# RELATIONSHIPS BETWEEN SOME FRUITS AND BUNCH TRAITS IN TENERA OIL PALM

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## Summary

Correlations were determined between three bunch traits viz.: mean bunch weight, number of bunches and fruit-to-bunch ratio; and six fruit traits: mesocarp content of fruit, shell content of fruit, kernel content of fruit, single fruit weight, fibre content of mesocarp and oil content of mesocarp using the mean of the first four years harvest records. The study was conducted on tenera fruits in four experiments of which two were Dura x Pisifera trials and the rest were: mixtures of Dura x Tenera, Tenera x Dura and Tenera x Tenera trials. These nine traits gave thirty-six correlation pairings for which six pairings showed significant differences. Significant negative correlations were observed between mesocarp and shell content of fruits, mesocarp and kernel content and mesocarp content and single fruit weight. Positive significant correlations were found between shell content and single fruit weight, oil content of mesocarp and fibre content of mesocarp and also between number of bunches and mean bunch weight. It is evident from this study that efforts at oil yield improvement should dwell on characteristics that correlated positively with oil yield which included: mesocarp, fibre content of mesocarp, number of bunches and bunch weight. Characteristics that were negatively corrected with oil yield were: shell and kernel content of fruits and single fruit weight.

## Introduction

The oil palm is cultivated for oil from the pulp or mesocarp and kernel. Palm oil yield is known to be influenced by: number of bunches, mean bunch weight, fruit-to-bunch ratio, mesocarp content of fruits and oil content of mesocarp (Van der Vossen, 1974). This relationship is expressed in an oil yield equation as follows (Van der Vossen, 1974):

Palm oil yield = NB X BWT X % M/F X % O/M

where NB = Number of Bunches produced
BWT = Mean Bunch Weight
%F/B = Fruit-to-Bunch ratio
%M/F = Mesocarp-to-Fruit ratio
%0/M = Oil-to-Mesocarp ratio

The success of any selection programme depends on the amount of variability in the initial population and the heritability of the fruit and bunch traits concerned. The type of correlations or relationship existing between the traits of interest will also determine whether improvement in a particular trait will adversely affect the expected overall improvement. This study was conducted on tenera fruits in four experiments of which two were Dura x Pisifera trials and the other two were mixtures, namely: Dura x Tenera, Tenera x Dura and Tenera x Tenera. Three bunch traits: number of bunches, mean bunch weight and fruit-to-bunch ratio and six fruit traits: mesocarp content of fruit, shell content of fruit, kernel content of fruit, single fruit weight, fibre content of mesocarp and oil content of mesocarp were utilized in this work. These nine traits gave 36 correlation pairings and the study was conducted using the mean of the first four years harvest records. The results of this work will indicate the kind of association that exists between two traits at any particular time. To facilitate selection, a selection index may be postulated. In the absence of that, a combination of some of these traits, could be used as the basis for selection.

## Experimental

Records from plot K2-1, K3-4, K4-1 and K4-6 at the Council for Scientific and Industrial Research's (CSIR's) Oil Palm Research Institute at Kusi were used in these studies. Plants growing K2-1 and K4-1 comprised crossings of Dura x Tenera, Tenera x Dura and Tenera x Tenera; whereas those on plots K3-4 and K4-6 consisted of only crossings of Dura x Pisifera. Fruit and bunch analyses were carried out on segregating tenera palms of four to nine years old to determine the fruit and bunch traits as follows :

*Bunch Traits*

i. Number of bunches (NB): The total number of bunches harvested from each plant between January and December were determined.

ii. Mean bunch weight (BWT): This is the mean of all the bunches harvested within the desired period.

iii. Fruit-to-bunch ratio (%F/B): This is the simple ratio of the fruits in a bunch; given by a formula:

$$\%F/B = \frac{(WTA+WTB)(WTi+WTii)}{WT{\cdot}A \times B{\cdot}WT \text{ in } LABORATORY}$$

*Fruit Traits*

Fruit traits were determined using a sample size of 30 fruits made up of 20 inner and 10 outer fruits. The weight of the 30 fruits was taken as sample weight (S.Wt.).

Mesocarp of sample fruits were scraped and weight of seed was determined before the kernel was dried to determine the shell and kernel weights of the 30 sample fruits and the fruit traits determined as follows:

i. Mesocarp-to-fruit ratio (%M): $$\%M = \frac{WT.\ of\ Mesocarp \times 100}{S.Wt}$$

ii. Kernel-to-fruit ratio (%K): $$\%K = \frac{WT.\ of\ Kernel \times 100}{S.Wt}$$

iii. Shell-to-fruit ratio (%S): $$\%S = \frac{WT.\ of\ Shell \times 100}{S.Wt}$$

iv. Single fruit weight (S. fr. wt.): $$S.\ fr.\ wt = \frac{Sample\ weight}{Sample\ Number \text{ or } 30}$$

v. Oil-to-mesocarp ratio (%O/M): this measures the quantity of palm oil in the sample mesocarp. The method determined by Vander Weyen *et al.* (1947) and later confirmed by Chapas *et al.* (1957) in Nigeria (NIFOR) was used:

%O/M = 100 - fm - WM
= 84-Wm; where fm = 16% (Vander Weyen, 1947)
and Wm = % Water/Wet mesocarp
Om = Oil content/Dry mesocarp
fm = Fibre content/Dry mesocarp

vi. Fibre per mesocarp (fm):

fm = 100 - Om-Wm (Vander Weyen, 1947). This value is known to be approximately 16%.

After these determinations for each of the four experiments, the correlations between each pair of variants were determined using the standardized formula:

$$Correlation\ r = \frac{S_{xy}}{S_x.S_y} = \frac{\Sigma(X_i - X)(Y_i - Y)}{(\Sigma(X_i - X)^2)\Sigma(Y_i - Y)^2)^{1/2}}$$

A total of 36 correlations were obtained in each of the four (4) experiments. However, there were some missing figures brought about by the lack of laboratory facilities to determine the traits.

## Results

The results obtained are summarized in Table 1.

**TABLE 1**

*Relationships among the various traits investigated in plot trials of different oil palm genotypes: Dura (D), Pisifera (P) and Tenera (T).*

| PAIR OF VARIANTS | DXT, TXD, TXT TRIAL K2 - 1 | DXP TRIAL K3 - 4 | DXT, TXD TXT TRIAL K3 - 4 | DXP TRIAL K4 - 6 |
|---|---|---|---|---|
| % F/B and % M | 0.1192 | -0.0692 | 0.1347 | 0.6799** |
| -do- % S | 0.1277 | -0.4101 | 0.0256 | 0.1182 |
| -do- % K | 0.1549 | 0.1177 | 0.0612 | 0.0462 |
| -do- S.fr.wt | 0.5095** | -0.3725 | 0.1972 | 0.3253 |
| -do- %O/M (sox) | -- | -0.4373 | 0.0274 | 0.1257 |
| -do- % F/M | -- | -0.3795 | 0.0277 | 0.1415 |
| -do- %NB | -0.1158 | -0.1594 | 0.0824 | 0.0033 |
| -do- %BWT | 0.0677** | 0.0883 | 0.1507 | 0.0970 |
| % M and S | -0.9769** | -0.0377 | -0.7298** | -0.9585** |
| " and K | -0.7458** | -0.3771* | -0.2231 | -0.6381** |
| " and S.fr.wt. | 0.5363** | 0.1863 | 0.3960** | 0.5853** |
| " and %O/M (sox) | -- | 0.2015 | 0.0116 | 0.2792 |
| " and %F/M | -- | 0.2968 | 0.0422 | 0.2529 |
| " and NB | 0.0595 | 0.2486 | 0.0692 | 0.2211 |
| " and BWT | 0.1629 | 0.1948 | 0.0692 | 0.0467 |
| % S and %K | 0.6980** | 0.1974 | 0.1970 | 0.2364 |
| " and S.fr.wt. | 0.0801 | 0.7239** | 0.5003* | 0.6669** |
| " and %O/M (sox) | -- | 0.2265 | 0.0751 | 0.1284 |
| " and S %F/M | -- | 0.0305 | 0.0536 | 0.0570 |
| " and S NB | 0.1216 | 0.1369 | 0.0087 | 0.1867 |
| " and BWT | 0.2355 | 0.1882 | 0.1540 | 0.0425 |
| " K and S.fr.wt. | 0.2961* | 0.1456 | 0.0821 | 0.0646 |
| " and %O/M | -- | 0.0646 | 0.1610 | 0.4641 |
| " and %F/M | -- | 0.0663 | 0.0620 | 0.4104 |
| " and NB | 0.0063 | 0.0958 | 0.1141 | 0.3097 |
| " and BWT | 0.0974 | 0.0230 | 0.2108 | 0.0705 |
| S.fr.wt. and O/M (sox) | -- | 0.1376 | 0.1849 | 0.3820 |
| " and %F/M | -- | 0.1855 | 0.1121 | 0.0420 |
| " and NB | 0.2180 | 0.2412 | 0.1596 | 0.1268 |
| " and BWT | 0.0248 | 0.3403 | 0.0174 | 0.0442 |
| %O/M (sox) and %F/M | 0.1409 | 0.7028 | 0.4121** | 0.3311 |
| " and NB | -- | 0.2265 | 0.0046 | 0.2685 |
| " and BWT | -- | 0.3633 | 0.1178 | 0.3222 |
| %F/M and NB | -- | 0.1798 | 0.0816 | 0.1831 |
| " and BWT | -- | 0.0979 | 0.0519 | 0.0339 |
| NB and BWT | 0.6044** | 0.9403 | 0.6388** | 0.8232** |

* Significant at 5% ** Significant at 1%.

Significant negative correlations were observed between mesocarp content and shell content; mesocarp content and kernel content; mesocarp content and single fruit weight.

Significant positive correlations were also observed between shell content and single fruit weight; oil per mesocarp and fibre per mesocarp; and most importantly between number of bunches and bunch weight.

It is observed that all the tenera fruits used in this work, behaved alike regardless of the parents, whether from Dura x Pisifera, Dura x Tenera, Tenera x Dura or Tenera crosses.

## Discussion

The results indicate that in Tenera fruits, the greater the content of mesocarp, the smaller the content of shell or kernel or single fruit weight and vice-versa. This was confirmed by the negative correlations between mesocarp content and each of the three traits i.e., shell, kernel and single fruit weight. Thus, these three traits should not be selected for directly where higher palm oil yields are the target.

Again, this provided the justification for oil palm selection based on indirect selection for shell thickness by which the crop is grouped into the three fruit forms; i.e., Dura, Tenera and Pisifera.

In addition, the significant positive correlation between shell content and single fruit weight indicated that the shell thickness was the major determinant of the fruit weight. It was also observed that oil per mesocarp had a high positive correlation with fibre content of the mesocarp. Palm oil is embedded in the fibre and as such the higher the fibre content, the greater the quantity of oil that can be obtained from the fruit and vice-versa.

It is known that with time, there is a negative correlation between the number of bunches produced and the bunch weight. From three years after planting, the crop produces high bunch numbers with low bunch weights and at older ages of about twenty years, it produces fewer bunches with high bunch weights.

Yet, in spite of this inverse variation in bunch numbers and bunch weights in old plants, it was observed that the total bunch yield (FFB) was always higher in older plants than in younger plants.

It was also noticed in this work that high bunch numbers always contributed to high bunch weights. This indicated that selection could be done at an earlier age based on number of bunches produced since bunch traits are known to carry greater weight in oil palm and that number of bunches ranks next to the total bunch yield (FFB)(Okyere-Boateng, 1991).

Furthermore, this highly significant positive correlation between number of bunches and bunch weight justifies work by Kouame and Noiret (1981) in which selection in oil palm by measurement of mitochondrial activities was based only on number of bunches.

## Conclusion

Results obtained in this study support the rationale for selection for higher yields of oil in oil palm based on shell thickness inheritance, (i.e., Dura, Tenera and Pisifera fruits).

It is also concluded that single fruit weight like most of the fruit characters, should never be considered directly in selection for higher palm oil yield. On the other hand, shell and mesocarp content need to be considered indirectly and directly, respectively for palm oil yield (Okyere-Boateng, 1991).

Genes controlling bunch weight and number may either be linked or pleiotropic in which one gene controls both traits. Thus, number of bunches should basically be used for selection in order to cut down on the years needed to complete one cycle of selection in the oil palm crop.

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