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# Assessment of growth and yield parameters in Arecanut (*Areca catechu* L.) through correlation and path analysis under hilly zone of Karnataka

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## ABSTRACT

**Arecanut (*Areca catechu* L.) commonly called as betel nut is a high value commercial crop of coastal and Malnad region of Kerala and Karnataka. The present study was carried out at Agricultural and Horticultural research station Sringeri, UAHS Shivamogga in 2018. The study attempts the correlation studies in the germplasm will help to understand the mutual relationship among various traits and thereby assist in selecting the character contributing to the yield. In addition to this the selection for yield directly is ineffective as yield is affected by many other traits. The highest positive significant for the association of fruit yield per palm was with the fresh kernel weight per palm (0.96g) followed by dry weight of husk per palm (0.89g) and fresh weight of husk per palm (0.89g). Path analysis revealed that nineteen out of thirty-four characters recorded that fruit volume (2.40cc) had highest positive direct effect on fruit yield per palm followed by fresh fruit weight (2.17g) and breadth of leaf sheath (2.11m). It can be concluded that growth and yield characters may be considered in selection criteria for the improvement of yield in arecanut.**

**Keywords :** Arecanut, correlation, path analysis and yield

## INTRODUCTION

The coastal and Maland region of Karnataka has tremendous potential for cultivation of Arecanut due to favourable soil and climate, it is mostly confined to 28° north and south of the equator. It grows within a temperature range of 14 °C to 36 °C. Susceptibility to low and diverse temperature, it requires ample supply of soil moisture and plentiful of rainfall throughout the year (1,500-5,000 mm). It can be grown in a soil type such as laterites, red loamy and alluvial. The depth of soil may not be less than 1 m. The soil should be well drained.

Arecanut (*Areca catechu* L.) is a high value commercial crop of India, which is also called betel nut. It is widely distributed in Philippines, Indonesia, Sri Lanka, Southern China, Taiwan and Java. India stands first in the world in arecanut production followed by Myanmar, Bangladesh, China and Indonesia. (INDIASTAT, 2020). A total of 11.08 lakh tons of arecanut was produced from 7.43 lakh ha In India with a productivity of 1491 kg per ha (INDIASTAT, 2020). Area and production in different states indicate that Karnataka, Kerala and Assam occupy 80 per cent of area and production followed by Meghalaya, West Bengal, Tamil Nadu, Mizoram and Odisha. The little effort has been identifying the genetic potential of Arecanut genotypes in the region. The natural genetic variation for most of the yield contributing characters is considerable in this crop in the region and there is a need for the breeders to restructure the materials for increasing the production and productivity. Correlation study in yield and yield attributing characters/traits will be of value in selection of traits during improvement. Path analysis provides an effective means of finding out direct and indirect causes of association and permits a critical examination of given correlation and measures the relative importance of each factor. It gives more accurate pattern of trait association through direct and indirect effects.

## MATERIALS AND METHOD

Ten arecanut genotypes such as Sumangala, Sringeri local, Mohit Nagar, SAS-1, Hirhalli Dwarf, Keladi Local, Sagar Local, Thirthahalli Local, Sreemangala

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and Mangala as test entries with three replications, each having three palms of eight years old were evaluated at Agricultural and Horticultural Research Station, Sringeri, which is located in the Western Ghats and represents the typical hill zone (9) of Karnataka and lies at $13^0 25'$ North latitude and $75^0 25'$ East longitude with an altitude of 980 m above mean sea level during 2018. The observation on growth and yield characters were recorded at the time of maturity.

Phenotypic correlations of 34 characters both growth and yield quantitative characters namely, kernel breadth (mm), fresh weight of husk (g), number of bunches per palm, husk thickness (mm), dry weight of husk (g), fresh nut yield per palm (g), recovery percentage (%), bunch weight per palm (g), fresh kernel weight per palm (g), fresh weight of husk per palm (g), dry weight of husk per palm, (g) number of inflorescence, plant height (m), crown length (m), girth (m), inter nodal length (m), number of fronds , number of leaflets , length of oldest leaf (m), breadth of oldest leaf (m), length of leaf sheath (m), breadth of leaf sheath (m), number of female flowers per inflorescence, number of nuts per palm, fruit length(mm), fruit breadth (mm), fresh fruit weight (mm), kernel length (mm) , fruit volume (cc), dry weight of kernel (mm), Total chlorophyll content (µg /g) and number of nuts per inflorescence fruit yield per palm (g) presented in Table 1 and 2. Mean data was subjected for study of correlation and path coefficient as suggested by Miller *et al.* (1958) and Dewey and Lu (1959) respectively.

## RESULTS AND DISCUSSION

The analysis of variance showed significant differences among the genotypes for all the characters studied. The extent of variability present in the germplasm provides scope for the crop improvement programme and also depends on the extent of heritability for a trait. Range of variation observed for all the traits indicated the presence of sufficient amount of variation among the genotypes for all the characters studied. The genotype Mangala recorded higher mean value for traits like fruit length, fruit breadth, husk thickness, fresh weight of husk, fresh nut yield, bunch weight, fresh weight of kernel, dry weight of kernel, fresh weight of husk per palm, dry weight of husk per palm and number of inflorescences. SAS-1 recorded the lowest value for fruit length and kernel length. Sringeri Local recorded the lowest value for fruit breadth and fruit volume. Sumangala recorded higher value for fruit volume and lowest value for number of nuts per inflorescence. Mohit Nagar recorded higher value for fresh fruit weight, kernel breadth, fresh weight of kernel, dry weight of kernel and dry weight of husk while lower value for recovery percentage. The minimum kernel weight was observed in Hirehalli Dwarf. The higher kernel weight was observed in Sumangala, Mohit Nagar cultivars which has been reported earlier (Ananda and Rajesh, 2004) [2]. Phenotypic expression of any traits largely depends on the genotype of the plant and influences environmental variation but generally, higher environmental influence suppresses the complete expression of genes. Phenotypic coefficient of variation was higher than the genotypic coefficient of variation for all the characters studied but, this needs a good understanding of the association of different traits with yield and their association among themselves. The correlation analysis helps in examining the possibility of improving yield and its attributing traits through an indirect selection of their highly correlated component traits. In this investigation, correlation coefficients were worked out on ten genotypes of arecanut.

The study of the association of component characters with a complex trait like yield is very helpful for ease of gainful selection in any breeding programme. It has been established that the structure of yield must be probed through its components rather than yield. The concept of correlations was elaborated by Fisher (1918) and Wright (1921).

The association of fruit yield per palm was positive significant with the kernel breadth (0.39), fresh weight of husk (0.65), number of bunches per palm (0.68), husk thickness (0.69), dry weight of husk (0.40), fresh nut yield per palm (0.68), recovery percentage (0.36), bunch weight per palm (0.68), fresh kernel weight per palm (0.97), fresh weight of husk per palm (0.89), dry weight of husk per palm (0.90) and number of inflorescence (0.66) (Archana, 2017) and Rajesh (2007) for per cent nut set, the number of female flowers per inflorescence. Since these associated characters were in the desirable direction, it indicated that simultaneous selection for these characters would be rewarding in improving the dry kernel yield. Talukder *et al.* (2011) observed that nut weight showed a positive and significant correlation with husk weight, the volume of water, shell weight, kernel weight and kernel thickness in coconut. Highly significant positive correlations were observed among whole nut weight, dehusked nut weight and copra weight by Natarajan *et al.* (2010).

The remaining characters are positive but non-significant *viz.,* plant height (0.09), crown length (0.26), girth (0.12), inter nodal length (0.24), number of fronds (0.07), number of leaflets (0.10), length of oldest leaf (0.22), breadth of oldest leaf (0.30), length of leaf sheath (0.13), breadth of leaf sheath (0.31), which is mainly due to an increase in crown length would accommodate a greater number of leaves which in response produce high quantities of photosynthates. The number of female flowers per inflorescence (0.01), number of nuts per palm (0.46), fruit length (0.34), fruit breadth (0.62), fresh fruit weight (0.34), kernel length (0.16), fruit volume (0.19), dry weight of kernel (0.27) The results were confirmed with the findings of Rajesh (2007). In arecanut, plant height, husk thickness, kernel breadth and dry weight of kernel are important characters to be accounted for gaining improvement in yield per palm. Since these characters had a high direct association on dry kernel yield at the phenotypic level. This indicated that in arecanut production of nuts is not affected due to the individual nut weight and *vice versa*.

Total chlorophyll content (-0.10) and number of nuts per inflorescence (-0.30) had a negative association with fruit yield per palm but it was very low and non-significant and none of the characters showed negative correlation with yield/plant. Therefore, there may not be any problem in increasing the yield of arecanut through any of the characters under study. Anand *et al*. (2005) noticed the fresh fruit weight, dry kernel weight, dry kernel recovery, dry fruit weight was correlated positively with kernel yield while husk thickness had negative association with kernel yield in exotic accessions (Ananda *et al*., 2005). Similarly, characters like fresh fruit weight, dry kernel weight and dry kernel recovery had high magnitude of correlation with kernel yield and production of nuts in arecanut varieties during initial bearing in coastal region of Karnataka (Ananda *et al*., 2001) while negative correlations were reported between the dry nut weight and dry husk weight with kernel yield. Therefore, all the characters were found helpful in increasing the yield of arecanut. (Table 1 and 2).

The coefficient of correlation does not give the true picture under complex situations. Under such situations, path coefficient analysis provides a mean to determine the direct influence of one variable (cause) upon another variable (effect). For the establishment of cause and effect relationship path coefficient analysis offers an opportunity for partition of correlation coefficient into component of direct and indirect effects (Wright, 1921) and path coefficient analysis is the effective measure of direct and indirect causes of association and also depicts the relative importance of each factor involved in contributing to the final product that is yield (Dewey and Lu, 1959).Path coefficient analysis was carried out by taking fruit yield per plant as dependent variable. Positive and negative, direct and indirect effect of yield components on fruit yield per plant is presented in table 3 and 4.

The present investigation path analysis revealed that nineteen out of thirty-four characters recorded that fruit volume (2.40) had highest positive direct effect on fruit yield per palm followed by fresh fruit weight (2.18) and breadth of leaf sheath (2.12). Remaining characters had negative direct effect, among them number of inflorescences per palm (-0.25) had highest negative direct effect on fruit yield per palm followed by number of fronds (-2.22) and fresh husk weight per palm (-1.51). Rajesh (2007) observed the direct effects on dry kernel yield via nut set, breadth of leaflet, internodal length, the number of leaves, the number of inflorescences per palm, length of leaf, fresh fruit weight. The traits *viz*., crown length, internodal length and leaf breadth were negatively contributed towards dry kernel yield. Similar results were observed by Bavappa and Nair (1982). The local arecanut cultivar of South Kanara in coconut cultivars, such trends have been reported by Renuga (1999) and Jerard (2002), Ganesamurthy *et al.* (2002) in coconut and Natarajan *et al.* (2010) in Arecanut. Therefore, it can be concluded that these characters can be considered in selection criteria for the improvement of yield in arecanut. The residual effect (0.067) obtained was less than 0.5, suggesting that some of the characters have not been included, which may be responsible to enhance the fruit yield of arecanut.

**Table 1 : Estimates of phenotypic correlation coefficient for growth and yield attributing traits of arecanut**

| Trait | $X_1$ | $X_2$ | $X_3$ | $X_4$ | $X_5$ | $X_6$ | $X_7$ | $X_8$ | $X_9$ | $X_{10}$ | $X_{11}$ | $X_{12}$ | $X_{13}$ | $X_{14}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $X_1$ | **1.000** | 0.80** | 0.56** | 0.93** | 0.51** | 0.32 | 0.89** | 0.88** | 0.82** | 0.48** | 0.38* | -0.07 | 0.29 | 0.09 |
| $X_2$ | | **1.000** | 0.40* | 0.80** | 0.56** | 0.45* | 0.85** | 0.83** | 0.92** | 0.52** | 0.39* | -0.09 | 0.25 | 0.26 |
| $X_3$ | | | **1.000** | 0.59** | 0.71** | 0.73** | 0.59** | 0.55** | 0.52** | 0.82** | 0.44* | -0.09 | -0.09 | 0.12 |
| $X_4$ | | | | **1.000** | 0.40* | 0.47** | 0.94** | 0.89** | 0.82** | 0.51** | 0.31 | -0.09 | 0.35 | 0.20 |
| $X_5$ | | | | | **1.00** | 0.70** | 0.51** | 0.59** | 0.64** | 0.86** | 0.36* | 0.07 | -0.17 | 0.07 |
| $X_6$ | | | | | | **1.000** | 0.55** | 0.46* | 0.59** | 0.72** | 0.18 | 0.04 | -0.11 | 0.09 |
| $X_7$ | | | | | | | **1.000** | 0.92** | 0.92** | 0.52** | 0.38* | -0.07 | 0.32 | 0.22 |
| $X_8$ | | | | | | | | **1.000** | 0.86** | 0.58** | 0.43* | 0.07 | 0.19 | 0.30 |
| $X_9$ | | | | | | | | | **1.000** | 0.54** | 0.32 | -0.13 | 0.21 | 0.13 |
| $X_{10}$ | | | | | | | | | | **1.000** | 0.37* | -0.01 | -0.03 | 0.31 |
| $X_{11}$ | | | | | | | | | | | **1.00** | 0.04 | -0.28 | 0.68** |
| $X_{12}$ | | | | | | | | | | | | **1.00** | -0.25 | -0.09 |
| $X_{13}$ | | | | | | | | | | | | | **1.00** | 0.01 |
| $X_{14}$ | | | | | | | | | | | | | | **1.00** |

*Level of significance at 5%     ** Level of significance at 1%

Where,

$X_1$=Plant height (m) $X_2$= Crown length (m) $X_3$=Girth (m) $X_4$=Internodal length (m) $X_5$= No. of fronds. $X_6$= No. of leaflets. $X_7$=Length of oldest leaf (m) $X_8$=Breadth of oldest leaf(m) $X_9$=Length of leaf sheath (m) $X_{10}$=Breadth of leaf sheath (m). $X_{11}$=No. of bunches/ palm (m). $X_{12}$=Total Chlorophyll (µg/ml) $X_{13}$= No. of female flowers per inflorescence. $X_{14}$=Yield (g/ palm)

**Table 2 : Estimates of phenotypic correlation coefficient for yield and yield attributing traits of arecanut**

| Trait | $X_1$ | $X_2$ | $X_3$ | $X_4$ | $X_5$ | $X_6$ | $X_7$ | $X_8$ | $X_9$ | $X_{10}$ | $X_{11}$ | $X_{12}$ | $X_{13}$ | $X_{14}$ | $X_{15}$ | $X_{16}$ | $X_{17}$ | $X_{18}$ | $X_{19}$ | $X_{20}$ | $X_{21}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $X_1$ | **1.000** | 0.40* | 0.22 | 0.42* | 0.45* | 0.75** | 0.63** | 0.69** | 0.61** | 0.86** | 0.82** | 0.32 | 0.69** | 0.44* | 0.57** | 0.62** | 0.62** | 0.36 | -0.33 | -14 | 0.33 |
| $X_2$ | | **1.000** | 0.49** | 0.74** | 0.76** | 0.18 | 0.56** | 0.41* | 0.37* | 0.55* | 0.39* | 0.60** | 0.53** | 0.67** | 0.70** | 0.69** | 0.50** | -0.54 | 0.23 | -0.18 | 0.62** |
| $X_3$ | | | **1.000** | 0.86** | 0.63** | -0.32 | 0.24 | 0.25 | 0.22 | 0.37* | 0.40* | 0.05 | 0.06 | 0.18 | 0.14 | 0.12 | -0.07 | -0.29 | -0.07 | 0.12 | 0.19 |
| $X_4$ | | | | **1.000** | 0.71** | -0.01 | 0.58** | 0.58** | 0.57** | 0.60** | 0.62** | 0.44* | 0.39* | 0.38* | 0.41* | 0.35 | 0.25 | -0.07 | 0.12 | -0.05 | 0.33 |
| $X_5$ | | | | | **1.00** | 0.01 | 0.34 | 0.36* | 0.36 | 0.60** | 0.57** | 053** | 0.62** | 0.63** | 0.60** | 0.73** | 0.39* | -0.25 | 0.18 | 0.21 | 0.69** |
| $X_6$ | | | | | | **1.000** | 0.47 | 0.46** | 0.44* | 0.55** | 0.52** | 0.26 | 0.48** | 0.25 | 0.38* | 0.40* | 0.55** | 0.05 | -0.12 | -0.03 | 0.16 |
| $X_7$ | | | | | | | **1.000** | 0.84** | 0.89*** | 0.74** | 0.73** | 0.68** | 0.70** | 0.53** | 0.66** | 0.55** | 0.67** | 0.03 | 0.09 | -0.31 | 0.38* |
| $X_8$ | | | | | | | | **1.000** | 0.92** | 0.81** | 0.84** | 0.71** | 0.75** | 0.42* | 0.56** | 0.59** | 0.69** | -0.13 | 0.07 | -0.27 | 0.29 |
| $X_9$ | | | | | | | | | **1.000** | 0.71** | 0.84** | 0.72** | 0.78** | 0.37* | 0.49** | 0.45* | 0.53** | 0.15 | 0.10 | -0.23 | 0.27 |
| $X_{10}$ | | | | | | | | | | **1.000** | 0.86** | 0.61** | 0.79** | 0.37** | 0.81** | 0.78** | 0.76** | -0.39* | 0.03 | 0.02 | 0.64** |
| $X_{11}$ | | | | | | | | | | | **1.00** | 0.58** | 0.76** | 0.43* | 0.52** | 0.59** | 0.52** | -0.17 | -0.06 | 0.06 | 0.39* |
| $X_{12}$ | | | | | | | | | | | | **1.00** | 0.81** | 0.71** | 0.75** | 0.72** | 0.71** | 0.11 | 0.56** | -0.02 | 0.68** |
| $X_{13}$ | | | | | | | | | | | | | **1.00** | 0.70** | 0.78** | 0.82** | 0.72** | -0.05 | 0.15 | -0.11 | 0.66** |
| $X_{14}$ | | | | | | | | | | | | | | **1.00** | 0.97** | 0.89** | 0.77** | -0.32 | 0.41* | 0.16 | 0.96** |
| $X_{15}$ | | | | | | | | | | | | | | | **1.00** | 0.91** | 0.87** | -0.33 | 0.32 | -0.01 | 0.89** |
| $X_{16}$ | | | | | | | | | | | | | | | | **1.00** | 0.81** | -0.33 | 0.25 | 0.14 | 0.89** |
| $X_{17}$ | | | | | | | | | | | | | | | | | **1.00** | -0.38 | 0.29 | -0.08 | 0.66** |
| $X_{18}$ | | | | | | | | | | | | | | | | | | **1.00** | 0.22 | -0.11 | -0.30 |
| $X_{19}$ | | | | | | | | | | | | | | | | | | | **1.00** | 0.33 | 0.45* |
| $X_{20}$ | | | | | | | | | | | | | | | | | | | | **1.00** | 0.36* |

*Level of significance at 5% ** Level of significance at 1%

Where,

$X_1$=Fruit length (mm) $X_2$= Fruit breadth (mm) $X_3$=Fruit volume (cc) $X_4$=Fresh fruit weight (g/fruit) $X_5$=Husk thickness (mm). $X_6$=Kernel length (mm) $X_7$=Kernel breadth (mm) $X_8$= Fresh weight of kernel(g/fruit)$X_9$=Dry weight of kernel (g/palm) $X_{10}$=Fresh weight of husk (g/palm) $X_{11}$=Dry weight of husk (g/palm) $X_{12}$= Fresh nut yield (g/palm) $X_{13}$=Bunch wt (g/palm)$X_{14}$=Fresh kernel weight (g/ palm) $X_{15}$=Fresh husk weight(g/palm) $X_{16}$=Dry husk weight (g/palm) $X_{17}$=No. of Inflorescence $X_{18}$= No. Nuts per Inflorescence $X_{19}$=Total nuts per palm $X_{20}$= Recovery percentage(%) $X_{21}$= Yield (g/ palm).

**Table 3 : Direct and Indirect effects of growth parameters on kernel yield**

| Trait | $X_1$ | $X_2$ | $X_3$ | $X_4$ | $X_5$ | $X_6$ | $X_7$ | $X_8$ | $X_9$ | $X_{10}$ | $X_{11}$ | $X_{12}$ | $X_{13}$ | $X_{14}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $X_1$ | **0.75** | 0.59 | 0.42 | 0.69 | 0.38 | 0.24 | 0.67 | 0.65 | 0.61 | 0.36 | 0.28 | -0.05 | 0.22 | 0.09 |
| $X_2$ | -0.69 | **-0.87** | -0.35 | -0.69 | -0.49 | -0.39 | -0.74 | -0.72 | -0.80 | -0.45 | -0.34 | 0.08 | -0.22 | 0.26 |
| $X_3$ | -0.53 | -0.38 | **-0.94** | -0.55 | -0.67 | -0.68 | -0.56 | -0.52 | -0.49 | -0.77 | -0.41 | 0.09 | 0.08 | 0.12 |
| $X_4$ | -1.25 | -1.08 | -0.79 | **-1.34** | -0.55 | 0.63 | -1.27 | -1.21 | -1.11 | -0.69 | -0.42 | 0.12 | -0.48 | 0.20 |
| $X_5$ | -1.12 | -1.24 | -1.59 | -0.91 | **-2.22** | -1.57 | -1.14 | -1.30 | -1.44 | -1.91 | -0.81 | -0.16 | 0.39 | 0.07 |
| $X_6$ | 0.20 | 0.27 | 0.44 | 0.28 | 0.43 | **0.61** | 0.34 | 0.28 | 0.36 | 0.44 | 0.11 | 0.03 | -0.06 | 0.09 |
| $X_7$ | -0.58 | -0.56 | -0.39 | -0.62 | -0.34 | -0.36 | **-0.66** | -0.61 | -0.61 | -0.34 | -0.25 | 0.05 | -0.21 | 0.22 |
| $X_8$ | 0.70 | 0.67 | 0.44 | 0.72 | 0.47 | 0.37 | 0.74 | **0.79** | 0.69 | 0.46 | 0.34 | 0.05 | 0.16 | 0.30 |
| $X_9$ | 1.16 | 1.30 | 0.73 | 1.15 | 0.91 | 0.84 | 1.29 | 1.21 | **1.40** | 0.76 | 0.45 | -0.19 | 0.29 | 0.13 |
| $X_{10}$ | 1.03 | 1.11 | 1.74 | 1.09 | 1.82 | 1.52 | 1.10 | 1.22 | 1.15 | **2.11** | 0.79 | -0.24 | -0.08 | 0.31 |
| $X_{11}$ | 0.38 | 0.39 | 0.44 | 0.31 | 0.36 | 0.18 | 0.38 | 0.43 | 0.32 | 0.37 | **0.99** | 0.04 | -0.28 | 0.68 |
| $X_{12}$ | -0.01 | -0.01 | -0.013 | -0.01 | 0.01 | 0.01 | -0.01 | 0.01 | -0.02 | -0.02 | 0.01 | **0.13** | -0.03 | -0.09 |
| $X_{13}$ | 0.07 | 0.06 | -0.02 | 0.09 | -0.04 | -0.02 | 0.07 | 0.05 | 0.05 | -0.01 | -0.07 | -0.06 | **0.24** | 0.01 |
| $X_{14}$ | | | | | | | | | | | | | | **1.000** |

*Level of significance at 5% ** Level of significance at 1%

Where,

$X_1$=Plant height (m) $X_2$= Crown length (m) $X_3$=Girth (m) $X_4$=Internodal length (m) $X_5$= No. of fronds. $X_6$= No. of leaflets. $X_7$=Length of oldest leaf (m) $X_8$=Breadth of oldest leaf(m) $X_9$=Length of leaf sheath (m) $X_{10}$=Breadth of leaf sheath (m). $X_{11}$=No. of bunches/ palm (m). $X_{12}$=Total Chlorophyll (μg/ml) $X_{13}$= No. of female flowers per inflorescence $X_{14}$=Yield (g/ palm)

**Table 4 : Direct and Indirect effects of yield components on kernel yield**

| Trait | $X_1$ | $X_2$ | $X_3$ | $X_4$ | $X_5$ | $X_6$ | $X_7$ | $X_8$ | $X_9$ | $X_{10}$ | $X_{11}$ | $X_{12}$ | $X_{13}$ | $X_{14}$ | $X_{15}$ | $X_{16}$ | $X_{17}$ | $X_{18}$ | $X_{19}$ | $X_{20}$ | $X_{21}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $X_1$ | **0.12** | 0.05 | 0.03 | 0.52 | 0.06 | 0.09 | 0.08 | 0.09 | 0.07 | 0.11 | 0.10 | 0.04 | 0.08 | 0.05 | 0.07 | 0.07 | 0.07 | -0.04 | -0.04 | -0.01 | 0.33 |
| $X_2$ | -0.14 | **-0.34** | -0.17 | -0.25 | -0.26 | -0.03 | -0.19 | -0.14 | -0.13 | -0.19 | -0.14 | -0.20 | -0.18 | -0.23 | -0.24 | -0.23 | -0.17 | 0.02 | -0.08 | 0.06 | 0.62 |
| $X_3$ | 0.53 | 1.18 | **2.40** | 2.07 | 1.51 | -0.78 | 0.59 | 0.61 | 0.54 | 0.89 | 0.97 | 0.12 | 0.14 | 0.44 | 0.35 | 0.30 | -0.18 | -0.69 | -0.17 | 0.28 | 0.19 |
| $X_4$ | -0.64 | -1.12 | -1.39 | **-1.51** | -1.08 | 0.01 | -0.88 | -0.89 | -0.86 | -0.91 | -0.94 | -0.68 | -0.59 | -0.58 | -0.63 | -0.54 | -0.39 | 0.11 | -0.17 | 0.08 | 0.33 |
| $X_5$ | -0.13 | -0.22 | -0.18 | -0.20 | **-0.29** | -0.002 | -0.09 | -0.10 | -0.10 | -0.17 | -0.16 | -0.15 | -0.18 | -0.18 | -0.17 | -0.21 | -0.11 | 0.07 | -0.05 | -0.06 | 0.69 |
| $X_6$ | 0.64 | 0.08 | -0.28 | -0.01 | 0.01 | **0.85** | 0.40 | 0.39 | 0.38 | 0.47 | 0.44 | 0.22 | 0.41 | 0.22 | 0.33 | 0.35 | 0.47 | 0.04 | -0.10 | -0.02 | 0.16 |
| $X_7$ | 0.41 | 0.37 | 0.16 | 0.38 | 0.22 | 0.31 | **0.65** | 0.55 | 0.58 | 0.48 | 0.48 | 0.44 | 0.46 | 0.35 | 0.43 | 0.36 | 0.44 | 0.02 | 0.06 | -0.20 | 0.38 |
| $X_8$ | -0.44 | -0.26 | -0.16 | -0.37 | -0.23 | -0.29 | -0.53 | **0.63** | -0.58 | -0.51 | -0.53 | -0.44 | -0.47 | -0.26 | -0.35 | -0.32 | -0.43 | 0.08 | -0.04 | 0.17 | 0.29 |
| $X_9$ | -0.64 | -0.39 | -0.24 | -0.59 | -0.38 | -0.47 | -0.95 | -0.97 | **-1.05** | -0.75 | -0.89 | -0.76 | -0.82 | -0.39 | -0.51 | -0.48 | -0.56 | -0.16 | -0.11 | 0.24 | 0.27 |
| $X_{10}$ | 0.46 | 0.29 | 0.19 | 0.32 | 0.32 | 0.29 | 0.39 | 0.54 | 0.38 | **0.53** | 0.46 | 0.33 | 0.42 | 0.39 | 0.43 | 0.42 | 0.41 | -0.21 | 0.02 | 0.01 | 0.64 |
| $X_{11}$ | -0.84 | -0.40 | -0.42 | -0.64 | -0.58 | -0.53 | -0.75 | -0.86 | -0.86 | -0.88 | **-1.02** | -0.59 | -0.78 | -0.44 | -0.53 | -0.61 | -0.53 | 0.17 | 0.07 | -0.07 | 0.39 |
| $X_{12}$ | 0.69 | 1.31 | 0.11 | 0.76 | 1.15 | 0.56 | 1.48 | 1.54 | 1.58 | 1.34 | 1.27 | **2.17** | 1.77 | 1.56 | 1.64 | 1.58 | 1.56 | 0.25 | 1.22 | -0.04 | 0.68 |
| $X_{13}$ | 0.54 | 0.42 | 0.47 | 0.30 | 0.49 | 0.38 | 0.56 | 0.59 | 0.62 | 0.63 | 0.60 | 0.65 | **0.79** | 0.56 | 0.62 | 0.65 | 0.57 | -0.04 | 0.12 | -0.09 | 0.69 |
| $X_{14}$ | -0.13 | -0.21 | -0.06 | -0.12 | -0.20 | -0.08 | -0.17 | -0.13 | -0.12 | -0.23 | -0.13 | -0.23 | -0.23 | **-0.32** | -0.31 | -0.28 | -0.25 | 0.10 | -0.13 | -0.05 | 0.96 |
| $X_{15}$ | -0.12 | -0.15 | -0.03 | -0.10 | -0.13 | -0.08 | -0.13 | -0.12 | -0.10 | -0.17 | -0.11 | -0.16 | -0.17 | -0.21 | **-0.21** | -0.19 | -0.18 | 0.07 | -0.06 | 0.00 | 0.89 |
| $X_{16}$ | 0.11 | 0.12 | 0.02 | 0.06 | 0.13 | 0.07 | 0.10 | 0.09 | 0.08 | 0.15 | 0.11 | -0.18 | 0.15 | 0.16 | 0.17 | **0.18** | 0.15 | -0.06 | -0.04 | 0.02 | 0.89 |
| $X_{17}$ | -0.15 | -0.12 | 0.02 | -0.06 | -0.10 | -0.14 | -0.16 | -0.17 | -0.13 | 0.18 | -0.13 | -0.02 | -0.18 | -0.19 | -0.22 | -0.20 | **-0.25** | 0.09 | -0.07 | 0.02 | 0.66 |
| $X_{18}$ | 0.05 | 0.01 | 0.04 | 0.01 | 0.03 | -0.01 | -0.01 | 0.072 | -0.02 | 0.05 | 0.02 | 0.00 | 0.01 | 0.04 | 0.04 | 0.65 | 0.05 | **-0.14** | -0.03 | 0.02 | -0.30 |
| $X_{19}$ | -0.000 | 0.00 | -0.00 | 0.00 | 0.00 | -0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -0.00 | -0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -0.00 | **0.00** | 0.00 | 0.45 |
| $X_{20}$ | -0.00 | -0.00 | 0.00 | -0.00 | 0.00 | -0.00 | -0.00 | -0.00 | -0.00 | 0.00 | 0.00 | -0.23 | -0.00 | 0.00 | -0.00 | 0.00 | -0.00 | -0.00 | 0.00 | **0.00** | 0.36 |

*Level of significance at 5% ** Level of significance at 1%

Where,

$X_1$=Fruit length (mm) $X_2$= Fruit breadth (mm) $X_3$=Fruit volume (cc) $X_4$=Fresh fruit weight (g/fruit) $X_5$=Husk thickness (mm). $X_6$=Kernel length (mm) $X_7$=Kernel breadth (mm) $X_8$= Fresh weight of kernel(g/fruit)$X_9$=Dry weight of kernel (g/palm) $X_{10}$=Fresh weight of husk (g/palm) $X_{11}$=Dry weight of husk (g/palm) $X_{12}$= Fresh nut yield (g/palm) $X_{13}$=Bunch wt (g/palm)$X_{14}$=Fresh kernel weight(g/ palm) $X_{15}$=Fresh husk weight(g/palm) $X_{16}$=Dry husk weight (g/palm) $X_{17}$=No. of Inflorescence $X_{18}$= No. Nuts per Inflorescence $X_{19}$=Total nuts per palm $X_{20}$= Recovery percentage(%) $X_{21}$= Yield (g/ palm)

## CONCLUSION

The study of the association of component characters with a complex trait like yield is very helpful for ease of gainful selection in any breeding programme. The association of fruit yield per palm was positively significant with most of the morphological characters under study. Path analysis revealed that nineteen of thirty-eight characters recorded fruit volume had highest positive direct effect on fruit yield per palm followed by fresh fruit weight and breadth of leaf sheath. It can be concluded that these characters may be considered in selection criteria for the improvement of yield in arecanut.

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