A Comparative Study of the Morphology and Yield of Oil Palm Trees Established using Imported and Local Seeds

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ABSTRACT

***Elaeis guineensis* of family Palmae is commonly known as oil palm and is being cultivated widely for vegetable oil production. The fresh fruit bunches (FFB) yield of oil palm is determined by number of yield components. In this study the yield components, fruit and tree morphology were compared in palms planted using imported seeds and palms planted using seeds from local plantations. A plantation having such fields of same age and grown under similar climatic conditions were identified for the study. The objective was to find out whether seeds of local plantations could be used to establish economically viable oil palm plantations in the country. Mesocarp and kernel weights were significantly higher in palms raised using imported seeds. However, the FFB yield per palm was high in palms established using local seeds. But the fertile tree percentage is high in palms derived from imported seeds. The studies reveal that the estimated FFB yield per hectare per annum could be higher with palms established using local seeds. Shell weight, trunk height and frond length were significantly higher in palms raised using local seeds. Studies on mesocarp and kernel oil content are proposed to establish the oil yields from the two types of planting material compared.**

KEYWORDS: Fresh fruit bunch, Fruit morphology, Oil palm, Tree morphology, Yield components

INTRODUCTION

The oil palm tree *(Elaeis guineensis)* is a member of the family Palmae and sub-family Cocoideae. The genus contains two main species: *E. guineensis* or African oil palm, and *E. melanococca* or American oil palm; the latter is only valuable for hybridization purposes (Anon, 2015).

Oil yield of this palm may be regarded as a composite characteristic since its final expression depends on a number of components, i.e. Fresh Fruit bunch Yield (FFB), bunch and fruit quality traits. The yield of FFB is the major economic trait that determine economic performance of this crop. Fresh fruit bunch yield is a function of number of bunches (BN) produced annually and the average bunch weight (ABW).The percentage of fruits per bunch (F/B%) is an important yield determining factor ,which increases the proportion of the economic component of the FFB. The fruit quality parameters, mesocarp to fruit ratio (M/F), shell to fruit ratio (S/F) and kernel to fruit ratio (K/F) are the relative proportion of mesocarp, shell and kernel to the fruit. The range of oil content in mesocarp and kernel is referred to as oil to mesocarp (O/M) and oil to kernel (O/K) ratios respectively (Okoye, 2009).

The availability of high-grade planting material is a key aspect for the sustainability of the oil palm industry. As it is for any agricultural industry, the genetic potential of the planting material used will indeed determine the maximum yield potential, which the plantation industry will strive to achieve (Thompson, 2003).

The production of fruit bunches in the oil palm is influenced by several factors, such as nutrients, water, carbohydrate supply and pollination. The latter depends on the pollen supply and pollinator activity. Changes to any of these may decrease or increase the level of fruit bunch production. Among these factors, pollination has the greatest influence on fruit bunch production. Nutrient deficiencies, poor pollination or inefficient pollinator activity, either separately or combined, will lead to low bunch production. Inefficient pollination can cause poor fruit set and result in bunch failure and loss in yield. This was a problem in the early days of oil palm cultivation, especially in young palms that produce insufficient male inflorescences. Assisted pollination has to be practiced to overcome the poor fruit set (Gray *et al.,* 1969).

An important practice in oil palm plantation is to harvest fresh fruit bunches at the optimum ripeness. The oil content of a fruit bunch is a function of its degree of ripeness. The ripeness at harvest varies from the standards established and will depend particularly on the length of harvesting round. With long rounds, harvester walking time is reduced as there is a high density of ripe bunches, but this is offset by the longer time required collecting the larger amounts of the loose fruits from the riper bunches. Fresh fruit bunch grading is the process of inspecting and assessing the quality oil palm fresh fruit bunches by taking random samples of bunches from a consignment at the mill or at the buyer's premises, i.e. FFB dealer (Anon, 2012).

Oil palms generally begin to produce fruits 30 months after being planted in the field with commercial harvest commencing six months later. However, the yield of an oil palm is relatively low at this stage. As the oil palm continues to mature, its yield increases and it reaches peak production in years 7 to 18. Yield starts to gradually decrease after 18 years. The typical commercial lifespan of an oil palm is approximately 25 years. Fully mature oil palms produce 18 to 30 metric tons of Fresh Fruit Bunches (FFB) per hectare per annum. The yield depends on a variety of factors, including age, seed quality, soil and climatic conditions, quality of plantation management and timely harvesting (Anon, 2016).

The usual frequency of a harvesting round is 10-15 days or 2-3 times a month. Harvesting is done using manual labor. The potential FFB yield in the country is 2.7-2.8 tons/ha/year which is nearly similar to the yield from Malaysia (2.5-3.8 tons/rai/year) because the seeds come from Malaysia and are thus the same type (Pleanjai, 2007).

The mean fruit weight is dependent on several components such as mesocarp, kernel and shell weights. The mean fruit weight from the outer bunch is slightly higher than from the inner bunch. The poor fruit growth in the inner bunch could either be due to their dense packing and lack of space for expansion or to a lower partitioning of assimilates to them (Mohd, 2002).

Altogether, there are four oil palm varieties namely, Macrocaria, Dura, Pisifera and Tenera. The commercially cultivated variety is Tenera which has a comparatively higher oil yield than the other varieties. Tenera is a hybrid obtained by crossing shell less Pisifera (female) and thick-shelled Dura (male). Since Sri Lanka does not have the mother varieties for crossing, oil palm is cultivated using imported seeds. There are constraints when using of imported seeds. Some of them are the quarantine procedures to be adopted, possibility of exotic deadly diseases entering the country, the longtime taken to obtain the seeds, high expenditure and loss of foreign exchange to the country and variations in germination ability and quality of seeds. The strategy to overcome the above constraints is to obtain the seeds locally for commercial planting. With this objective the fruit & palm tree morphology and the fresh fruit bunch yield of oil palm cultivations established using imported seeds and from seeds collected from local plantations were compared in this study. Local seeds were obtained from cultivations established in the country using imported Tenera seeds.

MATERIALS AND METHODS

Location

The study was carried out at Kithulwitigala and Giragoda divisions of the Elpitiya Estate managed by the Elpitiya Plantations. This plantation is situated in the low country wet zone with an average annual temperature of 26.8 °C. The mean annual rainfall is in the region of 3,339 mm. In this estate, two mature oil palm cultivations established in the same year (2007) were selected for the study. However, one cultivation was established using seeds obtained from local plantations (3 ha in extent) and the other from imported seeds (5 ha in extent). The sites were selected from same locality to minimize the soil and climatic conditions that could impact the cultivations.

Data Recording

From each of the two cultivations and from the best performing section an area having about 120 trees were identified for the study. Out of the 120 trees identified from each field, 20 oil palms trees were selected randomly to gather the following data.

Fresh Fruit Bunch, Fruit, Nut, Mesocarp, Endocarp, Kernel and Shell Weight

Fresh fruit bunch weight

One bunch was harvested from each of the 20 oil palm trees and the fresh fruit bunch weight of each bunch was determined separately using a balance having a range to measure up to 50 kg.

Fresh fruit weight

Five (05) fruits were identified randomly from each of the twenty bunches and were removed from the bunch to determine the total weight separately for each bunch using a balance with a range to measure 0 to 5 kg. The average fresh fruit weight was calculated by dividing the total weight by the number of seeds.

Nut and mesocarp weight

Each fruit was separated into the nut and mesocarp using a sharp knife. Then the average nut and mesocarp weights were determined separately for each of the twenty bunches using method followed to measure fresh fruit weight described above.

Kernel and shell weight

Each nut was separated into the shell & kernel using a sharp knife. Then the average kernel and shell weights were determined separately for each of the twenty bunches as described above.

Trunk height and girth

Using the twenty trees selected above, the trunk height was measured using a pole and a measuring tape. In the same palms, the girth of the trunk at a height of 100 cm from the ground level was measured using a measuring tape. Fronds attached to the trunk were difficult to remove prior to measuring the girth of palm tree.

Length and width of fronds

During harvesting of the selected twenty palms, the fronds were cut to facilitate the process. By using the most mature frond that was cut, the length and the width of the frond was measured.

Percentage of fertile palm trees

In each of the two fields selected for the study, number of fertile palms were counted and the percentage fertile palms were calculated as follows.

$$\text{Fertile palms (\%)} = \frac{\text{No. of fertile palms}}{\text{Total palm trees}} \times 100$$

Data Analysis

Parameters were statically analyzed by performing two sample t test using Minitab 15 statistical package.

RESULTS AND DISCUSSION

Fresh Fruit Bunch Weight

The fresh fruit bunch weight of palms established using imported and local seeds were (Table 1) statistically not significant. The mean fresh fruit bunch weight was 10.005 kg and 11.695 kg respectively.

Fresh Fruit Weight

The mean fresh fruit weight of palms established using imported and local seeds were 91.8 g and 90.3 g respectively. This difference in fresh fruit weight was statistically not significant (Table 1).

Nut Weight

The mean nut weight of two types of palms i.e. established using imported and local seeds were 15.95 g and 24.9 g respectively. Accordingly, the nut weight was significantly higher in palms established using local seeds (Table 1).

Mesocarp Weight

The mean mesocarp weight was 75.55 g and 65.4 g in fruits obtained from palms established using imported and local seeds respectively (Table 1). The difference is statistically significant indicating that fruits of imported seeds have a thicker mesocarp which could result in a higher palm oil yield.

Kernel Weight

Though statistically not significant the kernel weight was relatively higher in palms established using local seeds than in palms established using imported seeds (Table 1). Mean kernel weights were 6.05 g and 7.9 g for imported and local seeds respectively.

Shell Weight

The shell weight of fruits obtained from palms established using local seeds was significantly higher than in fruits obtained from palms established using imported seeds (Table 1). Further, the shell weight of local seed palms were almost double than that of imported seed palms, i.e. 17 g and 9.85 g respectively.

Table 1. The average weight of fresh fruit bunches and related parameters of palms established using local and imported seeds.

Parameter	Imported seeds	Local seeds	P value
Fresh fruit bunch weight	10.005kg	11.695kg	0.182
Fresh fruit weight	91.8g	90.3g	0.781
Nut weight	15.95g	24.9g	0.016
Mesocarp weight	75.55g	65.4g	0.015
Kernel weight	6.05g	7.9g	0.093
Shell weight	9.85g	17g	0.011

Trunk Height

The mean trunk height of 178.15 cm of palms established using local seeds were significantly higher than the trunk height of palms established using imported seeds which was 135.35 cm (Table 2). The higher trunk height could be due to relatively more dry matter portioning towards vegetative growth. A higher trunk height would also result in extra cost for the harvesting process.

Trunk Girth

Average trunk girth of palms derived from local and imported seeds were 260.25 cm and 270.9 cm respectively (Table 2).

The difference is statistically not significant. The higher girth is due to the same been measured without removal of the fronds attached to the trunk.

Table 2. Average and analyzed p values of growth parameters of local and imported palms

Parameter	Imported seed (average mean)	Local seed (average mean)	P value
Trunk height	135.35cm	178.15cm	0.000
Trunk girth	270.9cm	260.25cm	0.273
Frond length	521cm	626.6cm	0.023
Frond width	125cm	162.1 cm	0.018

Frond Length

Highest frond length, i.e. 626.1 cm was evident in palms raised using local seeds. It was significantly higher than in palms raised using imported seeds, i.e. 521 cm (Table 02). This further confirms that more dry matter is partitioned towards vegetative growth in palms established using local seeds. The higher number of fronds may not be suitable for productivity as overlapping fronds may lead to mutual shading and reduce photosynthesis activity.

Frond Width

The frond width of palms established using local and imported seeds were 162.1 cm and 125 cm respectively. The difference was statistically significant (Table 2).

Percentage of Fertile Palm Trees

The percentage of fertile palms was relatively high in palms established using imported seeds (93%) than in palms established using local seeds (85%; Figure 1).

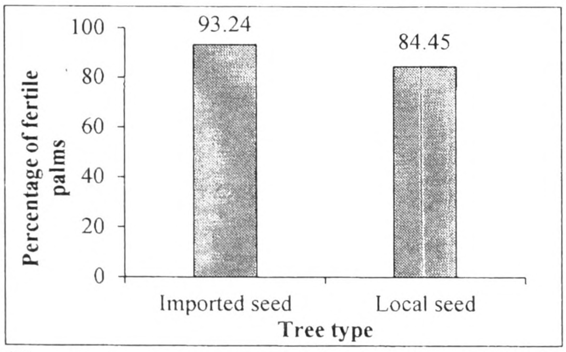

Figure 1. Percentage of fertile palms per hectare in cultivations established using local and imported palm seeds

The average yield per hectare was estimated assuming that ten bunches will be harvested from one palm during a year in palms cultivated using both local and imported seeds. The estimation was done using the following formula.

Average yield per hectare=average bunch weight $\times 10$ (rounds per year per palm) $\times 148$ (number of palms per hectare) x % of fertile palms.

Average yield per hectare in plantations established using local and imported seeds was 14,712 kg and 13,770 kg respectively (Figure 2). However, the oil yield could be higher in imported seeds due to the higher mesocarp component in the fruit (Table 1). Nevertheless, studies on oil content in the mesocarp have to be undertaken to arrive at a firm conclusion.

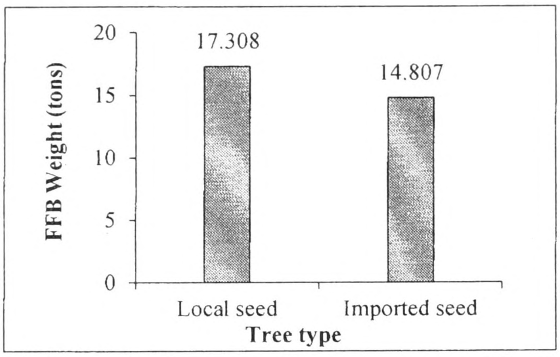

Figure 2. Average yield per hectare of fresh fruit bunches in cultivations established using local and imported palms

CONCLUSIONS

The economically valuable part of the oil palm plant is the mesocarp and kernel of the fruit. Although there is no significant difference in kernel weight per fruit the experiment proved that there is a significant difference in mesocap weight. It was high in palms established using imported seeds. However, the FFB yield per hectare per annum is high in cultivations established using local seeds. To gather information regarding oil yield further studies to determine mesocarp and kernel oil content are suggested.

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