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Diversity of Mango (*Mangiferaindica* L.) Cultivars in Shendi Area: Morphological Leaf Characterization

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Abstract **– Morphological characterization have great role for identification of different mango (*Mangiferaindica*L.) cultivars. Mango is perennial crop having long juvenile period and it is very difficult to identify a cultivar at theinitial stages of growth. Proper morphological leaf characterization can overcome these difficulties. This study was performed to identify mango cultivars in Sudan based on their leaf morphology. Leaves were collected in triplicate representing 30 cultivars Sixteen cultivars were grafted genotypes of Indian or Egyptian origin, 11 cultivars were grown directly from seeds (Balady) and 3 cultivars imported recently from South Africa. [1]descriptors were used in the study. Comparisons between means were made by least significant differences (LSD). The result Showed a high diversity of mango genotypes and cultivars. There were great variations in leaf length, width and petiole length with significant (P≤ 0.05) differences between the genotypes and cultivars in each genotype. Seedling cultivars showed longer leaves (≥20cm) compared to the South African and**

grafted cultivars which showed a wide range of leaf length. Leaf width followed the same trend as the leaf length .petiole length showed significant differences (P≤ 0.5) between the three genotypes but not between cultivars in each of them. Seedling cultivars have lanceolate leaf blade shape, 63% of them with acute leaf apex shape with obtuse , acute or round leaf blade shape. Grafted cultivars vary greatly in their leaf blade shape with most of them having acuminate apex Shape and acute or obtuse leaf base shape. South African cultivars vary in leaf blade and leaf apex shape but all of them have acute leaf base shape. Leaf margin and texture vary greatly between cultivars with no dominant shape among any of the three genotypes. The inflorescence length vary significantly (P≤ 0.5) between genotypes and cultivars with averages of 34.6, 24.2 and 23.3 Cm for the seedling, Grafted and South African cultivars respectively. The color, shape, density and floral leaves of the inflorescence of mango cultivars vary greatly. The color vary between yellow, green, red, green red and dark red with conical or pyramidal shape. Very few cultivars (3grafted and 4 seedling cultivars) exhibited floral leaves. Due to the great diversity between the genotypes and cultivars no specific correlations were found between all of the tested parameters.

Keywords **– Mango Diversity, Leaf Characterization, Mango Cultivars, Leaf Morphology.**

I. INTRODUCTION

The mango (*Mangiferaindica L.*) is one of the most important horticultural crops worldwide. Mangoes are a member of the *Anacardiaceae* family that comprises 73 genera, fitted in the order *Sapindales.* Thisorder belongs to the sub-class *Rosidae* from the class *Magnoliopside* and division *Magnoliophyta*[2];[3]. With 700 species the genus *mangifera* to which mangoes belong consists of 69 species and is classified into tow sub-genera with several sections based on morphological characters. Among the species ,*M. indica* is the most important, although there are other species that also produce edible fruits.

In Sudan mango production in 1999 was 190 thousand tons[4]. The annual production of mango in Sudan in (2004) was 603.00 (mmt) according to [5], [6] reported that the production of mango in Sudan has expanded tremendously because of the opened channels to European and Arab market. The varieties that cover almost the production areas are Alphonse, Abu-Samaka and Galbaltour, MabrokaShendi and White Zibda.

It was reported that in Sudan mango cultivars are classified in to three groups: True Indian cultivars, Egyptian seedling cultivars of Indian origin such as Zibda, Alphonse, Malgoba and Hindibesinara and Sudanese seedling cultivars of Indian origin of high quality including Shendi, Timoor, Nailm, Mabroka, Debsha and the famous sort Abu-Samaka .[7].In other regions of Sudan mango cultivars are classified into four groups; namely, seed propagated, monoembryonic, polyembryonic and newly introduced cultivars. The seed propagated cultivars are characterized by variations in colors and shapes. The most important seed propagated cultivar is Kitchener (early – maturing cultivar– called Baladi) which represents 90% of the total production in Sudan. [8].

The mango trees is an erect , branched ever green plant ranging from 8 to 40 meters in height depending on the cultivar , climate , soil type and root stock [9] .

The leaves of atypical mango tree ranged from 10 to 30cm in length and 1.8 to 5 Cm in width. Leaves are borne mainly in rosettes at the tips of the branches and numerous twigs from which they drop like ribbons on slender petioles 2.5 – 10 cm long [10] . The new leaves , appearing periodically and irregularly on a few branches at a time, are yellowish , pink , deep rose or wine red , becoming dark green and glossy above , lighter beneath . The midrib is pale and conspicuous with many horizontal and distinct veins.

The mango inflorescence and romomoeciuos, i.e. each inflorescence bears both hermaphrodite and male flowers in the same panicle. The flowers are usually yellowish or reddish in color and are borne in profuse, showy, erect, pyramidal, and branched clusters in the panicle. The size of both the staminate and hermaphrodite flowers varies from about 0.5 to 1.25cm in diameter (Morton, 1987). Staminate flowers 25 – 98% of hundreds and even as many as 3.000 to 4.000 small , yellowish or reddish flowers, the rest flowers are hermaphroditic, which borne in profuse , showy, erect, pyramidal, branched clusters6-40cmin length [11].

The application of morphological markers is the simplest of the formal, standardized and repeatable method of evaluating crop genetic diversity. Some of the most important advantage of using morphological characterization are that published descriptor lists are readily obtainable for most major crop species [1]. It can be carried out in situ, is relatively low- cost and easy to perform. Morphological characterization is the first step that should be done before more profound biochemical or molecular studies are carried out [12].

Morphological characters have great role for the identification of different cultivars. By using morphological characters it is not only easily possible to identify any cultivars well before the commencement of the cultivars to attain bearing stage but also reduces the time period require for improvement pro- gram. Keeping these facts in mind.

The aim of this study is to identify mango cultivars morphologically on bases of their leaves morphology.

II. Materials and Methods

Sampling area

Shendi is located on the east bank of the river Nile, River Nile state it is North-East of Khartoum about 170 Km, between latitudes (16 -42) North and longitude (33-26) East, it is the main area of mango cultivation in Sudan.

Sampling materials

Thirty mango (*Mangiferaindica* L) trees were used in this study. Sixteen of which were grafted trees of known varieties of Indian or Egyptian origin.V.Z: Abu samaka ,Shendi, Nailum, Mitlaky, Mabroka, Zibda, alphonse, Galbeltowr, Malgoba, Julik, Timor, Dibsha, Mahmoudi, Walibasha, Bet Abusamaka, Segrest .These varieties were well known in Sudan and cultivated for many years by formers .

Recently three cultivars were introduced from South Africa these were, Elkent, Elkeitt, Tommyatkinz. Eleven varieties were grown directly from seedling which in clude :Kutchineer, Bitbady , Wadsrear, Sinaria, Shabala , Shreefia, Yageen, Bizrtshendi, Rasmctul, Taiba, Higazia. These cultivars showed high production with high quality fruits.

Morphological characterization

Morphological characterization of the selected cultivars was carried-out for leaves and inflorescences using Bioversity International Descriptor [1]

Samples collection

From each variety three trees were used for collecting the leaves and inflorescences, and from each tree three leaves or inflorescences were taken randomly for measurements.

Leaf measurement

Leaves were cut from the base of the leaves and were taken to the laboratory for measurement.

Leaf length

The length of each leave was measurement from the apex to the base in cm.

Leaf width

The width of the leaves were measurement of the most wide area of the leaf in cm.

Petiole length

The length of the petiole was measurement from the base leaf to stick branch in cm.

Leaf shape

Blade shape, apex shape, base shape, texture and margin were tested and compared Discriptor measurements.

Inflorescences measurement:-

Inflorescences were cut from the base of the inflorescences and were taken to the laboratory for measurement.

Inflorescences length

The length of the inflorescences measured the length was measured from the apex to the base in cm.

Inflorescences shape

Blade shape, density, color, and floral leaves were tested and compared Discriptor measurements.

III. Results and Discussion

Leaf length, width and petiole length

Table (1) showed the length, width and petiole length of the leaves of mango cultivars under study. The cultivars showed a significant difference ($p \leq 0.05$) between them regarding the leaf length. Almost all the seedling cultivars showed longer leaves (≥ 20 cm in length). Whereas South African cultivars have shorter (< 20 cm) leaf length. On the other hand varying leaf length was reported for the grafted cultivars depending on the cultivar itself.Rasmctul cultivar showed the longest leaf length (28 cm) followed by Kutchineer and Taiba.

Grafted cultivars vary in leaf length ranging between 15.467 and 24.333cm which is almost shorter than the seedling cultivars and longer than South African cultivars leaves. Significant differences ($p \leq 0.05$) were shown between the seedling and grafted cultivars whereas no significant differences were observed between South African cultivars.

Leaf width showed significant differences ($P \leq 0.05$) between the cultivars. The width of the seedling cultivars showed the wider ones among the cultivars ranging between (3.700- 7.067 cm).

Petiole length showed significant differences($P \leq 0.5$) between the genotypes but not between the cultivars within the groups. The petiole showed varying length depending on the cultivar.

There are great variations in leaf length, width and petiole among the cultivars. These findings coincide with previous findings by [13]who reported leaf length of 15-35cm, width ranged from 4.0- 10.0cm, and petiole length of 1.1- 7.0cm.[14] reported similar ranges of length, width and petiole depending on cultivar, climate and cultural practices. Variations within the same cultivar were observed as a result of the area where the cultivar was grown, season of growth and position of the leaf on the flush[13] .

Leaf blade, apex and base shape

The leaf blade shape, apex shape and base shape was shown in table (2).

The leaf blade shapes of the cultivars vary between lanceolate and elliptic shape. Most of the seedling cultivars were lanceolate were as no dominant shape was observed with the grafted cultivars. Two of the South African cultivars showed lanceolate shape the third one showed elliptic shape.

Most of the grafted cultivar showed acuminate apex shape(75%) with little variation to acute shape in few cultivars while 63% of the seedling cultivars showed acute leaf apex shape. The dominant apex shape of South African cultivars was the acute shape.

The leaf base shape showed significant differences ($p \leq 0.05$) between cultivars.About 69% of the grafted cultivars 55% of the seedling cultivars and all of the South African cultivars showed obtuse leaf base shape. Only the Sinariacultivar (seedling cultivar) showed the round base shape.Other studies revealed that mango leaves are variable in shape and size and even color, a fact reported by[15].

Leaf margin and texture

Two types of leaf margin were observed (wavy and entire). The leaf margin showed no direct relationship between the genotypes, but it showed a cultivar characteristic.

Three types of leaf texture were observed (coriaceous, chartaceous and membranous). Half of the cultivars showed coriaceous texture although the texture was a cultivar characteristic (Table 3).

Variations in leaf margin and texture was reported by[16] who found that these variations were due to climate, cultural practices and growth stage.

Inflorescences

Most of mango cultivars have terminal inflorescences. Sometimes many panicles rise from the axillary buds[13]. These findings agreed with the results obtained from the study.

Inflorescences length

The inflorescences length of the 30 mango cultivars were shown in Table (4). The cultivars differ significantly ($p \leq 0.05$) in the inflorescences length regard less the origin of cultivar. The grafted cultivars differ from the seedling cultivars but showed more or less the same inflorescences length as South African cultivars. The length vary between the grafted cultivars depending on the cultivar showing a length between 37.200 (Dibsha) and 12.033cm (Shendi) with an average length of 24.187cm. With no significant differences from the South African cultivars.

The seedling cultivars showed longer inflorescences compared to the other cultivars with average length of 34.594cm. The showed no significant differences between them ranging from 39.000cm to 30.300cm.

The wide range of length variation due to the cultivar was reported [13]who reported a range of 17.6- 34.2 cm and a wider range was mentioned by Morton (1987) who reported a range of 6-40 cm inflorescence length. Regardless the cultivar origin grouped the inflorescence length three ranges viz 20- 29, 30- 39 and 40-50cm showing the wider range of the inflorescence length (20-50cm).

Inflorescences color, shape, density and floral leaves

The color, shape, density and floral leaves of inflorescences of the mango cultivars vary greatly depending on the cultivar (Table 5).

All the grafted cultivars showed green inflorescences, with very few ones showing a slight yellow or red color. The three cultivars from South Africa showed dark red color of the inflorescences. The seedling cultivar showed a varying inflorescences color from green red, green, yellow, red and dark red depending on the cultivar.

The grafted cultivars showed either conical or pyramidal inflorescences shape, most of the seedling cultivar showed a conical shape with few pyramidal inflorescences shape (30%). The South African cultivar showed a pyramidal inflorescences shape.

The densities of the inflorescences in all cultivars vary between Dense (43%), Sparse (30%) and Medium (27%), a finding reported by [15].

No floral leaves existed in all cultivars expet in a very few seedling cultivars 3(grafted) cultivars (Nailum, Dibsha and Mahmoud and 4 cultivars in the seedling ones Shabala, Yageen, Taiba and Shreefia.

As reported by[13]the shape of inflorescence differ with different cultivars either conical or pyramidal as the results of the study showed. The finding reported earlier showed dense to medium inflorescence [10],[13].

Table 1: Leaf length, width and petiole length (cm)of mango cultivars

No	Cultivar	Leaf length	Leaf width	Petiole length
1-	Abu samaka	19.133	5.367	2.233
2-	Nailum	16.800	4.967	2.867
3-	Mitlaky	21.067	5.300	2.733
4-	Mabroka	18.233	5.100	2.433
5-	Zibda	19.133	5.467	2.467
6-	Alphonso	21.367	4.200	3.700
7-	Galbeltowr	19.367	4.767	2.267
8-	Shendi 1	17.900	4.033	3.033
9-	Malgoba	20.100	4.467	3.433
10-	Julik	21.500	5.000	5.233
11-	Timor	21.867	5.500	4.267
12-	Dibsha	24.333	5.333	3.500
13-	Mahmoudi	19.733	5.733	3.033
14-	Walibasha	20.433	5.500	3.167
15-	Bet abusamaka	18.833	5.200	2.367
16-	Segrest	15.467	3.700	2.367
	Average	**19.704**	**4.977**	**3.069**
17-	Elkeitt	16.100	5.400	2.833
18-	Elkent	16.600	4.733	2.933
19-	Tommy atkinz	19.333	5.133	3.233
	Average	**17.344**	**5.089**	**2.999**
20-	Kutchineer	26.667	5.567	3.167

21-	Bet bady	26.800	6.467	3.767
22-	Wad srear	18.367	3.700	3.267
23-	Sinaria	24.500	7.067	3.400
24-	Shabala	17.200	4.300	2.367
25-	Higazia	16.700	3.700	2.367
26-	Yageen	20.300	5.267	4.600
27-	Taiba	26.633	4.733	2.700
28-	Bizrtshendi	17.233	6.600	4.333
29-	Rasmctul	28.800	6.700	4.133
30-	Shreefia	25.833	5.233	3.200
	Average	**22.639**	**5.394**	**3.391**

Table 2: Leaf blade shape, apex shape and base shape of mango cultivars

No.	Cultivar	Leaf Blade Shape	Leaf Apex Shape	Leaf Base Shape
1-	Abu samaka	Lanceolate	Acute	Obtuse
2-	Nailum	Elliptic	Acute	Acute
3-	Mitlaky	Elliptic	Acuminate	Obtuse
4-	Mabroka	Elliptic	Acuminate	Obtuse
5-	Zibda	Elliptic	Acuminate	Obtuse
6-	Alphonso	Lanceolate	Acuminate	Obtuse
7-	Galbeltowr	Lanceolate	Acuminate	Obtuse
8-	Shendi 1	Lanceolate	Acute	Acute
9-	Malgoba	Lanceolate	Acuminate	Acute
10-	Julik	Elliptic	Acuminate	Obtuse
11-	Timor	Elliptic	Acuminate	Obtuse
12-	Dibsha	Lanceolate	Acuminate	Obtuse
13-	Mahmoudi	Elliptic	Acute	Obtuse
14-	Walibasha	Elliptic	Acuminate	Obtuse
15-	Bet abusamaka	Lanceolate	Acute	Acute
16-	Segrest	Lanceolate	Acuminate	Acute
17-	Elkeitt	Elliptic	Acute	Obtuse
18-	Elkent	Lanceolate	Acute	Obtuse
19-	Tommy atkinz	Lanceolate	Acuminate	Obtuse
20-	Kutchineer	Lanceolate	Acute	Obtuse
21-	Bet bady	Lanceolate	Acuminate	Acute
22-	Wad srear	Lanceolate	Acute	Acute
23-	Sinaria	Elliptic	Acute	Round
24-	Shabala	Lanceolate	Acute	Obtuse
25-	Higazia	Lanceolate	Acuminate	Obtuse
26-	Yageen	Lanceolate	Acuminate	Acute
27-	Taiba	Lanceolate	Acute	Acute
28-	Bizrtshendi	Lanceolate	Acute	Acute
29-	Rasmctul	Elliptic	Acute	Obtuse
30-	Shreefia	Elliptic	Acuminate	Obtuse

Table 3: Leaf margin and texture of mango cultivars

No	Cultivar	Leaf Margin	Leaf Texture
1-	Abu samaka	Entire	Coriaceous
2-	Nailum	Entire	Coriaceous
3-	Mitlaky	Wavy	Chartaceous
4-	Mabroka	Entire	Membranous
5-	Zibda	Entire	Chartaceous
6-	Alphonso	Wavy	Coriaceous
7-	Galbeltowr	Wavy	Membranous
8-	Shendi 1	Entire	Chartaceous
9-	Malgoba	Wavy	Coriaceous
10-	Julik	Wavy	Chartaceous
11-	Timor	Wavy	Coriaceous
12-	Dibsha	Wavy	Chartaceous
13-	Mahmoudi	Entire	Chartaceous
14-	Walibasha	Wavy	Chartaceous
15-	Bet abusamaka	Entire	Coriaceous
16-	Segrest	Entire	Coriaceous
17-	Elkeitt	Entire	Membranous
18-	Elkent	Wavy	Coriaceous
19-	Tommy atkinz	Entire	Chartaceous
20-	Kutchineer	Entire	Chartaceous
21-	Bet bady	Wavy	Membranous
22-	Wad srear	Entire	Coriaceous
23-	Sinaria	Entire	Membranous
24-	Shabala	Entire	Coriaceous
25-	Higazia	Wavy	Coriaceous
26-	Yageen	Wavy	Coriaceous
27-	Taiba	Entire	Coriaceous
28-	Bizrtshendi	Entire	Coriaceous
29-	Rasmctul	Entire	Coriaceous
0-	Shreefia	Wavy	Membranous

Table 4: Inflorescences length(cm) of mango cultivars

No	Cultivar	Inflorescences length
1-	Abu samaka	19.400
2-	Nailum	20.933
3-	Mitlaky	28.367
4-	Mabroka	16.533
5-	Zibda	25.133
6-	Alphonso	22.900
7-	Galbeltowr	14.733
8-	Shendi 1	12.033
9-	Malgoba	24.567
10-	Julik	31.367
11-	Timor	28.133
12-	Dibsha	37.200
13-	Mahmoudi	35.133

14-	Walibasha	32.967
15-	Bet abusamaka	24.067
16-	Segrest	13.533
	Average	**24.187**
17-	Elkeitt	23.667
18-	Elkent	22.367
19-	Tommy atkinz	23.933
	Average	**23.322**
20-	Kutchineer	30.867
21-	Bet bady	33.600
22-	Wad srear	35.600
23-	Sinaria	38.600
24-	Shabala	38.067
25-	Higazia	32.267
26-	Yageen	35.833
27-	Taiba	33.767
28-	Bizrtshendi	30.300
29-	Rasmctul	32.633
30-	Shreefia	39.000
	Average	**34.594**

Table 5: Inflorescences color, shape, density and floral leaves of mango

No	**Cultivar**	**Inflorescences Color**	**Inflorescences Shape**	**Inflorescences Density**	**Floral Leaves**
1-	Abu samaka	Red light	Pyramidal	Dense	Not exist
2-	Nailum	Red	Conical	Dense	Exist
3-	Mitlaky	Greenish yellow	Conical	Medium	Not exist
4-	Mabroka	Red light	Pyramidal	Medium	Not exist
5-	Zibda	Green red line	Conical	Sparse	Not exist
6-	Alphonso	Red light	Pyramidal	Medium	Not exist
7-	Galbeltowr	Green light	Conical	Sparse	Not exist
8-	Shendi 1	Greenish yellow	Pyramidal	Dense	Not exist
9-	Malgoba	Greenish yellow	Conical	sparse	Not exist
10-	Julik	Green	Conical	sparse	Not exist
11-	Timor	Green red line	Conical	Dense	Not exist
12-	Dibsha	Dark red	Pyramidal	Dense	Exist
13-	Mahmoudi	Green	Pyramidal	sparse	Exist
14-	Walibasha	Greenish yellow	Pyramidal	sparse	Not exist
15-	Bet abusamaka	Green red line	Conical	Dense	Not exist
16-	Segrest	Red	Pyramidal	Dense	Not exist
17-	Elkeitt	Dark red	Pyramidal	Dense	Not exist
18-	Elkent	Dark red	Pyramidal	Dense	Not exist
19-	Tommy atkinz	Dark red	Pyramidal large	Dense	Not exist
20-	Kutchineer	Red	Conical	Medium	Not exist
21-	Bet bady	Green red line	Pyramidal	Dense	Not exist
22-	Wad srear	Red light	Pyramidal	Dense	Not exist
23-	Sinaria	Green	Conical	Medium	Not exist
24-	Shabala	Red light	Conical	Medium	Exist
25-	Higazia	Red light	Conical	Medium	Not exist
26-	Yageen	Dark red	Conical	sparse	Exist
27-	Taiba	Yellow	Conical	sparse	Exist
28-	Bizrtshendi	Red	Pyramidal large	Dense	Not exist
29-	Rasmctul	Red light	Conical	Medium	Not exist
30-	Shreefia	Green	Conical	sparse	Exist

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