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Variation studies in progenies of *Dialium guineense* Willd

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ABSTRACT
The study assessed variation in progenies of *Dialium guineense* Willd. Mature fruits of *Dialium guineense* were collected from four sources in Nigeria: Ijebu-Ode (latitude $6^0 40^1$N and longitude $3^0 50^1$E), Iperu (lat. $6^0 40^1 30$sN and long. $3^0 40^1 20$sE), Moniya (lat. $7^0 23^1$N and long. $3^0 54^1$E) and Odogbolu (lat. $6^0 40^1 20$sN and long. $3^0 40^1 30$sE). Fruits were depulped to extract seeds. Two hundred seeds from each progeny source were sown in germination trays containing washed-sterilized river sand and set under high humidity propagator. Germinations were observed till sufficient seedlings for the study were obtained. At four-leaf stage, forty uniformly growing seedlings from each seed source were transplanted into polythene pots (16cm x 14cm x 12cm) filled with topsoil and laid out in the open nursery in Randomised complete block design. Assessment of seedling growth for height, stem diameter, number of leaves and total dry weight was done fortnightly for twelve weeks. Data collected were subjected to analysis of variance. Significant differences ($P \leq 0.05$) were observed in the growth parameters assessed. Odogbolu seedlings had the highest mean height value of 14.7cm and highest mean diameter value of 1.8mm followed by Iperu with values of 13.7cm and 1.7mm for both height and diameter respectively while the lowest mean height and diameter values of 11.5cm and 1.6mm respectively were recorded among Moniya seedlings. There were no significant differences in leaf production by seedlings among the sources although age had significant effect on it. Odogbolu seedlings had the highest mean total dry weight value of 0.24g followed by those of Iperu with a value of 0.20g while Moniya gave the lowest mean total dry weight value of 0.18g. Furthermore, there were positive correlations between height of seedlings and diameter; height and number of leaves as well as diameter and number of leaves of seedlings from the sources as the values for r closely approached 1. Moreover, net assimilation rate (NAR) and relative growth rate (RGR) varied among the progenies. The implications of the results were discussed for further improvement of this multipurpose tree species.

Keywords: Net assimilation rate, Progeny, Relative growth rate. Seedling growth parameters.

INTRODUCTION

Forest has productive, protective and social functions (Mathew 1994). However, this important resource is being subjected to abuse from overexploitation to meet increasing needs of a rising human population; and land conversion into other competing land uses. This practice is causing genetic erosion of plant species especially trees. Gbadamosi (2005) opined that variation in population of species allows for conservation of unique genetic units and also provides a backup for the survival of these organisms. A quicker and cheaper alternative means in tree improvement strategies apart from field trials such as species elimination trials is the evaluation of the species performance and the selection of the progenies with the desirable characteristics since field trials such as species elimination trials could often be time consuming and expensive (Fatokun et al. 1994).

Progeny as defined by Dunster (1996) means the offspring of a particular tree. Progeny variation is highly important to tree improvement in that if superior trees are not chosen for breeding, all the effort of a tree breeder will amount to failure and subsequently money and labour would have been wasted. Before any species can even be tested on whether it is adapted to any site or not, progeny variation within such species need be carried out. Progeny variation is species specific as the variations existing within a particular species may be very different in another species even if both species belong to the same family.

Dialium guineense commonly known as Velvet tamarind is a woody perennial growing in dense Savannah forests, Shadowy canyons and Gallery forests (ICRAF 1996). It has been suggested for use in agroforestry both as a leguminous tree capable of fixing Nitrogen and as fodder for animals (Evans 1997, Larbi et

al. 1998, Ubani and Tewe 2001). Moreover, Shelton (2000) has recognized the importance of tree legumes for their multipurpose contributions to the productivity of farming systems, to the welfare of people and to the protection of the environment. Also, the introduction of tree and shrub legumes in agroforestry and livestock feeding systems offers promise for meeting the increasing demand for feed resources worldwide. Velvet tamarind fruits are consumed for their sweet edible pulp and the timber is also known to be hard and durable for use in house construction and flooring (ICRAF 1996). *Dialium guineense* has been classified as a multipurpose tree species by many authors (Okeke and Omaliko 1991, Evans 1997, Larbi et al. 1998). Moreover, in southeastern Nigeria, it is a predominant fallow species and it is believed to restore lost soil fertility as it usually emerges as one of the pioneer species in abandoned lands. It has been recommended for use in outlying farms in the forest area as agroforestry tree crop. Also, the wood is said to be a good source of charcoal (Okafor 1981). It supplies some farming materials such as stakes and mulch. Hence, this study of progeny variations in *Dialium guineense* Willd was carried out to document the variability in growth parameters as a prelude to the improvement of the species.

MATERIALS AND METHODS

Fruit collection, seed extraction and germination

Mature fruits of *Dialium guineense* were collected from four sources in Nigeria. Ijebu-Ode (latitude $6^0 40^1$N and longitude $3^0 50^1$E), Odogbolu (latitude $6^0 40^1 20$sN and longitude $3^0 40^1 30$sE), Iperu (latitude $6^0 40^1 30$sN and longitude $3^0 40^1 20$sE) and Moniya (latitude $7^0 23^1$N and longitude $3^0 54^1$E). Fruits from each source were depulped manually and seeds were extracted from them. Two hundred seeds per progeny source were sown in germination trays containing sterilized-washed river sand and set under high humidity propagator. Germinations were observed till sufficient seedlings needed for the study were obtained.

Seedling Growth and Biomass Assessment

At the four-leaf stage, forty uniformly growing seedlings from each source were transplanted into medium-sized polythene pots of dimension 16cmx14cmx12cm filled with topsoil. Also, five additional seedlings per source were transplanted to serve as buffer to augment for edge effects. The seedlings were allowed to wean under shade for two weeks before they were laid out in the open nursery in completely randomized design in three replicates. The following growth parameters viz height, stem diameter and number of leaves per seedling were measured fortnightly for twelve weeks. Height of seedling and collar diameter were measured using metre rule and caliper respectively. Biomass assessment of the seedlings was conducted through destructive samplings. On each occasion, five seedlings were randomly selected from each source and carefully uprooted in a bowl of water. The uprooted seedlings were each divided into root and shoot components. The total leaf area of each seedling was determined using the grid method. Afterwards, root and shoot components of each seedling were oven-dried for

24hours at 80^0C. The samples were allowed to cool to a constant temperature before the dry weights were measured using an electronic weighing balance. The data collected were used to calculate the Relative Growth Rate (RGR) and Net Assimilation Rate (NAR); and the entire data set was subjected to statistical analysis using SPSS package.

RESULTS

Seedling Height

There were significant differences ($P \leq 0.05$) in height of seedlings from the sources (Table 1). Odogbolu seedlings had the highest mean height value of 14.7cm followed by progenies from Iperu with a value of 13.7cm while the lowest mean height value of 11.5cm was recorded among the progenies from Moniya. There were significant differences in the mean height value of seedlings from the different sources (Table 2). There were differences in seedlings height across the assessment period and among progenies (Table 3). The greatest mean height value of 14.8cm was observed at weeks 10 and 12 followed by week 8 with a value of 14.5cm in Odogbolu seedlings while the least value of 7.6cm was observed at week 2 in Moniya seedlings.

Diameter

Seedling stem diameter differed significantly among the sources ($P \leq 0.05$) (Table 1). The highest mean value of 1.8mm was observed among the progenies of Odogbolu closely followed by 1.7mm for Iperu while the value of 1.6mm was recorded for both Ijebu-Ode and Moniya. The mean stem diameter of Odogbolu seedlings was significantly different from those of other sources (Table 2). Seedling stem diameter also differed among progenies across the assessment period (Table 3). The greatest mean stem diameter value of 2.5 was observed at week 12 in Odogbolu seedlings followed by 2.3mm in Ijebu-Ode seedlings while the least value of 0.8mm was observed at week 2 in Moniya seedlings.

Leaf Production

There were no significant differences ($P \leq 0.05$) in leaf production by seedlings among the sources (Table 1). Also, there were no significant differences in the mean number of leaves among the different progenies (Table 2).

Total Dry Weight

Biomass accumulation among the progenies varied significantly at $P \leq 0.05$ (Table 1). The highest mean total dry weight of 0.24g was observed among the seedlings of Odogbolu followed by those of Iperu with a

value of 0.20g. The seedlings of Ijebu-Ode and Moniya gave mean values of 0.19g and 0.18g respectively. The mean total dry weight of Odogbolu seedlings was significantly different from those of other sources (Table 2). Period of assessment also revealed significant differences among the progenies. Odogbolu seedlings harvested at week 12 had the highest mean biomass value of 0.45g followed by those of Ijebu-Ode and Iperu with mean values of 0.40 and 0.35g respectively. The lowest mean biomass value of 0.07g was recorded in week 2 among Ijebu-Ode and Odogbolu seedlings (Table 3).

CORRELATION ANALYSIS FOR THE GROWTH PARAMETERS

Correlation analysis was carried out to determine any relationship between growth parameters and period and among growth parameters and period, the result showed marked significance ($P \leq 0.05$) as revealed in Table 4. There is direct relationship between assessment period and height, assessment period and diameter, and assessment period and leaf number since correlation coefficient r, is greater than zero for all the possible combinations. It means as the assessment period increases, each growth parameter also increases. Moreover, the relationship is stronger between period and diameter; and period and leaf number each having r-values of 0.94 and 0.91 respectively hence closely approaching 1.

Furthermore, there were positive correlations between height of seedlings and diameter; height and number of leaves as well as diameter and number of leaves of seedlings from the sources.

Leaf Area

There were significant differences in leaf area among the progenies from the different sources ($P \leq 0.05$) as shown in Table 1. The highest mean leaf area was recorded among the seedlings from Odogbolu with a value of 24.7cm^2 followed by Moniya and Iperu seedlings with a value of 20.6cm^2 each while the lowest mean value of 19.9cm2 was observed in Ijebu-Ode seedlings. The mean leaf area of Odogbolu seedlings was significantly different from those of other sources (Table 2).

The interaction between progeny and assessment period gave no significant effect on leaf area production among the seedlings. However, assessment period had significant effect on leaf
area among the progenies (Table 3).

Net Assimilation Rate (NAR)

The values of NAR for the different progenies across the assessment period are given in Table 5. In weeks 2 - 4 (between second week and fourth week), Odogbolu progeny had the highest NAR value of $2.2x10^{-3}g/cm^2/wk$) followed by Moniya progeny with a value of $1.7x10^{-3}g/cm^2/wk$. Both Ijebu-Ode and Iperu had the same value of $1.0x10^{-3}g/cm^2/wk$. The result of weeks 4 – 6 revealed the same value of $1.2x10^{-3}g/cm^2/wk$ for all the progenies except Moniya which had a value of $8.0x10^{-4}g/cm^2/wk$. In weeks 6 – 8, NAR value is highest in Ijebu-Ode with the lowest in Odogbolu, Iperu had the highest value of $2.0x10^{-3}g/cm^2/wk$ in weeks 8 – 10 while the lowest value of $1.2x10^{-3}g/cm^2/wk$. In weeks 10 – 12, Ijebu-Ode had the highest value of $2.0x10^{-3}g/cm^2/wk$ while Moniya had the lowest value of $7.0x10^{-4}g/cm^2/wk$.

The highest mean NAR value across the assessment period was obtained in the seedlings of Odogbolu and Ijebu-Ode progenies being $1.5x10^{-3}g/cm^2/wk$ while the least was obtained in Moniya seedlings being $9.0x10^{-3}g/cm^2/wk$.

Relative Growth Rate (RGR)

The data on RGR are given in Table 6. Odogbolu progenies had the highest RGR value in weeks 2 – 4 with a value of 0.3364g/wk while Moniya had the least value of 0.1151g/wk. Furthermore, weeks 4 – 6 revealed a similar pattern to that of weeks 2 – 4. However, in weeks 6 – 8, Ijebu-Ode had the highest value of 0.1966g/wk while Odogbolu had the lowest value of 0.0912g/wk. 0.1866g/wk and 0.1135g/wk are the highest and lowest values obtained in Iperu and
Moniya respectively for weeks 8 – 10 while 0.1663g/wk and 0.0589g/wk are the highest and lowest values for weeks 10 – 12 obtained in Ijebu-Ode and Moniya progenies respectively.

Odogbolu seedlings had the highest overall mean RGR value of 0.1810g/wk followed by Ijebu-Ode seedlings with a value of 0.1678g/wk while Moniya had the lowest value of 0.1220g/wk.

ROOT LENGTH

The ratio of mean initial root length to mean final root length was computed for all the progenies and the result is shown in Table 7. Moniya progeny had the highest ratio of 1:4.01 while Odogbolu had the least of 1:2.74. The values of Ijebu-ode and Iperu progenies are very similar and these are 1: 3.47 and 1: 3.50 respectively.

DISCUSSION AND CONCLUSION

In order to achieve success in any tree improvement strategy, proper attention should be given to the genetic diversity occurring in that tree species. The differences can be exhibited not only between species but also within species. In other words, it may be impossible for progenies of the same species to express the same phenotypic traits even if they are full-sibs because of the effect of environmental factors. Therefore, a tree breeder is usually interested in experimenting with the seeds obtained from different progenies in order to make proper recommendations for selecting the suitable progeny for large-scale afforestation programme or plantation establishment inevitable.

There were significant differences in the growth parameters studied except in the number of leaves where the difference was not marked except in Moniya progeny. The results observed
in both the height growth and diameter increment among the four progenies confirm the existence of variations among the progenies. The significant levels of variation obtained in seedling height growth and diameter increment agreed with the earlier work of Adedire (1986) who obtained similar results in the seedling height and diameter growth of *Triplochiton scleroxylon.* Similarly Fatokun *et al.* (1994) observed variation in seedling height and diameter growth of *Mansonia altissima.*

The results of the correlation analysis showed that height, diameter and number of leaves increase as plant age increases. The corresponding increase is obvious in all the progenies. Leaves constitutes the photosynthetic site of plants hence the number of leaves of a plant to a large extent determines the amount of food being manufactured by it which also directly has effect on how other organs of such plant store food and get increased over time. This is shown in all the progenies because as the number of leaves increases across the assessment period, it resulted in the increase in height growth and diameter increment. Furthermore, in all the progenies studied the value of mean final root length to mean initial root length was about three times or even four times within the assessment period. This suggests that *Dialium guineense* has deep tap root which could serve in stabilization of sand dune and could also aid in soil fertility in agreement with earlier works that said it usually emerges as one of the pioneer species in abandoned lands (Okafor 1981).

NAR values did not follow any definite pattern but in summary, the best mean NAR value across the assessment period was obtained in both Odogbolu and Ijebu-Ode progenies, which suggest that these two progenies may have more photosynthesizing tissue than both Iperu and Moniya progenies. Also, strong within - population variation may be responsible for the
observed trend of NAR values obtained both among the progenies and across the assessment period. Similar trends were observed in RGR among the progenies with Odogbolu progenies having the highest value of RGR on the whole.

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Table 1: Summary of analysis of variance for Seedling height, Diameter, Number of leaves, Total Dry weight and Leaf area among four progenies of *D. guineense*

		PARAMETERS									
		Height		Diameter		No. of Leaves		Total Dry Wt		Leaf Area	
Sources of variation	**DF**	**MS**	**F-cal**	**MS**	**F-cal**	**MS**	**F-cal**	**MS**	**F-cal**	**MS**	**F-cal**
Progeny	3	24.1763	274.3412*	0.116	7.4284*	0.7222	2.889ns	0.0045	6.9627*	29.4200	3.7968*
Assessment Period	5	13.0092	147.6222*	2.5490	169.7436*	15.1833	60.7333*	0.0471	73.3154*	117.0361	15.1042*
Progeny X Assmt Period	15	0.6977	7.9166*	0.0344	2.2886*	0.2389	0.9556ns	0.0235	0.7682*		
Error	24	0.0881		0.0150		0.2500		0.0006			

Note: *Significant at P≤0.05 ns=not significant at P≤0.05

Table 2: Summary of mean values for Seedling height, Diameter, Number of leaves, Total Dry weight and Leaf area among four progenies of *D. guineense*

Progenies	**Height (cm)**	**Diameter**	**No. of leaves**	**Total Dry Wt**	**Leaf Area**
Ijebu-Ode	12.3[a]	1.6[ab]	6.0[a]	0.19[a]	19.9[a]
Iperu	13.7[b]	1.7[b c]	5.8[a]	0.20[a]	20.6[a]
Moniya	11.5[c]	1.6[a]	6.1[a]	0.18[a]	20.6[a]
Odogbolu	14.7[d]	1.8[c]	6.4[a]	0.24[b]	24.7[b]

Note: Figures with the same letter in each column are not significantly different from each other (P≤0.05).

Table 3: Summary of mean values for Seedling height, Diameter, Number of leaves, Total Dry weight and Leaf area among four progenies of *D. guineense* across the assessment period

Assess-ment Period (wk)	**Mean Height (cm)**				**Mean Diameter (mm)**				**Mean No. of Leaves**				**Mean Total Dry Wt (g)**				**Mean Leaf Area (cm^2**			
	IJ	**IP**	**MO**	**OD**	**IJ**	**IP**	**MO**	**OD**	**IJ**	**IP**	**MO**	**OD**	**IJ**	**IP**	**MO**	**OD**	**IJ**	**IP**	**MO**	**OD**
2	9.4	11.6	7.6	10.9	0.9	0.9	0.8	0.9	4	4	4	4	0.07	0.08	0.09	0.07	10.9	13.8	13.9	12.5
4	10.7	13.3	10.2	13.0	1.1	1.2	1.1	1.3	5	5	5	5	0.10	0.12	0.11	0.15	13.1	17.5	18.1	20.3
6	12.1	13.2	10.3	13.8	1.4	1.5	1.3	1.5	6	6	6	6	0.14	0.16	0.14	0.21	17.2	22.0	25.4	28.1
8	12.4	13.5	12.1	14.5	1.8	2.0	1.8	2.0	6	6	6	7	0.20	0.20	0.21	0.25	22.9	19.4	21.0	27.6
10	12.2	13.2	12.2	14.8	2.0	2.0	1.9	2.1	7	7	7	7	0.28	0.29	0.26	0.34	25.6	25.7	22.9	31.0
12	12.8	13.0	11.5	14.8	2.3	2.1	2.1	2.5	7	7	8	8	0.40	0.35	0.29	0.45	29.5	25.0	22.6	28.8

Note: IJ=Ijebu-Ode, IP=Iperu, MO=Moniya and OD=Odogbolu.

Table 4: Correlation analysis for the growth parameters in seedlings of *Dialium guineense* from four progenies

VARIABLE	**ASSESSMENT PERIOD**	**HEIGHT**	**DIAMETER**	**LEAF NUMBER**
Assessment period	1.00			
Height	0.60*	1.00		
Diameter	0.94*	0.69*	1.00	
Leaf Number	0.91*	0.62*	0.86*	1.00

*Indicates significance at P≤ 0.05.

Table 5: Net assimilation rate (g/cm^2/wk) among seedlings of *Dialium guineense* from four progenies

PROGENY	2-4	4-6	6-8	8-10	10-12	MEAN
Ijebu-ode	$1.0x10^{-3}$	$1.2x10^{-3}$	$1.6x10^{-3}$	$1.7x10^{-3}$	$2.0x10^{-3}$	$1.5x10^{-3}$
Iperu	$1.0x10^{-3}$	$1.2x10^{-3}$	$9.0x10^{-4}$	$2.0x10^{-3}$	$1.2x10^{-3}$	$1.3x10^{-3}$
Moniya	$1.7x10^{-3}$	$8.0x10^{-4}$	$1.3x10^{-3}$	$1.2x10^{-3}$	$7.0x10^{-4}$	$9.0x10^{-4}$
Odogbolu	$2.2x10^{-3}$	$1.2x10^{-3}$	$7.0x10^{-4}$	$1.6x10^{-3}$	$1.9x10^{-3}$	$1.5x10^{-3}$

Table 6: Relative growth rate (g/wk) among seedlings of *Dialium guineense* from four progenies

PROGENY	2-4	4-6	6-8	8-10	10-12	MEAN
Ijebu-ode	0.1456	0.1551	0.1966	0.1753	0.1663	0.1678
Iperu	0.1527	0.1788	0.0998	0.1866	0.0986	0.1431
Moniya	0.1151	0.1450	0.1777	0.1135	0.0589	0.1220
Odogbolu	0.3364	0.1912	0.0912	0.1603	0.1439	0.1810

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Table 7: Ratio of mean initial root length to mean final root length of *Dialium guineense* seedlings from different progenies

	Ijebu-ode	Iperu	Moniya	Odogbolu
Mean initial root length (cm) taken at week 2	7.00	5.88	5.30	7.18
Mean final root length (cm) taken at week 12	24.32	20.88	21.26	19.70
Ratio	1:3.47	1:3.50	1:4.01	1:2.74