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Assessment of Drumstick Tree (M. deifera) Accessions for Genetic Diversity in the Southern guinea Region of Nigeria

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Abstract— *An experiment was conducted to analyze the genetic diversity among 9 drumstick tree (Moringaoleifera) accessions in the Teaching and Research Farm of the University of Agriculture Makurdi. The experiment was laid out in a Randomized Complete Block Design (RCBD) replicated three times. Data were recorded on growth and yield characteristics before and after pruning. The result obtained showed that at 18 weeks after transplanting, accession UAM-NI had the tallest plants (3.63m) while UAM-BE had the shortest mean plant height (2.84m) under no pruning. Other parameters that showed significant differences were number of leaves per tree and stem diameter. Although accession UAM-OY recorded highest fresh (220.22g), dry (113.42g) and leaf powder (82.60g) weights, it was not significantly different from other accessions. However, at 18 weeks after pruning, there was a significant difference among the accessions with regard to leaf length. Although accession UAM-NA recorded highest fresh leaf weight (286.60g), dry leaf weight (90.67g) and leaf powder weight (85.60g), it was not statistically different from other accessions. For the pruned accessions, significant differences were recorded in leaf length, number of flowers/tree, days to podding and fifty percent podding, pod length, pod girth, pod weight, number of seeds/pod, number of seeds/tree and 100seed weight. The result also indicated that the pruned accessions recorded higher leaf yield than the unpruned. The result of the cluster analysis grouped the accessions into two clusters and an outlier both for the pruned and unpruned accessions irrespective of area of collection.*

Keywords— Drumstick, accession, cluster, pruned, unpruned, outlier.

I. INTRODUCTION

Drumstick (*Moringaoleifera*L.) is believed to have originated from Northern India and has been distributed world wide in the tropics and sub-tropics (Olson, 2002). It is one of the thirteen species belonging to the family moringaceae with only one genus, *moringa*. In West Africa, the family is represented by 10 species while in Nigeria, the plant is represented by the only species of *Moringaoleifera* (Keay, 1989). Drumstick (*Moringaoleifera*) is commonly named horse-radish tree, drumstick tree, mothers best friend, Indian ben among others. It is a fast growing drought resistant tree that is widely adaptable to the tropics and subtropics (Olson, 2002). Its fast growing attributes coupled with its ability to grow on marginal soils has particularly made drumstick an invaluable vegetable and fodder crop especially during the dry season (Price, 2007; Rajangam*et al.,* 2001; Foidl*et al.,* 2001). *Moringaoleifera*is considered one of the world's most useful trees as almost every part of the plant is useful in one way or the other. It is a multipurpose plant with a tremendous variety of potential uses and recently attracted the attention of several authors (Abubakar*et al.,* 2011).Thus *Moringaoleifera*could be useful in alley farming, animal forage, vegetable, biogas, dye, medicinal, water purification, edible oil (Foidl*et al.,* 2001, Rajangam*et al.,* 2001). The leaf of this plant is known to be rich in micro-nutrients and vitamins such as zinc, iron and vitamin A and thus, has been use in the treatment of malnutrition in children and in the improvement of the diets of lactating mothers in some African countries. The oil extracted from the seeds is used in lubricating delicate machines, cosmetics, perfume and pharmaceutical industries. Foidl*et al.,* (2001) has reported on the possibility of using the ben oil as a biofuel considering the high cost of crude oil in the international market. However, in the aspect of water purification, Aho and Agumba (2010), Foidl*et al.* (2001) had

reported that up to 99% of colloids can be removed from dirty (turbid) water and works more effectively than the imported alum (aluminiumsulphate). It has been documented that the drumstick plant have a lot of pharmaceutical properties for the control of terminal ailments such as high blood pressure, diabetes, typhoid, rheumatism and asthma due to the presence of antioxidants (Rajangam*et al.*, 2001, Foidl*et al.*, 2001).

However, despite the numerous economic significance of this crop, there is no evidence that it has benefited from adequate research and agronomic management attention that would promote its cultivation among the local farmers for increase yield. At present, its production in Nigeria is still in the hands of peasant farmers who cultivate it in home gardens and the few accessions under cultivation in Nigeria have not been fully characterized. Therefore, to wean its production from hands of the resource-poor farmers and integrate it into the commercial scale agriculture, knowledge of the extent of genetic variability in the population and the magnitude of genetic diversity in the accessions is extremely important. Similarly, Christopher (2010) had earlier reported that *moringa* trees should be trimmed in order to promote branching, increase yield and facilitates harvesting. If left to grow without pruning, the plants will grow straight and tall producing leaves and pods only on the primary stem. According to Palada and Chang (2003), pinching of drumstick trees at 1.0 – 2.0m height enhances production, controlled tree height and takes only three (3) weeks for the tree to be ready for a leaf harvest after the pruning. Thus, the present study was aimed at assessing the yield (leaf) performance of the moringa accessions under pruned and unpruned in order to ascertain the degree of similarity among the different accessions so as to establish their breeding potentials.

II. MATERIALS AND METHODS

The experiment was conducted at the Teaching and Research Farm of the Federal University of Agriculture Makurdi, Benue State. Makurdi is located on latitude 07^{o} 41'N, Longitude 08^{o} 37'E and altitude of 106.4 m above sea level. The experiment consisted of 9 accessions of drumstick seeds collected 9 different states of the country including Nasarawa, Benue, Kogi, Oyo, Kebbi, Niger, Adamawa, Abuja and Akwa-Ibom States. For the sake of identification, acronyms were used (Table 1).

The treatments were laid out in a Randomize Complete Block Design(RCBD) with three replicates in a 3m x 3m spacing as described by Patricio *et al*.(2011).Six weeks old seedlings were transplanted to the the field according to Palada and Chang(2003). Data were taken from two plants randomly selected and tagged in each plot on a weekly basis as follows.

Plant height (cm):Heights of two plants from each plot randomly selected were measured with a measuring tape from the base of the plant at soil level to the apical tip.

Number of branches/plant*:* These were taken by counting the number of branches in the selected plants on weekly bases.

Stem diameter (cm):The stems of the selected plants were measured at soil level using verniercalliper on weekly bases.

Table.1: Locations of M. oleifera accessions collected for yield performance

S/No	Accession Code	State	Location	Latitude	Longitude
1	UAM-NA	Nasarawa	Kolo	8^0 48´N	7^0 33´E
2	UAM-BE	Benue	Makurdi	7^0 41´N	8^0 37´E
3	UAM-KO	Kogi	Ankpa	7^0 30´N	6^0 42´E
4	UAM-OY	Oyo	Idere	7^0 23´N	3^0 55´E
5	UAM-NI	Niger	Kontagora	10^0 24´N	5^0 28´E
6	UAM-KE	Kebbi	Zuru	11^0 26´N	5^0 13´E
7	UAM-AD	Adamawa	Yola	9^0 14´N	12^0 18´E
8	UAM-AB	Abuja	Kuje	9^0 28´N	7^0 25´E
9	UAM-AK	AkwaIbom	Uyo	5^0 05´N	7^0 39´E

Number of leaves/plant*:* The numbers of leaves of selected plants were counted on weekly bases.

Leaf Length (cm):Lengths of the leaves selected on each plot were measured and the means were determined in centimeter on weekly bases.

Forty percent(40%) of total number of leaves on each selected plant were harvested at 18 weeks after transplanting and pruning respectively as described by Freer,(2006) and the fresh, dried and leaf powder weights were recorded. Pods were equally harvested from the selected plants as they dried and turned brown.

After trimming the trees at 2m height ,data were equally collected on number of branches/tree, stem diameter, number of leaves/ tree, leaf length, number of flowers/tree, number of pods/tree, pod length, pod girth, pod weight,

number of seeds/pod, number of seeds/tree and 100-seed weight.

The data collected were subjected to Analysis of variance (ANOVA) and Duncan Multiple Range Test (DMRT) was used to separate between significant treatments means (Singh and Chaudhary, 1979). Test of significance was at 5% probability level. Cluster Analysis was also computed according to Singh and Chaudhary (1979) using SAS 2000.

III. RESULTS AND DISCUSSION

Choice of parents for developing base population is a crucial step in plant breeding since it largely predetermines the outcome of subsequent selection steps in breeding programmes. The analysis of genetic diversity and the relationships among germplasm therefore, facilitates the selection of parents with diverse genetic background (Subramanian and Subbaraman, 2010). The result of this study showed that significant variations exists among the accessions in many of the characters studied. For the unprune, accessions, UAM-NI produced the tallest (3.63m) plants while UAM-BE(2.84m) produced the least. Accession UAM-OY recorded the highest (96) number of leaves/tree as UAM-NA had the least (37). On number of branches/tree, Accession UAM-OY recorded the highest (12.33) as the least (4) was recorded by UAM-NA. Other parameters which equally exhibited significant differences were stem diameter, days to flowering and days to fifty percent flowering (Table2). The result of the scatter plot analysis for the unpruned drumstick accessions therefore, classified the nine accessions into two broad groups, cluster I and cluster II and an outlier with distinct genetic potentials (Figure 1). The result further revealed that cluster I comprised of two accessions, UAM-NI and UAM-KE while cluster II consisted of six accessions including UAM-AK, UAM-AD, UAM-AB, UAM-KO, UAM-BE and UAM-NA (Figure 1) while the outlier, UAM-OY alienated from the other accessions because of its genetic dissimilarity and uniqueness. The accessions in cluster I are characterized by tall plants and highly profused branching habit which also translated into higher number of leaves per tree (71) as indicated by cluster mean (Table 3). However, cluster II comprised of accessions that had intermediate performances while the outlier was quite unique, indicating its distinct identity. It is comparatively short, and also gave the least number of branches and leaves. Consequently, it recorded the least fresh, dry and leaf powder weights.

Eighteen weeks (18weeks) after pruning, the result of the study showed that accession UAM-BE (66.07cm) recorded the longest leaf lengths while UAM-AB recorded the least(41.13cm).On number of flowers/ tree, accession UAM-OY had the highest(350) UAM-KO had the least(91).Similarly ,accession UAM-OY recorded the least number of days(189days and 206days) to podding and fifty percent podding respectively. Other parameters which exhibited significant differences were pod length, pod girth, pod weight, number of seeds/pod, number of seeds/tree and 100-seed (Table4). The result also revealed that the pattern of grouping of the accessions were similar to that observed in the unpruned data. The cluster analysis revealed that the 9 accessions were classified into two clusters, I and II and an outlier with the same members both in number and in kind. The cluster mean (Table 4) showed that cluster I was characterized by least number of leaves and branches, least values for fresh, dry and leaf powder weights were also obtained in this cluster. Cluster II showed intermediate performances in the characters studied while the outlier (UAM-OY) produced the highest number of leaves, highly branched and consequently produced the highest fresh, dry and leaf powder weights contrary to when it was unpruned. On the general note, the accessions exhibited increased in fresh, dry and leaf powder weights pruned (Table 4) than unpruned (Table 2). This finding supports the report of Palada and Chang (2003) who reported that trimming of drumstick trees promotes branching and increases leaf yield. However, the data for the unpruned and the pruned drumstick accessions were pooled together, but the clustering pattern was still consistent for the unpruned, pruned and when these results were pooled together. In all these situations, accession UAM-OY (outlier) from Oyo State maintained its distinctiveness and uniqueness. However, the clustering of two accessions UAM-NI from Niger State (guinea savanna) and UAM-KE from Kebbi State (sahel agro-ecological zone) into cluster I is indicative of the fact that regional boundary was not a criteria for genotype differentiation (Figure 1). Similarly, the accessions comprised in cluster II were also collected from across different agro-climatic areas. For instance, UAM-AK from Akwa-Ibom State in the rainforest zone, UAM-AB from Federal Capital Territory Abuja, UAM-KO from Kogi State, UAM-BE from Benue State and UAM-NA from Nasarawa State in the guinea savanna zone, UAM-AD from Adamawa State in the sudan savanna zone. Thus, it is evident that clustering of accessions was based on similarity irrespective of their place of collection;

Hence, regional boundary was not a criterion for genotype differentiation. This result agrees with the report of Thul*et al.* (2009) who reported four clusters and two outliers from

a collection of Capsicum species studied irrespective of area of collection

Abubakar*et al.* (2011) also reported six clusters from the 21 accessions of *Moringaoleifera*studied irrespective of where the accessions were collected. This appears to mean that factors other than regional boundaries are responsible for divergence in drumstick trees studied. Thus, the growth and vegetative characters differentiated the accessions into different groups from which superior hybrids can be derived. Based on the level of divergence among the clusters as revealed by the scatter plot analysis and mean cluster distance, cluster II and the outlier are highly dissimilar, suggesting that accessions from these two groups could be evaluated for their combining ability for possible utilization as parents in the heterosis breeding programme in drumstick as suggested in maize (Betran*et al.*, 2003) and Brassica (Mahmuda*et al.*, 2008) crops.

Table.2: *Performance of some vegetative and phenological characters of unprunedMoringa accessions evaluated in Makurdi. Means within column followed by same letter are not significantly different by Duncan at 5%.*

TRAITS	UAM-NA	UAM-BE	UAM-KO	UAM-OY	UAM-NI	UAM-KE	UAM-AD	UAM-AB	UAM-AK	MEAN
Plant height (cm)	3.11abc	2.84c	3.19abc	3.60a	3.63a	3.54ab	3.30abc	3.02bc	3.15abc	3.26
Number of leaves	37c	44c	46bc	96a	60bc	81ba	50bc	56bc	57bc	58.55
Number of branches	4c	6.33bc	7.17bc	12.33a	8.33abc	10.00ab	6.00bc	7.66bc	8.00bc	7.76
Leaf length (cm)	74.10	76.27	74.60	76.73	70.07	72.67	67.67	72.50	62.57	71.91
Stem diameter(cm)	21.17ab	19.07bc	17.60bc	23.00a	18.50bc	18.50bc	17.30c	17.93bc	18.50bc	19.06
Fresh leaf weight (g)	118.10	121.60	134.85	220.22	157.17	162.90	133.37	133.48	135.25	146.33
Dry leaf weight (g)	52.25	53.78	56.53	113.42	74.70	77.02	59.70	66.42	62.97	68.53
Leaf powder weight (g)	40.22	41.70	45.70	82.60	53.25	54.25	43.03	44.28	46.12	50.13
Days to flowering	152c	176a	179a	151c	153c	147c	159bc	154c	168ab	159.89
Days to 50% flowering	157bc	177a	180a	152c	155bc	148c	161bc	157bc	169ab	161.78

Table.3: Cluster means for unprunedM. oleifera accessions evaluated in Makurdi in 2012.

Trait	Cluster I	Cluster II	Outlier
Plant height (cm)	3.59	3.17cm	3.11
Number of leaves per plant	71.0	55.0	37.0
Number of branches per plant	9.0	7.0	4.0
Leaf length (cm)	71.37	72.06	74.0
Stem diameter (cm)	18.50	19.22	21.17
Fresh leaf weight (g)	160.04	142.41	118.10
Dry leaf weight (g)	75.86	66.44	52.25
Leaf powder weight (g)	53.75	49.09	40.22
Days to flowering	150.0	163.0	152.0
Days to 50% flowering	152.0	165.0	157.0

Table.4. Performance of some vegetative and phenological characters of pruned Moringa accessions evaluated in Makurdi

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	NOB	NOL	STD	LLGT	FLW/T	DLW/T	LPW/T	NFL/T	DPD	D50%P	NPD/T	PDL	PDG	PDW	NS/PD	NS/T	100-SW
UAM-NA	24	183	36.87	45.23 bc	286.60	90.67	85.60	279a bc	250 ab	269a	57	28.22 bc	4.62d	6.57d	8.0bc	429.0	22.95 bc
UAM-BE	21	136	34.47	66.07 a	253.11	82.93	78.33	197a bcd	274 a	285a	47	24.48 c	4.80bc	6.21d	6.0c	309	21.66 cd
UAM-KO	17	136	32.97	52.50 b	177.60	67.63	50.07	91d	282 a	290a	38	34.50 ba	5.22bc	10.67 abc	11.0 ab	420	27.27 a
UAM-OY	27	200	39.10	52.07 b	216.27	70.80	65.13	350a	189 c	206b	88	34.80 a	5.56b	11.78 ab	13.0 a	1329	23.09 bc
UAM-NI	16	113	32.37	44.00 bc	114.27	36.73	25.17	197a bcd	206 c	215b	72	35.02 a	6.22a	13.40 a	14.0 a	1070	25.78 a
UAM-KE	20	135	34.20	44.57 bc	115.10	42.67	39.37	316a b	193 c	206b	73	32.05 ab	5.52b	11.48 ab	11.0 ab	778	25.52 ab
UAM-AD	19	160	31.07	42.30 bc	184.63	64.53	53.13	191a bcd	225 bc	234b	60	28.91 bc	5.14bcd	8.50cd	13.0 a	753	19.65 d
UAM-AB	22	152	32.77	41.13 c	222.43	73.10	68.43	160b cd	203 c	218b	43	29.04 bc	6.06a	8.74bcd	9.0bc	372	26.56 a
UAM-AK	21	150	33.27	47.17 bc	188.00	68.32	54.67	120cd	283 a	290a	49	30.62 ab	5.13bcd	9.05bcd	13.0 a	588	20.56 cd
Mean	20.78	151.67	34.12	48.34	195.33	66.38	57.77	211.22	233.89	245.89	58.56	30.85	5.36	8.32	10.89	672.0	23.67

NOB=Number of branches/tree, NOL=Number of leaves/tree, STD=Stem diameter (cm), LLGT=leaf length (cm), FLW/T=Fresh leaf weight/tree (g), DLW/T=Dry leaf weight/tree (g), LPW/T=Leaf powder weight/tree (g), NFL/T=Number of flowers/tree, DPD=Days to podding, D50%P=Days to 50% podding, NPD/T=Number of pods/tree, PDL=Pod length (cm), PDG=Pod girth (cm), PDW=Pod weight (g), NS/PD=Number of seeds/pod, NS/T=Number of seeds/tree, 100-SD=100-seed weight (g).

Table.4: Performance of some vegetative and phenological characters of pruned Moringa accessions evaluated in Makurdi

Parameters	**UAM-NA**	**UAM-BE**	**UAM-KO**	**UAM-OY**	**UAM-NI**	**UAM-KE**	**UAM-AD**	**UAM-AB**	**UAM-AK**	**Mean**
Number of branches/tree	24	21	17	27	16	20	19	22	21	20.78
Number of leaves/ tree	183	136	136	200	113	135	160	152	150	151.67
Stem diameter (cm)	36.87	34.47.	32.97	39.10	32.37	34.20	31.07	32.77	33.27	34.12
leaf length (cm)	45.23bc	66.07a	52.50b	52.07b	44.00bc	44.57bc	42.30bc	41.13c	47.17bc	48.34
Fresh leaf weight/tree (g)	286.60	253.11	177.60	216.27	114.27	115.10	184.63	222.43	188.00	195.33
Dry leaf weigh/tree (g)	90.67	82.93	67.63	70.80	36.73	42.67	64.53	73.10	68.32	66.38
Leaf powder weight (g)	85.60	78.33	50.07	65.13	25.17	39.37	53.13	68.43	54.6	57.77
Number of flowers/tree,	279abc	197abcd	91d	350a	197abcd	316ab	191abcd	160bcd	120cd	211.22
Days to podding	250ab	274a	282a	189c	206c	193c	225bc	203c	283a	233.89

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Days to 50% podding	269a	285a	290a	206b	215b	206b	234b	218b	290a	245.89
Number of pods/ tree	57	47	38	88	72	73	60	43	49	58.56
Pod length (cm),	28.22bc	24.48c	34.50ba	34.80a	35.02a	32.05ab	28.91bc	29.04bc	30.62ab	30.85
Pod girth (cm),	4.62d	4.80bc	5.22bc	5.56b	6.22a	5.52b	5.14bcd	6.06a	5.13bcd	5.36
Pod weight (g),	6.57d	6.21d	10.67abc	11.78ab	13.40a	11.48abc	8.50cd	8.74bcd	9.05bcd	8.32
Number of seeds/pod	8.0bc	6.0c	11.0ab	13.0a	14.0a	11.0ab	13.0a	9.0bc	13.0a	10.89
Number of seeds/tree	429	309	420	1329	1070	778	753	372	588	672.0
100-seed weight (g).	22.95bc	21.66cd	27.27a	23.09bc	25.78a	25.52ab	1965d	26.56a	20.56cd	23.67

Means within row followed by same letter are not significantly different by Duncan at 5%.

Table.5: Cluster means of pruned Nine Moringaoleifera accessions evaluated in Makurdi in 2013.

Trait	**Cluster I**	**Cluster II**	**Outlier**
Number of branches per tree	18.0	22.0	27.0
Number of leaves per tree	124.0	160.0	200.0
Stem diameter (cm)	33.29	34.36	39.10
Leaf length (cm)	44.29	49.50	52.07
Fresh leaf weight (g)	114.69	189.80	216.27
Dry leaf weight (g)	39.70	74.0	70.80
Leaf powder weight (g)	32.27	65.05	65.13
Number of flowers per tree	257.0	198.0	350.0
Days to first podding	200.0	244.0	189.0
Days to 50% podding	211.0	256.0	206.0
Number of pods per tree	73.0	55.0	88.0
Pod length (cm)	33.54	30.84	34.80
Pod girth (cm)	5.87	5.22	3.56
Pod weight (g)	12.44	8.79	11.78
Number of seeds per pod	13.0	10.0	13.0
Number of seeds per tree	924.0	600.0	1329
100-seed weight (g)	25.65	23.11	23.09

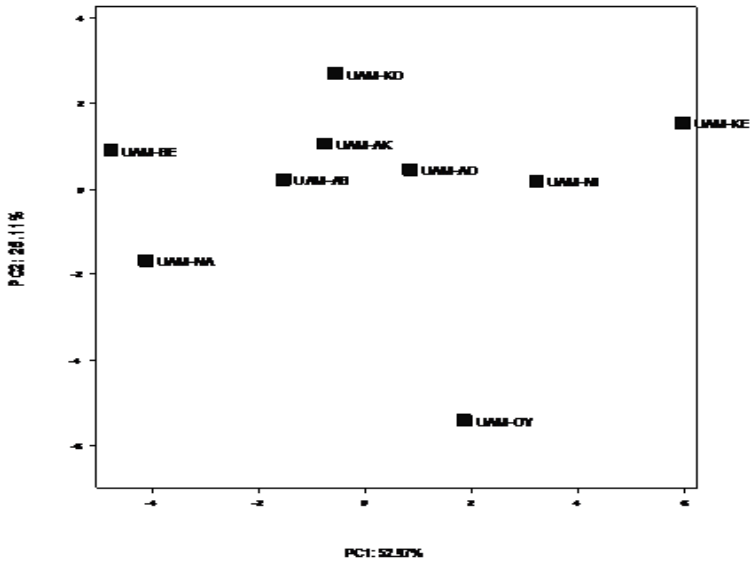

Fig.1: Scatter plot analysis for pruned Moringaoleifera accessions evaluated in Makurdi.

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IV. CONCLUSION

This study indicated that there is sufficient variability in the studied population to warrant the commencement of genetic improvement of drumstick through selection as revealed by the diversity analysis. It was also observed that the pruned accessions recorded higher fresh, dry and leaf powder weights than unpruned, with accession UAM-OY (outlier) expressing superiority over other accessions with regards to the fresh, dry and leaf powder weights and in most of the phenological characters studied.

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