

Evaluation of Early Growth of Bitter Kola, *Garcinia Kola* (Heckel) Development under Different Fertilizer Treatments

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Abstract

Garcinia kola seedling growth under different fertilizer treatments was investigated. The study was carried out at the Federal University of Technology, Owerri. The experiment was laid out in completely randomized design. Three different fertilizers with a control were used for the experiment. Each of the treatments was applied on *G. kola* seedlings. Sixty seedlings were used for the experiment with fifteen replicates each/treatment. 500 g of fertilizer was applied to each seedling at 10 cm away from the stem and 5 cm depth. Seedlings were allowed to stabilize for two weeks for nutrient assimilation. Information on seedling height, collar diameters, leaf area and production were collected. Data were analyzed using descriptive statistics and one-way ANOVA. The results revealed that there were no significant differences in mean seedling heights, leaf areas and leaf production among the treatments ($P > 0.05$). However, significant differences existed in mean collar diameters ($P < 0.05$). Seedlings that received poultry droppings recorded highest mean seedling height (44.71 ± 11.02 cm), while the control yielded the least mean height (39.71 ± 9.71 cm). Nevertheless, the values were not significantly different among the treatments. The mean collar diameter was highest in seedlings that received poultry droppings (2.13 ± 0.36 cm) and least in the control (1.81 ± 0.31 cm). Urea and poultry dropping did not differ significantly in terms of collar diameter growths. Similarly, urea and cow dung were not significantly different in mean effects on collar diameter. However, urea and poultry droppings were significantly different from the control. Poultry dropping was the best manure for *G. kola* seedling.

Keywords: Bitter kola, growth response, fertilizer application and seedling

1.0 Introduction

Garcinia kola is a species of flowering plant in the family *Guttiferae*. Its natural habitat is subtropical moist lowland forests. It is found in Benin, Cameroon, Democratic Republic of Congo, Ivory Coast, Gabon, Ghana, Liberia, Sierra Leone and Nigeria (Keay, 1989; Richards, 1990). The fruit, seeds and bark of the plant have been used for centuries in folk medicine to treat ailments from cough fever (Adu-Tutu *et al.*, 1979; Steentoft, 1988; Richards, 1990; Adebisi, 2004). It is traditionally used by Africans, who believe that it has purgative, antiparasitic and antimicrobial properties. The seeds are used to treat bronchitis, throat infections, head or chest colds and cough. It is also used for liver disorders, and as a chewing stick.

Thus, *Garcinia kola*, Heckel is one of the many non-timber forest products that are of high socio-economic importance (Adebisi, 2004). It's most important use is probably as a source of chewing-stick in West Africa, offering natural dental care (Adu-Tutu *et al.*, 1979). The trees are often felled to facilitate both removal of bark and harvest of chewing-sticks, contributing to the increasing scarcity of the species in West Africa (Adu-Tutu *et al.*, 1979). It is highly used for medicinal purposes because of its anti-viral, anti-inflammatory, anti-diabetic, brochio-dilator and anti-hepatotoxic attributes (Ofakansi *et al.*, 2008). Fruit extracts have proven effective in stopping ebola virus replication in laboratory trial (Ofakansi *et al.*, 2008). The sap from *G. kola* is used for the treatment of parasitic skin diseases, while the latex is orally ingested for the treatment of gonorrhea. It is also used in the eradication of guinea worm infestation.

Due to the high interest in its exploitation, *G. kola* is extinction-threatened in several West and Central African countries such as Ivory Coast, Togo, Congo and Cameroon (Eyog-Matig *et al.*, 2007). Another reason threatening the survival of the species is its poor natural regeneration and low-growing seedlings that are uncommon in the wild (Abbiw, 1990; Gyimah, 2000). The species generally exhibits low viability, short-lived, recalcitrant and desiccation sensitive (Morton, 1987; Chacko and Pillai, 1997). According to Gold and Hay (2007), Seed desiccation sensitivity may limit the ex-situ conservation of the species. In spite of the foregoing, little effort has been made to improve the growth conditions, particularly through nutrient supplementation.

Today, it is very hard to find plantation of *G. kola* in Nigeria due to difficulties associated with its propagation. Although studies have documented germination problems of *G. kola* and suggested various means of breaking its dormancy (Gyimah, 2000; Kanmegne and Ndoumou, 2007; Oboho and Urughu, 2010; Oboho & Ogana, 2011; Yakubu *et al.*, 2014), post-nursery performance through the use of nutrient supplements have not been thoroughly investigated. The main objective of the study was to assess the performance of *G. kola* seedlings under different fertilizer applications.

2.0 Materials and Methods

2.1 The study Area

The study was conducted on the Experimental Plot of the Department of Forestry and Wildlife Technology, Federal University of Technology Owerri, Nigeria. The area is centered on latitude 5° 29' 0" N and longitude 7° 2' 0" E in Imo State, south-eastern Nigeria. The mean annual rainfall ranged between 1,250 mm and 3,000 mm, with a relative humidity of about 90 %. The temperatures are between 25 °C and 35 °C.

Sixty (60) seedlings of *Garcinia kola* of five (5) months old were used for the experiment. The initial heights and collar diameters of all the seedlings were taken before the experiment. All the seedlings were planted at the same depth of 15 cm, and 5 m × 5 m spacing. The experiment was laid out in a completely randomized design (CRD). There were four treatments, namely: poultry droppings, cow dung, urea fertilizer, and a

control (zero-fertilizer treatment). After site preparation, fifteen (15) seedlings each were randomly allocated to each of the four treatments, while the control (zero-fertilizer) received no fertilizer application. In the absence of rainfall, the seedlings were watered adequately (once daily). Each manure was applied at the rate of 500 g to a total of 15 seedlings.

2.2 Data Collection

The seedlings were observed on daily basis. Data collections on seedling growth parameters started two weeks after the seedlings have been transplanted (to observe any possible development before the manures were applied). These were done three times before fertilization (i.e. 2nd, 3rd and 4th weeks). After four weeks of planting, the manures were applied, following the design of the experiment (i.e. CRD). The plants were then allowed to grow for another four weeks (i.e. in the 5th, 6th, 7th and 8th week) for possible nutrients assimilations and growth improvements.

The second phase of data collection commenced four weeks after fertilization has been carried out (i.e. at the end of the 8th week of planting). These were then done subsequently on weekly basis for four weeks. The whole experiment and data collection lasted for twelve (12) weeks. During data collection, Seedling heights, root collar diameters and leaf areas were measured using measuring tape, vernier caliper and leaf area metre, respectively. In addition, number of leaves on each of the seedlings counted and recorded. Every visible leaf on the seedlings was counted, including the tips of the new leaves, which were just emerging.

3.0 Results

The result of the one way analysis of variance (ANOVA) for seedling growth parameters under different fertilizer applications are presented in TABLE 1. The results revealed that there were no significant differences in mean seedling heights, leaf areas, and number of leaves/plant among the treatments (including the control) since $P > 0.05$. However, there were significant differences in mean collar diameters under different fertilizer treatments and control ($P < 0.05$).

Table 1: Results of ANOVA for *G. kola* seedlings growth parameters (GP) under different fertilizer (DF) applications

Growth parameter	Source of variation	df	SS	MS	F	P-value
Height	Treatment	3	248.6	82.9	0.87	0.463
	Error	52	4955.7	95.3		
	Total	55	5204.3			
Collar diameter	Treatment	3	1.0391	0.3464	3.55	0.021
	Error	52	5.0721	0.0975		
	Total	55	6.1112			
Leaf area	Treatment	3	665	222	0.88	0.456
	Error	52	13040	251		
	Total	55	13705			
Number of leaves	Treatment	3	279.1	93.0	2.38	0.080
	Error	52	2034.9	39.1		
	Total	55	2314.0			

N.B.: $\alpha = 0.05$

Table 2 presents the results of mean separations (LSD tests) for the seedling growth parameters under different fertilizer treatments. The seedlings that received poultry droppings developed the highest seedling height of 44.71 ± 11.02 cm followed by the value recorded for those that received urea fertilizer (43.51 ± 8.54 cm), cow dung (40.38 ± 9.62 cm), while the control had the least height of 39.71 ± 9.71 cm. The result for collar diameter showed that the poultry droppings produced seedlings with the highest of 2.13 ± 0.36 cm, which was followed by seedlings, which received urea fertilizer and cow dung with 2.06 ± 0.30 cm and 1.84 ± 0.28 cm, respectively. The least collar diameter was recorded under control, which had 1.81 ± 0.31 cm. The result further revealed that there was no significant difference in collar diameters between seedlings that received poultry droppings and urea. However, the collar diameter under poultry droppings significantly differed from the value recorded for seedlings that received cow dung or the control. The result further showed that the mean values under urea and cow dung were not significantly different from each other. Similarly, the effect of cow dung and control did not differ significantly on mean collar diameters.

The leaf areas under different manures showed that seedlings treated with poultry droppings had the largest leaf area of 54.75 ± 11.47 cm² followed by the mean leaf area of 54.63 ± 14.95 cm² recorded under urea fertilizer and leaf area recorded under cow dung (48.29 ± 17.37 cm²). The least leaf area (47.37 ± 14.38 cm²) was recorded under the control. There was no significant difference between the mean leaf area values of the seedlings treated with poultry droppings and urea, likewise cow dung and control differed insignificantly in terms of mean leaf areas.

The result for leaf production showed that Poultry droppings produced seedlings with highest (21) leaves/plant followed by the seedlings treated with urea with 18 leaves/plant. The seedling under the control was the least, with 14 leaves/plant. The results further revealed that there were no significant differences in mean effects of the four manures on leaf numbers.

Table 2: LSD results for Seedling growth parameters (GP) under different fertilizer (DF) treatments

Treatment	Growth parameters			
	Height (cm)	Collar diameter (cm)	Leaf area (cm ²)	Number of leaves
Urea	43.51±8.54 ^a	2.06±0.30 ^{ab}	54.63±14.95 ^a	17.71±6.32 ^a
Poultry dropping	44.71±11.02 ^a	2.13±0.36 ^a	54.75±16.47 ^a	20.71±7.75 ^a
Cow dung	40.38±9.62 ^a	1.84±0.28 ^{bc}	48.29±17.37 ^a	17.14±6.46 ^a
Control	39.65±9.71 ^a	1.81±0.31 ^c	47.37±14.38 ^a	14.43±3.86 ^a
LSD_{0.05}	7.4165	0.2370	12.0361	8.3610

N.B.: means with the same alphabets as superscripts under the same column were not significantly different from each other or one another, as the case may be

4.0 Discussion

Generally, all the manures applied improved the growth of *G. kola* seedlings, as the measured seedling parameters were greater under the three fertilizer treatments (urea, poultry droppings and cow dung) compared to the control (zero-fertilizer application). Among all the fertilizers, poultry droppings consistently produced the highest effects on all the *G. kola* seedling growth variables. This may be due to the fact that the manure had the highest rate of mineralization and assimilation than others, thereby quickening the nutrient uptake in plants resulting in seedling development. It could also be that some soil conditions such as air passages, nutrients, microbial activities and water percolation, down the horizon or soil play supportive role in yield of the seedling species. This corroborates the finding by (N'dayegamiye & Angers 1990), who noted that long-term organic residues or manure application increases microbial activity and potential mineralization of soil organic matter and soil conditions, and play supportive role in seedling growth and yield development in tropical rain forest species.

The mineralization of phosphorus in soil during the growing season is very important for phosphorus availability to plants. Nevertheless, the excessive application of manure or of any phosphorus rich in organic amendments plays a significant role in decreasing the phosphorus sorption capacity in soil

(Beauchamp *et al.*, 1986; Sharpley *et al.*, 1993). Decreased phosphorus sorption capacities might also increase the risk of die-back, which may have been responsible for the die-back of about 12 seedlings under urea fertilizer, perhaps as a result of increased soil acidity beyond tolerable limit of the species. This agrees with the report by Moyin-Jesu (2007), Moyin-Jesu (2008) and Okon *et al.* (2013), who noted negative effects of chemical fertilizers.

Furthermore, the impacts of tillage on the plot may have also affected the growth and development of the seedlings and the availability of nutrient contents in surface soil layer due to poor tillage operations. This is in line with works of Cruse *et al.* (1983) and Weill *et al.* (1990). This may be attributed to the enhanced microbial activity and mineralization of soil phosphorus as noted by Follett and Peterson (1988) or to a lack of soil mixing with fertilizer, thus reducing manure fixation by soil colloids. Therefore, as with fertilization, tillage can alter distribution of nutrient fractions and affect the transformation and transfer of nutrients in soil, leading to a reduction of improvement in plant growth and development as the case may be.

5.0 Conclusion

The study has shown that fertilization improved the growth of *G. kola*. Nevertheless, the effects of the fertilizers on seedling heights, leaf areas and leaf productions were not significantly different from the control experiment. However, fertilization significantly improved *G. kola* collar diameter growth with poultry droppings producing the highest mean growth effects. In context, poultry droppings had the highest mean growth effects on seedling height growth, collar diameter development, leaf areas as well as leaf production. Hence, it can be said that, among the manures investigated, poultry droppings produced the best result in terms *G. kola* seedling growths and development. Therefore, it is highly recommended that poultry droppings be adopted for *G. kola* seedling growth improvement in subsequent propagation of the species.

It was observed that some of the seedlings that received urea fertilizer recorded die-backs which may have been a result of close contact with the plants, or it may be that the amount (500 g) applied was in excess of the required quantity for *G. kola* optimum growth and development. For economical reasons, a considerable quantity of about 500 g is recommended during application under air dried condition, 10 cm away from the stem at 5 cm depth to minimize cost, time and maximize productivity. Nevertheless, when urea fertilizer is to be adopted, a wider spacing between the manures and plants should be considered, while also taking into account, the minimum quantity to reduce casualty. A spacing of up to 20 or 25 cm is recommended.

References

- Abbiw, D. K. (1990). *Useful Plants of Ghana: West African uses of Wild and Cultivated Plants*. Intermediate Technology Publications and Royal Botanic Gardens Kew, London, 337pp.

- Adebisi, A. A. (2004). *A Case Study of Garcinia kola Nut Production-to-Consumption System in J4 area of Omo Forest Reserve, South-West Nigeria*. In: Forest Products, Livelihoods and Conservation: Case Studies on Non-Timber Forest Systems, Sundeland, T. and Ndoye, O. (Eds.). Vol. 2, CIFOR, Bogor, Indonesia. Pp. 1-24.
- Adu-Tutu, M., Afful, L. Y., Asante-Appiah, K., Lieberman, D., Hall, J. B. & Elvin-Lewis, M (1979). Chewing stick usage in South. *Economic Botany*, 33, 320-328.
- Beauchamp, E. G. (1986). Availability of nitrogen from three manures to corn in the field. *Canadian Journal of Soil Science*, 66(4), 1918-1841.
- Chacko, K. C. & Pillai, P. K. C. (1997). Seed characteristics and germination of *Garcinia gummiguta* Robs L. *Indian Forester*, 123, 123-126.
- Cruse, R. M., Yackle, G. A., Colvin, T. C. & Timmons, D. R. (1983). Tillage effects on corn and soybean production in farmer managed, university-monitored field plots. *Journal of Soil and Water Conservation*, 38, 512-514.
- Eyog-Matig, O., Aoudji, A. K. N. & Linsoussi, C. (2007). *Garcinia kola* Heckel seeds dormancy- breaking. *Applied Ecology and Environmental Research*, 5, 63-71.
- Follett, R. F. & Peterson, G. A. (1988). Surface soil nutrient distribution as affected by wheat fallow tillage systems. *Soil Science Society of American Journal*, 52, 141-147.
- Gold, K. and Hay, F. (2007). *Equilibrating seeds to specific moisture levels*. Technical Information Sheet 09. Millennium Seed Bank Project. Kew, UK. 2pp.
- Gyimah, A. (2000). Effect of pre-treatment methods on germination of *Garcinia kola*, Heckel seeds. *Ghana Journal of Forestry*, 9, 39-44.
- Kanmegne, G. & Ndoumou, O. D. (2007). Effects of hormones application on the germination of six population of *Garcinia kola* Heckel (*Guttiferae*) seeds. *International Journal of Biological and Chemical Sciences*, 1(3), 255-261.
- Keay, R. W. (1989). *Trees of Nigeria*. Clarendon Press. Oxford. 476pp.
- Morton, J. F. (1987). Mangosteen (*Garcinia mangostana* L.). In: Fruits of Warm Climates, Morton, J.F (Ed.). Creative Resources Systems, Inc., Miami, FL., Winterville. Pp. 301-304.
- Moyin-Jesu, E. I. (2007). Effect of some organic fertilizers on soil and coffee leaf chemical composition and growth. *University of Khartoum Journal of Agricultural Science*, 15(1), 52-70.
- Moyin-Jesu, E. I. (2008). Comparative evaluation of different organic fertilizers on soil fertility, leaf minerals composition and growth performance of dikanut seedlings (*Irvingia gabonensis*, L.). *Emirate Journal of Food and Agriculture*, 20(2), 1-9.
- N'dayegamiye, A. & Angers, D.A. (1990). Effets de l'apport prolongé de fumier de bovins sur quelques propriétés physiques et biologiques d'un loam limoneux Neubois sous culture de maïs. *Canadian Journal of Soil Science*, 70, 259-262.
- Oboho E. G & Ogana F. N. (2011). Effects of varying water soaking duration on the germination of *Garcinia kola* (Heckel) seeds. *Nigerian Journal of Agriculture, Food and Environment*, 7(2), 57-62.
- Oboho, E. G. & Urughu, J. A. (2010). Effects of pre-germination treatments on the germination and early growth of *Garcinia kola* (Heckel). *African Journal of General Agriculture*, 6(4), 211-218.

- Ofakansi, K. C., Mbanefo, A. N., Ofakansi, M. N. & Esimone, C. O. (2008). Antibacterial interaction of crude methanol extract of *Garcinia kola* seed with gatifloxacin. *Tropical Journal of Pharmaceutical Research*, 7, 1159-1165.
- Okon, J. E, Mbong, E. O., Ebukanson, G. J. & Uneh, O. H. (2013). Influence of nutrient amendments of soil quality on germination, growth and yield components of two varieties of okra (*Abelmoschus esculentus* (L.) Moench) sown at University of Uyo botanical garden, Uyo, Akwa Ibom State. *Journal of Environmental Research and Management*, 4(3), 0209-0213.
- Richards, A.J. (1990). Studies in garcinia, dioecious tropical forest trees: Agamospermy. *Botanical Journal of Linnean Society*, 103, 233-250.
- Sharpley, A.N., Smith, S.J. & Bain, W.R. (1993). Nitrogen and phosphorus fate from long-term poultry litter applications to Oklahoma soils. *Soil Science Society of American Journal*, 57, 1131-1137.
- Steentoft, M. (1988). *Flowering plants in West Africa. 1st Education*. Cambridge University Press, Cambridge. 52pp.
- Weill, A.N., Mehuys, G.R. & McKyes, E. (1990). Effect of tillage reduction and fertilizer type on soil properties during corn production. *Soil and Tillage Research*, 17, 63-76.
- Yakubu, F.B., Bolanle-Ojo, O.T., Ogunade, O.J. & Yahaya, D.K. (2014). Effects of Water Soaking and Light on the Dormancy of *Garcinia Kola* (Heckel) Seeds. *European Journal of Agriculture and Forestry Research*, 2(2), 17-26.