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INFLUENCE OF SCION LENGTH AND POINT OF ATTACHMENT ON ROOTSTOCK ON SURVIVAL AND GROWTH OF GRAFTED SOURSOP

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ABSTRACT

Soursop (*Annona muricata*) is a multipurpose fruit tree species, which is mostly propagated by seeds, thus producing plants that exhibit various degree of variability. The objective of this study was to assess the influence of scion length and point of attachment on rootstock on survival and growth on grafted *Annona muricata.* Varying points were marked out on the rootstock from the base of the plant and varying scion lengths (5, 10 and 15 cm) were collected. The modified cleft method of grafting was adopted and this was monitored daily for freshness and appearance of new shoot. At the end of two months, survived grafted plants were removed and arranged under a weaning shed, where they were further monitored for number of leaves, height of graft, diameter of scion and rootstock. Results showed that scion length varied significantly (P<0.05) for all the parameters assessed. The effect of point of attachment on rootstock was also significant on the number of leaves, as well as scion collar diameter. The effect rootstock on graft height and rootstock collar diameter was not significant. The interactive effect of scion and rootstock was significant (P<0.05) for all parameters, except height of graft. For successful graft, survival and growth of grafted *A. muricata,* 10 - 15 cm long scion should be used and this should be inserted at the upper part (15 cm) of the rootstock.

Key Words: *Annona muricata,* collar diameter, graft height, survival

RÉSUMÉ

Le corossol (*Annona muricata*) est une espèce d'arbre fruitier à usages multiples, qui se propage principalement par graines, produisant ainsi des plantes qui présentent divers degrés de variabilité. L'objectif de cette étude était d'évaluer l'influence de la longueur du greffon et du point d'attache sur le porte-greffe sur la survie et la croissance d'*Annona muricata* greffée. Des points variables ont été marqués sur le porte-greffe à partir de la base de la plante et des scions de différentes longueurs (5, 10 et 15 cm) ont été collectés. Une méthode de greffe modifiée par fente a été adoptée et celle-ci a été surveillée quotidiennement pour la fraîcheur et l'apparence de la nouvelle pousse. Au bout de deux mois, les plantes greffées survivantes ont été retirées et disposées sous un hangar de sevrage, où elles ont été davantage surveillées pour le nombre de feuilles, la hauteur de la greffe, le diamètre du greffon et le porte-greffe. Les résultats ont montré que la longueur du greffon était significative (P<0,05) pour tous les paramètres évalués. L'effet du point d'attache sur le porte-greffe était également significatif sur le nombre de feuilles, ainsi que sur le diamètre du collet du greffon ; tandis que l'effet du porte-greffe sur la hauteur du greffon et le diamètre du collet du porte-greffe n'était pas significatif. L'effet interactif du greffon et du porte-greffe était significatif (P<0,05) pour tous les paramètres, sauf la hauteur du greffon. Pour une greffe réussie, la survie et la croissance d'Annona. muricata greffé, un scion de 10 à 15 cm de long doit être utilisé et celui-ci doit être inséré dans la partie supérieure (15 cm) du porte-greffe.

Mots Clés : *Annona muricata*, diamètre du collet, hauteur du greffon, survie

INTRODUCTION

Soursop (*Annona muricata* L.) is a multipurpose tree species which is cultivated for their edible fruits, raw materials and herbs for medicinal purposes. The fruit pulps are sources of vitamin C and minerals, which include calcium, phosphorus and potassium (Pinto *et al*., 2005). All parts of the soursop plant are locally used for treatment of ailments and diseases such as cancer and parasitic infections (Adewole and Ojewole, 2009). The fruits can be eaten by new mothers to stimulate milk post childbirth. The fruit pulp is also eaten to relieve arthritis pain, fever, diarrhea, malaria, skin rashes, worms and rheumatism. The juice from the leaf decoction is known to have anti-neuralgic and rheumatic properties (Adewole, 2006; De Sousa *et al.,* 2010; Mishrad *et al.,* 2013); while the leaves are extensively used as anticancer for tumor and cancer treatment in Tropical Africa and South America (Adewole and Ojewole, 2009). Apart from the herbal properties of *A. muricata,* the fruits also contribute significantly to household incomes of both rural and urban dwellers in West Africa.

Annona muricata is an evergreen, terrestrial, erect tree that belongs to the family Annonaceae. It is native to the tropical areas of South and North America and is widely distributed throughout tropical and subtropical parts of the world (Richardson *et al.,* 2004). The tree grows from 5 to 8 metres in height and there are approximately 130 genera and 2300 species (Richardson *et al.,* 2004; Mishra *et al*., 2013).

Soursop is commonly propagated from seeds and this has resulted in fruit production variability in terms of fruit quality, as well as, resistance to pests and diseases. Propagation by seeds produces plants with various degrees of genetic variability as a result of cross-pollination. However, the increasing demand of high quality planting stock for mass establishment of soursop plantation for both economic and medicinal values, necessitates that alternate methods of propagation be developed. Genetic improvement strategies are, therefore, required to enhance fruit production and germplasm conservation of soursop trees.

To overcome the problems of seed propagation, vegetative propagation becomes a viable option. The advantages of using vegetative propagation outweigh those of seeds. Grafting is a vegetative propagation technique that enables regeneration of clones with the same genetic constitution as the mother plant and therefore enhance production of superior genotypes (Hartmann *et al*., 1997; Tchoudjeu *et al*., 2006; Ofori *et al*., 2008). It is the union of a root system (rootstock) with a shoot system (scion) in such a manner that they unite, and subsequently grow and develop as a composite plant (Hartmann *et al*., 2002). Grafting is widely used in tree crops to improve yield and quality traits (Leakey *et al*., 2005; Leakey and Akinnifesi, 2008; Miller and Gross, 2011; Leakey, 2014). It can also be used to facilitate production of plants in the reproductive phase when plus trees are selected and scions are taken from crowns of mature trees.

A successful graft takes place where the rootstock and the scion are compatible. Graft compatibility means establishment of a successful graft union, as well as extended survival and proper functioning of the grafted plant (Yin *et al*., 2012; Eliezer, 2014). One of the problems associated with grafting is the incompatibility of rootstocks and scions (Ni Luh and Karsinah, 2011). Therefore, selection of suitable scions, as well as rootstocks, will increase the success rate of this vegetative propagation technique. This study was, therefore, carried out to investigate the possible effect of scion length and point of attachment to the rootstock on the survival and early graft of *Annona muricata.*

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MATERIALS AND METHODS

Experimental materials. Seeds of *A. muricata* were sourced from high yielding and vigorous mother trees from the arboretum of Forestry Research Institute of Nigeria (FRIN), Ibadan, Oyo State of Nigeria. The seeds were sown in germination boxes in the nursery facility of Multipurpose Tree Species Improvement Unit of FRIN, Ibadan. At 4 weeks after sowing, the seedlings were pricked and potted. The potted seedlings were nursed and maintained for 15 months to attain desirable size (pencil size). Healthy and good formed seedlings were carefully selected from the pots, giving consideration to length. Selected seedlings ranged from 25-30 cm high. These selected seedlings were used as rootstocks in this experiment. Varying points were measured and marked out on the rootstock from the base of the plant *viz*: base (5 cm), middle (10 cm) and upper (15 cm).

The scions used were collected from healthy matured mother plants, with desirable fruiting ability. The scions were cut into three lengths (5, 10 and 15 cm) with the aid of sharp budding knife.

Experimental site. The experiment was carried out at the Multipurpose Tree Species Improvement Unit of Forestry Research Institute of Nigeria, FRIN, Ibadan Oyo state Nigeria. FRIN is located on the longitude 07023'18''N to 07023'43''N and latitude 03051'20''E to 03051'43''E. The climate of the study area is the West African monsoon, with dry and wet seasons. The dry season is usually from November through March and is characterised by dry cold wind of Harmattan. The wet season usually starts from April to October, with occasional strong winds and thunderstorms. Mean annual rainfall is about 1548.9 mm, falling within approximately 90 days. Mean maximum temperature is 31.9 °C, minimum 24.2 °C; while the mean daily relative humidity is about 71.9% (FRIN, 2015).

Experimental procedure and design. Rootstocks were 5, 10 and 15 cm and various lengths of scions (5, 10 and 15 cm) were inserted using the modified Cleft method (Yakubu *et al.*, 2014) and tied with budding tape.

The grafted materials were kept under high humidity (72%) propagators. Fungicides were applied into the propagator before the introduction of the grafted plants. This was repeated at one month after grafting. Watering with clean water was done with the aid of hand sprayer, to avoid water stress, and keep the propagator moistened.

The grafted materials were observed for the appearance of new shoot, which is the indicator of survival (successful graft). At the end of two months, survived grafted plants were removed and arranged under a weaning shed, where they were further monitored for 4 months. The factorial experiment was laid in completely randomised design with three replications. The soils were well drained, with pH values close to 7.0.

Data collection and analysis. Data were collected on percentage survival of graft, number of leaves, height of graft, diameter of scion, and diameter of rootstock. Data collected were subjected to descriptive statistics and analysis of variance using Minitab 17. Significant means were separated using Fishermen Least Significant Differences at 5% level of probability.

RESULTS

Graft survival. The result showed that the longest scion attached to upper rootstock (15 cm long scion attached at 15 cm on rootstock) had the highest survival rate (80%). This was followed by longest scion attached to basal point of rootstock and longest scion attached to middle point on rootstock, with survival rate of 70% each. The shortest scion attached to the basal point on rootstock (5 cm long scion attached at 5 cm on rootstock) performed poorly with 40% survival rate (Fig. 1).

Data collected for the effect of scion length and point of attachment on rootstock on early growth of grafted *A. muricata* showed that the scion (irrespective of the length) attached to the upper part (15 cm) of the rootstock produced higher values of number of leaves as well as graft height when compared to other points of attachment on the rootstock (Table 1). A different trend was observed in collar diameter as scion attached to the 10 cm length produced the highest values compared to other points of attachment.

The effect of scion length was significant ($P<0.05$) for all the parameters assessed (Table 2). The effect of point of attachment on rootstock was significant on number of leaves as well as scion collar diameter; though not significant on graft height and rootstock collar diameter. The interactive effect of scion and rootstock was significant ($P<0.05$) for number

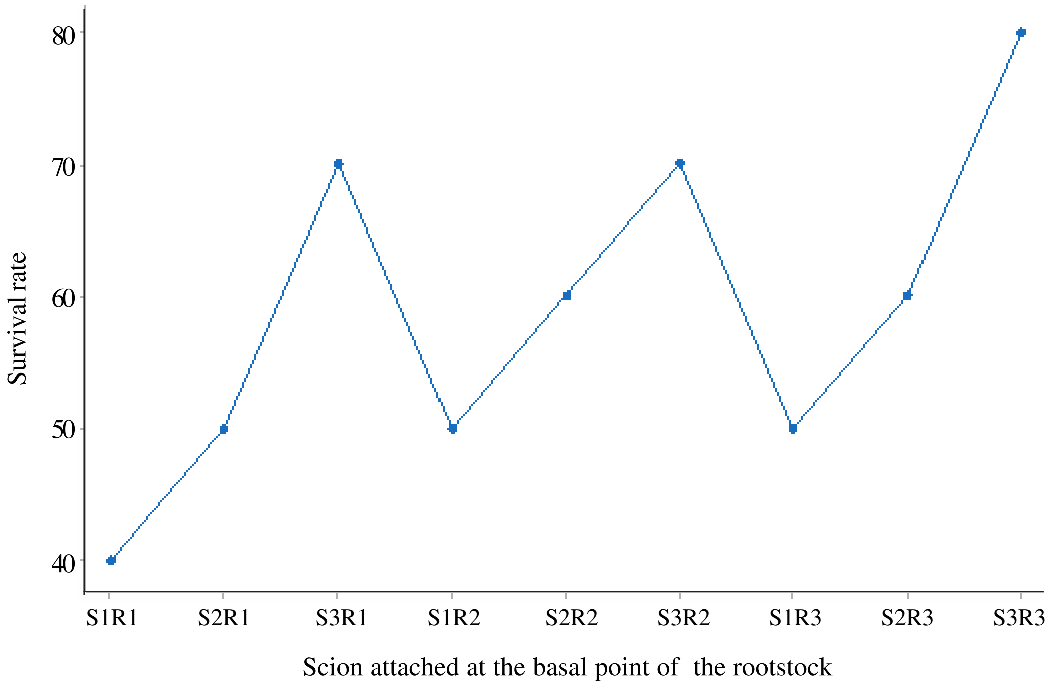

Figure I. Influence of scion length and point of attachment on rootstock on the survival of grafted *Annona. muricata.* S1R1 = 5cm scion attached at the basal point (5 cm) on the rootstock; S2R1 = 10 cm scion attached at the basal point on the rootstock; S3R1 = 15 cm scion attached at the basal point on the rootstock; S1R2 = 5 cm scion attached at the middle point (10 cm) on the rootstock; S2R2 = 10 cm scion attached at the middle point on the rootstock; S3R2 = 15 cm scion attached at the middle point on the rootstock; S1R3 = 5 cm scion attached at the upper point (15 cm) on the rootstock; S2R3 = 10 cm scion attached at the upper point on the rootstock; S3R3 = 15 cm scion attached at the upper point on the rootstock.

TABLE 1. Mean effect of scion length and point of attachment on rootstock on early growth of grafted *Annona muricata*

Scion length	Rootstock length	NOL	GH (cm)	CDS (mm)	CDR (mm)
5	5	9.8b	8.96a	5.504b	7.678b
5	10	10.0b	13.32a	7.306a	5.714c
5	15	15.0ab	20.78a	4.652b	6.776bc
10	5	9.6b	8.4a	6.978a	5.748c
10	10	12.0b	13.66a	7.508a	7.534b
10	15	25.0a	20.52a	6.598a	9.372a
15	5	11.2b	7.76a	5.774b	5.774c
15	10	16.8ab	13.8a	7.528a	7.283b
15	15	22.0a	22.42a	5.668b	6.748bc

Mean with the same alphabet in a column are not significant different from each other according to Fishermen least significant difference at 5% level of probability. NOL = Number of leaves, GH = Height of the graft. CDS = Collar diameter of scion, CDR = Collar diameter of rootstock

TABLE 2. Main effect of scion length and point of attachment on rootstock on the growth of grafted *Annona muricata*

Scion length (cm)	NOL	GH	CDS	CDR
5	11.600b	18.840c	5.798b	6.692b
10	15.539a	25.100b	7.028a	7.551a
15	16.667a	31.286a	6.323ab	7.593a
Point of attachment rootstock (cm)				
5	10.200c	24.293a	6.239b	6.997a
10	14.667b	25.040a	7.271a	7.567a
15	18.933a	25.893a	5.639b	7.632a

Mean with the same alphabet in a column are not significant different from each other according to Fishermen least significant difference at 5% level of probability. NOL = Number of leaves, GH = Height of the graft, CDS = Collar diameter of scion, CDR = Collar diameter of rootstock

of leaves, collar diameter of scion and collar diameter of rootstock.

Number of leaves. The effect of scion length on number of leaves of grafted *A. muricata* was significant (P<0.05) as the length varied from 11.60 to 16.667, among the various scion lengths (Table 2). The15 cm scion produced the highest number of leaves (16.667), which was closely followed by 10 cm scion with average 15.539 leaves. The least number of leaves (11.600) was observed with the 5 cm scion length.

The effect of point of attachment on rootstock was also significant (P<0.05) on number of leaves produced. The highest mean number of leaves (18.933) was observed at point 15 cm on the rootstock; while the least number of leaves was 10.200 at point 5 cm on the rootstock.

The interactive effect of scion length and point of attachment on rootstock was also significant for the number of leaves produced. The values ranged from 9.6 to 25.0 leaves with the 10 cm scion attached to 15 cm rootstock having the highest leaves while the combination of 10 cm scion on 5 cm rootstock produced the least number of leaves.

Height of grafts. The mean height of grafted *A.muricata* varied from 18.84 to 31.28 cm among the various scion lengths (Table 2). Longest scion (15 cm) length produced grafts with the highest mean height of 31.289 cm; followed by 10 cm (25.100 cm); while 5 cm scions recorded the least mean height of 18.840 cm.

The effect of point of attachment on rootstock on graft height was not significant on heights of grafts. Nonetheless, the upper point (15 cm) tended to have the tallest graft of 25.893 cm, followed by point 10 cm (25.040 cm).

The interactive effect of scion length and point of attachment on rootstock was not significant for the height of graft (Table 1). Nevertheless, the highest value of 22.42 cm was observed in 15 cm scion attached to 15 cm rootstock while the combination of 10 cm scion on 5 cm rootstock produced the least graft height of 8.4 cm.

Scion diameter. The effect of scion length on scion diameter of the graft was significant ($P<0.05$), with values ranging from 5.79 to 7.03 mm. (Table 2). The highest mean value was recorded in 10 cm length (7.02 mm); while the least scion diameter was recorded in 5 cm length (5.798 mm).

In terms of point of attachment on rootstock, the highest scion diameter (7.27 mm) was observed at middle point (10 cm) on rootstock; while the least value was recorded at upper point (15 cm) of attachment on the rootstock. For the interactive effect of scion length and point of attachment at rootstock on scion diameter, a significant effect was observed. The highest value of 7.528 mm was observed in 15 cm scion attached on point 10 cm on the rootstock. This was closely followed by 10 cm scion attached to 10 cm rootstock. The least value (4.652 mm) of scion diameter was observed in 5 cm scion attached to point 5 cm on the rootstock.

Rootstock diameter. The effect of scion length on rootstock diameter was evident with scion lengths of 10 cm (7.551mm) and 15 cm (7.593 mm) having similar effects, which were significantly different ($P<0.05$) from length 5 cm (6.997 mm) (Table 2). The effect of point of attachment on rootstock on rootstock diameter was not significant, as the three points produced similar effects on rootstock diameter. The interactive effect of scion length and point of attachment on rootstock was also significant for rootstock diameter. The 10 cm scion attached to point 15 cm on the rootstock favoured the rootstock diameter as this produced the highest value of 9.372 mm.

DISCUSSION

The results of this study are an indication that *A. muricata* can be successfully grafted. Scion length and point of attachment on the rootstock were revealed as important variables that influenced the success rate and survival of *A. muricata* grafts. All the scion lengths evaluated grew vigorously on all the point of attachment tested on the rootstock.

Interaction between scion length and point of attachment on rootstock. Overall, the 15 cm scion length attached at upper part (15 cm) on rootstock has highest survival percentage of 80% (Fig. 1), indicating that insertion of long scions onto the upper part of rootstocks supported survival of grafted *A. muricata* and are more suitable for grafting. The optimum value observed in treatment combination S3R3 (15 x 15 cm) may suggest the ease of developing good union between the cambium in both rootstock and scion, and/ or presence of adequate carbohydrates in both scion and rootstock that may be proportionate to enhance food resource partitioning, thus facilitating good contact and bud growth. Thokchom *et al.* (2019) also reported that 15 cm scion length and 15 cm grafting point on the *Citrus reticulata* recorded maximum values in all the growth variables assessed. Since rootstocks affect scion growth, which is an important indicator of vigour differences among rootstocks (Warmund *et al*., 2012), inserting the scion at the upper rootstock was successful in enhancing the vegetative growth of the grafted *A. muricata,* by increasing the number of leaves as well as the height of the graft. The present study has revealed that 15 cm scion length attached at 15 cm graft height to the rootstock was more suitable for graft survival and growth of *A. muricata* as indicated in the result The highest scion collar diameter produced by 10 cm scion length further confirmed that the survival, as well as growth of *A. muricata* graft, is affected by the length of scion used in grafting.

Effect of point of attachment on the rootstock. Maximum value recorded at 15 cm graft point of attachment for number of leaves and collar diameter (Table 2) may be attributed to presence of flushing buds and higher concentrations of photosyntates that may facilitate bud initiation and subsequent leaf growth. This is in agreement with the findings of Thokchom *et al.* (2019) who noted that graft height has significant influence on survival and growth of *Citrus reticulata*, with best performance recorded at 15 cm graft height. Similar results were also observed in apple grafts where 15 cm grafting point on the rootstock gave the best result (Singh, 2000). Ogunwande *et al.* (2018), also observed that the survival of *Garcinia kola* depended on the position at which it was inserted on the rootstocks, and that scion insertion at upper part of rootstock enhanced the survival of the grafts. The reason for lack of significant effect of rootstock grafting point on height of graft is unclear. However, scion insertion at the upper part of rootstock (15 cm) had the tallest grafts and significantly enhanced the leaf growth which is the photosynthetic site of the plant that is responsible for plant growth and survival.

Effect of scion length. A significant effect of scion length was observed for all the parameters assessed (Table 2). The growth of *A. muricata* graft was influenced by scion length, as the longest scion (15 cm) produced the highest number of leaves, highest graft and the highest rootstock collar diameter (Table 2). This result could be explained by the possibility that the longest scion had a greater number of matured buds where new shoots could emerge, when compared to other lengths. Initial bud break may depend on the development of axillary buds and their maturity sequence affected by the scion length (Heenkenda *et al.,* 2009). However, Thokchom *et al.* (2019) attributed optimum growth in longer scions of *C. reticulata* to larger food reserves in tissues which facilitate bud and leaf growth. This is similar to the findings of Sadhu (1992) that scion length of 15 cm in Sapota produced taller grafts.

CONCLUSION

From the study, the survival and growth of grafted *A. muricata* depends on the length of scion used as well as point at which they are attached on the rootstocks. The10-15 cm long scion should be used and this should be inserted at the upper part (15 cm) of the rootstock for successful graft, survival and growth of grafted *A. muricata*.

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REFERENCES

Adewole, S.O. 2006. Morphological changes and hypoglycemic effects of *Annona muricata* Linn. (Annonaceae) leaf aqueous extract on pancreatic B-cells of streptozotocin-treated diabetic rats. *African Journal of Biomedical Research* (9):173-187

Adewole, S. and Ojewole, J. 2009. Protective effects of *Annona muricata* linn. (annonaceae) leaf aqueous extract on serum lipid profiles and oxidative stress in hepatocytes of streptozotocin treated diabetic rats. *African Journal of Traditional, Complementary and Alternate Medicine* 6:30-41.

De Sousa, O.V., Vieira, G.D.V., De Pinho, J.D.J.R., Yamamoto, C.H. and Alves, M.S. 2010. Antinociceptive and anti-inflammatory activities of the ethanol extract of *Annona muricata* L. leaves in animal models. *International Journal of Molecular Science* 11: 2067-2078.

Eliezer, E.G. 2014. Plant grafting: New mechanism, evolutionary implications. *Frontiers in Plant science* 5:727-736

Hartmann, H.T., Kester, D.E., Davies, Jr F.T., and Geneve, R.L. 2002. Plant propagation: principles and practices. 7th Edition Upper Saddle River, New Jersey, USA. pp. 12-19.

Heenkenda, H.M.S., Gunathilaka, B.L. and Iswara, J.P. 2009. Rootsock-scion interactions of selected Annona species. *Journal of National Science Foundation Sri Lanka* 37:71-75.

Intven, W.J. and Intven, T.J. 1989. Apical grafting of *Acer palmatum* and other deciduous plants. *Proceeding of International Plant Propagation Society Conference* 39:409-12.

Leakey, R.R.B., 2005. Domestication potential of Marula (*Sclerocarya birrea* subsp *caffra*) in South Africa and Namibia: Multi-trait selection. *Agroforestry Systems* 64:51-59.

Leakey, R.R.B., 2014. Plant cloning: Macropropagation. In: Van Alfen, N. (Ed.) Encyclopedia of Agric and Food Systems. Elsevier Publishers San Diego USA. pp. 349-359.

Leakey, R.R.B. and Akinnifesi, F.K. 2008. Towards a domestication strategy for indigenous fruit trees in the tropics. World Agroforestry centre: Nairobi, CAB International Publishinh Wallingford, UK. pp. 28-49

Miller, A.J. and Gross, B.L. 2011. From forest to field: Perennial fruit crop domestication. *American Journal of botany,* 98:1389-1414

Mishra, S., Ahmad, S., Kumar, N. and Sharma, B.K..2013: *Annona muricata* (the cancer killer): A review. *Global Journal for Pharmaceutical Research* 2:1613-1618.

Moghadamtousi, S.Z., Fadaeinasab, M., Nikzad, S., Mohan, G., Ali, H.M. and Habsah,, A. 2015. *Annona muricata* (Annonaceae): A review of its traditional uses, isolated acetogenins and biological activities *International of Molecular Science* 16 (7):15625-15658

Ni Luh Putu Indriyani and Karsinah. 2011. The effect of rootstocks on soursop (A*nnona muricata* L.) grafting. *ARPN Journal of Agricultural and Biological Science* 6(11):29-32.

Ofori, D.A., Peprah, T., Henneh, S., Von Berg, J.B., Tchoundjeu, Z., Jamnadass, R. and Simons, A.J. 2008.Utility of grafting in tree domestication programme with special reference to *Allanblackia parviflora* A. Chev. *Ghana Journal of Forestry* 23 and 24:42-48

Ogunwande, O.A., Majolagbe, M.A. and Adegoke, F.F., 2018. Scion positioning on different points on rootstock: Influence on survival and early growth ofgrafted *Garcinia kola* Heckel. *Proceedings of the Commonwealth Forestry Association (CFA) conference, Nigeria chapter 2*: 164-170.

Pinto, A.C. de Q., Cordeiro, M.C.R., De Andrade, S.R.M., Ferreira, F.R., Filgueiras, H.A., Alves, R.E. and Kinpara, D.I. 2005. *Annona species.* In:William, J.T., Smith, R.W., Hudges, A., Haq, N. and Clement, C.R. (Eds.). *Annona species.* International Center for Underutilised Crops, University of Southampton, Southampton, United Kingdom. pp. 17-25.

Richardson, J.E., Chatrou, L.W., Mold, J.B., Erkens, R.H.J. and Pirie. M.D. 2004. Historical biogeography of two cosmopolitan families of flowering plants: Annonaceae and Rhamnaceae. *Philosophical transactions of the Royal Society of London Series B* 359:1495-1508.

Sadhu, M.K. 1992. Standardization of grafting techniques in Sapota (*Actraszapota* L.). *Acta Horticulturae* 321:610-615.

Singh, R.K. 2000. Studies on rootstock, scion and interstock growth interactions in apple. PhD. Thesis submitted to College of Horticulture., Dr.Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan, India. 168pp.

Tchoundjeu, Z., Asaah, E., Anegbeh, P.O., Degrande, A., Mbile, P., Facheux, C., Tsobeng., A., Atangana, A.R. and Ngo-Mpeck M.L. 2006. Putting participatory domestication into practice in West and Central Africa. *Forests, Trees and Livelihoods* 16:53-70

Thokchom, A., Dilip Singh, R.K., Begane, N., Mathukmi, K. and Sabastian, K.S. 2019. Influence of grafting height and scion length on healing of graft union and growth characteristics of citrus reticulata cv. Nagpur Mandarin grafted on rough lemon rootstocks. *International Journal of Current Microbilogy and Applied Sciences* 8(03):2066-2074.

Warmund, M.R., Cumbie, B.G. and Coggeshall, M.V. 2012. Stem anatomy and grafting success of Chinese chestnut scions on '*AU*-Cropper' and 'Qing' seedling rootstocks. *Hortscience* 47(7):893-895.

Yakubu, F.B., Adejoh, O.P., Ogunade, J.O. and Igboanugo, A.B.I. 2014. Vegetative propagation of *Garcinia kola* Heckel. *World Journal of Agricultural Science* 10:85-90

Yin, H., Yan, B., Sun, J., Jia, P., Zhang, Z., Yan, X. and Chai, J. 2012. Graft union development : A process that involves cell-communication between scion and stock for local auxin accumulation. *Journal of Experimental Botany* 63:4219-4232