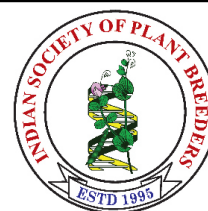


Electronic Journal of Plant Breeding



Research Article

Correlation and path coefficient studies for fruit component traits in coconut (*Cocos nucifera* L.) hybrids

V. Sivakumar^{*1}, S. Geethanjali², A. Subramanian³, S. Praneetha⁴,
H. P. Maheswarappa⁵ and D. Rajkumar⁶

^{*1&4}Coconut Research Station (AICRP on Palms), Tamil Nadu Agricultural University, Aliyarnagar, Coimbatore.

² Department of Genetics and Plant Breeding, CPBG, Tamil Nadu Agricultural University, Coimbatore.

³AC & RI, Tamil Nadu Agricultural University, Tiruchirappalli.

⁵Project Coordinator Cell, AICRP on Palms, ICAR-CPCRI, Kasaragod.

⁶Department of Agronomy, AC & RI, Killikulam, Thoothukudi.

*E-Mail: shivafruitscience@gmail.com

Abstract

The present investigation was carried out at the ICAR-AICRP Palms centre, Coconut Research Station, TNAU, Aliyarnagar, Tamil Nadu during 2012 to 2020 with five location specific coconut hybrids along with two tall varieties as local adopted checks viz., West Coast Tall (WCT) and Kalpatharu. Correlation and path analysis was performed to assess the association among nut yield and copra yield with important yield contributing traits in Coconut (*Cocos nucifera* L.). Correlation and path analysis revealed that copra yield per palm was positively and significantly associated with the fruit component traits viz., nut yield per palm per year, de-husked nut weight, whole nut weight, copra weight, fruit breadth and fruit length. A positive correlation was found among fruit component traits viz., fruit length, fruit breadth, whole nut weight, de-husked nut weight and copra weight. Path coefficient analysis showed that nut yield, de-husked nut weight, and copra weight recorded the highest positive direct effect on copra yield per palm. The results of the present study suggest that selection for high copra yield based on the total number of nuts per palm per year, copra weight per nut and de-husked nut weight in coconut would be rewarding for developing high yielding genotypes in coconut.

Key words

Coconut, fruit component traits, correlation, path analysis

INTRODUCTION

Coconut (*Cocos nucifera* L.) belongs to the palm family Arecaceae and is a traditional plantation crop of the tropics. It is commonly known as the 'tree of life' due to the versatile economic benefits derived from each and every part of the palm contributing to the sustained livelihood of its growers. There are two diverse forms of coconut viz., the tall (*Cocos nucifera* var. *typica*) and the dwarf coconuts (*Cocos nucifera* var. *nana*). A wide array of genetic diversity exists in tall coconut populations compared to the dwarf types due to their heterozygous and heterogeneous nature. Identification

of agronomically desirable genotypes from the existing variation and utilizing them in hybridization programmes would help in the production of superior hybrids. The selection of superior coconut hybrids is generally based on phenotypic evaluation for yield, which depends primarily on fruit component traits such as the number of nuts, kernel weight and copra content per nut. Assessing the correlation of various morphometric traits with yield is helpful in a breeding programme aimed to attain a rational enhancement in yield (Natarajan *et al.*, 2010). However, selection based on simple correlation coefficients by

omitting interactions among yield and yield components may mislead the breeders to reach their main breeding purposes (Garcia del Moral *et al.*, 2003). Separation of total correlation into direct and indirect effect by path analysis would assist in making the selection more valuable (Geethanjali *et al.*, 2014). With this view, the present study was undertaken to study the association among the fruit component traits and analyze the direct and indirect effects of these fruit component parameters on yield in coconut hybrids.

MATERIAL AND METHODS

The investigation was carried out at Coconut Research Station, Aliyarnagar, Coimbatore district, Tamil Nadu. The experimental material comprised of five coconut hybrids planted along with two check varieties (**Table 1**). The hybrids were synthesized during 2010-11. One year old healthy vigorous hybrid seedlings were planted during 2012, at a spacing of 7.5 m x 7.5 m and maintained under irrigated conditions with the standard package of practices for per se performance studies. The experiment was laid out in a randomized block design (RBD) with four replications consisting of six palms per treatment per replication.

In all the hybrids, morphological observations on fruit component traits were recorded on 18 nuts/palm/year/replication as per the standard descriptors. The fruit component traits were measured/weighted as follows: the number of buttons per inflorescence, fruit length (cm), fruit breadth (cm), tender nut water content (ml), whole nut weight (g), de-husked nut weight (g), kernel thickness (cm), copra weight (g), nut yield (number) and copra yield per palm (kg).

The mean data were subjected to correlation and path coefficient analysis using TNAU STAT (Manivannan, 2014) (<https://sites.google.com/site/tnaustat/>). Genotypic and phenotypic correlation coefficients were computed as per the methods suggested by Al-Jibouri *et al.* (1958). Path coefficients were estimated according to Dewey and Lu, (1959).

RESULT AND DISCUSSION

Yield is a complex quantitative trait controlled by polygenes and greatly affected by the environment. Due to genotype x environmental interactions, a high selection response directly for yield may not always be fruitful. Correlation coefficients help in improving a complex trait such as yield

Table 1. Details on parents, hybrids and check varieties

S. No.	Name of the parents/hybrids	Accession number/Abbreviation	Abbreviation
Parents			
1.	Chowghat Orange Dwarf	IND 007	COD
2.	Malayan Green Dwarf	IND 049	MGD
3.	Kenthali Dwarf	IND 074	KTD
4.	Arasampatti Tall	ALR (CN) 1	APT
5.	West Coast Tall	IND 069	WCT
6.	Kalpatharu	IND 125	TPT
Hybrids			
1.	Chowghat Orange Dwarf x Arasampatti Tall,	COD x ALR	-
2.	Arasampatti Tall x Malayan Green Dwarf	ALR x MGD	-
3.	Malayan Green Dwarf x Arasampatti Tall,	MGD x ALR	-
4.	Chowghat Orange Dwarf x West Coast Tall	COD x WCT	-
5.	Kenthali Dwarf x Arasampatti Tall	KTD x ALR	-
Check varieties			
1.	West Coast Tall	WCT	-
2.	Kalpatharu	TPT	-

by throwing light on the pattern of association among yield contributing traits. Association of yield and yield attributing traits thus assumed special importance as the basis for selecting desirable genotypes. Genetic correlation between different characters is reported to often arise due to its tight linkage or pleiotropy (Thakur *et al.*, 2018). In coconut, the fruit component traits are comparatively less influenced by environmental factors, traits and could

be used with a fair degree for genetic studies (Harries, 1982; Wickramaratna and Rathnasiri, 1986 and Perera *et al.*, 1996; Ashburner *et al.*, 1997; Baudoin *et al.*, 2005; Geethanjali *et al.*, 2014; Geethanjali *et al.*, 2018).

The results of the present investigation on the phenotypic and genotypic correlation of fruit component traits with copra yield per palm are presented in **Table 2**. Copra yield

per palm was positively and significantly associated with most of the fruit component traits such as nut yield per palm per year (0.9199), de-husked nut weight (0.7130), whole nut weight (0.7085), copra weight (0.6076), tender nut water content (0.6055), fruit breadth (0.4895), and fruit length (0.4848). A positive correlation was also found between fruit component traits viz, fruit length, fruit breadth, whole nut weight, de-husked nut weight and copra weight. These results clearly indicate that indirect

selection for copra weight in coconut can be based on these traits. Similar results of a positive association between these fruit component traits have been reported by Satyabalan and Mathew (1984), Baudoin *et al.* (2006), Natarajan *et al.* (2010) and Geethanjali *et al.* (2014). Such a positive association is due to the interdependence of the various fruit parts tending to vary in the same direction (Baudoin *et al.*, 2006).

Table 2. Genotypic (above diagonal) and phenotypic (Lower diagonal) correlation of fruit component traits in coconut hybrids

Characters	NB	FL	FB	TWC	WNW	DNW	KT	CW	NY	CYP
NB	1	0.0231	0.2445*	0.0811	0.1035	0.2008*	-0.0240	0.1605	0.4265**	0.4668**
FL	-0.0332	1	0.6018**	0.4782**	0.8843**	0.6449**	0.8236**	0.5764**	0.3680*	0.4848**
FB	0.0941	0.4829**	1	0.9749**	0.8792**	0.9618**	0.4535**	0.9106**	0.1435	0.4895**
TWC	0.0775	0.4469**	0.8110**	1	0.8322**	0.9603**	0.0493	0.9119**	0.2909*	0.6055**
WNW	0.0939	0.8298**	0.7318**	0.8221**	1	0.9179**	0.4287**	0.8276**	0.4916**	0.7085**
DNW	0.1721	0.6178**	0.7896**	0.9514**	0.9107**	1	0.2646*	0.9663**	0.4033**	0.7130**
KT	0.0351	0.3734*	0.1759	0.0640	0.2388*	0.1522	1	0.3982*	-0.4580**	-0.2503*
CW	0.1413	0.5242**	0.7508**	0.8944**	0.8138**	0.9558**	0.2000*	1	0.2561*	0.6076**
NY	0.4026**	0.3337*	0.1478	0.2872*	0.4844**	0.3933*	-0.2450*	0.2537*	1	0.9199**
CYP	0.4374**	0.4388**	0.4272**	0.5945**	0.6970**	0.6991**	-0.1362	0.6053**	0.9196**	1

* = 0.05 level of significance; ** = 0.01 level of significance.

Number of buttons (NB); Fruit length (FL) ; Fruit breadth (FB); Tender nut Water Content (TWC) ; Whole nut weight (WNW); De-husked nut weight (DNW) ; Kernel thickness (KT) ; Copra weight (CW); Nut yield (NY) per annum; Copra yield per palm (CYP).

Table 3. Character associations for fruit component traits in coconut hybrids by path co-efficient analysis

Characters	NB	FL	FB	TWC	WNW	DNW	KT	CW	NY	CYP
NB	0.0479	0.0002	-0.0064	-0.0045	-0.0178	0.0856	0.0003	0.0330	0.3284	0.4668
FL	0.0011	0.0101	-0.0157	-0.0265	-0.1516	0.2749	-0.0094	0.1185	0.2834	0.4848
FB	0.0117	0.0061	-0.0261	-0.0540	-0.1508	0.4101	-0.0052	0.1872	0.1105	0.4895
TWC	0.0039	0.0048	-0.0254	-0.0554	-0.1427	0.4094	-0.0006	0.1875	0.2240	0.6055
WNW	0.0050	0.0089	-0.0229	-0.0461	-0.1715	0.3913	-0.0049	0.1702	0.3785	0.7085
DNW	0.0096	0.0065	-0.0251	-0.0532	-0.1574	0.4263	-0.0030	0.1987	0.3105	0.7130
KT	-0.0012	0.0083	-0.0118	-0.0027	-0.0735	0.1128	-0.0115	0.0819	-0.3527	-0.2503
CW	0.0077	0.0058	-0.0238	-0.0505	-0.1419	0.4120	-0.0046	0.2056	0.1972	0.6076
NY	0.0204	0.0037	-0.0037	-0.0161	-0.0843	0.1719	0.0052	0.0527	0.7700	0.9199

Residual effect: 0.1651; Number of buttons (NB); Fruit length (FL) ; Fruit breadth (FB) ; Tender nut Water Content (TWC) ; Whole nut weight (WNW) ; De-husked nut weight (DNW) ; Kernel thickness (KT) ; Copra weight (CW) ; Nut yield (NY) per annum; Copra yield per palm (CYP) .

However, an increase in nut yield in the hybrids was found to be negatively correlated with kernel thickness (-0.4580). With an increasing number of nuts, the competition for assimilates among the developing nuts in each bunch could result in reduced kernel thickness. Such a partitioning of assimilates has been also been reasoned out as a major determining factor for the significant negative correlation between nut yield and fruit size in coconut varieties by

Bourdeix, (1989). The number of buttons did not show a significant correlation with most of the fruit component traits but was positively associated with nut yield per palm (0.4265) and copra yield per palm (0.4668). In coconut, not all female flowers turn into fruits after pollination and fertilization. An increase in the number of buttons per inflorescence increases the chance of several buttons entering into the fist size nut phase after fertilization.

This could attribute to an increase in nut yield per palm and thereby the copra yield per palm. The correlation analysis exposed that the genotypic correlation coefficients were higher than phenotypic values indicating that the strong inherent associations are reduced at the phenotypic level due to environmental effects.

Path coefficient analysis was carried out to partition the genotypic correlations into direct and indirect effects by taking copra yield per palm per year as a dependent variable and the rest of the quantitative traits as independent variables (Table 3). Nut yield (0.7700), de-husked nut weight (0.4263), and copra weight (0.2056) recorded the highest positive direct effect for copra yield per palm. Whereas, negative direct effects on copra yield per palm per year were observed due to kernel thickness, whole nut weight and tender nut water content. Water content in the nut varies largely with seasonal influence and harvest time (Geethanjali *et al.*, 2014). Since the whole nut weight is accounted for by both kernel and water content inside the nut, such a negative direct effect is possible. The low residual effect observed suggested that fruit component traits accounted for most of the variations in determining the yield of coconut.

Thus, the present study reveals that selection for high copra yield should be based on the total number of nuts per palm per year, copra weight per nut and de-husked nut weight in coconut. Therefore, these traits may be given due to emphasis and weightage while selecting for high yielding hybrids or genotypes in coconut.

ACKNOWLEDGEMENTS

The authors are extremely thankful to ICAR, New Delhi, AICRP on Palms, CPCRI, Kasaragod and Tamil Nadu Agricultural University for the technical and financial support provided to carry out this project.

REFERENCES

- Al Jibouri, H.A., Millar, P. A. and Robinson, H.F. 1958. Genotypic and environmental variances and covariances in an upland cotton cross of inter-specific origin. *Agronomy Journal*, **50**: 633-636. [Cross Ref]
- Ashburner, G.R., Thompson, W.K. and Halloran, G.M. 1997. RAPD analysis of south Pacific coconut palm populations. *Crop Sci.*, **37**: 992-997. [Cross Ref]
- Baudoin, L., Lebrun, P., Konan, J.L., Ritter, E., Berger, A. and Billotte, N. 2006. QTL analysis of fruit components in the progeny of a Rennell Island Tall coconut (*Cocos nucifera* L.) individual. *Theor. Appl. Genet.*, **112**: 258-268. [Cross Ref]
- Bourdeix, R. 1989. Le selection du cocotier (*Cocos nucifera* L.). Etude theorique et pratique des strategies d'amelioration genetique. Ph.D., thesisi, Universite de Paris Sud, Centre d'Orsay, France, 194.
- Dewey, D. R, Lu, K.H. 1959. A correlation and path coefficient analysis of components of crested wheat grass seed production. *Agro. J.*, **9**: 515 - 518. [Cross Ref]
- Garcia Del Moral, L.F., Rharrabti, Y., Villegas, D. and Royo, C. 2003. Evaluation of grain yield and its components in durum wheat under Mediterranean conditions. *Agron. J.*, **95**: 266 - 274. [Cross Ref]
- Geethanjali, S., Anitha Rukmani, J., Rajakumar, D., Kadirvel, P. and Viswanathan, P. 2018. Genetic diversity, population structure and association analysis in coconut (*Cocos nucifera* L.) germplasm using SSR markers. *Plant Genetic Resources: Characterization and Utilization*, **16**(2): 156-168. [Cross Ref]
- Geethanjali, S., Rajkumar, D. and Shoba, N. 2014. Correlation and path coefficient analysis in coconut (*Cocos nucifera* L.). *Electronic Journal of Plant Breeding*, **5**(4): 702-707.
- Harries, H.C. 1982. Coconut varieties. *Indian Coconut J.*, **12** (11): 3-10.
- Manivannan, N. 2014. TNAU STAT-Statistical package. Retrieved from <https://sites.google.com/site/tnaustat>.
- Natarajan, C., Ganesamurthy, K. and Kavitha, M. 2010. Genetic variability in coconut (*Cocos nucifera*). *Electron. J. Plant Breed.*, **1**(5): 1367-1370.
- Patel, J. S. 1937. Coconut Breeding. *Proc. Assoc. Econ. Biol.*, **5**: 1-16.
- Perera, L., Peries, R.R.A. and Fernando, W.M.U. 1996. Collection and Conservation of coconut biodiversity in Sri Lanka. *Int. Plant Genet. Res. Newsrl.*, **106**: 1-4.
- Satyabalan, K. and Jacob Mathew. 1984. Correlation studies on the nut and copra characters of West Coast Tall coconut harvested during different months of the year. *J. Plantn Crops*, **12** (1) : 17-22.
- Thakur, N.R., Toprope, V.N. and Koppuravuri SaiPhanindra. 2018. Estimation of Genetic Variability, Correlation and Path Analysis for Yield and Yield Contributing Traits in Chickpea (*Cicerarietinum* L.). *Int.J.Curr. Microbiol.App.Sci.*, **7**(2): 2298-2304. [Cross Ref]
- Wickramaratna, M.R.T. and Rathnasiri, W.G.A. 1986. New variety block of crop museum. In: Mahindapala R (ed) Ann Rep Coconut Res Institute Sri Lanka, 56.