PROVENANCE VARIATIONS IN FRUITS AND SEED MORPHOLOGIES OF *Annona muricata* L. FROM SELECTED ECOLOGICAL ZONES IN SOUTHERN NIGERIA

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Abstract
Different fruits of Annona muricata were sourced from different ecological zones within the southern parts of Nigeria which include Port Harcourt, Ibadan, Umuahia and Benin. The fruits physiological characteristics were taken. Some of these were; fruit length, fruit breadth, fruit weight, average seed weight, number of viable and non-viable seeds. The results shown that fruit from Port Harcourt had the highest length (46.38 mm), fruit breadth (38.64 mm), fruit weight (4.33 kg), number of viable seeds (82.60) and average seed weight (0.54 kg) followed by this is the fruits from Ibadan provenance with a fruit length of (37.66 mm), fruit breadth (30.07 mm), fruit weight (4.92 kg), average seed weight (0.50 kg), number of viable seeds (70.93) and. However, fruits from Benin provenance had the least fruit and seed morphological features with fruit length (33.82 mm), fruit breadth (28.45 mm), fruit weight 3.51 kg and average seed weight (0.43 kg). It was generally recommended that fruit from Port Harcourt has most of the desired characters which are sought in seeds and seedlings production for plantation establishment and therefore the ecological zone is recommended for collection of seeds for raising planting stock.

***Keywords**: Annona muricata, ecological zones, provenance, fruit length, viability test.*

Introduction

Fruits and seeds characterization is a study which plays a major role in successful plant production. The role of good seeds in plantation establishments cannot be overemphasised, therefore maximum attention needs to be given especially at this era of climate change so that selecting good seed source (s) can be achieved as a basis for crop improvements (FAO, 2018). However, the choice of seed sources is a major factor affecting the establishment and productivities of forest plantation on a large basis. In the recent practice of silviculture, provenance research provides a sound basis for the selection of seed sources, which is a yardstick for tree improvement.

Differences in seed germination patterns and seedling growth rates may be due to climatic and geographic influences or more importantly the genetic composition (Villalobos *et al*.., 2002). The genetic component of variation among populations from different regions can, therefore, be identified by testing different seed sources and exploited through selection of superior plant populations.

Annona muricata L. popularly known as soursop is a home garden plant; it is also called guanabana (Melissa, 2018). It is a shrub or small tree of three to ten metres in height. It is adapted to humid tropical climate and can tolerate partial shade. This fruit crop grows in any kind of soil, but does well in loose, fairly rich, deep loam and well-drained soil with pH between 6.0 - 6.5. The young green fruits with soft seeds can be cooked as vegetable; the ripe fruits can be eaten off hand or as dessert, or processed into candies, jams and jelly or processed drinks. The leaves are used as herbal medicine. As a result of its moderate size, the tree can be intercropped as agroforestry species with tree and agricultural crops. It is a good source of vitamins B and C, calcium and phosphorus (Trupti and Rajendra, 2014).

Annona muricata is a promising tropical tree, a good species for agroforestry practices and wealth creation as it provides income generation. *A muricata* is proven to possess a wide spectrum of biological activities for body improvement processes (Orwa *et al*., 2013). According to De Lima *et al*., (2006), there are basic procedures that need to be employed for successful seedlings production that will guarantee plantation establishment of the species: selection of good viable seeds, raising of seedlings, site clearing and land preparation, planting-out of high graded seedlings, weeding, and continuous monitoring of the plantation. Therefore, to reproduce the species that have good vigour and withstand unstable environmental conditions especially for commercial or afforestation project, large number of high graded seedlings is required.

According to Oyebade *et al*., (2012), provenance trials serve as useful tool to support a rational planting decision on sustainable basis for forest improvement, and for fruit and wood production in this rapid changing environment (Akoun, *et al.*, 2009). In forestry sector, the concept of identifying similarities in the climates to match forest seed materials to certain sites in order to assist species selection is a well-established approach for efficient and sustainable forest production (Kapeller *et al*., 2012). The concepts of provenance trial remain valuable in the selection of seeds with desired qualities for propagation especially for seedling production

both for commercial nurseries and plantation establishment (Yeaman, 2006). Provenance is the geographical source or place of origin from where a given lot of seeds or plants materials are collected (Kapeller *et al.*, 2012). The survival of forest plantation, growth performance, volume and quality of forest produce harvested over time in a given plantation is by no doubt influenced by the seed qualities which give birth to quality seedling production (Wang *et al*., 2017). Therefore, this process could be achieved by determining a better seed zone for most forest species thereby reducing the risk of planting poorly adapted tree crops that pose a great threat for sustainable forest growth (Hamann *et al*., 2000) but making use of well adapted plant stock that is able to withstand any environmental imbalance (Charity *et al*., 2015).

Quality seed has been recognized as an important input in forestry and is considered essential for increasing production. Provenances has a great influence on phenological variation in fruits and seeds formation as it affects the fruiting time, fruit sizes and number of seeds per fruit in relation to different ecological areas. Many works have been done on some forest species but there is dearth of information as regard the fruit and seed physiological variation of *A. muricata* in relation to the provenances as this study will go a long way to identify a better seed zones for seedlings production.

MATERIALS AND METHODS

Reconnaissance survey on the abundance of *A. muricata* fruiting trees in some urban settlements in selected states in the Southern parts of Nigeria was carried out. This was done to determine the differences in relative abundance, fruiting period and maturity time for fruit/seeds collection and seasonality.

The provenances in Southern Nigeria were carefully studied and categorized into four major ecological zones; derived savanna, tropical rain forest, high rain forest and swampy forest zone. Two states were strategically visited for the pilot information with respect to selected provenances and studies. Some of the states visited in each classification include; Osun and Oyo (Derived savanna region), Cross River and Abia (humid rainforest region), Ondo, and Edo (dry rainforest region), and Bayelsa and Rivers States (freshwater swamp forest region). However, from the information gathered, four (4) States with highest abundance of the species were considered for fruit collection, one in each ecological zone. These include: Oyo, Abia, Edo and Rivers States. The State Capital of each states were selected since the abundance of the species was mostly observed in the cities. Accordingly, fruit/seeds were collected from Ibadan, Umuahia, Benin City and Port Harcourt.

Seed collection areas

Mature fruits of *Annona muricata* were identified and harvested from the suitable mother plants from the four (4) identified towns in the Southern part of Nigeria. In each of the state, a total number of five (5) locations were identified as fruit collection points. Each of the locations was considered at a distance of five (5) kilometres apart so that the whole community can be adequately covered. Twenty (20) locations were used for fruit and seed collections in all the ecological zones. For ecological zone, the fruits were harvested and number 1 to 25; total number of five (5) fruits were harvested per each location and arranged for fruit and seed morphological examinations. One hundred mature fruits of *A. muricaa* were used for the study.

Experimental site

The study was carried out in the greenhouse chamber of the Tree Improvement Section, Sustainable Forest Management Department, Forestry Research Institute of Nigeria (FRIN), Jericho, Ibadan, Oyo State, Nigeria. FRIN is located on latitude 7° 23' 5" to 7°24 0'0"N and 3° 51' 0" to 3° 52' 15"E (FRIN, 2015).

Seed processing and viability test

Twenty-five (25) fruits were carefully harvested from all the four locations per state (provenance). The fruits were numbered and kept separately in an open chamber to get fermented naturally. This was necessary for easy extraction of the seeds. Plate 1 and 2 showed the fruit and seeds of *Annona muricata.* The seeds extracted per fruit in each of the provenance were counted and carefully identified. Simple water floating test was conducted on the seeds to determine the viability potential of the seeds, the number of seeds extracted, the number of the sinkers and floaters were recorded and statistically analyzed. The seeds were packed separately and air dried for a period of forty-eight (48) hours in an open chamber to prevent fungi attack. The seeds in each of the fruit per provenance were mixed and shaken to allow a homogenous mixing. From the mixture, five hundred (500) seeds were randomly picked from each provenance. A total of two thousand (4 x 500) seeds were measured for various parameters.

Assessment of fruit and seed morphology characteristics of *Annona muricata* from different ecological zones in southern Nigeria

Four (4) states representing the major ecological zones in Southern Nigeria was studied for this experiment. From each selected town per state, five (5) locations were considered; four (4) to five (5) kilometers apart and all the harvested fruits from each location were labeled for the study. Total collected fruits were put together for random sampling. The assessment was carried out on the frame of completely randomized design with ten replicates. Ten (10) fruits of *A. muricata* were randomly selected from the total collections of each provenance for fruit and seed morphological examinations. The fruits collected were measured for the fruit

sizes, this include length (cm), diameter (cm) and fruit weight (kg). Metre rule with the aid of thread was used to determine the length and diameter of the fruits while the sensitive weighing balance was used to determine the fruits weight. Each of the fruits was cut, depulped after it has fermented for two days and extracted for the different seed morphological experiments (Figs 1 &2). Total number of seeds per fruits was recorded, the average weight of seed per fruit was also determined. This was necessary to know the relative contents of the fruits. This was done according to each location and provenance. Data collected were subjected to analysis of variance (ANOVA).

Plate 1: Mature fruit of *Annona muricata*

Plate 2: Seed samples of *A. muricata* according to provenances

RESULTS AND DISCUSSIONS

The means' fruit and seed morphological parameters of *A. muricata* from the four provenances are presented in Table 1.

Fruit length

The value of the fruit length from all the provenances were significantly ($p<0.05$) different from one another as presented in Table 1. The fruits from Port Harcourt had the highest mean value of 46.38 cm, followed by the fruits from Ibadan provenance with the mean value of 37.66 cm while fruits from Benin provenance had the least mean value of 33.82 cm and followed by fruits from Umuahia provenance with the mean value of 34.66 cm.

Fruit breadth

The results of the fruit breadth as analyzed and showed on Table 1 indicated that fruits from Port Harcourt had the highest mean value of 38.64 cm which was significantly ($p<0.05$) different from those from other sources, while the fruit breadth from other provenances were not significantly ($p<0.05$) different from one another: The fruits from Umuahia and Ibadan provenances had the mean value of 30.73 cm and 30.07 cm respectively while Benin had the least mean value of 28.45 cm.

Fruit weight

The results presented in Table 1 indicated that fruit weights from all the provenances were significantly ($p<0.05$) different from one another. The fruits of *A.muricata* sourced from Port Harcourt had the highest mean weight value of 4.33 g; this was followed by the fruits from Ibadan (4.02 g), Umuahia (3.80 g) while the least was weight of fruits from Benin with the mean value of 3.51 g.

Number of viable seeds

According table 1 bellow, the results indicated that seeds of *A. muricata* sourced from Port Harcourt and Ibadan have a significant number of viable seeds with mean values of 82.60 and 70.92 respectively. While on the other hands the results also shown that seeds from Umuahia provenance had the least number of viable seeds with a mean value of (50.52) and was not significantly different from Benin provenance (52.52).

Number of non-viable seeds

The mean values of floated seeds of the *A. muricata* sourced from the different provenances indicated that seeds from Ibadan had the highest mean value of 3.48 and was significantly ($p<0.05$) different from seeds from other provenances. Seeds from Umuahia (3.12) and Benin (2.52) provenances were not significantly different from each other. Seeds from Port Harcourt had the least mean value of 2.20 for the number of floated seeds and were significantly different from other provenance studied.

Average seed weight

The Port Harcourt and Ibadan provenances were not significantly ($p<0.05$) different from one another with the mean value of 0.54 g and 0.50 g respectively but significantly different from the two other provenances (Table 1). Meanwhile seed weight source from Umuahia and Benin provenance were not significantly different from one another but significantly different from Port Harcourt and Ibadan (Table 1). The mean value of Umuahia provenance was 0.45 g while seed weight from Benin provenance had the least mean value of 0.43 g (Table 1).

Table 1: Means of fruit length, fruit breadth, fruit weight, seed weight, viable seeds and non-viable seeds of the provenances

Provenance	Fruit length	Fruit breadth (cm)	Fruit weight (kg)	Number of viable seed	Number of non-viable seeds	Average seed weight (g)
Port-Harcourt	46.38^{a}	38.64^{a}	4.33^{a}	82.60^{a}	2.20^{b}	0.54^{a}
Umuahia	34.66^{bc}	30.73^{b}	3.80^{c}	50.52^{b}	3.12^{ab}	0.45^{b}
Benin	33.82^{c}	28.45^{b}	3.51^{d}	50.96^{b}	2.52^{ab}	0.43^{b}
Ibadan	37.66^{b}	30.07^{b}	4.02^{b}	70.92^{a}	3.48^{a}	0.50^{a}

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

DISCUSSION

It was observed that fruits from Port Harcourt had the highest means' fruit length, fruit breadth, fruit weight, average seed weight and number of viable seed except the number of non-viable seeds which was least level as compared to other provenances. The results was also in line with Oluyole (2010), that *Jathropha curcas* sourced from Port Harcourt had highest germination rate than other sources within the Southern parts of Nigeria. Fruit variability analysis showed that Port Harcourt and Ibadan have the best fruit sizes and was significantly different from Umuahia and Benin provenances. Similarly, the result of the fruit weight, average seed weight and number of sank seeds which determine the germination potential of the seeds indicated that seeds from Port Harcourt and Ibadan were similar to one another but significantly different from the two other locations, while Umuahia and Benin were at the lower level, this also contributed to the amount of viable seeds available per fruit and per provenances that could be planted. On the other hands, the number of non-viable seeds from fruits sourced from Ibadan was on high side and was significantly different from the other three provenances while Port Harcourt source had the least non-viable seeds. This result is in agreement with Ogunwande *et al*., (2014) that average number of seeds of *Garcinia kola* varied with the pod sizes. This is also in contrast with Adeyemo and Odiaka (2005) which reported that there was no significant difference in the average number of seeds with the pod length and breadth of fluted pumpkin. Seeds from Port Harcourt and Ibadan provenances had higher mean seed weight (MSW)

than the seeds from Umuahia and Benin. This is in agreement with the findings of Prusinski (2017) on *Lupinus albus* that the pod that produced the large number of seeds will also produce the largest seeds in terms of the sizes.

CONCLUSION

The seeds from Port Harcourt and Ibadan are recommended as the best source for plantation establishment of *Annona muricata* as both provenances displayed greater fruits and seeds characteristics that can guarantee quality seedlings production for plantation establishment as a means of growing multifunctional trees to combat climate change.

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