Seed Weight Distribution of Different Crosses and Relationships between Seed Weight and Some Physical Characteristics of Oil Palm Seed (*Elaeis guineensis* Jacq.)

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**Abstract**

Physical characteristics are suspected as the factors related to dormancy breaking period and percent of germination. Distribution percentage of seed weight among crosses was different. Seed weighted within the range of 1.6–3.1 g was the highest number in cross no. 23, 27, 37, 38, 40 and 46 and the range of 3.2–4.6 g weight, in cross no. 20 and 35. The seed of 4.7–6.1 g was distributed ranging from 3 to 23%, while the seed of 6.2–7.6 g and 7.7–9.1 g were negligible, thus latter two weights were excluded in the study of physical characteristics. Shell and kernel weight and eccentricity value (seed shape) were found significantly different among crosses. Shell weight of cross no. 20 was the heaviest and significantly heavier than cross no. 23, 27, 38 and 46. Kernel weights from cross no. 20 and 35 were lighter and significantly lower than cross no. 27 and 46. Cross no. 20 was the highest eccentricity value. Comparing among seed weight ranges, the biggest seed used in this study had the heaviest in seed weight, shell and kernel weight, thickest in shell and more number in kernels. Physical characteristics of seed presented highly correlation with seed weight. Seed weight versus shell thickness, r = 0.865**, R² = 0.748, versus shell weight, r = 0.990**, R² = 0.98, and versus kernel weight (g/seed), r = 0.867**, R² = 0.751. These results pointed out the relationships between seed weight and seed physical characteristics of different oil palm crosses.

**Keywords**: *Elaeis guineensis*, physical dormancy, physical characteristics, seed weight ranges, tenera crosses

**Introduction**

Palm oil is now the largest source of edible oil in the world (Pua and Davey, 2007). Biodiesel industry from crude palm oil (CPO) is taken into account as a national agenda since petroleum cost has affected the economics of the country. These favorable situations have been encouraging to expand the cultivation of oil palm. Normally, germinated tenera hybrid seed is used as a commercial planting material to establish the oil palm plantation. Oil palm seeds present difficulties in terms of germination due to a pronounced physical dormancy. Seed germination is difficult and requires lengthy treatments. Many researchers have been trying to break the dormancy and to reduce the time to germination in many ways using with growth regulators, scarification and accelerated aging (Nagao et al., 1980; Nwankwo, 1981; Wan and Hor, 1983; Herrera et al., 1998; Murugesan et al., 2005).

Seed weight is often related to germination percentage and mean germination time (Larsen and Andreassen, 2004). Panyangnoi et al. (1997) stated in the dura oil palm seed, the relationships between seed weight and physical characteristics such as shell thickness, shell weight, kernel weight and number of kernel as well as germination response due to seed weight.

Physical characteristics of oil palm seeds are considered herein as the factors related to dormancy breaking period and percent of germination. This study was carried out to investigate the seed weight distribution of different crosses and to identify the relationships between some physical characteristics of eight oil palm crosses (hybrids).

**Materials and Methods**

This study was conducted in Surat Thani Oil Palm Research Center in May, 2008. Two factors factorial combination in CRD design with three replications in which five different seed weights ranging the seeds from 1.6-3.1 g/seed, 3.2-4.6 g/seed, 4.7-6.1 g/seed, 6.2-7.6 g/seed and 7.7-9.1 g/seed referred to Panyangnoi et al. (1997) were assigned as factor A and eight local tenera crosses of cross no. 20, 23, 27, 35, 37, 38, 40 and 46, as factor B. Bunches of eight crosses were harvested on March-April, 2008 then oil palm seeds were separated from the fruits according to the seed processing procedure. Air-dried seeds come from one bunch were recorded as one replication and grouped into

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five categories. Seed physical characteristics of seed size (length, width, thickness), seed weight, seed volume, specific gravity, eccentricity (seed shape), shell thickness, shell weight, kernel weight and number of kernel were recorded in individual cross. The data were statistically analyzed by using IRRISTAT software. Mean separation was performed using with the Least Significant Difference (LSD) at 5% level.

**Seed size and seed shape (eccentricity)**

Three replications of 10 seeds each from each treatment combination were measured seed length (mm), width (mm) and thickness (mm) to describe the seed size and to calculate the seed shape which defines eccentricity by the following equation shown by Kuo (1989), in which the values closed to 0 refer spherical shape and the values closed to 1 refer oblong or linear shape.

\[
e = \left(\frac{a^2 - b^2}{a^2}\right)^{0.5}
\]

Where \(a\) is half the length of the longest axis, \(b\) is half the average of width and thickness and \(e\) is the eccentricity

**Seed weight and Seed volume**

Seed weight (g/seed) was determined through on three 10 seeds samples of replicates each. Three replications of 5 seeds each from each treatment combination were used to determine the seed volume (cm\(^3\)/seed) by water displacement method.

**Specific gravity**

Specific gravity (SG) was calculated by the formula:

\[
SG = \frac{SD}{water \ density}
\]

Where, \(SD = seed \ weight/ seed \ volume\)

**Shell thickness, shell weight, kernel weight and number of kernel**

Three replications of 5 seeds from each treatment were cracked then three cracked pieces in each seed were randomly taken to measure the shell thickness. It was then recorded shell weight, kernel weight and the number of kernel as well.

**Results and Discussion**

**Distribution percentage of oil palm seed**

Distribution percentage of seed weight among crosses was found to be different (Figure 1). Among five seed weights categorized following by Panyangnoi et al. (1997), i.e. 1.6-3.1 g/seed, 3.2-4.6 g/seed, 4.7-6.1 g/seed, 6.2-7.6 g/seed and 7.7-9.1 g/seed, the seeds in the latter two seed weights were found negligible, thus these two weights were excluded in the following study. Seed weight ranging between 1.6–3.1 g/seed was obtained the highest number of seeds in cross no. 23, 27, 37, 38, 40 and 46 in which cross no. 40 was about 82%, and to a lesser extent of cross no. 27, 36, 23, 46 and 37, about 68, 67, 61, 46 and 41%, respectively. Cross no. 20 and 35 had the largest amount of their seeds in the 3.2-4.6 g/seed range which contributed about 44% and 52%, respectively. The seed of 4.7-6.1 g/seed range was distributed in all crosses ranging from 3-23%. Corley and Tinker (2003) reported that there was variation in nut weight of different dura genotypes. African Dura nuts may be average 4g while Deli Dura nuts, 5-6 g. There was a very rare research with oil palm seed concerning with the seed weight. Panyangnoi et al. (1997) tested with dura oil palm seed and indicated that the largest number of seeds from the medium seed weight. Experiments on seed weight of some other seeds were also shown that variation in seed weight exists among cultivars within species in which *Poa pratensis* L. and *Poa trivialis* L. seeds were used (Churchill et al., 1997), among seed lots within cultivars in which turfgrass cultivars were used (Christians et al., 1979). In this study, the largest number of seed varied from the ranges of seed weight according to cross. It would be the crosses used come from different parents which generated from different genotypes.

**Some physical characteristics of oil palm seed among seed weight ranges and among crosses**

Some physical characteristics, i.e. shell weight, kernel weight and eccentricity were found to be significantly different among crosses, while seed weight, shell thickness and number of kernel was not significantly different (Table 1). In seeds of eight oil palm crosses, cross no. 20 showed a heaviest shell weight (3.14 g/seed) and significantly heavier than cross no. 23, 27, 38 and 46 while cross no. 35, 37 and 40 were not significantly different with the cross no. 20 whilst cross no. 46 was the lightest (2.56 g/seed). Kernel weights of cross no. 20 and 35 were lightest but no significant differences were found when compared with cross no. 23, 37, 38 and 40 however these crosses were significantly lower than cross no. 27 and 46. The cross which had heavier in shell weight was lighter in kernel weight. Considering the response of kernel weight to germination, Nwankwo and Krikorian (1982) pointed out that the size of oil palm kernel could not be directly correlated with germination. Shell weight may therefore contribute to more or less to the germination. The eccentricity value was highest in cross no. 35 and lowest in cross no. 20 this means cross no. 35 was likely to be more oblong shape when compared with cross 20. This may be due to the crosses produced from different genes of their parents which may influence on type of frond canopy and orientation of the bunch that in-turn affect the fruit separation.
Within each cross a comparison was also made between the physical characteristics from small to large seed groups. Except in the eccentricity value which showed no significant differences between the seed weight ranges, the biggest seed (4.7-6.1 g/seed) used in this study had the heaviest in seed weight, shell and kernel weight, highest in seed volume, thickest in shell and more number in kernel followed by 3.2-4.6 and 1.6-3.1 g/seed, respectively (Table 1). As described by Panyangnoi et al. (1997), the maximum germination was observed in the medium seed weight but not in the smallest and largest. This may be due to the larger ratio of shell thickness as well as more number of kernels in the largest seed and small reserved food in the smallest seed which could restrict the germination of oil palm seed. In the study of Milberg et al. (1996), it was found that medium weight seeds germinated faster than both lighter and heavier seeds in one population whereas in another population the medium weight seeds had the slowest germination. Weis (1982) also reported in Mirabilis hirsute seed that heavy seeds germinated more slowly than light seeds.

Figure 1 Distribution (%) of eight crosses of oil palm seed among five ranges of seed weight, i.e. 1.6-3.1 g/seed, 3.2-4.6 g/seed, 4.7-6.1 g/seed, 6.2-7.6 g/seed and 7.7-9.1 g/seed.

Table 1 Some physical characteristics of oil palm seed from different seed weight ranges and different crosses.

<table>
<thead>
<tr>
<th>treatment</th>
<th>eccentricity</th>
<th>seed weight (g/seed)</th>
<th>seed volume (cm³/seed)</th>
<th>shell thickness (mm)</th>
<th>shell weight (g/seed)</th>
<th>kernel weight (g/seed)</th>
<th>kernel weight (g/kernel)</th>
<th>no.of Kernel</th>
</tr>
</thead>
<tbody>
<tr>
<td>cross 20</td>
<td>0.612 d</td>
<td>4.07 a</td>
<td>3.48 a</td>
<td>2.57 a</td>
<td>3.14 a</td>
<td>0.926 c</td>
<td>0.690 d</td>
<td>1.33 a</td>
</tr>
<tr>
<td>cross 23</td>
<td>0.710 abc</td>
<td>3.83 a</td>
<td>3.30 a</td>
<td>2.24 a</td>
<td>2.77 bc</td>
<td>1.05 abc</td>
<td>0.874 abcd</td>
<td>1.27 a</td>
</tr>
<tr>
<td>cross 27</td>
<td>0.732 ab</td>
<td>3.92 a</td>
<td>3.44 a</td>
<td>2.32 a</td>
<td>2.78 bc</td>
<td>1.15 ab</td>
<td>0.956 ab</td>
<td>1.20 a</td>
</tr>
<tr>
<td>cross 35</td>
<td>0.773 a</td>
<td>3.93 a</td>
<td>3.46 a</td>
<td>2.45 a</td>
<td>3.02 ab</td>
<td>0.911 c</td>
<td>0.780 bcd</td>
<td>1.20 a</td>
</tr>
<tr>
<td>cross 37</td>
<td>0.713 abc</td>
<td>4.07 a</td>
<td>3.37 a</td>
<td>2.39 a</td>
<td>3.04 ab</td>
<td>1.03 abc</td>
<td>0.919 abc</td>
<td>1.20 a</td>
</tr>
<tr>
<td>cross 38</td>
<td>0.671 bcd</td>
<td>3.90 a</td>
<td>3.34 a</td>
<td>2.14 a</td>
<td>2.81 bc</td>
<td>1.09 abc</td>
<td>0.735 cd</td>
<td>1.44 a</td>
</tr>
<tr>
<td>cross 40</td>
<td>0.750 ab</td>
<td>3.89 a</td>
<td>3.21 a</td>
<td>2.25 a</td>
<td>2.89 ab</td>
<td>1.002 bc</td>
<td>0.773 bcd</td>
<td>1.29 a</td>
</tr>
<tr>
<td>cross 46</td>
<td>0.631 cd</td>
<td>3.77 a</td>
<td>3.19 a</td>
<td>2.33 a</td>
<td>2.56 c</td>
<td>1.21 a</td>
<td>1.04 a</td>
<td>1.18 a</td>
</tr>
<tr>
<td>LSD 0.05</td>
<td>0.087 ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>0.263</td>
<td>0.185</td>
<td>0.113</td>
<td>ns</td>
</tr>
</tbody>
</table>

Means followed by the same letter in the same column do not differ statistically by LSD at 0.05
Correlation between some physical characteristics of oil palm

Some physical characteristics of oil palm seed showed highly significant correlation coefficient when pared with seed weight (Table 2, Figure 2a, 2b and 2c). Shell thickness, shell and kernel weight, seed volume and number of kernel presented a positive relationship with seed weight. Seed weight versus shell thickness, \( r = 0.865** \), \( R^2 = 0.748 \), versus shell weight, \( r = 0.990** \), \( R^2 = 0.980 \), versus kernel weight (g/seed), \( r = 0.867** \), \( R^2 = 0.751 \). Similar effect apart from shell thickness was found in the report by Panyangnoi et al. (1997) in which shell thickness was not highly correlated with seed weight.

### Table 2

<table>
<thead>
<tr>
<th>Eccentricity</th>
<th>Seed weight (g/seed)</th>
<th>Seed volume (cm(^3)/seed)</th>
<th>Specific gravity</th>
<th>Shell thickness (mm)</th>
<th>Shell weight (g/seed)</th>
<th>Kernel weight (g/seed)</th>
<th>Kernel weight (g/kernel)</th>
<th>No. of Kernel</th>
</tr>
</thead>
<tbody>
<tr>
<td>eccentricity</td>
<td>1</td>
<td>0.070</td>
<td>1.000</td>
<td>0.074</td>
<td>0.987**</td>
<td>1.000</td>
<td>0.044</td>
<td>0.274</td>
</tr>
</tbody>
</table>

*,** marked the correlation coefficient that was significant at the probability level of 0.05 and 0.01, respectively.

**Figure 2** Relationships between seed weight and (a) shell thickness (b) shell weight and (c) kernel weight (g/seed).

### Summary

These results pointed out the relationships between seed weight and seed physical characteristics of different oil palm crosses. The largest number of seed varied from the ranges of seed weight according to cross. Some physical characteristics, i.e. shell weight, kernel weight and eccentricity were found to be significantly different among crosses. The biggest seed used in this study had the heaviest in seed weight, shell and kernel weight, highest in seed volume, thickest in shell and more number in kernel. Shell thickness, shell and kernel weight, seed volume and number of kernel presented a positive relationship with seed weight.

### Literature cited


