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Metroglyph and index score analysis of morphological variations in *dura* oil palms

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ABSTRACT

Forty high yielding *dura* palms (genotypes) developed from two indigenous *dura* × *dura* crosses were characterized morphologically for palm height, girth at 25 cm, sex ratio, number of developing fruit bunches, number of leaves, petiole width, petiole depth, number of leaflets, rachis length, leaflet length. Metroglyph and index score analyses were carried out for all these characters. Character-wise index score was assigned and total index score for each palm was calculated. Palm height had highest variance followed by rachis length. All the palms were grouped into nine clusters based on low, medium and high value of palm height and rachis length. Mean and SD for total index score of all palms were 19.65 and 4.51, respectively. Scatter diagram revealed that the nine clusters distinguished on the basis of morphological variation. The cluster V consists of nine palms, out of which six palms were close proximity to each other. Palms in other eight clusters showed scatterings, which indicated existence of morphological variation within clusters. Character-wise index score was assigned and total index score for each genotype was also calculated. Based on index scores, the genotypes were grouped into three clusters. The two divergent groups of genotypes with low and high index scores could be effectively used in future hybridization programme.

Key words: Metroglyph, morphological variations, oil palm, *dura.*

INTRODUCTION

Oil palm (*Elaeis guineensis* Jacq.) is a perennial crop and gives the highest oil yields per hectare among all oil yielding crops. It was introduced in India as an irrigated crop for bringing self sufficiency in edible oil production. Germplasm from different countries have been collected and subsequently different population has been developed indigenously, which are maintained at Directorate of Oil Palm Research (DOPR), Pedavegi and Palode. Major prerequisite for a successful breeding programme is assessing the genetic variation in the existing population. Metroglyph and index score analysis of several field as well as plantation crops have been reported from India (Gadekar *et al*., 4; Pandey and Naik, 9; Raveendran *et al*., 11; Sharma *et al*., 12; Sidhu and Chadha, 13) for grouping the genotypes, and the result could be successfully incorporated in the breeding programme. Since oil palm is the new introduced crop, no report on such analysis on oil palm from India is reported so far.

However, characterization of oil palm germplasm and pre-breeding population based on morphological parameters has been reported (Rajanaidu, 10; Ooi *et al*., 8; Oboh and Fakorede, 7; Musa *et al*., 6) from other countries. Due to its allogamous and heterozygous nature, each palm is considered as a separate genotype, hence, palm-wise characterization is more useful than that of accession-wise or cross-wise characterization. In the present study, 40 high yielding *dura* palms from two crosses were characterized morphologically for ten different parameters and subjected to metroglyph and index score analyses to determine the variation among the palms (genotypes).

MATERIALS AND METHODS

The experimental materials comprised of 40 *dura* palms selected from two different crosses (240D × 281D and 80D × 281D) planted at Directorate of Oil Palm Research (DOPR), Pedavegi, Andhra Pradesh during October 2000. Both the *dura* x *dura* populations were developed by crossing selected elite *dura* palms at DOPR Regional Station at Palode, Kerala. The palms were evaluated for height; collar girth (25 cm above the soil), sex ratio (number of female inflorescence : total number of inflorescence), number of developing fruit bunches and number of leaves. The characters like petiole width, petiole depth, number of leaflets, rachis length and leaflet length were recorded on 17^{th} open leaf. Metroglyph

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and index score analyses were carried out (Anderson, 1) for the above mentioned characters to study the morphological diversity.

Two characters which exhibited highest variance were selected as parameters for X and Y-axes. The values of X for each genotype were plotted against the Y values in the form of a glyph. Variation for remaining characters of each genotype was displayed on the respective glyphs by rays. Each character occupied a definite ray position. The variation for each character was divided into three groups, *i.e.* low, medium and high. The genotypes with low, medium and high values for each character was given index scores of 1, 2 and 3, respectively. Variation for each character was depicted by the length of ray. The worthiness of a genotype was calculated by adding the index value of all the characters. Total genotypes were divided into different clusters based on low, medium and high values on X and Y-axes and then were divided into three groups based on the total index score.

RESULTS AND DISCUSSION

From the genetic variability parameters, *viz.* maximum value, minimum value, sd/N and variance for each character over 40 palms (Table 1), it was observed that palm height had the highest variance followed by rachis length and then they were plotted on X and Y-axes, respectively for the representation of the genotypes in the form of glyph. Class interval, index value, position of the rays and length of the ray was assigned for each character (Table 2). The entire metroglyph plot for 40 palms based on 10 characters was developed (Fig. 1). All the genotypes were distributed into nine clusters based on low, medium and high value for palm trailts like height and rachis length (Table 3), which was also revealed from the scatter diagram (metroglyph plot). The Cluster V consisted of nine genotypes, out of which six, *i.e.*, *Eg* 67, *Eg* 122, *Eg* 54, *Eg* 161, *Eg* 168 and *Eg* 107 had close proximity to each other. This indicates that these genotypes are morphologically more similar

Table 1. Summary of the morphological parameters of 40 *dura* palms for ten characters.

Character	Palm height (cm)	Girth at 25 cm (cm)	Sex ratio	No. of DFBs	No. of leaves	Petiole width (cm)	Petiole depth (cm)	No. of leaflets	Rachis length (cm)	Leaflet length (cm)
Max. value	344.0	386.0	1.00	15	44	9.0	5.5	328	533.0	89.5
Min. value	104.5	232.0	0.00	1	31	5.0	3.3	220	311.0	62.9
Range	239.5	154.0	1.00	14	13	4.0	2.2	108	222.0	26.6
SD	52.065	30.846	0.366	3.928	4.032	1.093	0.580	18.372	50.050	6.08
Variance	2710.796	951.459	0.134	15.430	16.254	1.195	0.336	337.536	2505.05	36.90
CV%	25.504	11.255	90.539	48.050	10.765	15.789	13.940	6.345	12.64	7.98

Table 2. Class interval, index score and ray position and length of ray for ten characters.

Character	Class interval	Index score	Ray position & length	Class interval	Index score	Ray position & length	Class interval	Index score	Ray position & length
Palm height (cm)	< 178.112	1	X - axis	178.112 - 230.178	2	X - axis	> 230.178	3	X - axis
Rachis length (cm)	< 371.100	1	Y - axis	371.100 - 421.150	2	Y - axis	> 421.150	3	Y - axis
Sex ratio	< 0.221	1	o	0.221 - 0.587	2	ó	> 0.587	3	ó
No. of DFBs	< 6.211	1	o	6.211 - 10.139	2	ó	> 10.139	3	ó
Girth at 25 cm (cm)	< 258.632	1	o	258.632 - 289.478	2	ó	> 289.478	3	ó
No. of leaves	< 35.434	1	o	35.434 - 39.466	2	ó	> 39.466	3	ó
Petiole depth (cm)	< 3.870	1	o	3.870 - 4.450	2	ó	> 4.450	3	ó
Petiole width (cm)	< 6.376	1	o	6.376 - 7.469	2	ó	> 7.469	3	ó
Leaflet length (cm)	< 73.135	1	o	73.135 - 79.210	2	ó	> 79.210	3	ó
No. of leaflets	< 280.364	1	o	280.364 - 298.736	2	ó	> 298.736	3	ó

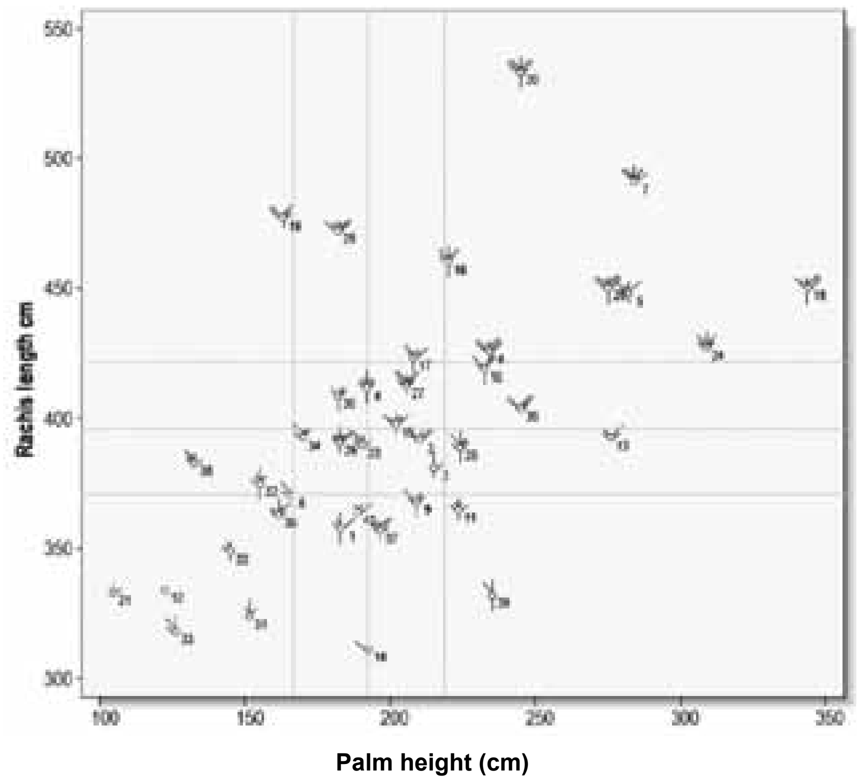

Fig. 1. Metroglyph plot for 40 dura oil palm genotypes based on 10 characters. (All the palms are presented in the form of 1 to 40 serial numbers as mentioned in the Table 3.)

than the other three. Genotypes in other eight clusters showed high variation and scattered in different clusters. This indicates existence of morphological variation within clusters. The variation between clusters were more than that within clusters with few exceptions. Genotype *Eg* 59 of Cluster IX exhibited greater similarity to *Eg* 89 of Cluster VI than any other genotypes of Cluster IX. Similarly, genotype *Eg* 166 of Cluster VIII exhibited more similarity to *Eg* 164 of Cluster V than any other genotypes of Cluster VIII.

Character-wise index score was assigned and total index score for each genotype was calculated (Table 4). Mean and standard deviation (SD) for total index score of all genotypes were 19.65 and 4.51, respectively. All genotypes were grouped into three groups with value ranging from 15.14 to 24.16.

The index score value of all the 40 *dura* palms for ten characters under study ranged from 10 to 29. Genotype *Eg* 125 scored the lowest index score, while the highest index score was shown by the *Eg* 136. The genotypes having total index score < 15.14 were grouped into Group I, whereas the genotypes having total index score from 15.14 to 24.16 and > 24.16 were grouped into Group II and Group III, respectively (Table 5). Genotypes *Eg* 100, *Eg* 125, *Eg* 104, *Eg* 130, *Eg* 223, *Eg* 218 and *Eg* 213 were in the Group I due to low index score, whereas *Eg* 59, *Eg* 56, *Eg* 46, *Eg* 149, *Eg* 136, *Eg* 169 and *Eg* 165 were in the Group III for their high index score. Hence, there might be fruitful results when these two groups of palms are hybridized.

Though the metroglyph and index score analysis of oil palm population based on different morphological characters has not been reported earlier, it is established that the relationship among the traits are useful in making decision in breeding and selection programme, because they indicate changes that may occur in unselected traits when single-trait or index selection is practised. Breeders often use correlations, stepwise multiple regressions and path coefficient analyses to determine the nature of relationships among such characteristics (Oboh and Fakorede, 7; Mandal *et al*., 5). Correlation, path coefficient analysis and heritability of oil palm populations were also reported based on different morphological and agronomic characters (Ataga, 2; Eksomtramage *et al*., 3).

In the present study, variation in the *dura* genotypes comprising of 40 *dura* palms was grouped in nine clusters based values of palm height and rachis length. Variation between clusters was in general more than that of within cluster. Based on Mean ± SD value of total index score, eight palms scored low index value, while seven scored high index

Table 3. Clustering of 40 *dura* oil palm genotypes based on metroglyph analysis.

Cluster No.	Values of palm height (cm)	Values of rachis length (cm)	Palm No.	No. of genotype(s)
I	< 178.112 (low)	< 371.100 (low)	*Eg* 100, *Eg* 215, *Eg* 130, *Eg* 223, *Eg* 125, *Eg* 218 & *Eg* 104	7
II	178.112 - 230.178 (medium)	< 371.100 (low)	*Eg* 66, *Eg* 213, *Eg* 208, *Eg* 93, *Eg* 95 & *Eg* 127	6
III	> 230.178 (high)	< 371.100 (low)	*Eg* 210	1
IV	< 178.112 (low)	371.100 - 421.150 (medium)	*Eg* 220, *Eg* 221 & *Eg* 224	3
V	178.112 - 230.178 (medium)	371.100 - 421.150 (medium)	*Eg* 163, *Eg* 168, *Eg* 161, *Eg* 107, *Eg* 67, *Eg* 122, *Eg* 164, *Eg* 54 & *Eg* 45	9
VI	> 230.178 (high)	371.100 - 421.150 (medium)	*Eg* 89, *Eg* 206 & *Eg* 118	3
VII	< 178.112 (low)	> 421.150 (high)	*Eg* 132	1
VIII	178.112 - 230.178 (medium)	> 421.150 (high)	*Eg* 133, *Eg* 162 & *Eg* 166	3
IX	> 230.178 (high)	> 421.150 (high)	*Eg* 59, *Eg* 165, *Eg* 56, *Eg* 169, *Eg* 149, *Eg* 136 & *Eg* 46	7

Table 4. Total index score of 40 *dura* oil genotypes for 10 characters.

Sl. No.	Palm No.	Index Score for individual character										Total index score
		Palm height (cm)	Rachis length (cm)	Sex ratio	No. of DFBs	Girth at 25 cm (cm)	No. of leaves	Petiole depth (cm)	Petiole width (cm)	Leaflet length (cm)	No. of leaflets	
1.	Eg 66	2	1	3	3	1	2	1	1	3	2	19
2.	Eg 45	2	2	2	3	1	1	1	1	2	1	16
3.	Eg 54	2	2	1	1	2	1	3	3	3	2	20
4.	Eg 59	3	3	2	2	3	2	3	3	3	3	27
5.	Eg 56	3	3	2	2	1	2	3	3	1	2	22
6.	Eg 67	2	2	3	3	2	2	2	2	2	2	22
7.	Eg 46	3	3	1	3	3	3	3	2	3	1	25
8.	Eg 100	1	1	1	1	1	3	1	1	1	2	13
9.	Eg 93	2	1	3	1	2	1	3	2	2	2	19
10.	Eg 89	3	2	3	1	3	1	3	3	1	2	22
11.	Eg 95	2	1	2	2	2	2	1	1	2	2	17
12.	Eg 125	1	1	1	1	1	1	1	1	1	1	10
13.	Eg 118	3	2	1	1	1	1	2	3	2	2	18
14.	Eg 127	2	1	1	1	1	1	1	1	1	3	13
15.	Eg 122	2	2	2	2	2	1	2	2	3	3	21
16.	Eg 133	2	3	3	3	3	3	2	2	1	2	24
17.	Eg 166	2	3	3	1	2	3	2	2	3	1	22
18.	Eg 149	3	3	3	2	3	1	2	3	3	3	26

Contd...

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Sl. No.	Palm No.	Index Score for individual character										Total index score
		Palm height (cm)	Rachis length (cm)	Sex ratio	No. of DFBs	Girth at 25 cm (cm)	No. of leaves	Petiole depth (cm)	Petiole width (cm)	Leaflet length (cm)	No. of leaflets	
19.	Eg 132	1	3	2	1	3	1	3	2	2	3	21
20.	Eg 136	3	3	3	3	3	3	3	3	2	3	29
21.	Eg 104	1	1	1	2	1	1	1	1	2	1	12
22.	Eg 130	1	1	2	2	1	2	1	1	1	2	14
23.	Eg 107	2	2	1	2	1	3	2	1	2	2	18
24.	Eg 169	3	3	1	3	3	3	2	2	2	2	24
25.	Eg 163	2	2	3	3	2	3	1	2	2	2	22
26.	Eg 161	2	2	2	3	2	2	2	3	3	2	23
27.	Eg 164	2	2	2	2	2	3	3	3	2	2	23
28.	Eg 165	3	3	3	2	3	2	3	3	3	3	28
29.	Eg 162	2	3	1	2	2	2	2	3	3	3	23
30.	Eg 168	2	2	3	1	2	1	2	2	2	1	18
31.	Eg 223	1	1	1	3	1	2	1	2	1	1	14
32.	Eg 220	1	2	3	3	2	2	1	2	1	2	19
33.	Eg 218	1	1	1	3	1	3	1	1	1	2	15
34.	Eg 221	1	2	1	1	2	3	1	2	1	2	16
35.	Eg 206	3	2	1	1	3	1	3	3	2	3	22
36.	Eg 215	1	1	1	3	2	1	2	3	2	2	18
37.	Eg 208	2	1	2	2	3	2	2	3	2	2	21
38.	Eg 224	1	2	1	2	1	3	2	1	2	2	17
39.	Eg 210	3	1	3	3	1	3	1	1	1	1	18
40.	Eg 213	2	1	1	1	2	2	1	1	3	1	15
Mean index scores of the 40 genotypes												19.65
Standard deviation of index scores of the 40 genotypes												4.51

values, which reflected their promiscuity in crossing programme aimed at identifying superior palms.

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Table 5. Grouping of 40 *dura* oil palms based on total index score values.

Cluster No.	Total index score value	Genotypes	No. of genotypes
I	< 15.140	*Eg* 100, *Eg* 125, *Eg* 127, *Eg* 104, *Eg* 130, *Eg* 223, *Eg* 218 & *Eg* 213	8
II	15.140 - 24.160	*Eg* 66, *Eg* 45, *Eg* 54, *Eg* 56, *Eg* 67, *Eg* 93, *Eg* 89, *Eg* 95, *Eg* 118, *Eg* 122, *Eg* 133, *Eg* 166, *Eg* 132, *Eg* 107, *Eg* 169, *Eg* 163, *Eg* 161, *Eg* 164, *Eg* 162, *Eg* 168, *Eg* 220, *Eg* 221, *Eg* 206, *Eg* 215, *Eg* 208, *Eg* 224 & *Eg* 210	27
III	> 24.160	*Eg* 59, *Eg* 46, *Eg* 149, *Eg* 136 & *Eg* 165	5

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