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***Short communication***

# Genetic analysis in Pacific and Nicobar Islands coconut collections conserved at Andaman Islands, India

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## ABSTRACT

**Characterization and genetic analysis of coconut accessions collected from Pacific Ocean Islands and Nicobar Islands for morphological, physio-chemical traits and fruit component traits resulted into six distinct clusters with maximum inter-cluster distance $D^2$ value was obtained between cluster IV, V and VI. Cluster VI resulted with high copra yield (244. 3 g), dwarfness and other yield attributing characters followed by clusterIII. Among the accessions high heritability coupled with high genetic advance was observed for fruit weight, weight of dehusked fruit, kernel weight, shell weight and plant height which had direct influence on the copra yield/ palm in coconut. Hence, due weightage for these traits must be given in coconut selections for the improvement of copra yield.**

**Key words:** Coconut, genetic analysis, heritability, cluster analysis.

Coconut palm (*Cocos nucifera* L.) is one of the most important plantation crops of India. Genetic improvement of coconut has been effective through selection and hybridization and 15 hybrids and 18 selections have been released for commercial cultivation in different parts of India. There are two major plant types available in coconut, *viz*., tall and dwarf based on differences in number of morphological traits such as growth rate, earliness, plant height, pollination behavior and nut characteristics. Dwarf palms are normally low (5%) in frequency (Ganeshamurthy *et al*., 1). Dwarf palms are mainly cultivated for tender nut purpose and tall cultivars are preferred for copra and oil extraction. The main objective of any coconut breeding is to increase the nut yield, which is a complex character depended on interaction of large number of component characters. The copra yield is the most important economic trait governing the oil yield per unit area, which depends not only on the nut yield but also on the nut characteristics. Several studies (Ganeshamurthy *et al*., 1; Kumaran *et al*., 3; Upadhyay *et al*., 6) indicated that the phenotypic association among the characters. Although correlations are helpful in determining the components of complex traits like yield, they do not provide an exact picture of relative importance of direct and indirect influence of each of the complex characters towards this trait. Utilization of conserved coconut accessions in breeding programmes needs the genetic diversity information and diverse parents. In order to get the genetic diversity in coconut, the accessionsneed to be conserved and evaluated for more than 30 years.

An attempt was made to elucidate the genetic parameters of coconut accessions conserved at World Coconut Germplasm Centre. The experimental material comprised of 30 coocnut accessions including 24 accessions originally collected from Pacific Ocean Islands and 6 from Nicobar Islands that were conserved and evaluated since 1983 to 2012 in the filed gene banks (Table 1). The analysis of genetic divergence

**Table 1.** Pacific and Nicobar coconut accessions used for characterization.

| Acc. No. | Genotype | Country of origin |
|---|---|---|
| WCGC 01 | Soloman Tall | Soloman Island |
| WCGC 02 | Rennel Tall | Soloman Island |
| WCGC 03 | Fiji Tall | Fiji Island |
| WCGC 04 | Niu Drau Tall | Fiji Island |
| WCGC 05 | Niu Lekha Green Dwarf | Fiji Island |
| WCGC 06 | Niu Bulavu Tall | Fiji Island |
| WCGC 07 | Local Tall | American Somoa |
| WCGC 08 | Niu Oma Yellow Dwarf | American Somoa |
| WCGC 09 | Local Tall (Tutiala) | American Somoa |
| WCGC 10 | Niuui Tall | American Tonga |
| WCGC 11 | NiuTaukave Tall | American Tonga |
| WCGC 12 | Niu Hake Tall | American Tonga |
| WCGC 13 | Tahiti Tall Tall | French Polynesia |

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*Table 1 Contd...*

| Acc. No. | Genotype | Country of origin |
|---|---|---|
| WCGC 14 | Local Tall (Paopao) | French Polynesia |
| WCGC 15 | Local Tall (Haepiti) | French Polynesia |
| WCGC 16 | Local Tall (Bora Bora) | French Polynesia |
| WCGC 17 | Rangiroa Tall (Avaoru) | French Polynesia |
| WCGC 18 | Hari Papua Orange Dwarf | French Polynesia |
| WCGC 19 | Rangiroa Tall (Tiputa) | French Polynesia |
| WCGC 20 | Kiriwana Tall | Papua New Guinea |
| WCGC 21 | Muwa Tall | Papua New Guinea |
| WCGC 22 | Nikkore Orange Dwarf | Papua New Guinea |
| WCGC 23 | Kaveing Tall | Papua New Guinea |
| WCGC 24 | Natava Tall | Papua New Guinea |
| WCGC 25 | Auckchang Tall | Car Nicobar Island |
| WCGC 26 | Tamaloo Tall | Car Nicobar Island |
| WCGC 27 | Kimios Tall | Car Nicobar Island |
| WCGC 28 | Kinmai Tall | Car Nicobar Island |
| WCGC 29 | Katchal | Katchal Island, Nicobar |
| WCGC 30 | Campbell Bay Tall | Great Nicobar Island |

was carried out by using Mahalanobis $D^2$statistics (Mahalanobis, 4). The genotypes were grouped in to different clusters as per Tocher's method.

The analysis of variance for 11 quantitative characters showed significant differences among 30 accessions indicated existence of wide genetic diversity. These 30 accessions were grouped in to 6 clusters (Fig. 1). Tocher's method of clustering and combined analysis of variance revealed the cluster I with 20 tall accessions, cluster II with one tall accession, cluster III with 5 accessions (four tall and one dwarf accessions), cluster IV with two dwarf accessions, cluster V with one tall accession and cluster VI with one dwarf accession. The pattern of distribution of accessions in different clusters indicated that it was related to not only geographic differentiation but also related to the morphological and fruit component traits. Clustering of genotypes from different geographic locations into one cluster can be attributed to the possibility of human selection for desirable traits. The unidirectional selection practiced for particular trait or group of linked traits in several places may produce similar phenotype, which can be aggregated in to one cluster irrespective of their geographic origin (Rajesh, 5).

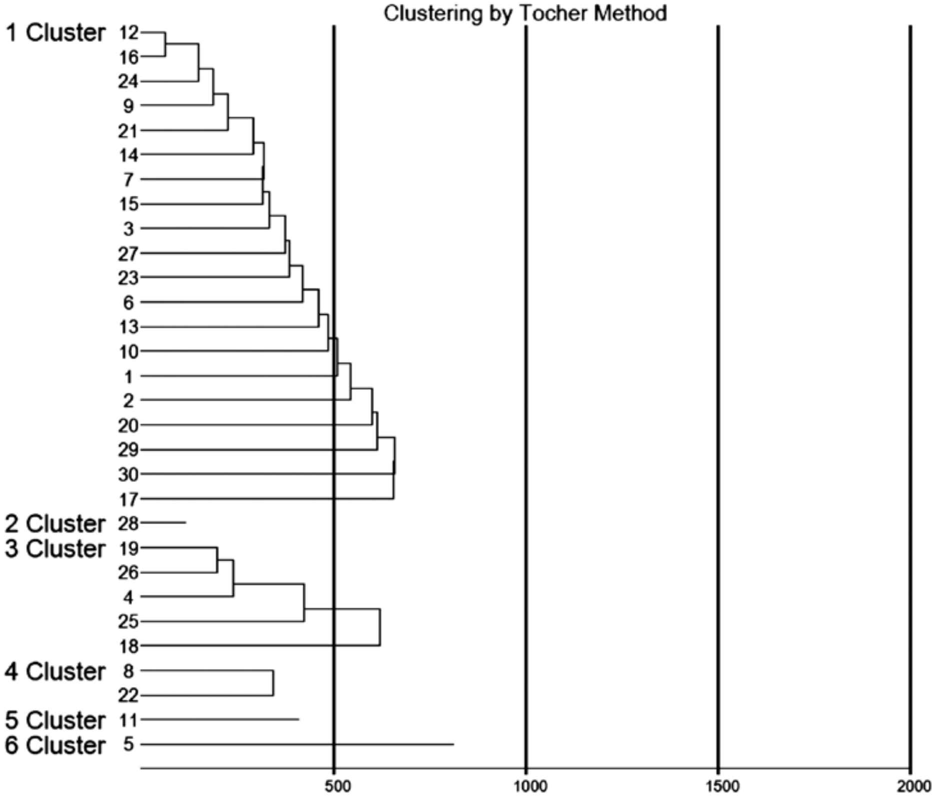
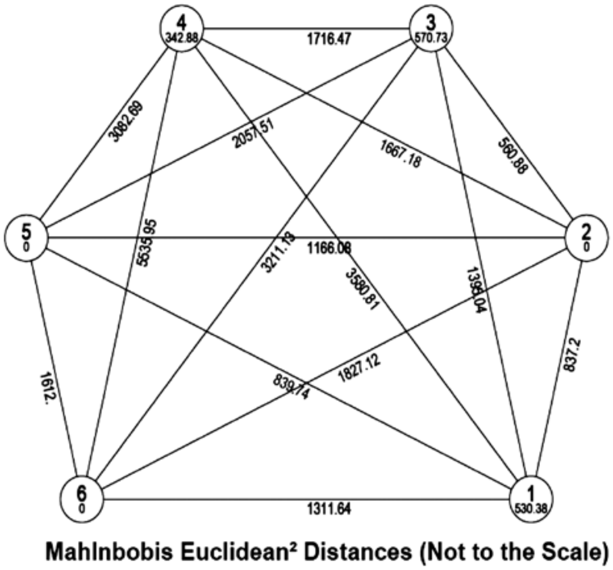


**Fig. 1.** Clustering of coconut accessions by Tocher's method.

The maximum inter-cluster distance $D^2$ value was obtained between clusters IV,V and VI (Fig. 2). These three clusters may be used in the hybridization programme due to wide variability and expected generation of transgressive segregants. Among the accessions in the clusters, three accessions were dwarfs and one dwarf WCGC 05 was observed to form a distinct cluster owing to it unique traits of dwarf stature combined with other morphological and fruit traits as talls. The grouping of the dwarf accession WCGC 18 along with tall accessions, indicate the existence of out-crossed progenies in it. The minimum inter-cluster distance was observed between clusters 1 and 2.

The comparison of cluster means revealed that cluster VI gave high values for copra yield, dwarf ness and other yield contributing characters followed by cluster III (Table 2). Cluster mean for leaf phenol was highest in cluster VI followed by cluster III which indicates that the higher levels of phenol is negatively correlated with the plant height, which is a important trait. Therefore, these genotypes can be used in hybridization programme to get recombinations with highest value for the all traits under study. The coconut cultivars based on leaf polyphenol (Jay *et al*., 2) and suggested that the appearance of dwarfism on the species historic scales is relatively recent phenomenon. In this study, the most dwarf cultivar is cluster VI and is considerably distant from other groups which are tall.

The magnitude of variations as represented by range, phenotypic coefficient of variation and genotypic coefficient of variation (Table 3) were moderate to high for most of the traits except length of longest leaflet and copra content. The genotypic coefficient of variation is a measure of genetic variability and provides means to compare with other characters facilitating successful isolation of desirable types. Genetic coefficients of variation together with heritability estimates can give the best picture of the amount of genetic advance to the expected selection.



**Mahlnbobis Euclidean$^2$ Distances (Not to the Scale)**

**Fig. 2.** Average cluster distance from cluster centroids.

**Table 2.** Cluster mean for different traits in coconut.

| Trait | Group 1 | Group 2 | Group 3 | Group 4 | Group 5 | Group 6 |
|---|---|---|---|---|---|---|
| Plant height (cm) | 949.14 | 587.50 | 936.60 | 614.25 | 787.50 | 484.25 |
| No. of leaves on the crown | 29.80 | 29.84 | 27.36 | 22.38 | 28.09 | 32.25 |
| Petiole length (cm) | 116.69 | 108.67 | 112.31 | 99.88 | 101.50 | 98.00 |
| Length of leaflet bearing petiole (cm) | 379.49 | 369.84 | 375.40 | 297.75 | 347.84 | 279.50 |
| No. of leaflets on one side of petiole | 111.90 | 115.67 | 104.14 | 90.88 | 111.34 | 97.75 |
| Length of longest leaflet (cm) | 116.86 | 107.50 | 113.82 | 110.00 | 100.34 | 103.75 |
| Leaflet breadth (cm) | 5.21 | 5.59 | 4.85 | 4.00 | 4.59 | 5.50 |
| Trunk girth (cm) | 85.30 | 73.17 | 76.34 | 66.63 | 76.67 | 103.25 |
| No. of leaf scars | 21.89 | 24.09 | 21.21 | 34.50 | 21.84 | 33.25 |
| Percentage of nut weight to whole fruit | 53.42 | 51.64 | 48.89 | 64.57 | 64.98 | 57.64 |
| Kernel thickness (cm) | 1.34 | 1.28 | 1.29 | 1.05 | 1.20 | 1.38 |
| Shell thickness (cm) | 0.51 | 0.48 | 0.48 | 0.41 | 0.48 | 0.50 |
| Copra content/nut (g) | 209.09 | 210.50 | 215.06 | 86.62 | 122.50 | 244.28 |
| Leaf polyphenol (mg/100 g FW) | 205.98 | 182.77 | 163.62 | 248.16 | 240.93 | 259.86 |
| Leaf nitrogen (%) | 0.74 | 0.58 | 0.46 | 0.80 | 0.52 | 0.30 |
| Leaf protein (%) | 4.61 | 3.63 | 2.87 | 5.00 | 3.22 | 1.85 |

**Table 3.** Genetic parameters of coconut accessions conserved in Andaman Islands.

| Trait | Mean | Range | PCV (%) | GCV (%) | Heritability ($h^2$) | Genetic Advance as % of Mean |
|---|---|---|---|---|---|---|
| Plant height (cm) | 891.784 | 484.25-1308.14 | 24.230 | 21.976 | 0.823 | 41.060 |
| No.of leaves on the crown | 28.929 | 20.75-33.91 | 11.603 | 9.135 | 0.620 | 14.816 |
| Petiole length (cm) | 113.443 | 87.50-130.83 | 8.808 | 7.396 | 0.725 | 12.795 |
| No. of leaflets on one side of petiole | 108.845 | 82.00-122.00 | 8.659 | 7.702 | 0.791 | 14.11 |
| Length of longest leaflet (cm) | 114.595 | 100.33-125.00 | 6.321 | 4.564 | 0.521 | 6.790 |
| Breadth of leaflet (cm) | 5.075 | 3.50-5.91 | 11.446 | 8.676 | 0.575 | 13.54 |
| Girth of trunk at 1 m (cm) | 82.47 | 66.25-103.25 | 10.510 | 9.596 | 0.834 | 18.048 |
| No. of leaf scars in 1m | 23.071 | 16.25-35-25 | 20.142 | 18.371 | 0.832 | 34.516 |
| Fruit length (cm) | 22.785 | 18.08-28.18 | 11.015 | 9.964 | 0.818 | 18.566 |
| Fruit weight (g) | 1469.78 | 422.09-2099.25 | 30.544 | 28.420 | 0.866 | 54.475 |
| Husk thickness (cm) | 2.465 | 1.48-3.05 | 16.860 | 15.334 | 0.827 | 28.728 |
| Dehusked fruit wt. (g) | 767.966 | 267.71-1060 | 26.967 | 24.868 | 0.850 | 47.243 |
| Kernel weight (g) | 372.864 | 147.71-466.09 | 21.988 | 20.872 | 0.901 | 40.814 |
| Shell thickness (cm) | 0.4986 | 0.38-0.61 | 11.427 | 9.223 | 0.61 | 15.334 |
| Kernel thickness (cm) | 1.304 | 0.95-1.55 | 9.247 | 8.040 | 0.756 | 14.401 |
| Weight of shell (g) | 208.752 | 91.88-260.91 | 23.072 | 21.377 | 0.858 | 40.814 |
| Copra content/ nut (g) | 200.25 | 71.67-256.71 | 23.768 | 21.948 | 0.53 | 41.750 |

The heritability estimates in the present study were observed high for all the traits.

High heritability coupled with high genetic advance was observed for weight of fruit, weight of dehusked fruit, kernel weight, shell weight and plant height. The results indicated that these characters were highly heritable and hence were less affected by the environment. Heritability in conjunction with genetic advance would give a more reliable index of selection value. Hence, selection based on this phenotypic performance would result in considerable genetic gain for these traits. It may be concluded that from the present study that weight of fruit, weight of de-husked fruit, weight of kernel, weight of shell and plant height are important components that showed largest influence directly on the copra yield/ palm in coconut (Ganeshamurthy *et al.*, 1). They also showed higher heritability with appreciable level of genetic gain there by suggesting that an emphasis on these characters in selection programmes would result in improvement of copra yield in coconut.

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