

# Evaluation of the growth and development of oil palm (*Elaeis guineensis* Jacq.) under two nursery production systems

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## ABSTRACT

**Objective:** To evaluate the growth and development of two varieties of oil palm (*Elaeis guineensis* Jacq.) under nursery conditions, planted in bags and tubes.

**Design/methodology/approach:** The research was carried out in a nursery located in Macuspana Tabasco, Mexico, under a randomized block experimental design, with four treatments and four repetitions each. Two commercial varieties of *E. guineensis* were studied: Deli×Compacta and Compacta×Ghana, in two tube and bag containers. The variables recorded were height, number of leaves, and stem diameter every 15 days for 180 days. Data were analyzed using ANOVA and Tukey's mean tests.

**Results:** Significant differences were found between the treatments in plant height; T3 was the one that recorded the greatest increase with  $32.33 \pm 0.51$  cm. In relation to the variables number of leaves and stems, the tube treatments obtained the highest averages with both germplasms compared to the bag treatments.

**Limitations of the study/implications:** The probable variability of germplasm impacts the development of the plant with respect to the containers.

**Findings/conclusions:** The tube treatments achieved greater plant height, number of leaves, and greater stem diameter. It is considered that the tube treatments allow the development of robust plants.

**Keywords:** Containers, height, increase, number of leaves, plant quality.

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## INTRODUCTION

Oil palm cultivation is considered profitable due to its high yield, which is approximately 4.3 million tons of palm oil per million hectares; this represents a source of employment in producing countries and economic development for the country (Mohamad-Zaki *et al.*, 2025). Producers face challenges in seedling germination and production due to low efficiency of the techniques used to obtain and develop them, which impacts the



production rate and demand for the fruit (Beveridge *et al.*, 2022). Therefore, it is important to inquire about conditions that favor seedling development, such as containers and type of substrate for the plant; these practices have had positive effects on plantations such as coffee, eucalyptus, acai palm, among others (Paim *et al.*, 2023).

One of the practices that has allowed the production of higher quality seedlings with uniform growth vigor has been nursery growth (Gúzmań-Camposeco *et al.*, 2021). This can be carried out in two ways; the first is the simple or single-stage system, which involves directly planting the germinated seed in polyethylene bags and allowing them to develop for 10 to 12 months, followed by transplanting to the field (Lédo *et al.*, 2019). The other is the double or two-stage nursery system, which begins with a pre-nursery stage where the germinated seeds are planted in a polyethylene bag, for a period of three to four months; a pre-selection of vigorous and uniform seedlings is made, and then comes the nursery stage, where pre-selected seedlings are transplanted into larger bags for a period of seven to nine months so that at the end of this period, they are transplanted to the field (Adileksana *et al.*, 2020). There are some specifications that have become important given the improvements that have been observed in some other crops, such as the size and characteristics of the bags for growing, since this ensures the protection and development of the seedling (Furcal-Beriguete *et al.*, 2023). Establishing ideal agronomic conditions allows the existence of production materials that meet the demands of the environment, physical and chemical environment of the soil, which impacts crop yield and longevity, among others (Kouame *et al.*, 2021).

To verify that the nursery conditions implemented favor the development of the seedlings, it is important to measure biometric variables, such as root size, height, number of folioles, number of leaves, and stem diameter (Furcal-Beriguete *et al.*, 2023; Gúzmań-Camposeco *et al.*, 2021).

Therefore, the objective of this study was to evaluate the growth of two varieties of oil palm (*Elaeis guineensis* Jacq.) using tube containers and bags in the nursery.

Hypothesis: The use of different production systems has an effect on oil palm seedlings, which will be reflected in their growth and development.

## **MATERIALS AND METHODS**

This study was carried out in the experimental plot “Predio la Sombra”, located at 13.5 km on the Zapatero-Jonuta federal highway, latitude North 17.841086 W, 92.198414 N, with average temperature of 27 °C (National Institute of Statistics and Geography, 2022).

### **Experimental design**

The nursery was established and monitored for 180 days, according to a standardized technological package (Gremial de Palmicultores de Guatemala, 2017). A randomized complete block experimental design was used, with four treatments that include two varieties (Deli×Compacta and Compacta×Ghana), planted in two types of containers (bag and tube); each treatment had four repetitions and each of the repetitions had 100 experimental units (plants) (Table 1).

**Table 1.** Randomized complete block experimental design to determine nursery development of *E. guineensis* Jacq.

Treatments	Description	Repetitions	N° of plants	Plants by treatment
T1	D×Ct*	4	100	400
T2	D×Cb**	4	100	400
T3	C×Gt***	4	100	400
T4	C×Gb****	4	100	400
Totals		16	400	1600

\*Deli×Compact-Tube; \*\*Deli×Compact-Bags; \*\*\*Compact×Ghana-Tube; \*\*\*\* Compacta×Ghana-Bags.

The polyethylene bags used in the present study were black, 40 to 45 cm high by 28 cm wide, caliber 0.015 and 0.020 cm, with perforations in the lower third and the bottom; the tubes were made of grayish black polypropylene, 13 cm high and 15 cm wide, with internal grooves along the tube and open at the bottom (Mashani-Ahmad *et al.*, 2022). The experiment was set up in a planting frame of 1×1×1 meters, with 80 cm streets. Later, the nursery was established in which the plants were placed in 40×53 cm bags, made of 500 caliber plastic, at a distance between bags of 100 cm.

### Registry and analysis of variables

The variables height, number of leaves, and diameter of the stem were measured every 15 days with a total of 12 measurements over 180 days (six months) (Gremial de Palmicultores de Guatemala, 2017). The ANOVA statistical analysis was performed, followed by Tukey's means comparison as a post-hoc test, with a confidence level of 95%. Previously, the normality and homoscedasticity of the data were verified (Beltrán-Rodríguez *et al.*, 2022), all of this with the InfoStat-Statistical Software version 2017 (InfoStat, 2017).

## RESULTS AND DISCUSSION

### Increase in height in the nursery

The two treatments that used tubes (T1 and T3) showed greater height compared to those produced in bags ( $p < 0.0001$ ) (Table 2). T3 (C×Gt) recorded a greater increase in average height, of  $32.33 \pm 0.51$  cm after 180 days ( $p < 0.0001$ ), compared to T1, T2 and T4 which had average height of 25.66, 11.25 and 8.8 cm, respectively.

**Table 2.** Mean values  $\pm$  SE of the height, number of leaves, and stem diameter variables of two oil palm varieties at 180 days.

Variable	Treatments				F16	P
	1	2	3	4		
Height	25,7±0,51 c	11,3±0,51 b	32,3±0,51 d	8,8±0,51 a	487.3	0.0001
Leaf	5,9±0,1 b	1,5±0,1 a	5,8±0,1 b	1,8±0,1 a	615.2	0.0001
Diameter	1,3±0,04 c	0,5±0,04 b	1,3±0,04 c	0,41±0,04 a	188.2	0.0001

T1: D×Ct, T2: D×Cb, T3: C×Gt, T4: C×Gb. Means with a common letter between rows are not significant ( $p > 0.05$ ), Alpha=0.05,  $\pm$ SE: standard error.

When analyzing the accumulated growth in height over a period of six months (180 days), T2 and T4 in bags started with greater heights in the nursery compared to those in tubes (T1, T3); four months later, those in tubes equaled those produced in bags. At 180 days, tubes recorded greater growth in height compared to the bag treatments, with T3 showing the greatest growth with  $68.37 \pm 0.61$  cm in height in the nursery, followed by T1 with  $65.71 \pm 0.61$ , and to a lesser extent, T4 and T2 followed with  $58.73 \pm 0.61$  and  $54.97 \pm 0.61$ , respectively (Table 3). The greatest growth effect on plants is significantly observed 90 days after sowing. It is likely that at 45 days, they use the seed reserves and not the contribution provided in the soil directly, even when the elements for their nutrition and development that accompany their growth are applied in a standard way (Purnama & Afrillah, 2022).

With height, although not an indicator of survival, vigor is considered to be determined by the size of the bulb (Madrigal-Valverde & Garbanzo-León, 2018), which provides nutrient transfer capacity (Greenshields *et al.*, 2022). On the other hand, Cobas-López, Sotolongo-Sospedra and Almora-Ramos, (2020) mention that the tube technique helps to avoid plant dehydration; the substrates are kept in good condition and can be adapted to the cultivation field during transplanting (Mashani -Ahmad *et al.*, 2022).

### **Number of leaves**

Treatments T1 and T3 in tubes showed a greater number of leaves, with average of  $5.9 \pm 0.1$  and  $5.8 \pm 0.1$ , respectively, during the 180 days ( $p < 0.0001$ ), both treatments being statistically different from treatments T2 and T4 in bags ( $p > 0.05$ ), which presented values of  $1.5 \pm 0.1$  and  $1.8 \pm 0.1$  leaves, respectively (Table 2).

Regarding the accumulated number of leaves over a period of six months (180 days), T1 and T3 in tubes recorded a higher average number of leaves at transplanting, with  $12.95 \pm 0.11$  and  $12.38 \pm 0.10$ , respectively. The T2 and T4 treatments in bags presented a lower number of leaves at transplanting, with average values of  $10.98 \pm 0.10$  and  $11.08 \pm 0.10$  leaves (Table 3).

Regarding the number of leaves, the difference between treatments was observed to be significant independently. The varieties grown in tubes presented higher values, when defined from day 90 onwards. Paim *et al.* (2023) reported that the growth of swamp palm (*Mauritia flexuosa* Lf.) seedlings showed a higher leaf height-diameter ratio than those grown in  $20 \times 30$  cm polyethylene bags, which could be due to better transpiration of the plant, nutrient proportion, and good photo assimilation.

Ibarra-Ruales and Reyes-Cuesta (2015) mention that with the use of tubes, plants present less stress, and this promotes growth in the palm's aerial organs in the nursery (Radin *et al.*, 2018).

### **Stem diameter**

The stem diameter of the treatments evaluated showed significant differences ( $p < 0.0001$ ). T1 and T3 in tubes showed greater significant differences with respect to T2 and T4 in bags, presenting average values of  $1.3 \pm 0.04$ ,  $1.3 \pm 0.04$  and  $0.5 \pm 0.04$ ,  $0.41 \pm 0.04$ , respectively (Table 2).

**Table 3.** Increase (over a six-month period) in height, number of leaves, and stem diameter in *E. guineensis* Jacq. for 180 days.

Variables	T1	T2	T3	T4
Height (cm)	65,71 ± 0,61	54,97 ± 0,61	68,37 ± 0,61	58,73 ± 0,61
N° of leaves	12,95 ± 0,11	10,98 ± 0,10	12,38 ± 0,10	11,08 ± 0,10
Diameter (cm)	2,21 ± 0,03	2,19 ± 0,03	2,11 ± 0,03	1,95 ± 0,02

For stem diameter, comparisons of the data accumulated during the six months (180 days) between the tube and the bag treatments were decisive; there was greater growth in diameter in treatments T1 and T3 compared to T2 and T4; the treatments in bags (T2 and T4) finished their nursery cycle with an average stem thickness of 20.7 millimeters, while those in tubes (T1 and T3) had an average of 21.6 millimeters (Table 3).

Castro-Garibay *et al.* (2018) report higher values of variables in seedlings, such as dry weight in root aerial and length, better quality plants, greater biomass obtained in the aerial/root ratio, height and diameter, due to their probable capacity for adaptation and survival, although the effect of the genotype must be considered (Ibarra-Rurales and Reyes-Cuesta, 2015).

A container must promote the efficient use of nutrient resources, for example, phosphorus and potassium found in the substrate, which will directly correlate with the growth of the plant (Hapsos *et al.*, 2020; Basyar *et al.*, 2023), something that this study also noted since there was better growth and development with the tube treatments.

Generating plants using this method requires careful agronomic management, especially in the container itself with variables such as stem height and thickness, although a cone-shaped pot is recommended to reduce growth time, transportation costs, transplanting, among others. In palm, growth in tubes is considered to increase the number of plants per unit area, and labor and input efficiency in the activity (Chaves-Vargas, Peraza-Padilla and Sancho-Barrantes, 2020).

## CONCLUSIONS

Oil palm seedlings (*Elaeis guineensis* Jacq.) grown in tube-type containers showed greater growth in height, number of leaves, and stem diameter compared to those produced in bags, with no significant differences between the varieties. This indicates that the use of tubes favors optimal plant development in the nursery.

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