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INFLUENCE OF DIFFERENT MACROPROPAGATION METHODS AND POINTS OF SCION INSERTION ON SURVIVAL AND GROWTH OF *Gmelina arborea* ROXB. SEEDLINGS

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ABSTRACT

Influence of different macropropagation methods and different points of scion insertion was investigated to determine the survival and growth of *Gmelina arborea* Roxb seedlings. Vegetative propagation works carried out on *G. arborea* include cleft grafting and patch budding and stem cuttings. The experiment consists of 4 x 3 factorial treatment combinations with 5 replications and laid in a Completely Randomized Design (CRD). Variables observed include number of surviving seedlings, number of new leaves and stem height at 6 weeks after propagation (WAP). Data were subjected to descriptive statistics as well as analysis of variance (ANOVA). The results showed that wedge method recorded the highest number of survived grafts (60%). Highest percentage survival of 35% and 20% was observed from insertion at points 15 cm and 45 cm. Wedge with scion inserted at 15 cm recorded highest survival (80%). The effects of points of scion insertion on rootstock on number of leaves showed that insertion at 45 cm produced significantly ($p<0.05$) highest average number of new leaves with 7±4.7. Wedge had the highest mean height (48.9±12.4cm). The results show that different macropropagation methods (wedge, side cleft, T-budding and chip budding) and different point of scion insertion (15 cm, 30 cm and 45 cm) had significant ($p<0.05$) effects on survival and growth of *G. arborea* grafted/budded seedlings. Hence, for successful production of improved *Gmelina arborea* seedlings, wedge grafting method and 15cm point of scion insertion should be employed.

Keywords: micropropagation; rootstock; grafting; cuttings; patch budding.

INTRODUCTION

Gmelina arborea is a fast-growing deciduous tree with a wide spreading canopy having numerous branches which form a large shady crown (Arura and Tamrakar, 2017). It belongs to Laminaceae family (Keay,1989). It grows up to 30 m tall while the bole is usually straight and cylindrical. The first flowers are borne 3-4 years after planting (Okoro, 1983). The wood is of good quality which is used and traded locally (Adegbehin *et al.*, 1988). It is suitable for general utility purposes especially light construction, utility furniture, packaging, decorative veneers and many more (Orwa *et al.*, 2009). The tree has suitable characteristics for agroforestry, with fast growth, ease of establishment and relative freedom from pests outside its natural range. The species also regenerates well from both sprouts and seeds (Alfaro and De Camino, 2002).

In spite of *G. arborea* qualities and importance, its use for sawn timber is limited (Ogunsanwo, 2011). This is caused by poor form and tapering of bole which contributes to the lower market value of its wood compared to sawn wood of similar quality (Ogunsanwo, 2011). The species has also been observed with growth variation on different soil types (Hartmann *et al*., 1993). Thus, there is need for application of macropropagation techniques on the species for improvement in order to produce new breeds that can be of multipurpose use in nature (sawn timber, wood pulp, fuelwood) and in environmental conservation activities.

Asexual or vegetative propagation of plants plays an important role in development of fruits and horticultural plant species (Roberto and Colombo, 2020). According to Gradziel *et al.* (2019), vegetative propagation can be classified as macropropagation and micropropagation. Macropropagation methods include cuttings, grafting, budding and layering. Grafting or budding technique mainly involves joining parts of plants (scion and rootstock) in a manner to unite both parts so they can form a plant. Such plants can reach fruition stage at short height thereby giving room for further improvement study (Roberto and Colombo, 2020). A large number of research works has been carried out on agricultural fruit trees using different techniques of grafting and budding (Poletto *et al*., 2018). However, little successes have been recorded with the use of the techniques in the forestry sector (Tian *et al*., 1999). These may be due to weather variations, incompatibility and suitability of methods among others. Therefore, there is a need to improve and expand the present grafting possibilities on forestry tree species. Meanwhile, vegetative propagation works carried out on *G. arborea* include cleft grafting and patch budding (Gonzalez *et al*., 2004) and stem cuttings (Singh and Ansari; Mayavel *et al*., 2014). The present study is viewed as a step forward towards granting easy access to inflorescence by production of *G. arborea* short trees useful for further genetic improvement in Nigeria. Hence, the study aims to identify appropriate macropropagation methods and assess the influence of points of scion insertion on survival and growth of grafted *G. arborea* seedlings.

MATERIALS AND METHODS

Rootstock Production

Seeds of *G. arborea* were collected from mature fruiting tree stand at the arboretum of Forestry research Institute of Nigeria. The seeds were processed and sown in sterilized river sand. Germinated seeds were pricked and transplanted into 1kg capacity polythene pots (16 x 7 x 0.05 cm^3) filled with topsoil. Transplanted seedlings were placed under the weaning shed for 3 months where they were allowed to adapt to the climate condition and have the desired stem girth for grafting and budding. Sixty (60) healthy uniform seedlings of 5 mm diameter were selected from the stock in the nursery and used as rootstock.

Scion and Bud Preparation

Some healthy trees already fruiting had some of their branches decapped and de-leafed and were regularly checked for bud initiation and collection. As soon as buds were observed, scions and buds were collected.

Macropropagation Techniques and Procedure

Different macropropagation techniques employed include grafting (wedge and side cleft) and budding (T-budding and chip budding). Three points of scion insertion (point where the scion is joined to the rootstock) considered include 15, 30 and 45 cm measured from the base of the rootstock towards apical bud. Each macropropagation technique had the scion/bud inserted at designated points clearly marked with a permanent marker on the stem of rootstocks. The leaves on both rootstocks and scions were reduced by half to reduce the rate of transpiration. Procedures for each technique were followed and the point of union was properly tied with budding tape. Each grafted and budded plant was labelled, arranged randomly under high humidity propagator and monitored for six weeks.

Data Collection and Analysis

The experiment consists of 4x 3 factorial treatment combinations with 5 replications and laid in Completely Randomized Design. Observations made include the number of surviving seedlings, number of new leaves and stem height (measured in cm) at 6 weeks after propagation. Data collected were subjected to descriptive statistics and analysis of variance using SPSS package while Least Square Difference (LSD) was used to separate means that are statistically significant ($p<0.05$).

RESULTS

Survival Percentage

Macropropagation techniques and scion point of insertion affected *G. arborea* grafts/buds survival as revealed by this study. The results (Figures 1 and 2) showed that wedge method recorded the highest number of survived grafts (60%) followed by46.6% and 13.3%from side cleft and T-budding respectively while there was no survived buds from chip budding at 6Weeks After Propagation (WAP) as shown in Figure1. The survival of the grafted/budded seedlings were also affected by scion points of insertion.Highest percentage survival was observed from using points 15cm and 45cm with both having 35% while insertion on point 30cm recorded 20% at 6WAP as shown in Figure 2. Table 1 showed the results of interaction of macropropagation techniques and different points of scion/bud insertion on survival of grafted/budded *G. arborea* seedlings. Wedge with scion inserted at 15cm recorded highest survival percentage (80%) followed by wedge with scion inserted at 45cm (60%). T-budding did not show encouraging results as rootstocks with scion inserted at points 15cm and 45cm recorded 20% survival. Chip budding on the other hand failed to produce any survived seedlings irrespective of the point of scion insertion under the periods of investigation.

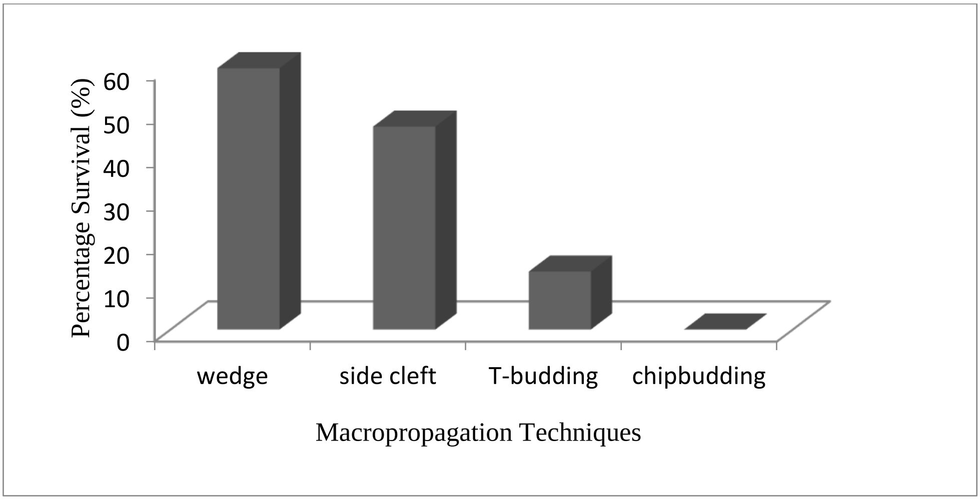

Figure 1: Effects of macropropagation techniques on percentage survival of graft/buds of *G. arborea* seedlings at 6 weeks after propagation

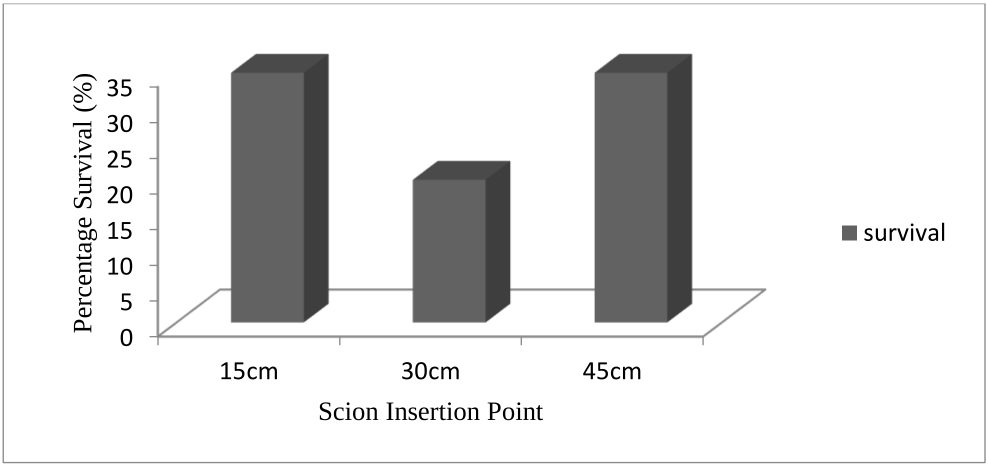

Figure 2: Effects of scion point of insertion on percentage survival of graft/buds of *G. arborea* seedlings at 6 weeks after propagation.

Number of New Leaves

The results of effects of macropropagation techniques and point of scion insertion on production of new leaves by grafted/budded *G. arborea* seedlings are presented in Tables1-3. Analysis of variance revealed there was significant difference ($p < 0.05$) between the macropropagation methods, points of scion insertion and their interactions for number of new leaves produced at six weeks after grafting/budding (Table 2). The main effects of macropropagation techniques showed that side cleft had highest number of leaves (9±8.5) which was similar to other techniques except chip budding which failed at 6 WAP (Table 3). The effects of points of scion insertion on rootstock on number of leaves showed that insertion at 45 cm produced significantly highest average number of new leaves with 7±4.7 while the least was recorded in 15cm (4.1±3.7). The interactive effects of macropropagation technique by points of scion insertion on production of new leaves by the survived grafts/buds revealed that T-budding at 15cm scion insertion point recorded highest average number of leaves (12±4.77) followed by side cleft with scion inserted at 15cm point on rootstock (10±3.57). The least number of leaves was recorded in wedge having scion inserted at 45cm on rootstock (7±3.16).

Seedling Height

Macropropagation technique and point of scion insertion significantly ($p<0.05$) affected grafted/budded seedling height of *G. arborea* (Table 2). Specifically, of all the macropropagation techniques, wedge had the highest mean height (48.9±12.4cm), similar to side cleft (47.5±12.3cm) while both were significantly higher than T and Chip budding with 38.0±30.4cm and 0cm, respectively at 6WAP.The point of scion insertion also had significant effect on the height of the seedlings. Insertion at point 45cm on the rootstock influenced highest mean height (39.7±27.1) which was comparable to 34.7±23.9from point 15cm while both were significantly higher than 26.3cm±26.2 from point30cm (Table 3).

Table 1: Interactive effects of macropropagation methods and scion insertion point on growth attributes of *G. arborea* seedlings at 6 weeks after propagation

Macropropagation Techniques	Insertion points (cm)	Survival rate (%)	Av. Number of new leaves	Mean Seedling height (cm)
Wedge	15	80	$7±1.58^{b}$	$38.0±5.43^{c}$
	30	40	$80±1.34^{b}$	$50.8±2.8^{abc}$
	45	60	$7±3.16^{b}$	$57.7±15.6^{a}$
Side cleft	15	40	$10±3.57^{b}$	$38.6±5.4^{bc}$
	30	40	$8±3.94^{ab}$	$54.5±5.8^{a}$
	45	60	$8±0.0^{b}$	$49.3±17.3^{abc}$
T- budding	15	20	$120±4.77^{a}$	$62.2±13.6^{a}$
	30	0	0^{c}	0^{d}
	45	20	$8.0±7.07^{b}$	$51.8±16.5^{ab}$
Chip budding	15	0	0^{c}	0^{d}
	30	0	0^{c}	0^{d}
	45	0	0^{c}	0^{d}

* Mean values with the same letters along the column are not significantly different ($p<0.05$).

The results of interactive effects of the macropropagation methods and scion insertion points on seedling stem height of *G. arborea* seedlings showed that T-budding with scion inserted at 15cm gave highest stem height (62.2±13.6cm) at 6 WAP. This was followed by wedge with 45cm scion insertion point (57.7±15.6) while the least mean height was recorded in wedge with scion insertion point at 15cm having 38.0cm at same period (Table 1).

Table 2: Analysis of variance showing the effects of macropropagation methods and scion insertion points on new leaf production and stem height of *G. arborea* seedlings

Dependent Variable	Source of variation	df	Sum of Squares	Mean Square	F	Sig.
Number of new leaves	Macropropagation techniques (MPT)	3	672.73	224.24	41.15	0.00
	Scion insertion point (SIP)	2	99.30	49.65	9.11	0.00
	MPT * SIP	6	310.97	51.83	9.51	0.00
	Error	48	261.60	5.45		
	Total	59	1344.60			
Height	Macropropagation techniques (MPT)	3	23588.91	7862.97	85.64	0.00
	Scion insertion point (SIP)	2	1826.43	913.213	9.95	0.00
	MPT * SIP	6	10918. 35	1819.73	19.82	0.00
	Error	48	4407.07	91.81		
	Total	59	40740.76			

Table 3: Effect macropropagation methods and scion insertion points on new leaf production and stem height of *G. arborea* grafted/budded seedlings

Treatments		Number of leaves	Seedling height (cm)
Macropropagation Techniques	T-budding	9±6.8[a]	38.0±30.4[b]
	Chip budding	0[b]	0[c]
	Wedge grafting	9±7.5[a]	48.9±12.4[a]
	Side cleft	9±8.5[a]	47.5±12.3[a]
Scion point of insertion	15cm	4.1±3.7[c]	34.7±23.9[a]
	30cm	5.6±5.5[b]	26.3±26.2[b]
	45cm	7.3±4.7[a]	39.7±27.1[a]

* Mean values with the same letters along the column are not significantly different at ($p<0.05$).

DISCUSSION

This study was conducted to identify appropriate macropropagation methods and assess the influence of points of scion insertion on survival and growth of grafted/budded *G. arborea* seedlings. Different macropropagation methods such as cuttings, grafting, budding and layering have been observed to yield different levels of successes as reported by Kamanga *et al*. (2017). This was evident in the present study as grafting methods (wedge and side cleft) performed better than budding methods by survival rate, number of new leaves and stem height. The underperformance of budding method could be attributed to the use of single buds which are not as strong as scions which comprise of multiple buds as also reported by Agbo and Omaliko (2006). In addition, the observed difference in the survival rate of the seedlings by the use of different macropropagation techniques could be as a result of variation in the level of cambium contact as opined by Lewis and Alexander (2008). Aside retention of old leaves production of new leaves and increase in stem height by grafted seedlings implies that they have resumed life cycle. These results could be related to that of Ikeuchi (2019) when grafting methods produced the highest number of surviving *Gmelina* grafts compared with budding methods used. It also correlates to that of Kamanga *et al*. (2017) who reported higher graft survival in *Citrus sinensis* subjected to grafting while least was observed in budding. Gregoire *et al*. (2023) opined that grafting is becoming a technique with high potential in improving the efficiency of present-day vegetable cultivation.

Furthermore, the position of scion influenced the survival and growth of grafted *G. arborea* seedlings as 15 cm and 45 cm from the base of rootstocks had better survival rate while least was recorded in 30 cm. Similarly, seedling height followed same trend with survival rate while number of leaves produced increased as the insertion point goes higher on the stem of rootstock. In his report, Yakubu *et al*. (2022) obtained maximum values for growth variables on survived grafted *Annona muricata* respectively by inserting scion at 15cm on rootstocks. Similarly, Ogunwande *et al*. (2018) observed that the survival and growth of *Garcinia kola* scion depends on its position of insertion on the rootstocks as scions inserted at upper part supported survival of grafted *Garcinia kola.*

CONCLUSION

The results of this study have shown that different macropropagation methods (wedge, side cleft, T-budding and chip budding) and different scion insertion points had significant effects on survival and growth of *Gmelina arborea* grafted/budded seedlings. Hence, for successful production of improved *Gmelina* seedlings, wedge grafting method and 15 cm scion insertion point should be employed while more research work should be carried out to unravel the reason for low survival rate in budding.

REFERENCES

Adegbehin, J.O., Abayomi, J.O., Nwaigbo, L.B. (1988). *Gmelina arborea* in Nigeria. *Commonwealth Library Review*, 67(2): 159-166.

Agbo, C.U., Omaliko C.M. (2006). Initiation and growth of shoots of *Gongronema latifolia* Benth stem cuttings in different rooting media. *African. Journal of Biotechnology*, 5(5): 425-428.

Alfaro, M., R. De Camino. (2002). Melina (*Gmelina arborea*) in Central America. Working Paper 20. FAO, Forest Resources Division, *Forest Resources Development Service,* Rome, Italy. Pp.16-22.

Arora, C., Tamrakar, V. (2017). *Gmelina arborea*: Chemical constituents, pharmacological activities and applications. *International Journal of Phytomedicine*, 9(2017):528-542.

Gonzalez, G., Moya, R, Mong, F., Cordoba, R, Coto, J. C. (2004). Evaluating the strength of finger jointed lumber of *Gmelina arborea* in Costa Rica. *New Forest,* 28(2-3): 319-323.

Gradziel, T. Lampinen, B. and Preece, J.E. (2019). Propagation from basal epicormic meristems remediates an aging-related disorder in almond clones. *Horticulturae*, (5): 28.

Gregoire, L., Lysiane, B., Nathalie, O., Sarah, J.C. (2023). Grafting in plants: recent discoveries and new applications. *Journal of Experimental Botany*, 74(18):2433-2447.

Hartmann, H.T., Kester, D.E., Fred, T, Davies J.R. (1993). Plant propagation Principle and Practices (5th edition). *Prentice-Hall of India Pvt. Ltd. New Delhi*. pp. 24.

Kamanga, R.M., Chilembwe, E., Chisangak, M. (2017). Comparative success of budding and grafting citrus sinensis: effect of scions number of buds on the bud take, growth and studiness of seedlings. *Journal of horticulture.* http:// www.researchgate.net/publication/323237083.

Keay, R.W.J. (1989). *Trees of Nigeria. A Revised Version of "Nigerian Trees"*. Clarendon Press, Oxford.

Lewis, W., Alexander, M. (2008). *Grafting and Budding: A Practical Guide for Fruit and Nut Plants and Ornamentals* Second Edition. Collingwood 3066. Australia. LandRisks press.

Mayavel, A, Soosai, R., Gurudev, S.B., Krishnakumar, N. (2014). Cultivation Techniques for *Gmelina arborea* Transfer of Tree cultivation technologies to Krishi vigyankendras (kvks) of Tamilnadu and Puducherry. 23-27.

Ogunsanwo, O.Y (2011) Waste generation and utilization in Nigerian sawmill industry. *In*: Aiyeloja, A.A. and Ijeoma, H.M (Eds). *Book of Readings in Forestry, Wildlife Management and Fisheries*. Top Base Nigeria limited in conjunction with green canopy consultants, Port Harcourt, Nigeria. ISBN 978-978-919-624-1 Pp 156-180.

Ogunwande, O.A., Majolagbe M.A. and Adegoke F.F. (2018). Scion positioning on different points on rootstock: Influence on survival and early growth of grafted *Garcinia Kola* Heckel. *In*: Agbeja, B.O., Adetogun, A.C., Adejoba, R.O. and I.O.O. Osunsina (Eds). *Collaboration of Stakeholders for Dynamic Restoration of Forest Estate in Nigeria*, Proceedings of the 2nd Commonwealth Forestry Association (CFA) Conference, Nigeria Chapter, FUNAAB, Abeokuta Ogun State, 5-7th June, 2018 pp. 156-162

Okoro, O.O. (1983). Revolutionizing procedure gurding*G. arborea* seed in Nigeria. *In Proceedings of the 13th Annual Conference Forestry association of Nigeria. Benin.* 1-12.

Orwa, C., Mutua, K.A., Jamnadass, R., Anthony, R, S (2009). Agroforest tree Data base: *a tree reference and selection guide version 4.0* (http://www.worldagroforestry.org/sites/treedbs/treedatabases.asp)

Poletto, T.; Stefenon, V.M.; Poletto, I.; Muniz, M.F.B. (2018). Pecan propagation: Seed mass as a reliable tool for seed selection. *Horticulturae* 4: 26.

Singh, S., Ansari, S.A. (2014). Mass multiplication of mature trees of *Gmelina arborea* Roxb. Through ex-vitro rooting of rejuvenated bud sprouts. *Forest Resources Journal*; 8(1):25-31.

Tian, L., Tan, H.Y., Zhang, L. (1999). Stem segment culture and tube propagation of *Dracaena saneriana*virscens. *Acta Horticulture,* 26: 133–134.

Yakubu, B.F., Alaje, V.I., Olaniyi, A.A., Nola, M.O., Odewale, M.A., Fadulu, O.O., Adeniyi, K.K. (2022). Influence of scion length and point of attachment on rootstock on survival and growth of grafted soursop. *African Crop Science Journal,* 30(1):77-85.