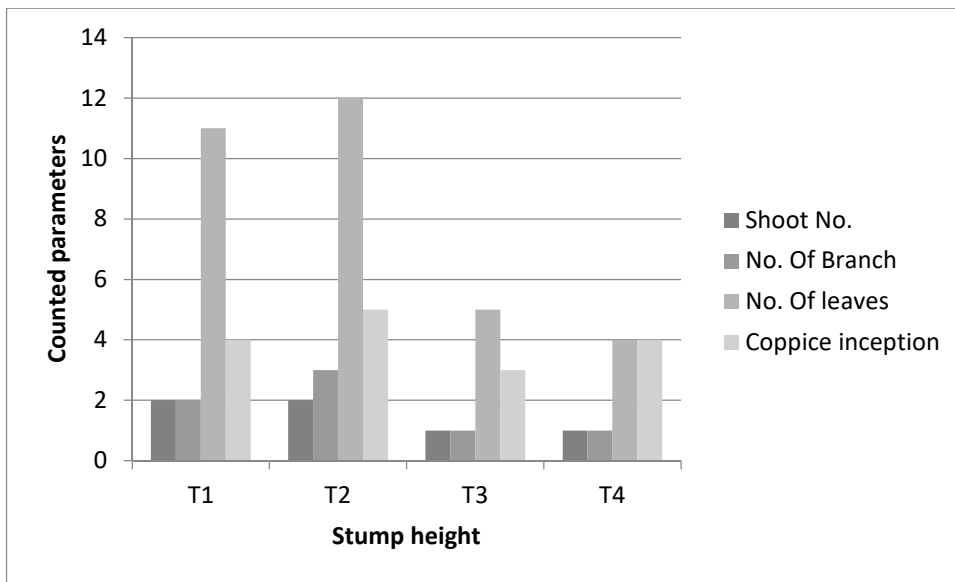
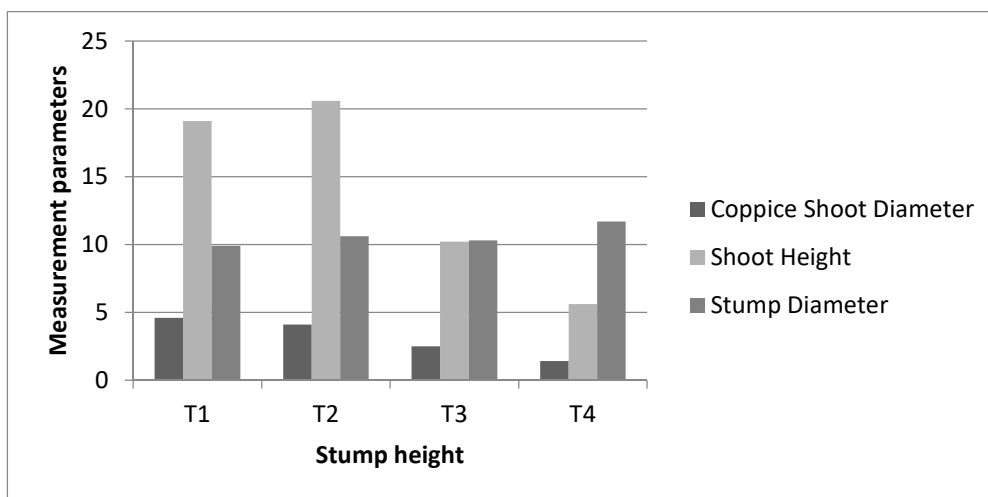


Fig. 3a: Coppices shoot growth for counted parameters in *Garcinia kola*

Fig. 3b: Coppice shoots growth for measurement parameters in *G. kola*Table 2: Analysis of Variable for coppice shoots growth parameters in *Garcinia kola*

SOV	DF	SS	MS	F-Ratio	P-Value
<b>Inception of coppice</b>					
Between groups	3	3.9878	1.3291667	6.4056225	0.0077437*
Within groups	12	2.49	0.2075		
Total	15	6.4775			
<b>Shoot height (cm)</b>					
Between groups	3	619.2725	206.4242	3.232596	0.060738 <sup>ns</sup>
Within groups	12	766.285	63.85708		
Total	15	1385.558			
<b>Shoot Number</b>					
Between groups	3	2.1425	0.714167	17.31313	0.000117*
Within groups	12	0.495	0.04125		
Total	15	2.6375			
<b>Leaf number</b>					
Between groups	3	170.4619	56.82063	0.983712	0.432996 <sup>ns</sup>
Within groups	12	693.1373	57.76146		
Total	15	863.5994			
<b>Coppice shoot diameter</b>					
Between groups	3	26.29268	8.764225	8.43	0.002766*
Within groups	12	12.4697	1.039143		
Total	15	38.76238			
<b>Coppice branch</b>					
Between groups	3	5.575	1.858333	0.410492	0.748421 <sup>ns</sup>
Within groups	12	54.325	4.527082		
Total	15	59.9			
<b>Stump diameter</b>					
Between groups	3	6.795	2.265	92.13559	1.49E-08*
Within groups	12	0.295			
Total	15	7.09			

\* = significantly different, ns = numbers significantly different

Table 3 showed correlations (r) and p-values between the growths of the different morphological parameters and stump heights in coppice of *G. Kola*. The correlation and p-value of coppice inception x stump height, coppice branch x stump height, and coppice height x

stump height, coppice shoot x stump height and coppice leaf number x stump height have no significant effects of stump height on number of coppice. Although, coppice diameter x stump height has significant negative effect of stump height on number of coppice.

Table 3: Regression Analysis for coppice growth parameters

Coppices growth parameters	Correlation coefficient	P-Value
Coppice inception x Stump height	- 14.00	0.36 <sup>ns</sup>
Coppice branch x Stump height	- 9.10	0.33 <sup>ns</sup>
Coppice height x Stump height	- 20.00	0.11 <sup>ns</sup>
Coppice shoot x Stump height	- 1.65	0.08 <sup>ns</sup>
Coppice diameter x Stump height	- 8.63	0.02*
Coppice leaf number x Stump height	- 2.80	0.11 <sup>ns</sup>

\* = Significant, ns = Not Significant

## Discussion

Most tropical fruit tree species are known to possess long tap root, example: *Treulia africana*, *G. kola* and *Dacrode edulis* especially at tender age, hence needs for roots pruning. Pruning being root or vegetative parts is an aged long practice by foresters, environmentalists and agriculturists to improve the quality of their planting materials either in the nursery or field at early stage of growth, especially from desirable genetic stock. Roots pruning of *G. kola* was carried at various sizes of wildings and though of same aged, as one of nursery management technique to reduce the root length of the species which has a prolong tap roots. Shry and Reiley (2011) reported that root pruning is an important step in transplantation of plants, involves cutting off all the lateral roots of the plant with a sharp spade in a circle around the stem. Root pruning in *G. kola* has the potential for increasing the amount of absorbing roots moved with transplanted trees and delayed in growth due to shock. No significantly different amongst various

treatments on survival of *G. kola* wildlings could be attributed to transplanting shocked that affected all the treatments at the nursery. Pruning tree roots before planting reduces transplant shock in plantation establishment (<https://www.gardeningknowhow.com/ornamental/trees/tgen/root-pruning-trees-shrubs.htm>). It's obvious that pruning tree roots before planting gives new roots time to grow. Root pruning of any tree or shrub depend on the season which the intended species will be planted out in the permanent site or field. The best time to trim roots of a tree or shrub to be transplanted depends on whether you are moving it in spring or in fall (<https://www.gardeningknowhow.com/ornamental/trees/tgen/root-pruning-trees-shrubs.htm>). When the root tips are cut, establishment is delayed, which can be the difference between surviving (Shaw, 2019). Slowing down the growth not only puts the plant at risk. The significant different recorded in plant height might be due to variation in terms of leaf numbers and wildling lengths. It's

obvious that treatment (T<sub>4</sub>) with higher leaf number had performed exceedingly well than others, which mean that more leaf were able to trapped adequate sunlight, air and water to enhance photosynthesis, which automatically lead to increment in wildling sizes. Table 1 and figure 1 showed that there was no significant different ( $p \leq 0.05$ ) among various treatments on the effects of root pruning on *G. kola* wildlings on leaf number.

The study revealed that *G. kola* saplings had capacity to coppice at any height, but more effective at the lower portion/height. Coppice produced by saplings with one branch was very strong. All species exhibited a strong coppicing ability following cutting (Shackleton, 2000). The lower saplings height was indication of few numbers of buds or branches, and these enhanced, encouraged and promoted stronger and rapid growth parameters. This was in agreement with the work of Bory *et al.* (1991); Luostarinen and Kauppi (2005) the low number of buds produced by coppicing stumps with one node caused low competition for the resources needed for growth and development.

Coppice shoots growth parameters in *G. kola* on stump height was significantly affected by the stump height. This is in line with the work of Shackleton (2000) who said that the taller the height potential of a species, the fewer their coppice shoots per stump surface area. This finding revealed that number of coppice shoots did not depends on stump height, closed observation indicates that saplings at different treatments produced shoot at the same rates. Dick *et al.* (2004), noted great interaction between species and stem diameter on total shoot, root number and length. Number of leaf production and

coppice shoots diameter increased were invariably depending on the number of branch and length of coppice shoots. According to Shackleton (2000) relatively low number (2–3) of shoots produced on *G. kola* study was as a result of small diameter of the young plants used as cuttings. The number of shoots per stump was most frequently related to cutting height, although this was not always the most significant predictor (Shackleton, 2000). The numbers of branches on coppice were highly related to the stump height, generally it was noted that the shorter height (treatment at 25cm) produced viable and healthy coppice as compared to other treatments at 35cm, 45cm and 55cm. The variation in stump heights affected different coppice parameters in terms of growth performance. The various size of stump height/length was determinant factor for the quality and quantity of coppice growth parameters that was produced, it was highly noted that the thicker stump diameter and shorter stump height produced strong and quality coppice as compared to other. This also will strengthen availability of viable seedlings that will enhance fruits and seeds production of *G. kola* in sustainable manner, with it associated effects on food, medicine production and environmental values.

Comparisons between the simple linear regressions suggest that stump height had negative correlation coefficient among all coppice growth parameters in *G. kola*. This implies that stump height did not influence the formation of coppice inception, coppice height, coppice shoots, number of coppice, leaf number of coppice, except in the coppice diameter. Also, growth in various coppice growth parameters did not proceed separately but

simultaneously in a closely relationship with other variables. Sinnott (1960) and Igboanugo, (2006) noted that growth in various aerial plant parts does not proceed independently but simultaneously in closely linked pattern with the growth of some of these parts exhibiting some degree of dominance.

### Conclusion

Root pruning in *G. kola* has the potential for increasing the number of absorbing roots moved with transplanted trees and delayed in growth due to shock. Root pruning of *G. kola* and any other tree or shrub depend on the season which the intended species will be planted out in the permanent site or field. Suitable period for roots pruning and saplings encouraged sustainable development and sustainability of *G. kola* in our environment. The study revealed that *G. kola* saplings had capacity to coppice at any height, but more effective at the lower portion/height. Coppice shoots growth parameters in *G. kola* on stump height was significantly affected by the stump height.

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