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

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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.

The mean data were subjected to correlation and path coefficient analysis using TNAUSTAT (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 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

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**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 | - |
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 | 0.8566 | 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 |
| CW         | -0.0012 | 0.0083 | -0.0118 | -0.0027 | -0.0735 | 0.1128 | -0.0115 | 0.0819 | -0.3527 | -0.2503 |
| NY         | 0.0077 | 0.0058 | -0.0238 | -0.0505 | -0.1419 | 0.4120 | -0.0046 | 0.2056 | 0.1972 | 0.6076 |
| CYP        | 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 first 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.

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