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Seedling stage variability studies among *Detarium microcarpum* Guill. & Perr. (Sweet dattock) as revealed by measurable morphological parameters

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Abstract
The research work on seedling variability studies among *Detarium microcarpum* Guill & Perr was conducted to assess the variation among the mentioned species as a stage towards domestication in breeding programme. The seeds used for the research were collected from four locations in the Guinea savanna zone of Nigeria; New Bussa, (GNbs); Mokwa, (GMkw); Zugruma, (GZug) and Guffanti, (GGug). The research was carried-out in the nursery of Federal College of Forestry, Ibadan, Nigeria and laid in Completely Randomized Design. Silvicultural activities were performed on the experimental units from seed extraction, cleaning, viability test, sowing at uniform depth, weeding by hand-picking, watering to data collection. Data were collected before sowing on fruits and seeds weight and diameters using electronic scale and graduated ruler respectively. In fruit weight, Zugruma genotype recorded the highest value of 1.17g followed by Mokwa genotype with 1.09g while genotype of Guffanti origin had the least value of 0.67g. On germination percentage, all the genotypes are significantly unrelated with GMkw having the highest mean germination count of 100.67±0.33 followed by GGuf and GNbs with 98.57±1.38 and 95.71±0.74. GNbs has the highest value in height with 15.50±0.31 and significantly related to GMkw of the least value of 12.99±0.01 and of not significant relation to GGuf and GZug which are not also significantly related to one another. Stem girth record showed that there is significant relationship between GMkw and GZug with GMkw having the greater value of 0.26±0.01 but lowest value of 12.99±0.01 in plant height which indicates that plant height is inversely proportional to stem girth. It was then concluded that all the genotypes considered at seedling stage were significantly different from one another showing that there is great measurable variability as revealed by all quantitative morphological characters used among the genotypes of *Detarium microcarpum* considered. And that in breeding programme for domestication of this valuable forest species, parent stocks should be collected from the areas of collection for this research. Also concluded is that further research should be carried-out on the species on early life after planting-out, and all other phenological stages in order to have complete phenological document on the species.

Keywords: seedling stage, variability, modified gravimetric method, genotypes, morphological parameters

1. Introduction
The environment in which man live is dwindling gradually in term of food shortage and environmental pollution. In the cause of this, man is searching everywhere in the forest to find alternative to domesticated plants in order to cushion the effect of devastated environment and all it brought upon men. In the forest and savanna regions of Nigeria, a lot of forest resources that are yet to be discovered and or improved abound. These resources range from timber and non-timber resources among which is *Detarium microcarpum* that serves multipurpose uses to the people of the regions.

Detarium microcarpum is a well known fruit bearing tree species yet in wild. Its distribution cuts across both the derived and guinea savanna zones of the country.

Detarium microcarpum, commonly known as sweet detar, sweet dattock or tallow tree, is an under-utilized leguminous tree that grows naturally in the drier regions of West and Central Africa. It is abundant in Guinea Savanna, Southern Sudan Savanna and Derived Savanna areas of Nigeria. It is a multipurpose species, with a wide range of uses due to its medicinal properties. This makes it a valuable and appreciated species to local communities, but further research and efforts are needed for its domestication (1).

Detarium microcarpum Guill. & Perr is a deciduous tree of the family *Leguminosae*, subfamily *Caesalpinioideae* (2), (3). It is found in semi-arid sub-Saharan Africa from Senegal to Cameroon, extending east to the Sudan. It has an irregular distribution, but it can be locally very common. Typically, it is found in high rainfall savanna areas, dry forests and fallow lands on sandy or iron rich hard soils as well as scattered trees on farms. It also occurs in dry savanna as a more stunted tree with smaller fruits (3) reaching ca. 10 m high and with a dense rounded crown; in wet areas it can grow up to 25 m tall.

The fruits that are drupe-like, circular and disc shaped, containing fibers are edible and rich in vitamin C, potassium and calcium. The seeds, singly embedded within the hard fruits are used to thicken soups (4). *D. microcarpum* is classified as a major African medicinal plant. The roots, stems, bark, leaves and fruits are all used to treat ailments such as tuberculosis, meningitis, itching, syphilis and diarrhea (5), (6), (7), (3). Isolation of terpenoids and anti-HIV flavans from *D. microcarpum* extracts have been reported (6). In Burkina Faso, *D. microcarpum* is also known as the most important commercial fuelwood species harvested from the State forests (8), (9). Its hard dark brown wood provides very high quality fuelwood (19 684 kj/kg) and charcoal (8) and good quality timber that is used in carpentry and construction (3).

In Kainji and its environs in Nigeria, *Detarium microcarpum* trees are so economical that indiscriminate cutting of any attracts litigation from the Emirate Council.

Detarium microcarpum still exists in the wild, and its numerous uses necessitate need for domestication. This calls for deeper knowledge in morphological status of the species through phenotypic variability in genotypes of the Guinea savanna zone of Nigeria.

Phenotypes are traits or characteristics of an organism that we can observe, such as size, color, shape, capabilities, behaviors, etc. Not all phenotypes can actually be seen. For example, blood types are phenotypes that we can only observe using laboratory techniques. Phenotypes can be caused by genes, environmental factors, or a combination of both. Phenotypic variation as an adaptation mechanism is an important biological phenomenon which was not previously known to exist. When aware of it, it is easy to see in plants. (10) reported that plants growing in different environments are likely to grow at different rates, and will be of different sizes and stages of development at a particular age. When we compare plants as a function of plant size or developmental stage, as well as a function of age, we broaden our understanding of phenotypic variation between plants.

2. Materials and Methods

2.1 Experimental site

The research was carried out at the Nursery Unit of Forestry Research Institute of Nigeria, Jericho, Ibadan. The Institute is situated at Jericho area in Ibadan South West Local Government of Oyo State, The area lies on Latitude 7º 23¹ N and Longitude 3º 51¹E. The climate condition of the area is tropically dominated by rainfall pattern from 1200mm-1250mm. The average temperature is about 32ºC, average relative humidity of 80 -85% and the climate of the area experience rainfall with two distinct seasons, dry season usually from November-March and raining season usually from April - October (11).

2.2 Seeeds collection Areas

Two hundred matured fruits of *Detarium microcarpum* were collected from four locations where the species are dominant across Guinea savanna zone. At Northern Guinea Savanna, the locations of collection were New Bussa and Guffanti while collection was also be made at Mokwa and Zugruma in Southern Guinea Savanna. Five fruits were collected per tree of 10 from each location making total number of 200 fruits from 40 trees.

The fruits collected were bulked based on location and the pods split opened with knife to release seeds. The fruit of *Detarium microcarpum* has only one seed.

2.3 Soil collection and sieving

Top soil was collected from less disturbed part of FRIN forested area along the proposed Zoological garden. The top soil was collected on the same point covering 45cm radius to the depth of 5 – 15cm. The collected soil was sieved with 2mm sieve to get rid stones, weeds and other foreign materials that may impede germination and development of the experimental seeds.

2.4 Filling of poly-pots

One hundred poly pots of size 15cm x 25cm was filled with top soil collected to the depth of 5cm – 15cm. The filled poly pots were arranged in the nursery and watered.

Table 1: Materials and their uses

S. No.	Name	Use
1	Seeds	Planting materials
2	Polythene pots	Sowing container to raise seedlings
3	2mm Sieve	Tool for separating foreign materials from soil
4	Hand trowel	Tool for transplanting from baskets to pots
5	Watering can	Tool used for watering sampling units
6	Plastic spoons	Tools used for experimental tagging
7	Electronic Sensitive	Weighing Scale Equipment for measuring fruits and seeds
8	Vernier caliper	Equipment for measuring the seedling girth and other diameter
9	Top soil	Soil medium for growing of the seeds collected from less disturbed area of FRIN forested zone at the depth of 10 – 15cm.
10	Seeds	Tool to split open the fruits to release seeds.

Table 2: Parameters assessed and methods of assessment s/n parameters methods of assessment

S. No.	Parameters	Methods of Assessment
1	Emergence	It refers to the shooting-out of seeds above soil level and measured by counting
2	Seedling height	It refers to the vertical length of the seedling from the soil level to the tip of the seedling and measured using graduated ruler.
3	Seedling girth	It refers to the diameter of seedling measured below the first two true leaves above the soil surface with Vernier caliper
4	Number of Leaves	It refers to the number of leaves produced on each seedling by counting.
5	Leaf area	It refers to the coverage portion of leaf using modified gravimetric method.
6	Root number	It refers to the number of roots produced by the seedling using counting method.
7	Seed weight	This is the weight of the seed measured by sensitive scale.
8	Seed diameter	It refers to the diameter of the seed using Vernier caliper.
9	Fruit weight	It refers to the weight of the fruit measured by sensitive scale.
10	Fruit diameter	It refers to the diameter of the fruit using Vernier caliper.

2.5 Seeds cleaning, viability test and sowing

One hundred and sixty seeds of *Detarium microcarpum* were selected from the 200 location-based bulked seeds, cleaned by making sure no seed of other plant was found, and wrinkle and broken seeds were removed, and other foreign materials were made non-available.

Viability test was performed on the seeds using water floatation method. In this method, seeds were poured in a clean bowl containing pure water. Any seed found floated in the water was removed and categorized as non-viable as a result of dead cotyledon. But the one that wholly or partially immersed in water was considered viable and was used for the research.

After the seeds might have being certified viable via water floatation method, the seeds were planted in top soil filled poly pots (One seed per pot) by sowing at the depth of 2.5cm with horizontal planting positioning.

The experimental units were watered twice a day; early in the morning around 7:00 – 8:00 a.m and in the evening around 6:00 – 6: 45p.m.

2.6 Research treatments

Four treatments were identified in the experiment. The treatments were based on locations as part of environment which has been seen as one of the factors affecting the genetic constituent of plant.

Treatment A: Genotypes from New Bussa. [GNbs]
Treatment B: Genotypes from Guffanti. [GGuf]
Treatment C: Genotypes from Mokwa. [GMkw]
Treatment D: Genotypes from Zugruma. [GZug]

2.7 Experimental design

The research work was set up in a FRIN nursery in Completely Randomized Design with identified 4 treatments based on location.

2.8 Data Collection

Data were collected from parameters highlighted in table 2 above from 100 seedlings (25 seedlings per location). Data on parameters numbered 11 to 15 were taken before sowing and on 5 fruits/seeds per location while that of parameters numbered 1 to 10 were taken after sowing on 100 seedlings. At interval of 4 weeks, 5 seedlings per location were uprooted for root analysis.

Data were collected daily for emergence and fortnightly for other parameters.

From germination count, germination percentage was deduced using the formula below;

$$\text{Germination \%} = \frac{\text{NSG}}{\text{NSP}} \text{X} 100$$

Where; NSG is the Number of Seeds Germinated, NSP is the number of Seeds Planted.

The Leaf Area was measured using modified gravimetric method. The leaves to be measured will still be intact on the parent plant and tagged. (This modifies the gravimetric method initiated by (12); (13) where the leaf would be plucked before the leaf area could be measured which made the method a destructive method). One leaf each was taken at each nodal region of the seedling and average leaf area was calculated per seedling. White plain paper was provided and each leaf was carefully placed and traced on the paper. The traced line was then cut carefully of each traced leaf and weighed using electronic sensitive scale. Plain paper of the same gram measured 1cm^2 was carefully cut and weighed

$$\text{Leaf Area} = \text{X/Y cm}^2$$

Where;
X is the weight of leaf traced paper; Y is the weight of 1cm^2 plain paper.

2.9 Data analysis

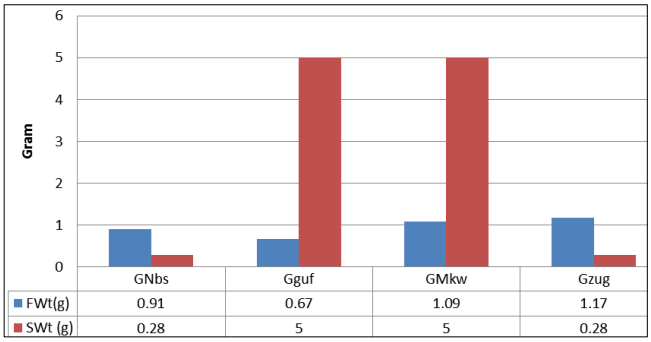
Data collected were analyzed using SAS package 2011.

Data collected on fruits and seeds weight and diameter with roots proliferation were presented using graph.

Mean square of all the parameters in relation to the genotypes was determined to identify the significant relationship among the genotypes.

ANOVA was used to test the significant differences among the parameters considered.

3. Result and Discussion

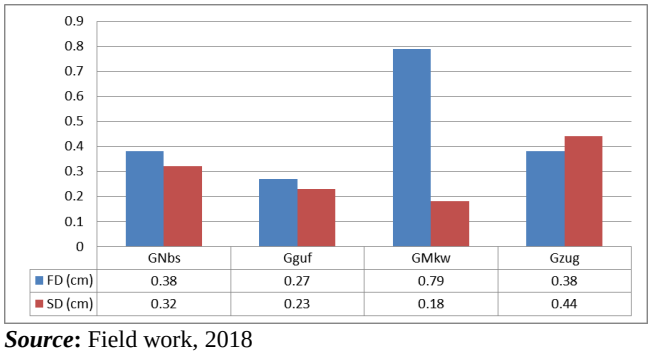


***Source*:** Field work 2018

Fig 1: Fruit-Seed Weight Analysis of *Detarium microcarpum*

GNbs, New Bussa Genotype; GGuf, Guffanti Genotype; GMkw, Mokwa Genotype; GZug, Zugruma Genotype; FWt, Fruit Weight in gram; SWt, Seed Weight in gram.

From figure 1, both the fruit and seed weight of *Detarium microcarpum* from Guinea savanna zone of Nigeria were taken using electronic weight scale. In fruit weight, Zugruma genotype recorded the highest value of 1.17g followed by Mokwa genotype with 1.09g while genotype of Guffanti origin had the least value of 0.67g. With this, it indicates that GZug genotype will be graeter in both the seed and fleshy spongy parts of the species fruit. Considering the seed weight, both GGuf and GMkw had the equal greatest value of 5.00g with GZug and GNbs having the same least value of0.28g. This indicates that seeds of both GGuf and GMkw have highest cotyledon in term of food reserve which will add to the germination and growth vigour of the species.



***Source*:** Field work, 2018

Fig 2: Fruit-Seed Diameter Analysis of *Detarium microcarpum*

GNbs, New Bussa Genotype; GGuf, Guffanti Genotype; GMkw, Mokwa Genotype; GZug, Zugruma Genotype; Fruit Diameter in cm; Seed Diameter in cm.

Figure 2 depicts the diameter trend in cm of fruit and seed of selected genotypes of *Detarium microcarpum* with GMkw having the highest value of fruit diameter but least value in seed diameter of 0.79cm and 0.18cm respectively. This indicates that the fruit of *Detarium microcarpum* of Mokwa origin is fleshy followed by Gzug with 0.38cm and 0.44cm for fruit and seed diameter respectively while GGuf has the least fruit diameter of 0.27cm, and seed diameter of 0.23cm.

Table 3: Mean separation showing the significant relationship in shoot morphological traits among the *Detarium microcarpum* genotypes

Locations	Germination	Plant Height	Number of leaves	Stem Girth	Internodes	Number Branches	Leave Area
GNbs	95.71±0.74^{b}	15.50±0.31^{a}	19.11±0.01^{a}	0.19±0.00^{a}	0.35±0.00^{d}	7.88±0.01^{a}	0.04±0.00^{b}
GGuf	98.57±1.38^{c}	15.21±0.00^{c}	19.92±1.03^{a}	0.23±0.00^{b}	0.29±0.00^{a}	8.40±0.06^{b}	0.04±0.00^{b}
GMkw	100.67±0.33^{d}	12.99±0.01^{a}	23.26±0.03^{b}	0.26±0.01^{c}	0.32±0.00^{b}	9.33±0.05^{c}	0.03±0.01^{a}
GZug	78.57±0.59^{a}	14.59±0.06^{b}	24.75±0.88^{c}	0.25±0.00^{c}	0.34±0.01^{c}	9.48±0.05^{d}	0.03±0.01^{a}

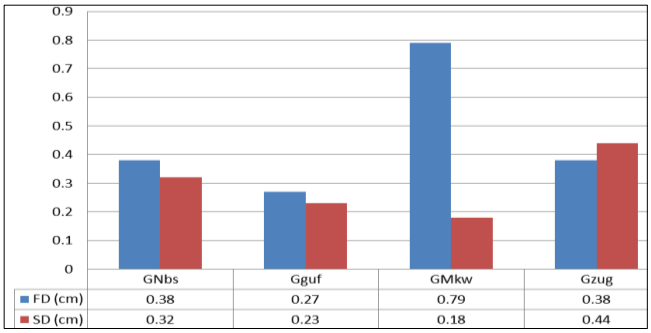
Mean ± SE with the different alphabet in column are significantly different (P<0.05)

GNbs, New Bussa Genotypes; GGuf, Guffanti Genotypes; GMkw, Mokwa Genotypes; GZug, Zugruma Table 3 above reveals the significant relationship among the seedlings of *Detarium microcarpum* genotypes. On the perspective of germination, all the genotypes are significantly unrelated with GMkw having the highest germination count of 100.67±0.33 followed by GGuf and GNbs with 98.57±1.38 and 95.71±0.74 while GZug has the lowest germination count of 78.57±0.59. This reveals that the first three genotypes should be considered in term of germination as against GZug with germination below 80%. Since there is no standard germination percentage for forest seeds due their high wild intrinsic ability and longevity in maturity compared with agricultural crops, germination rate of 75% should be considered standard for forest seeds.

Within the period of the research, GNbs has the highest value in height with 15.50±0.31 and significantly related to GMkw of the least value of 12.99±0.01 and of not significant relation to GGuf and GZug which are not also significantly related to one another. This indicates that germination is directly proportional to height.

From stem girth, the result showed that there is significant relationship between GMkw and GZug with GMkw having the greater value of 0.26±0.01 but lowest value of 12.99±0.01 in plant height which indicates that plant height is inversely proportional to stem girth.

On leaf area, there is significant relationship between GNbs and Gguf, and GMkw and Gzug. Both GNbs and GGuf had the highest value of 0.04±0.00 appease while GMkw and GZug had 0.03±0.01 appease. This indicates that both GNbs and GGuf would have higher photosynthetic capability than GMkw and GZug which would aid their growth. This is supported by the work of (14) stated that leaf area is an important variable for most Eco physiological studies in terrestrial ecosystems concerning light interception, evapotranspiration, photosynthetic efficiency, fertilizers, and irrigation response and plant growth



***Source*:** Field work, 2018

Fig 3: Root Number Analysis of *Detarium microcarpum*

WK, Week; GNbs, New Bussa Genotype; GGuf, Guffanti Genotype; GMkw, Mokwa Genotype; GZug, Zugruma Genotype Figure 3 shows the root analysis of *Detarium microcarpum* in term of proliferation and counting every four week during the research period.

At the end of the collection, GZug had the highest number of root proliferation to the tune of 91 followed by GNbs with 83 while the least value of 60 has GGuf. From this, it showed that the anchorage ability of the species is okay with even the least root number at 60. Apart from this, the nutrient absorption level of GZug would be the greatest with the hope of enhanced growth. This conforms to the report of (15) "Roots are very important for the plant because they suck the water and nutrients up out of the soil and into the plant" and that of (16) assertion, "the roots anchor the plant in place, resisting the forces of wind and running water or mud flow. The root system takes in oxygen, water and nutrients from the soil, to move them up through the plant to the stems, leaves and blooms. Roots often store the energies created by the plant through photosynthesis, to make them available to the plant as it is needed. Plant roots also stimulate and support microorganisms in the soil that benefit plant life".

Table 4: Analysis of variance showing the significant differences among the *Detarium microcarpum* genotypes as revealed by morphological traits

Parameters	Source of Variation	df	Sum of Squares	Mean Square	F	Sig.
Germination	Locations	3	2443.10	814.37	463.03	0.00*
	Error	28	49.25	1.76		
	Total	31	2492.35			
Plant Height	Locations	3	29.99	10.00	195.46	0.00*
	Error	28	1.43	0.05		
	Total	31	31.42			
Number of leaves	Locations	3	172.20	57.40	54.92	0.00*
	Error	28	29.27	1.05		
	Total	31	201.47			

Stem Girth	Locations	3	0.02	0.01	460.42	0.00*
	Error	28	0.00	0.00		
	Total	31	0.02			
Internodes	Locations	3	0.01	0.00	51.18	0.00*
	Error	28	0.00	0.00		
	Total	31	0.01			
Number Branches	Locations	3	14.00	4.67	1062.42	0.00*
	Error	28	0.12	0.00		
	Total	31	14.13			
Leave Area	Locations	3	0.00	0.00	14.47	0.05*
	Error	28	0.00	0.00		
	Total	31	0.00			

*-Significant (P<0.05)

From table 4 above, the analysis of variance on all parameters considered among the four genotypes of *Detarium microcarpum* selected for research showed that there is significant difference among all the genotypes at probability level of 0.05 (P<0.05). This indicates that each and every genotype selected can be chosen for growth selection depending on the parameter aimed to develop.

4. Conclusion

From the result, it was concluded that all the genotypes considered are significantly different from one another showing that there is great measurable variability among the genotypes of *Detarium microcarpum* considered.

However, it was concluded that GMkw, GGuf and GNbs had germination percent of 100.67±0.33 98.57±1.38 and 95.71±0.74 respectively far beyond standard germination percentage of 85%. This and other growth parameters considered serve as pointer to the fact that each genotype can be considered for domestication and/or crossed with one another to have desirable traits.

5. References

1. Ajani MO, Ojo MO, Okeleke SO, Agboola FO. Investigating the Growth Response of Sweet Dattock (*Detarium microcarpum* Guill and Perr) to Selected Forms of Poultry Manure in 2nd Conference Proceedings of Commonwealth Forestry Association, Nigeria Branch, 2018, 284.
2. Watson L, Dallwitz MJ. The genera of Leguminosae-Caesalpinioideae and Swartzieae: descriptions, identification and information retrieval, 1993, http://delta-intkey.com.
3. Vautier H, Sanon M, Sacandé M. *Detarium microcarpum* Guill. & Perr. Forest & Landscape Denmark, Millennium Seed Bank Project. Seed Leaflet. 2007; 122:2.
4. Akpata MI, Miachi OE. Proximate composition and selected functional properties of *Detarium microcarpum*. Plant Foods for Human Nutrition (Formerly Qualitas Plantarum. 2001; 56(4):297-302.
5. Arbonnier M. Arbres, arbustes et lianes des zones sèches d'Afrique de l'Ouest (2nd ed.). Montpellier. CIRAD, MNHN, UICN, 2000, 542.
6. Abreu P, Relva A. Carbohydrates from *Detarium microcarpum* bark extract. Carbohydrate Research. 2002; 337(18):1663-1666.
7. Kouyaté AM, Van Damme P. (eds.). Medicinal plants/ Plantes médicinales 1. [CD-Rom]. PROTA Foundation, Wageningen, Netherlands. 2006; 11:1.
8. Kaboré C. Aménagement des forêts au Sahel – Point sur vingt années de pratiques au Burkina Faso. Ouagadougou, Burkina Faso. Ministère de l'Environnement et de l'Eau, 2005.
9. Savadogo P, Tigabu M, Sawadogo L, Odén PC. Woody species composition, structure and diversity of vegetation patches of a Sudanian savanna in Burkina Faso. Bois et Forêts des Tropiques. 2007; 294(4):5-20.
10. James SC, Kelly DMM, David DA. Interpreting Phetypic Variation in Plants. Journal of Trends in Ecology & Evolution. 1994; 19(5):187-191.
11. Forestry Research Institute of Nigeria, (FRIN), Meterological Report on Weather Forecast, 1994-2015.
12. Ross J, Ross V. Phytometrical characteristics of the willow plantation at Toraver. Joint Swedish–Estonian seminar, 24–26. Swedish Univ. Agric. Sci. Uppsala, Report. 1995; 57:133-145.
13. Pandey SK, Hema Singh. Leaf Area Distribution Pattern and Non- destructive Estimation Methods of Leaf Area for Stevia rebaudiana (Bert) Bertoni. Asian Journal of Plant Science, 2011.
14. Blanco FF, Folegatti MV. Estimation of leaf area for greenhouse cucumber by linear measurements under salinity and grafting, Agricultural Science. 2005; 62(4):305-309.
15. Kid Ecology Corps. Importance of Roots. Surfed at, 2010, www.kidsecologycorps.org
16. Easy to Grow Bulb. Importance of Healthy Roots to Plants. Surfed at, 2019, www.easytogrowbulb.com