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Short Communication

Variability and principal component analysis for yield and yield contributing traits in West Coast Tall coconut (*Cocos nucifera* L.) palms

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Abstract

A total of 64 West Coast Tall (WCT) coconut population were characterized for morphological, reproductive, tender nut, fruit component and yield traits. High coefficient of variation was observed in length of single internode, number of rachillae and female flowers per inflorescence, total no. of nuts, volume of tender nut water, weight of tender nut, mature nut and husked nut, husk thickness and shell thickness. Principal component analysis revealed that length of spikelet bearing portion, no. of rachillae, female flowers per inflorescence, total no. of bunches and nuts were the important traits in differentiating the WCT palms under study. The results of this study showed that consideration should be given for the above characters while selecting elite lines for yield and copra production.

Key words: Variability, WCT palms, selection, yield

The coconut (*Cocos nucifera* L.) is an economically significant crop species in the humid tropics. It is securing food and livelihood for millions of people. Coconut cultivation is vital in the Asian and Pacific region to sustain the economy of a number of countries. It offers food, fibers, beverage, nutrition, medicine, shelter and broad range of handicrafts all through its lifetime. Of the varieties of coconut available in India, the West Coast Tall (WCT) cultivar is the most common. This variety of coconut is extensively cultivated in all the important coconut tracts of India and is of commercial importance. WCT is a hardy palm, yielding nuts, copra, oil, and good quality coir fibre. In heterozygous crops such as coconut, population improvement is important than individual hence recurrent selection is the suitable breeding approach (Baudouin et al. 1997). Selection among the population is important to enhance the performance of desirable trait and it could be done only if there is genetic variation. Hence assessment of level of variability will be of enormous value for discovering superior lines suitable for high yield and copra content. Principal Component Analysis (PCA) grouping the individuals with comparable characteristics and studying its correlation is possible (Valladares et al. 2008). In addition to this, Cluster Analysis classifying objects into groups with more steadiness within groups and more heterogeneity between groups (Hair et al. 2009) either by hierarchical methods or otherwise, (Ferraudo 2010). These techniques have been highly useful in crop improvement, providing significant information which support the selection process. Therefore, the present study was undertaken at ICAR-CPCRI to investigate the West Coast Tall population for high yield and copra content.

A set of 64 West Coast Tall palms maintained at Central Plantation Crops Research Institute, Kasaragod, Kerala were characterized for morphological, reproductive, tender nut, fruit component and yield traits during 2017-2018. The palms were planted during 1972 and hence attained stabilized

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Table 1. Mean and variability for morphological, reproductive, tendernut, fruit component characters and yield in West coast Tall (WCT) palms

S.No.	Characters	Mean	Range	CV	S.No.	Characters	Mean	Range	CV
1.	Plant Height (cm)	1174.56	664-1799	17.46	21.	Volume of tender nut water (ml)	266.99	162.5-420	20.56
2.	Plant Girth (cm)	81.58	61-114	13.61	22.	Kernal thickness of tender nut (cm)	0.52	0.1-0.9	71.81
3.	Number of leaves	28.12	15-37	12.90	23.	Kernal weight of tender nut (g)	78.05	45-163	47.69
4.	Length of the leaf (cm)	4.91	3.1-6.3	10.31	24.	Husk thickness (cm)	2.93	1.75-10.25	37.25
5.	Length of leaflet bearing portion (cm)	353.26	264-452	7.00	25.	Tender nut length without husk (cm)	9.98	8.4-17.2	11.32
6.	Number of leaflets	242.98	204-293	7.22	26.	Tender nut breadth without husk (cm)	9.24	8.05-10.9	7.13
7.	Length of single internode (cm)	6.88	3.2-13	23.83	27.	Fruit weight (g)	800.00	0.55-1.38	21.86
8.	Length of inflorescence (cm)	108.24	75-180	13.98	28	Fruit Length (cm)	19.82	17-24	9.52
9.	Length of spikelet bearing portion (cm)	38.23	22-55	17.77	29.	Fruit girth (cm)	13.65	12-19.5	10.33
10.	Length of spikelet (cm)	37.21	26-57	14.67	30.	Polar circumference of fruit (cm)	56.88	49-66	7.27
11.	Number of spikelets per inflorescence	36.11	25-61	20.00	31.	Equatorial circumference of fruit (cm)	48.62	40-65	9.09
12.	Number of female flowers per inflorescence	23.04	8-48	30.10	32.	Husk thickness of fruit (cm)	2.80	0.7-4.3	24.60
13.	Total number of bunches	15.87	6-21	15.41	33.	Weight of the husked fruit(g)	450.00	0.16-0.74	25.24
14.	Total number of nuts per palm	126.99	16-260	38.42	34.	Length of the husked nut (cm)	11.10	9-13	7.65
15.	Tender nut weight (g)	1520.00	0.5-2.28	20.90	35.	Girth of the husked nut (cm)	9.24	7.5-11	8.66
16.	Tender nut length (cm)	17.74	15-21.75	8.31	36.	Polar circumference of the husked nut (cm)	34.46	30-39	6.52
17.	Tender nut breadth (cm)	12.71	10.7-15.7	8.23	37.	Equatorial circumference of the husked nut (cm)	32.05	26-38	8.23
18.	Tender nut circumference (polar) (cm)	49.19	46-56.5	6.45	38.	Kernel thickness (cm)	1.23	0.9-1.4	10.96
19.	Tender nut circumference (Equitorial) (cm)	42.28	37.5-49.5	7.10	39.	Shell thickness (cm)	0.31	0.2-0.5	26.15
20.	TSS (ºBrix)	6.31	5-7.1	7.42	40.	Copra content (g)	181.33	116-259	17.42

bearing phase. Observations on morphological, reproductive, tender nut, fruit component and yield traits were recorded according to the standard descriptors.

The variation of individual WCT palms for the traits was analyzed in terms of mean, range and coefficient of variation as per the method described by Sivasubramanian and Madhava Menon (1973) using excel. Principal component analysis was done using the MVSP 3.2 (Multi-Variate Statistical Package) software (Kovach 2007). The dendrogram was made using the technique of Unweighted Pair Group Method using Arithmetic average (UPGMA) with MVSP software version 3.2 (Figure not given in the paper).

For a successful breeding program, the knowledge of genetic variability of desirable characters is very important. Variability point outs the recombination extent for starting efficient selection procedures, hence variability facilitates to select a potential line. In the current study, high coefficient of variation was observed in length of single internode (23.83), no. of spikelets/inflorescence (20.00), no. of female flowers/inflorescence (30.10), total no. of nuts (38.42), tender nut weight (20.90), volume of tender nut water (20.56), weight of mature nut (21.86), husk thickness (24.60), weight of the husked nut (25.24) and shell thickness (26.15). Moderate coefficient of variation was observed in plant height (17.46), plant Girth (13.61), number of leaves (12.90), leaf length (10.31), inflorescence length (13.98), spikelet bearing portionlength (17.77), spikelet length (14.67), total no. of bunches (15.41),tender nut length (11.31), girth of the matured fruit (10.33), thickness of the kernel (10.96) and copra content (17.42) (Table 1). Hence, selection based on the above parameters is good for further improvement. Similarly, genetic variability of nut and copra yield and other fruit component characters was analysed by Ganesamurthy et al. (2002) in 14 coconut genotypes and opined that high amount of variability for whole nut weight and dehusked nut weight and yield of nut and copra.

Principal component (PC) analysis has been used to understand how different parameters in crops contributed to the total variability for the traits. The proportion of total variance is explained by each PC. For the two groups of traits, two PCs, each having eigen values more than one will determine the most significant components (Bollinedi et al. 2020). Further, partitioning of eigen values of the significant PCs, the factor-variable correlations may indicate that certain traits may have positive influence on PCs and few may have negative influence towards other principal components. The PCA recognizes quantitative characters that contribute most of the observed variations within 64 WCT coconut palms (Table 2). In the total variability, first four principal components contributed about 62.25 per cent with Eigen value of more than 0.202 in 64 palms involving 30 quantitative traits. The total variance of 82.40 per cent contributed by the first four PC axes pointed out that the variation within the palms was greatly influenced by the quantitative traits within those axes. The first principal component contributed for 62.25 per cent of total variation, where plant height, girth at base and at 0.5 m height, number of rachillae and female flowers per inflorescence, spikelet bearing portion length, total number of bunches and nuts were positively contributed. The second principal component accounted 10.59 per cent of the total variability. Variables such as plant height, girth at base and at 0.5 m height, spikelet bearing portion length, number of rachillae per inflorescence, fruit weight of tender nut, volume of tender nut water and copra content contributing most positively. The third principal component contributed for 5.26 per cent of the total variation, in which the variables are plant height, girth at base and at 0.5 m height, total number of bunches and nuts. The fourth principal component accounted 4.29 per cent of variation in the total variation, in which the variables, length of the inflorescence and rachillae bearing portion, total number of bunches and nuts, weight, length and breadth of the tender nut, volume of water and husk thickness of the tender nut and copra content. The criteria employed by Clifford and Stephenson (1975) and authenticated by Guei et al. (2005), was followed in principal component analysis which advocated that the first three principal components are frequently the powerful in revealing the pattern of variation in the population and the traits correlated with these are more helpful in distinguishing the population. The important characters are coming simultaneously in various principal components and contributing towards variability have tendency to remain together. This may be considered during exploitation of these traits in breeding programme. The 64 WCT palms were clustered into six main groups. Group I had three WCT palms, WCT51, WCT52 and WCT55, group II had one palm, WCT28 and Group III contains four palms, WCT37, WCT26, WCT30 and WCT21. Group IV contained 24 progenies while group V contains 25 WCT palms. Group VI had seven palms, WCT45, WCT46, WCT24, WCT7, WCT62, WCT8 and WCT1. The Palms in cluster I characterised by plant

Table 2. Eigen values, factor scores and contribution of principal component axes

Principal Components	PC1	PC2	PC3	PC4
Eigen values	0.202	0.034	0.017	0.014
Percentage of variance	62.25	10.59	5.27	4.29
Cumulative Percentage	62.25	72.84	78.11	82.40
Plant Height	**0.194**	**0.109**	**0.245**	-0.094
Plant Girth at base	**0.149**	**0.472**	**0.400**	-0.083
Plant girth at 0.5 m	**0.150**	**0.357**	**0.351**	-0.012
Length of the inflorescence	0.069	0.073	-0.033	**0.237**
Length of the spikelet bearing portion	**0.201**	**0.214**	-0.017	**0.308**
Number of spikelets/inflorescence	**0.146**	**0.215**	-0.043	0.043
Number of female flowers/ inflorescence	**0.750**	0.027	-0.537	-0.305
Total number of bunches	**0.134**	-0.051	**0.141**	**0.186**
Total number of nuts	**0.498**	-0.554	**0.482**	**0.242**
Tender nut weight	0.008	**0.114**	-0.076	**0.271**
Tender nut length	0.013	-0.009	-0.046	**0.112**
Tender nut breadth	0.032	0.089	-0.021	**0.118**
Volume of water	0.046	**0.234**	-0.254	**0.611**
Husk thickness	-0.051	-0.314	-0.090	**0.310**
Copra content	0.026	**0.120**	-0.028	0.177

height and girth and low kernel weight and thickness of tender nut. Group II characterised by thickness of husk, Group III characterised by thickness and weight of the kernel, Group IV, Group V and Group VI characterised based on the number of spikelets and female flowers per inflorescence, spikelet bearing portion length, number of bunches and nuts per palm. Sarkar et al. (2012) worked on the morphometric characterization of coconut germplasm and PCA, results revealed that days taken for spathe opening, days taken for male phase and total number of nuts per palm contributed 66.73 per cent of observed variation and twenty seven coconut genotypes were grouped into seven clusters. Perera and Perera (2015) studied morphological data of six coconut varieties and first two principal components revealed that stem and inflorescence traits showed 98.3 per cent of the variation among accessions. Sathish Kumar (2016) studied the PCA of Komadan palms and revealed that, in total variability the first four components contributed on 92.08 per cent. The characters such as weight and number of whole nuts and husked nuts per palm per year, number of nuts per bunch, copra content per nut and copra weight per year were most significant ones contributing to the overall variability.

Authors' contribution

Conceptualization of research (RS, VN); Designing of the experiments (RS, VN, KS); Contribution of experimental materials (RS, VN, KS); Execution of field/lab experiments and data collection (YD); Analysis of data and interpretation (RS, VN, KS); Preparation of manuscript (RS, VN, KS).

Declaration

The authors declare no conflict of interest.

References

Baudouin L., Lebrun P., Konan J. L., Ritter E., Berger A. and Billotte N. 2006. QTL analysis of fruit the progeny components in of a Rennell Island Tall coconut (*Cocos nucifera* L.) individual. Theor. Appl. Genet., **112**: 258-268.

Bollinedi Haritha, Vinod K. K., Bisht K., Chauhan A., Gopala Krishnan S., Bhowmick Prolay K., Nagarajan M., Sanjeeva Rao D., Ellur R. K. and Singh A. K. 2020. Characterising the diversity of grain nutritional and physico-chemical quality in Indian rice landraces by multivariate genetic analyses. Indian J. Genet., **80**(1): 26-38. DOI: 10.31742/IJGPB.80.1.4.

Clifford H. T. and Stephenson W. 1975. An introduction to numerical classification. Academic Press, London, pp.229.

Ferraudo A. S. 2010. Técnicas de AnáliseMultivariada: umaintrodução. São Caetano: StatSoft South América.

Guei R. G., Sanni K. A. and Fawole A. F. J. 2005. Genetic diversity of rice (*Oryza sativa* L.). Agron. Afr., **5**: 17-28.

Hair J. F., Anderson R. E., Tatham R. L. and Black W. C. 2009. Multivariate Data Analysis. 6ed. Prentice Hall, New York, NY, USA.

Kovach 2007. Multivariate statistical Package (MVSP) ver 3.22. Kovach Computing Services, All Rights Reserved Published by Kovach Computing Services, Pentraeth, Wales, U.K. Printed September 2007.

Patel J. S. 1937. Coconut Breeding. Proc. Assoc. Econ. Biol., **5**: 1-16.

Perera K. N. S. and Perera S. A. C. 2015. Multivariate discrimination of exotic coconut varieties for stem and inflorescence morphology. Sri Lanka Assoc. for the Advmt. of Sci., **201**(1): 10-13.

Sarkar M. D., Choudhury S., Islam N. and Islam M. N. 2012. Morphometric characterization of coconut germplasm conserved at Bari. Int. J. Sustain. Agric., **4**(3): 52-56.

Sathish Kumar S. 2016. Intra-varietal variability in komadan coconut (*Cocos nucifera* L.) palms. Ph.D. Thesis, Kerala agricultural University, Thrissur, p. 141.

Sivasubramanian S. and Madhava Menon P. 1973. Genotypic and phenotypic variability in rice. Madras. Agric. J., **60**: 1093-1096.

Valladares G. S. et al. 2008. Análise dos components principais e métodosmulticritérioordinais no estudo de Organossolos e solos afins. Revista Brasileira de Ciência do Solo, v. 32, n. 1, p. 285-296.