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Seedlings Growth Performance of *Diospyros mespiliformis* Hocst. as Influenced by Different Provenances

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ABSTRACT

Seedling growth performance is influenced by several factors which include varying provenances. The seed germination and seedling vigour are being influenced by seed sources. The study therefore investigated comparative studies on seedling growth of *Diospyros mespiliformis* from different provenances. Seeds of *D. mespiliformis* were sourced from four (4) sources namely; Ore (Ondo state), Sapoba (Edo state), Abeokuta (Ogun state) and Ibadan (Oyo state). *D. mespiliformis* seeds were germinated and after germination, uniform seedlings from each provenance were transplanted into nursery polythene pots containing 2kg of top soil. The study comprised of four (4) treatments (Each provenance represents a treatment). The experiment was laid out in Completely Randomized Design (CRD) with five (5) replicates per treatment. Seedlings variables (Plant height, collar diameter and leaf production) were observed and recorded fortnightly for eighteen (18) weeks. At 18th week of study, biomass accumulation (g) was assessed. Data collected were subjected to Analysis of Variance (ANOVA) at 5% level of probability. Seedlings from Edo showed better growth performance It had highest height of 9.57 ±0.53 cm followed by Ondo (9.15 ±0.61 cm), Oyo (8.13 ±0.82 cm) and Ogun with the least (7.87 ±0.81cm). The seedlings collar diameter was highest in Edo (0.64 ±0.29 mm) with the least from Ondo (0.38 ±0.17 mm). In terms of leaf production, seedlings from Ondo produced the highest mean leaves, (4.80 ±0.44) while the least was produced from Ogun (4.45 ±0.39). There was no significant difference (P>0.05) among the provenances. The total biomass accumulation was highest in seedlings raised from seed sourced from Edo (23.87g) followed by Ondo (21.78g) while Ogun provenance had the least (14.64g). Provenances trials provide information about plant growth vigour that can enhance management and conservation the genetic resources of desirable traits for afforestation programmes.

Keywords: *Diospyros mespiliformis*, provenance, growth variables, biomass accumulation

Introduction

Evaluation of adaptive variation within a species' range requires the measurement of ecologically important heritable traits of plants from different sources. (Crandall *et al*., 2000; McKay *et al*., 2005). Over decades ago, provenance trials have been used in forestry for detecting populations with economically desirable characteristics to be targeted for tree-breeding programmes (Guries 1990). Having known source of material in provenance studies, existing trials may be utilized to study variation of ecologically important traits and identify appropriate source populations for restoration. For long-lived, slow-growing species, such as many forest trees, long-established trials provide a unique opportunity to examine later life-history traits, which may reveal important variation not evident in younger plants (McKay *et al*., 2005; Adio *et al*., 2006).

No matter how sophisticated the breeding techniques, the largest, cheapest and fastest gains in most forest tree improvement programs will accrue if use of suitable species and seed sources within species is assured (Zobel and Talbert, 1984). Provenance research is therefore of paramount importance. Provenance is defined as a subdivision of species consisting of genetically similar individuals, related by common descent and occupying a particular territory to which it has become adapted through natural selection. Therefore, the study investigated morphometric variation in *Diospyros mespiliformis* sourced from different provenances.

Diospyros mespiliformis is commonly known as the African Ebony which belongs to the family Ebenaceae. It is a large deciduous tree found mostly in savanna giants that can live for more than 200 years (Coates, 2002). Mature trees have dark gray fissured bark. An adult tree reaches an average of 4 to 6 meters in height, though occasionally trees reach 25 meters. The foliage is dense and dark green with elliptical leaves, which are often eaten by grazing animals such as elephants and buffalo. The tree flowers in the rainy season; the flowers are imperfect with gender on separate trees, and are cream-colored (Albrecht, 1993). The female trees bear fruit in the dry season and these are eaten by many wild animals; they are oval-shaped, yellow and about 20-30mm in diameter. When the fruits ripen, they turn purple and it is a traditional food plant in Africa, this fruit has potential to improve nutrition, boost food security, foster rural development and support sustainable land care (Coates, 1988).

The fruit is edible for humans; its flavor has been described as lemon-like, with a chalky consistency. The seeds can be dried and ground into a flour, and are often used for brewing beer and brandy. The leaves, bark and roots of the tree contain tannin, which can be used as a styptic to staunch bleeding (Coates, 2002). The roots are consumed to purge parasites and are thought to be a remedy for leprosy. The wood of the species is almost impervious to termite damage. The heart wood is fine-grained and strong, and is often used for making wood floors and furniture. Trunks of the tree are used for canoes. The wood ranges in color from light reddish-brown to a very dark brown (Venter and Venter, 1996).

McKay *et al*. (2005) reported in ecological survey of selected species that *D. mespiliformis* is one or the threatened species due to indiscriminate exploitation of the species for commercial purposes. It is threatened in its natural habitat because of overexploitation. Demand for *D. mespiliformis* has resulted in the unsustainable harvesting of the species, leading to local extinctions. To prevent further loss of the species, and to maximize their availability of the one with desired characteristics for human use, there is need to ensure propagation of germplasm from appropriate sources. The source of seed or plant material can have profound implications for the success of restoration efforts because most species exhibit adaptive genetic variation within their range (Ofori and Cobbinah 2007; FAO, 2017). Understanding the geographical distribution of ecologically relevant genetic variation and the environmental factors driving adaptive divergence within species will help to ensure appropriate sourcing of material for ecological restoration.

Materials and methods

Study area

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The study was carried out at the Tree Improvement Nursery of Forestry Research Institute of Nigeria (FRIN). It is located on the longitude 07º 23' 18"N to 07º23' 43"N and latitude 03º51' 20"E to 03º51'43"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 characterized 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. The mean maximum temperature is 31.9^{o}C, minimum 24.2^{o}C while the mean daily relative humidity is about 71.9% (FRIN, 2015).

Experimental procedure

Seeds of *Diospyros mespiliformis* were sourced from four (4) sources namely; Ore (Ondo state), Sapoba (Edo state), Abeokuta (Ogun state) and Ibadan (Oyo state). These provenances have different rainfall, co-ordinates and reliefs (Table 1)

Table 1: The Geographical Positions of different provenances of seeds

Provenances	Latitude	Longitude	Altitude
Ondo	7º 09' and 7^{o} 26'N	5º 78' and 5^{o} 64'E	254m
Edo	6º 33' and 6^{o} 19'N	5º 61' and 5^{o} 23'E	88m
Ogun	7^{o} 47' and 7^{o} 25'N	3^{o} 38' and 3^{o} 21'E	77m
Oyo	8^{o} 59' and 8^{o} 48'N	3^{o} 43' and 3^{o} 45'E	298m

D. mespiliformis seeds from different sources were soaked in hot water for 20 minutes to hasten germination and to obtain a more even germination.

Four plastic germination baskets were filled with washed and sterilized river sand. Sixty (60) seeds from each provenance were broadcast and then covered with enough river sand to avoid exposure of the seeds during watering. They were therefore placed under midst propagator and watered accordingly. After germination, 20 uniform seedlings from each provenance were transplanted into nursery polythene pots (8cm x 16cm) containing 2kg of top soil. Watering was done daily and weeding was carried out as and when due. The study comprised of four (4) treatments (Each provenance represents a treatment). The experiment was laid out in Completely Randomized Design (CRD) with five (5) replicates per treatment.

Seedlings variables (Plant height, collar diameter and leaf production) were observed and recorded fortnightly for eighteen (18) weeks. The Plant height was measured using a transparent graduated ruler and the measurement was taken from the surface of the soil to the terminal bud of the plants. Collar diameter was recorded using veneer caliper while leaf production was determined by physical counting. At 18th week of study, biomass accumulation (g) was assessed. In order to determine total initial and final biomass, four (4) seedlings from each treatment were randomly selected and dipped in a bowl of water to loosen the soil off the roots. The seedlings were gradually uprooted, washed and separated into roots, stems and leaves. Fresh weights were determined using sensitive weighing balance. The separated plant parts were placed in oven at constant temperature of 70^{o}C until constant weights were obtained after 72 hours. Data collected were subjected to Analysis of Variance (ANOVA) at 5% level of probability.

Results and discussion

The result of effects of provenance on the Growth of *D. mespiliformis* Seedlings is presented in table 2. The growth performance of seedlings from Edo showed better growth performance as shown in all the morphological parameters except on leaf production. It had highest height of 9.57 ±0.53 cm followed by Ondo (9.15 ±0.61 cm), Oyo (8.13 ±0.82 cm) and Ogun with the least (7.87 ±0.81cm). The highest collar diameter was also recorded for seedlings raised from seeds sourced from Edo (0.64 ±0.29 mm). This was followed by seedlings from Oyo (0.58 ±0.26 mm), seedlings from Ogun (0.54 ±0.24 mm) and the least from Ondo (0.38 ±0.17 mm). In terms of leaf production, seedlings from Ondo produced the highest mean leaves, (4.80 ±0.44) this was closely followed by seedlings from Edo (4.78 ±0.27) while the least was produced from Ogun (4.45 ±0.39). Successful establishment and the productivity of forestry plantation is governed largely by the species used and the source of seed within species (Kumar *et al*., 2013). According (Shivakumar and Banerjee 1986) regardless the breeding techniques, the largest, cheapest and fastest gains in most forestry improvement processes will be achieved if suitable species and seed sources within species is assured. Seeds were much influenced by their place of origin (Raymond, 2002) especially due to environmental variation in latitude, altitude, rainfall, temperature, moisture, soil and the external factors (Vakshasya *et al*., 1992). The seed source variations were reported on many tree species (Shivakumar and Banerjee, 1986; Murthy, 1989; Masilamani and Dharmalingam, 1999) and were dictated by environ-mental and edaphic factors. This might also be due to altitudinal variation or region of collection (Kumar *et al*., 2013; Oyun *et al*., 2010).

Variation in morphological variables from seedlings from different provenances implies that geographical location and the latitude of the seed sources have greater influence on plant growth (Vera, 2007). The results from this study is in line with findings from Suresh *et al.* (2007) that reported variations in the growth potential of *Acacia nilotica* sourced from different provenances. Many forest tree species including tropical tree species were also reported to exhibit a marked variation between and within provenance such as *Eucalyptus camaldulensis Eucalyptus urophylla*; *Acacia carracicarpa* and *Acacia magnium* (Mahamood *et al.*, 2003; Maelim *et. al.*, 2003; Ofori *et al*., 2007).

Table 3 shows Analysis of variance (ANOVA) for the effects of different provenances on the growth of *D. mespiliformis* Seedlings. There was no significant difference (P>0.05) among the provenances. This could be attributed to the fact that the four sources investigated fall to similar geographical/ecological location. Also genetically make up might have dominated environmental influence on growth variables. This corroborates the assertion of Kitzmiller, (2005) that provenance trials provide pre-requisite knowledge of both genetic and environmental variation which allows direct genetic comparison among seed sources growing in multiple “common garden” or field.

The total biomass accumulation was highest in seedlings raised from seed sourced from Edo (23.87g) followed by Ondo (21.78g) while Ogun provenance had the least (14.64g) (Table 4). This implies that biomass accumulation by *D. mespiliformis* is influenced by efficiency of food production from seeds supplied from

different sources. It could be inferred that seed source constitute life history trait that has on the plant growth variables (Singh and Beniwal, 1993: Hall *et al.*, 2003; Arnold and Cuevas, 2003).

Table 2: Mean Values for the Effect of provenance on the Growth of *Diospyros mespiliformis* Seedlings

Provenance	Plant Height (cm)	Collar Diameter (mm)	Leaf Production
Edo	9.57 ±0.53	0.64 ±0.29	4.78 ±0.27
Ondo	9.15 ±0.61	0.38 ±0.17	4.80 ±0.44
Oyo	8.13 ±0.82	0.58 ±0.26	4.60 ±0.42
Ogun	7.87 ±0.81	0.54 ±0.24	4.45 ±0.39

Mean±SE followed by the same superscripts in column are not significantly different (p> 0.05)

Table 3: Analysis of variance (ANOVA) for the effects of different provenances on the growth of *Diospyros mespiliformis* Seedlings

Variables	SV	df	SS	MS	F	Sig.
Height (cm)	Provenances	3	9.84	3.28	1.33	0.30^{ns}
	Error	16	39.43	2.46		
	Total	19	49.27			
Collar Diameter (mm)	Provenances	3	0.98	0.33	1.11	0.38^{ns}
	Error	16	4.73	0.30		
	Total	19	5.71			
Leaves Production	Provenances	3	0.27	0.09	0.12	0.95^{ns}
	Error	16	11.87	0.74		
	Total	19	12.13			

ns- not significant (p>0.05)

Table 4: Biomass Accumulation of *D. mespiliformis* at 18th week of study

Treatments	Root (g)	Leaves (g)	Stem (g)	Total (g)
Edo	6.92	7.82	9.13	23.87
Ondo	7.49	8.15	6.14	21.78
Oyo	5.54	6.45	7.45	19.44
Ogun	4.21	5.11	5.32	14.64

Conclusion

The significance of provenance trial in forest tree improvement cannot be overemphasized. This is evident in variations observed on the growth variables from seedlings raised from different sources of seeds. The intraspecific variation in the tree species which can be used in making choice of source with appreciable trait was acquired. This will enhance management and conservation of genetic resources of desirable traits.

It is recommended that the best source to collect *D. mespiliformis* for seedling growth and afforestation is Edo state but when

considering distance depending on the location of the collector, Ondo state can be a better source.

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