COCOS, (1987), 5, 32–38.
Printed in Sri Lanka

Metroglyph Analysis in Coconut (*Cocos nucifera L.*)

T. S. RAVEENDRA[1], T. RAMANATHAN[2], G. NALLATHAMBI[3] and H. VIJAYARAGHAVAN[4]

Coconut Research Station, Veppankulam—614 906, Thanjavur District, Tamil Nadu

[1] *Associate Professor* [2] *Professor and Head* [3] & [4] *Assistant Professor*

ABSTRACT

Metroglyph analysis was done in a group of 23 genotypes of coconut, *Cocos nucifera* L. The varieties came under two groups based on morphological characters. Three groups were recognized when the classification was made on the basis of nut characters. The exotic cultivars, in general, had relatively higher expression for morphological and nut characters. The possibility of obtaining heterotic hybrids from divergent parental combinations was indicated.

INTRODUCTION

The study of metrical variation in cultivated crops is an essential pre-requisite to the identification of varieties superior in respect of their economic attributes. Although methods to estimate genetic variability are available in annual crops, such procedures have not been standardised in perennial crops like coconut in view of obvious difficulties. However, metroglyph analysis proposed by Anderson (1957) will be useful to study the pattern of variation in coconut and to solve the problems of classification.

MATERIALS AND METHODS

Twenty three genotypes of coconut (*Cocos nucifera L.*) maintained at the Coconut Research Station, Veppankulam, Tamil Nadu, India, formed the materials for the study. The trees in different accessions were in the age group of 24–26 years. The experiment was raised in a completely randomised design. Among the 23 cultivars, 14 were collected from India and the rest exotic. The exotic types were drawn from Malaysia (three) Philippiness, Java, Siam, Fiji, New Guinea and Vietnam (Cochin China) through Central Plantation Crops Research Institute, Kasaragod, India. Although the number of palms in each genotype varies from 6 to 13, observations were limited to only 4 palms in each genotype which resemble to each other very closely in morphology and nut characters, to avoid intra genotypic variation. The mean data over the four palms were subjected to study.

Observations were made on six morphological traits viz. plant height, number of functional leaves, girth at collar, length of petiole, length of leaflet bearing portion and the number of leaflets on one side, during 1982 to 1984. For studying the nut components, two nuts of 12 months maturity were collected from each of the four trees at harvest. Data were collected on weight of whole nut, dehusked nut, kernel and copra per nut and kernel thickness for each nut separately by following standard procedures during the summer months (March, April, May, June), The mean data over 96 observations (2 nuts, 4 palms, four months and three years) in each variety were used for the study.

Table 1. *Morphological characters in different coconut genotypes*

Sl. No.	*Genotype*	*Abbreviation used*	*Origin*	*Plant height (m)*	*No. of functional leaves*	*Girth at collar (cm)*	*Length of petiole (m)*	*Length of leaflet bearing portion (m)*	*No. of leaflets on one side*	*Total score*
1.	Ayiramkachi	(AY)	India	5.00(1)	26.7(1)	69.9(1)	1.10(2)	3.04(2)	98(2)	9
2.	Kanyakumari Yellow	(KY)	India	7.47(2)	37.8(3)	67.0(1)	1.05(1)	3.07(2)	88 (1)	10
3.	Kanyakumari Red	(KR)	India	6.02(2)	31.7(2)	61.6(1)	0.97(1)	2.(982)	88 (1)	9
4.	Kanyakumari Green	(KG)	India	8.99(3)	41.5(3)	73.8(2)	1.18(3)	3.90(3)	100(2)	16
5.	Lakshadweep Micro	(LM)	India	8.43(3)	36.6(3)	72.5(1)	1.20(3)	3.73(2)	112(3)	15
6.	Lakshadweep Small	(LS)	India	7.76(3)	37.6(3)	67.9(1)	1.06(2)	3.51(2)	108(3)	14
7.	Lakshadweep Ordinary	(LO)	India	8.18(2)	29.3(1)	65.0(1)	1.15(3)	3.42(2)	108(3)	12
8.	Lakshadweep Pink	LP)	India	8.19(2)	36.6(3)	68.0(1)	1.15(3)	3.31(2)	108(3)	14
9.	Andaman Dwarf	(AD)	India	5.10(2)	29.7(1)	76.7(2)	0.98(1)	2.98(2)	99 (2)	9
10.	Andaman Ordinary	(AO)	India	7.63(2)	35.3(2)	82.3(2)	1.19(3)	3.48(2)	111(3)	14
11.	Andaman Giant	(AG)	India	8.42(3)	33.4(2)	96.2(3)	1.44(3)	4.98(3)	116(3)	17
12.	Gangabondam	(GGB)	India	6.70(2)	37.1(3)	72.0(1)	1.20(3)	3.55(2)	109(3)	14
13.	Spicata	(SP)	India	7.95(2)	32.8(2)	71.3(1)	1.09(2)	3.53(2)	114(3)	12
14.	East Coast Tall	(ECT)	India	7.61(2)	32.0(2)	76.7(2)	1.03(1)	3.14(2)	106(2)	11
15.	Dwarf Green	(DG)	Malaysia	3.67(1)	28.4(1)	61.9(1)	1.03(1)	2.71(1)	91(1)	6
16.	Straits Settlements Green	(SSG)	Malaysia	7.96(2)	38.8(3)	66.3(1)	1.05(1)	2.96(2)	99 (2)	11
17.	Federated Malayan States	(FMS)	Malaysia	9.48(3)	39.2(3)	73.3(1)	1.24(3)	3.89(3)	111(3)	16
18.	Fiji	(Fiji)	Fiji	9.09(3)	38.8(3)	70.0(1)	1.13(2)	3.40(2)	108(3)	14
19.	Philippines Ordinary	(PHO)	Philippines	9.05(3)	39.8(3)	73.3(1)	1.04(1)	3.81(3)	104(2)	13
20.	Java Giant	(JG)	Java	10.30(3)	39.5(3)	72.5(1)	1.23(3)	3.88(3)	112(3)	16
21.	Siam	(SI)	Siam	8.45(3)	38.5(3)	72.5(1)	0.98(1)	3.36(2)	117(3)	13
22.	New Guinea	(NG)	New Guinea	9.24(3)	32.2(2)	72.0(1)	1.11(2)	3.33(2)	102(2)	12
23.	Cochin China	(CC)	Vietnam	9.23(3)	35.5(2))	75.0(2)	1.13(2)	3.43(2)	100(2)	13

T. S. RAVEENDRA,[1] T. RAMANATHAN,[2] G. NALLATHAMBI[3] and H. VIJAYARAGHAVAN[4]

Table 2. *Nut characters of different coconut genotypes*

Sl. No.	*Genotype*	*Whole nut weight (g)*	*Dehusked nut wt. (g)*	*Kernel thickness (cm)*	*Kernel weight (g)*	*Copra weight (g)*	*Total score*
1.	Ayiramkachi ...	435(1)	220(1)	1.1(1)	128.0(1)	55.0(1)	5
2.	Kanyakumari Yellow ...	810(2)	450(1)	1.1(1)	146.5(1)	78.1(1)	6
3.	Kanyakumari Red ...	700(1)	428(1)	1.3(2)	225.0(2)	119.0(1)	7
4.	Kanyakumari Green ...	852(2)	582(2)	1.4(3)	311.0(3)	156.7(2)	12
5.	Lakshadweep Micro ...	499(1)	265(1)	1.4(3)	175.0(1)	83.1(1)	7
6.	Lakshadweep Small ...	655(1)	330(1)	1.5(3)	183.5(1)	84.7(1)	7
7.	Lakshadweep Ordinary ...	1,018(2)	545(2)	1.2(2)	213.0(2)	114.0(1)	9
8.	Lakshadweep Pink ...	805(2)	425(1)	1.2(2)	220.0(2)	100.0(1)	8
9.	Andaman Dwarf ...	752(1)	510(2)	1.1(1)	270.0(2)	124.8(1)	7
10.	Andaman Ordinary ...	1,288(3)	788(3)	1.3(2)	370.7(3)	185.3(3)	14
11.	Andaman Giant ...	1,510(3)	756(3)	1.4(3)	320.8(3)	190.0(3)	15
12.	Gangabondam ...	1,00(2)	601(2)	1.4(3)	307.8(3)	168.8(2)	12
13.	Spicata ...	890(2)	505(2)	1.3(2)	260-0(2)	128.6(2)	10
14.	East Coast Tall ...	962(2)	526(2)	1.3(2)	274.4(2)	118.6(1)	9
15.	Dwarf Green ...	447(1)	242(1)	1.1(1)	129.5(1)	83.8(1)	5
16.	Straits Settlements Green ...	1,014(2)	623(2)	1.5(3)	326.7(3)	157.1(2)	12
17.	Federated Malayan States ...	1,252(3)	902(3)	1.4(3)	375.0(3)	174.6(3)	15
18.	Fiji ...	808(2)	493(2)	1.4(3)	272.5(2)	161.5(2)	11
19.	Philippines Ordinary ...	933(2)	605(2)	1.4(3)	388.3(3)	162.3(2)	12
20.	Java Giant ...	1,195(3)	673(2)	1.5(3)	362.5(3)	191.9(3)	14
21:	Siam ...	1,365(3)	725(3)	1.5(3)	375.0(3)	220.0(3)	15
22.	New Guinea ...	1,480(3)	720(3)	1.4(3)	335.0(3)	194.0(3)	15
23.	Cochin China ...	1,250(3)	900(3)	1.4(3)	350.0(3)	178.3(3)	5

Table 3. *Index scores and signs for different traits in coconut germplasm varieties*

Sl. No.	*Character*	*Range of means*	*Score I Value less than*	*Sign*	*Score II Value (ranges)*	*Sign*	*Score III Value more than*	*Sign*
	(a) Morphological characters							
1.	Plant height (m)	3.67–10.30	5.49		5.50– 8.23		8.23	
2.	Number of functional leaves	26.70–41.50	31.63		31.64–36.56	|	36.56	|
3.	Girth at Collar (cm)	61.90–96.20	73.33	—	73.34–84.76	0	84.76	0
4.	Length of petiole (m)	0.97– 1.24	1.06	—	1.07–1.15	0—	1.15	0—
5.	Length of leaflet bearing portion (m)	2.71– 4.98	2.88	—	2.89 –3.79	0	3.79	0
6.	Number of leaflets on one side	88.0–117.0	97.66	—	97.67–107.32	—0	107.32	—0
	(b) Nut characters							
1.	Whole nut weight (g)	447.0–1510.0	801.0		802.0–1155.0		1155.0	
2.	Dehusked nut weight (g)	242.0–900.0	461.0		462.0–680.0	|	680.0	|
3.	Thickness of kernel (cm)	1.1–1.5	1.2	—	1–.3–1.4	0	1.4	0
4.	Weight of kernel (g)	129.5–375.0	211.4	—	211.5–293.3	0	293.3	0
5.	Weight of copra (g)	78.1–220.5	125.6	—	125.7–173.1	0—	173.1	0—

The morphological and nut characters were assigned scores in three grades and the scores are presented along with the mean values in Tables 1 and 2. Two separate diagrams were constructed to show the distribution of genotypes one for morphological traits and the other for nut characters. Since plant height and number of leaves are the two most important morphological characters, these two were allotted to Y and X axis of Figure 1, respectively. Similarly, weight of whole nut and dehusked nut were taken in Y and X axis of the Figure 2 based on their importance in nut analysis. The scatter diagrams (Fig . 1 and 2) were constructed in which each accession was represented by a circle with its code appropriate for the intervals of the traits (Table 3). The range of variation in each character was represented by a corresponding range in the length of the ray. The different characters were represented by different positions of the rays on the glyph. The index values for each character were divided into three classes—1 no ray; 2 short ray and 3 long ray. The total index was recorded by summing up the index score of all the characters.

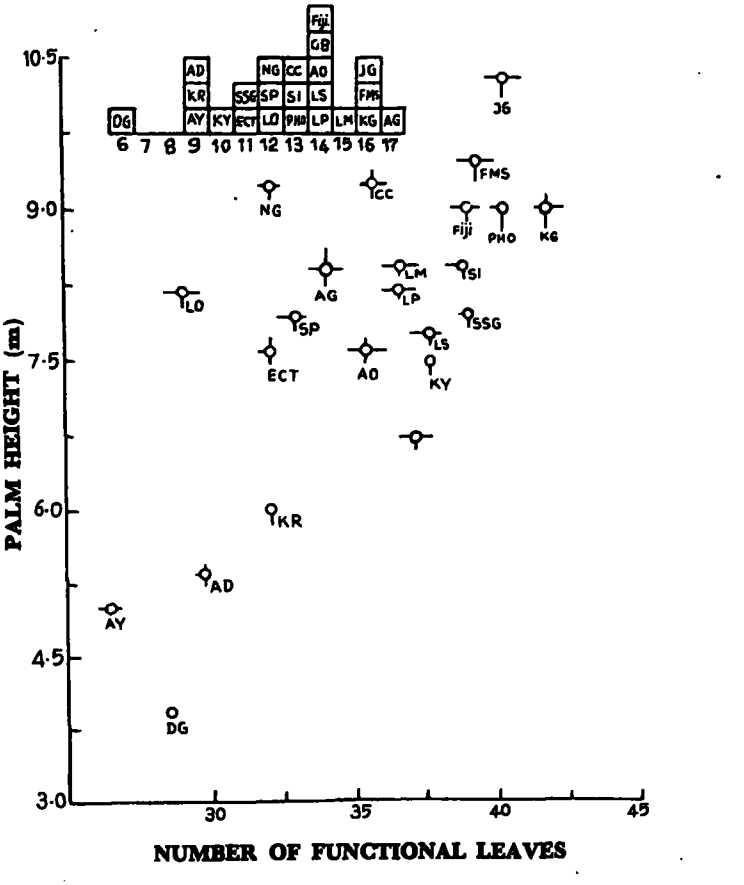

Fig. 1. Metroglyph analysis of morphorlogical characters in coconut.

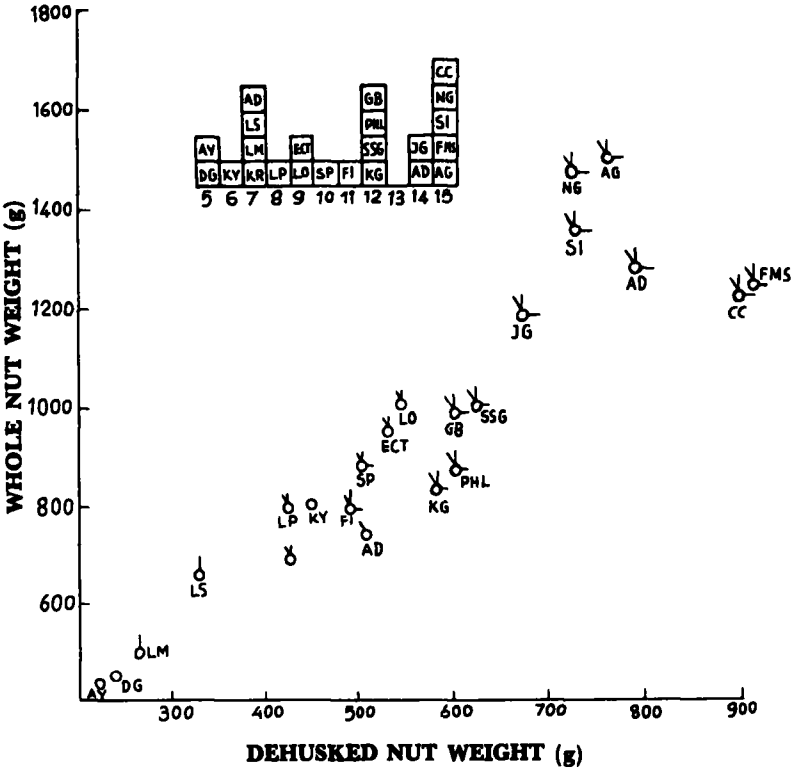

Fig. 2. Metroglyph analysis of nut characters in coconut.

RESULTS AND DISCUSSION

1. Variation in morphology

Among the 14 accessions of Indian orgin, Ayiramkachi, Andaman Dwarf and Kanyakumari Red were dwarf and the others were Tall. One of the nine exotic genotypes, Dwarf Green (Malaysia) also expressed dwarfism. All these four cultivars were intermediate or low in their phenotypic expression.

The girth at collar did not vary much in most of the tall cultivars. However, Andaman Giant had thick collar. Exotic types, in general and Java Giant and Federated Malay States in particular, had high expression for all the characters. The four Lakshadweep types were almost similar in their morphology. The three accessions from Andaman showed a gradation in their morphological expression, Andaman Ordinary being intermediate between 'Giant' and 'Dwarf' types. Similarly, the three types collected from Kanyakumari (Tamil Nadu) also showed a range of variation. The 'Green' had larger size of palms followed by 'Yellow' and 'Red' types. East Coast Tall, the native genotype of Tamil Nadu, was intermediate in its morphology.

Thus, from the morphology, two distinct groups were evident, the large group of 'Tall' cultivars with a high phenotypic expression for all the metrical traits and the second group of 'Dwarf' cultivars.

2. Variation in nut characters

Three distinct groups of genotypes could be rceognized based on nut characters The first group had four types, 'Ayiramkachi', 'Lakshadweep Small', 'Lakshadweep Micro'(India) and 'Dwarf Green' (Malaysia). This group is characterised by small sized nuts. Nine Indian and three exotic varieties come under the second group which is distinguished from their moderate sized whole and dehusked nuts. The three exotic cultivars 'Fiji', 'Philippines Ordinary' and 'Straits Settlements Green' of this group had thick meat. Among these, 'Fiji' had intermediate kernel and copra weights per nut while the other two had a high content of kernel and copra per nut. Moderate kernel and copra weights were observed in two of the nine Indian cultivars, 'Gangabondam' and 'Kanyakumari Green' of the second group. The others were moderate or low in their nut component.

The third group includes seven genotypes, two Indian ('Andaman Giant' and 'And a man Ordinary') and five exotic ('New Guinea', 'Siam', 'Cochin China', 'Federated Malay States' and 'Java Giant') accessions. These are characterised by high expressions for the different nut characters studied. Harries (1978) classified coconut varieties based on nut size into 'Niu Vai' types possessing larger nuts and lesser husk content and 'Niu Kafa' types representing the naturally evolved genotypes. Accordingly these seven genotypes could be classified under 'Niu Vai' types in view of their bigger whole nut and dehusked nut.

Although, the three collections from Kanyakumari (Tamil Nadu) occupy a single group they vary slightly in their nut size. 'Green' exhibits higher expression for nut characters than 'Yellow' and 'Red' types. The nut characters in respect of the four Lakshadweep accessions also show a range of variation as seen from their positions in the scatter diagram. 'Lakshadweep Micro' which is close to the origin and 'Lakshadweep Small' had thick meat while 'Lakshadweep Pink..' and 'Lakshadweep Ordinary' had intermediate kernel thickness. Among the indigenous types 'Ayiramkachi' was the lowest in nut weight. This variety could be characterised by small nuts, thin kernels and low kernel and copra yield.

It could be seen that nut characters provide a more reliable scale for classification of the varieties than the morphological expressions. Menon and Pandalai (1958) reported that varieties differed from each other in their morphology of the tree and to a larger extent in respect of their nut characters. Rao and Pillai (1982) also mentioned that morphological characters depend more on the age of the palm and need repeated recording Although the four Lakshadweep collections express similarity in morphology, they vary considerably in their nut characters. These types might have arisen as a product of introgression from a common parentage and subsequent selection might have stabilized their morphology. Rao and Pillai (1982) indicated that the island populations, 'Andaman Ordinary', 'Andaman Giant' and 'Lakshadweep Ordinary' represent introgressed form. Similarly, the three different cultivars from Kanyakumari might also have their origin from a common parentage. A tendency of dominance was evident in 'Green' and recessiveness in 'Red' and 'Yellow' was intermediate for morphology. While in respect of nut characters, 'Red' and 'Yellow' express poorly. It would be worthwhile to initiate a hybridisation programme between Dwarf Green (Malaysia) and the Indian genotypes 'Andaman Giant' or 'Ordinary' to obtain hybrids of superiority as crossing between divergent parents is likely to yield high heterosis. Hybridisation between locally adapted 'East Coast Tall' and exotic genotypes, 'New Guinea', 'Siam', 'Cochin China', 'Philippines' and 'Federated Malay States' may also yield fruitful results.

ACKNOWLEDGEMENTS

The authors are thankful to Dr. S. Chelliah, Director, Tamil Nadu Rice Research Institute, Aduthurai for the encouragement and the ICAR, New Delhi for the financial support.

REFERENCES

Anderson, E., (1957). A Semigraphical method for the analysis of complex problems. *Proc. National Acad. Sci.* Washington 43: 923–927.

Harries, H. C., (1978). The evolution, dissemination and classification of *Cocos nucifera* L. *Bot. Rev.* 44 : 265–319.

Menon, K. V. and Pandalai, K. M. (1958). The coconut palm—A *Monograph Indian Central Cocon. Committee. The times of India Press, Bombay* PP. 86–102.

Rao, E. V. V. B., and Pillai, R. V., (1982). Characterisation of coconut germplasm based on fruit component analysis. *Proc. Fifth Symposium on Plantation Crops Kasaragod India* PP. 112–124.