

Growth of Seedlings of two Oil Palm Varieties (*Elaeis guineensis* Jacq.) in the Nursery Using two Container Types

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ABSTRACT

Background: The production of high-quality planting material during the nursery stage is essential for establishing productive, competitive, and sustainable oil palm plantations. Genetic material and container type may influence seedling development.

Objective: To evaluate the growth of seedlings of two oil palm varieties, Deli × Compacta and Compacta × Ghana (*Elaeis guineensis* Jacq.), produced using two container types.

Methods: The experiment was conducted in Macuspana, Tabasco, Mexico. Seedling growth was evaluated in two varieties, Deli × Compacta and Compacta × Ghana, using tube containers and plastic bags. A randomized complete block design was established with four treatments and four replications, with 100 seedlings per replication (400 seedlings per treatment; 1,600 seedlings in total). Plant height, number of leaves, and stipe diameter were measured every 15 days over 180 days. The same agronomic management was applied to all treatments. Descriptive statistics, analysis of variance (ANOVA), and Tukey's multiple comparison test.

Results: Significant differences among treatments were detected for the evaluated growth variables. For plant height, T3 (Compacta × Ghana in tube containers; CxGt) showed the greatest value at 180 days, reaching 68.37 ± 0.61 cm. For number of leaves, T1 (Deli × Compacta in tube containers; Dx Ct) and T3 (Compacta × Ghana in tube containers; CxGt) recorded 12.95 ± 0.11 and 12.38 ± 0.10 leaves, respectively, at 180 days. For stipe diameter, T1 and T2 showed the highest values at 180 days, with 2.21 ± 0.03 and 2.19 ± 0.03 cm, respectively, whereas T4 recorded 1.95 ± 0.02 cm.

Conclusions: Under the conditions evaluated, seedlings produced in tube containers showed greater plant height and number of leaves at the end of the nursery period. Stipe diameter was higher in the Deli × Compacta material than in the Compacta × Ghana material at 180 days. These results support the potential use of tube containers for nursery production.

KEYWORDS: *Elaeis guineensis*, oil palm, nursery, container type, seedling growth, plant height, number of leaves, stipe diameter

INTRODUCTION

Oil palm or African oil palm (*Elaeis guineensis* Jacq.) is native to the coastal areas of the Gulf of Guinea in West Africa. It grows in tropical regions and is considered one of the most efficient oilseed crops per unit area (1). Following the Spanish conquest, it was introduced into the Americas in the sixteenth century, where the Antilles, the Guianas, and Brazil are considered centers of probable acclimatization and domestication (2, 3).

In 2022, global palm oil production was 73.83 million metric tons in more than 23 countries. In 2023, an increase of 3.39 to 5.63 million tons of fresh fruit bunches was estimated, with an oil volume ranging from 77.22 to 79.46 million metric tons. In 2022, Indonesia accounted for 58.92% of production and Malaysia for 24.34%. Mexico ranked 18th, with 230 thousand metric tons, representing 0.29% of production (4, 5).

In other terms, palm oil has versatile uses because its fruits contain high concentrations of carotenoids, lycopene, and xanthophylls, which are antioxidant compounds, as well as high levels of β -carotene and tocopherols that contribute to mitigating vitamin A and E deficiencies (6). Each fruit contains approximately 30–35% oil, which is important to the food industry as a raw material for dairy formulations, snacks and fried foods, confectionery, instant soups, sour creams, ice-cream bases, cheese production, and edible oil. In the chemical industry, it is used in cosmetics, soaps, and printing inks, as well as for energy-related applications such as biodiesel, among others (7).

In Mexico, four southeastern states produce oil palm. Chiapas is the main producer, with 51,165.39 ha in 22 municipalities and 11 extraction plants in operation. It is followed by Campeche, with 30,782.7 ha in six municipalities and two plants in operation; Tabasco, with 27,520.3 ha in nine municipalities and two extraction plants; and Veracruz, with 8,065.62 ha in 17 municipalities and one extraction plant. A total of 117,534.01 hectares is estimated (Federación Mexicana de Palma de Aceite, 2018, 2021), with average yields of 9.52 tons of fresh fruit bunches and an oil extraction rate (OER) of 21%. In 2020, Mexico consumed 847.13 thousand tons of oil, while domestic production was 252.46 thousand tons, covering only 29.90% of demand. Therefore, 594.66 thousand tons (70.10%) were imported from Costa Rica, Guatemala, Colombia, Nicaragua, Panama, Honduras, and Malaysia, in order of importance (8).

Under these conditions, promoting oil palm cultivation in Mexico is important, considering agronomic management from the pre-nursery and nursery stages through establishment, maintenance, and harvesting. The crop may have a productive lifespan of up to 25 years, provided appropriate management practices are implemented, particularly when production is aligned with the processes of the Roundtable on Sustainable Palm Oil (RSPO). It is also important to note that, in Mexico, the production of planting material for field establishment depends on certified seed produced in Colombia or Costa Rica. Such material is developed under specific management practices that produce high-quality plants capable of responding to climatic, management, production, and oil-extraction requirements (9).

To establish 143 plants per hectare in the field, 245 seeds must be placed for germination, 200 germinated seeds must be transplanted to the nursery, and approximately 170 seedlings must remain in the nursery, with a selection rate of 58–60% and a discard rate of 40–42% from the initial germination process (9). This suggests the need to focus on efficient production of high-quality plants for transplanting. Two production systems are considered: single-stage nurseries, in which seedlings remain in production for up to 12 months, as in the present study; and two-stage systems, in which the first stage is the pre-nursery, where seedlings are produced for up to three months, followed by the nursery stage, where seedlings develop under physiological conditions suitable for transplanting to the production area. In both cases, objectives, environmental conditions, and costs should be considered; a single-stage system may represent a profitable alternative (10).

Regardless of whether one- or two-stage nurseries are used, nursery production in this monocot species is useful for managing and reducing plant growth time, particularly because a greater total number of leaves provides adequate leaf area for light interception and, consequently, greater photosynthetic area (11). Establishing appropriate agronomic conditions for different varieties allows production materials to meet environmental requirements as well as the physical and chemical conditions of the soil, affecting yield, crop longevity, costs, benefits, and the implementation of good management practices (12).

Plant production is considered to comprise two stages. The pre-nursery stage consists of placing fully developed and differentiated seeds in bags or tube containers for seedling development until they reach the characteristics required for transplantation to the nursery, where they are placed in larger bags for acclimatization and subsequent field transplanting. Nutrition also influences development, and organic components can contribute to adequate growth (13).

For the measurement of biometric variables in the nursery, root size, plant height as a measure of maximum light interception, and the number of leaflets is considered important. The number of leaves is related to photosynthetic activity, while stipe diameter is important because a thicker stipe at the nursery stage is considered an indication of a plant capable of supporting a high fruit load during adulthood. Leaf production, together with factors such as nutrition, soil, environment, and management, is related to palm yield and productive lifespan (14, 15).

OBJECTIVE OF THE STUDY

Thus, the objective of this study was to evaluate the nursery performance of two commercial oil palm varieties (*Elaeis guineensis* Jacq.) in two types of containers (tube container and bag).

MATERIALS

The study was conducted during 2023 at the experimental plot “The Shadow,” located 13.5 km from the federal highway connecting Zapatero and Jonuta, Macuspana, Tabasco Mexico. at 17.841086° N latitude and 92.198414° W longitude, at an elevation of 8 m. The climate is warm humid and subhumid, with an average annual precipitation of 2,550 mm, an average temperature of 27 °C, an average maximum temperature of 35 °C, and an average minimum temperature of 18.5 °C, with abundant rainfall from June to October (16).

Experimental Design

The nursery was established and monitored for 180 days using a randomized complete block design with four treatments involving two varieties. Deli $\times$ Compacta originated from crosses between Deli dura palms (Bogor, Java) and compact pisifera palms derived from successive backcrossing of a natural *E. oleifera* $\times$ *E. guineensis* hybrid with *E. guineensis*. These palms are characterized by shorter leaves and trunks than common *E. guineensis* varieties, slow trunk growth (40–45 cm/year), medium bunches (18–22 kg), medium fruit (9–11 g), oil content of 28–30% of the bunch, moderate-to-high drought tolerance, and moderate tolerance to low temperatures and low light (17).

The other variety, Compacta $\times$ Ghana, originated from crosses between compact dura mother palms derived from successive backcrossing of a natural *E. oleifera* $\times$ *E. guineensis* hybrid with *E. guineensis*, with Calabar paternal lines originating in Nigeria (NIFOR) and introduced into Costa Rica from the Kade Experimental Station in Ghana. It has slow trunk growth (40–45 cm/year), medium bunches (18–22 kg), medium fruit (9–11 g), excellent bunch oil content (28–30%), moderate-to-high drought tolerance, and moderate tolerance to low temperatures and low light (17).

Two propagation methods were used in the pre-nursery. The first consisted of black polyethylene bags measuring 40–45 cm in height and 28 cm in width, with a 5–7 cm gusset and a thickness of 0.015–0.020 cm, with perforations in the lower third and at the bottom. The second consisted of grayish-black polypropylene tube containers measuring 13 cm in height and 15 cm in width, with internal ribs along the tube and an open lower end. Their average weight was 22 g. The ribs direct the roots downward and facilitate separation of the root plug from the walls of the cone during transplanting (11). These were arranged at 1 $\times$ 1 $\times$ 1 m spacing, with 80-cm alleys. The nursery was subsequently established, with plants placed in 40 $\times$ 53 cm plastic bags, gauge 500, at 100 cm between bags, according to the experimental design shown in Table 1.

Table 1. Randomized complete block experimental design used to determine the nursery development of *E. guineensis* Jacq. in Macuspana, Tabasco, 2019–2020.

Treatments	Description	Replications	Number of plants	Plants per Treatment
T1	Deli $\times$ Compacta – Tube container (DxCt)	4	100	400
T2	Deli $\times$ Compacta – Bags (DxCb)	4	100	400
T3	Compacta $\times$ Ghana – Tube container (CxGt)	4	100	400
T4	Compacta $\times$ Ghana – Bags (CxGb)	4	100	400
Total	Experimental units	16	400	1600

After the plots were marked and treatments were assigned to the lots, a selective herbicide was applied inside and outside the lots. The mixture consisted of 10 g of metsulfuron-methyl + 1.5 L of haloxyfop-R-methyl ester + 300 mL of polyether-polymethylsiloxane copolymer + 300 mL of Prolux PlusPh + 2 kg of ammonium sulfate, all diluted in 200 L of water and applied per hectare. A contact herbicide mixture of 1.5–2 L of paraquat (depending on the weed species) + 300 mL of ethoxylated alcohol C8–C10, 5EO (equivalent to 215.72 g a.i./L) + citric acid (equivalent to 215.72 g a.i./L) + 300 mL of polyether-polymethylsiloxane copolymer, diluted in 200 L of water, was also applied per hectare (18).

For fungal control, 1 kg of mancozeb + 300 mL of ethoxylated alcohol C8–C10, 5EO (equivalent to 215.72 g a.i./L) + citric acid (equivalent to 215.72 g a.i./L) + 300 mL of polyether-polymethylsiloxane copolymer were mixed in 200 L of water and applied every 20 days. Fertilization consisted of a physical mixture of 12-13-19 + 6 magnesium (Mg).

Variables were measured every 15 days, for a total of 12 measurements over 180 days (six months). Data were entered into Microsoft Office Excel, followed by analysis of variance (ANOVA) and Tukey's mean comparison test using InfoStat Statistical software, version 2017 (InfoStat, 2017). The variables measured were total plant height, measured from the base of the plant stem to the apex of the longest leaf, regardless of whether it was a primary or secondary leaf; number of leaves, counting fully formed leaves with a visible rachis, while leaves not meeting these criteria were not recorded; and stipe diameter. From the first through the sixth month, the leaf sheath was exposed as much as possible for measurement. From the fifth month onward, the sheath became attached to the stem, so the stem and attached sheaths were included in measurement (19).

RESULTS

Increase in Plant Height During the Nursery Stage

Of the four treatments evaluated in oil palm seedlings (*Elaeis guineensis* Jacq.) produced in the nursery, the two treatments using tube containers showed greater plant height (Table 2) than those produced in bags (SC type III; $p < 0.0001$). Among treatments, T3 (Compacta $\times$ Ghana – tube container [CxGt]) recorded the greatest increase in height, with a mean of 32.33 ± 0.51 cm after 180 days ($p < 0.0001$), compared with T1 (25.66 cm), T2 (11.25 cm), and T4 (8.8 cm).

Table 2. Increase in height of oil palm (*Elaeis guineensis* Jacq.) over 180 days using four nursery treatments.

Treatments	Means	N	SE	$p > 0.05$
T4 (CxGb)	8,8	400	0,51	A
T2 (DxCb)	11,25	400	0,51	B
T1 (DxCt)	25,66	400	0,51	C
T3 (CxGt)	32,33	400	0,51	D

Means followed by a common letter are not significantly different ($p > 0.05$); $\alpha = 0.05$; LSD = 1.86761.

The bag treatments (T2 and T4) began the nursery stage with greater plant height than the tube-container treatments (T1 and T3). Four months later, the tube-container treatments reached heights comparable to those of the bag treatments. Subsequently, by 180 days, the tube-container treatments recorded greater plant height in the nursery than the bag treatments, with T3 showing the highest value, followed by T1 (Table 3).

Table 3. Height growth of *Elaeis guineensis* Jacq. plants over 12 measurements in four nursery treatments.

Days	Treatments			
	T1	T2	T3	T4
15	$40,06 \pm 0,51$ b	$45,39 \pm 0,49$ b	$35,82 \pm 0,51$ a	$49,93 \pm 0,50$ c
30	$40,42 \pm 0,49$ b	$48,68 \pm 0,50$ a	$36,37 \pm 0,49$ a	$52,49 \pm 0,49$ b
45	$40,52 \pm 0,48$ b	$51,80 \pm 0,51$ c	$36,51 \pm 0,48$ a	$52,68 \pm 0,51$ c
60	$41,30 \pm 0,47$ b	$51,93 \pm 0,53$ a	$38,41 \pm 0,47$ a	$52,78 \pm 0,53$ a
75	$43,16 \pm 0,47$ b	$53,01 \pm 0,49$ b	$41,27 \pm 0,47$ a	$52,94 \pm 0,49$ b
90	$44,01 \pm 0,49$ a	$53,13 \pm 0,49$ b	$44,69 \pm 0,49$ a	$52,95 \pm 0,49$ c
105	$46,31 \pm 0,49$ a	$53,34 \pm 0,47$ c	$47,68 \pm 0,49$ a	$53,34 \pm 0,47$ c
120	$48,92 \pm 0,49$ a	$53,41 \pm 0,49$ c	$51,20 \pm 0,49$ c	$53,98 \pm 0,47$ c
135	$52,75 \pm 0,50$ b	$53,53 \pm 0,47$ c	$55,33 \pm 0,50$ c	$54,15 \pm 0,49$ c
150	$55,67 \pm 0,53$ b	$54,06 \pm 0,48$ c	$58,50 \pm 0,53$ c	$54,65 \pm 0,48$ c
165	$61,24 \pm 0,57$ b	$54,97 \pm 0,53$ a	$63,39 \pm 0,53$ c	$55,93 \pm 0,53$ a
180	$65,71 \pm 0,61$ c	$54,97 \pm 0,61$ a	$68,37 \pm 0,61$ d	$58,73 \pm 0,61$ b

T: Treatments; T1: Deli $\times$ Compacta – tube container (DxCt); T2: Deli $\times$ Compacta – bags (DxCb); T3: Compacta $\times$ Ghana – tube container (CxGt); T4: Compacta $\times$ Ghana – bags (CxGb); M: Measurement. Mean $\pm$ standard error (SE); means followed by a common letter are not significantly different ($p > 0.05$). The table should be analyzed horizontally (by days of development).

In T3 recorded the greatest plant height at 180 days, reaching 68.37 ± 0.61 cm. Because field performance was not evaluated in this study, any inference regarding subsequent field performance should be considered a hypothesis for future research.

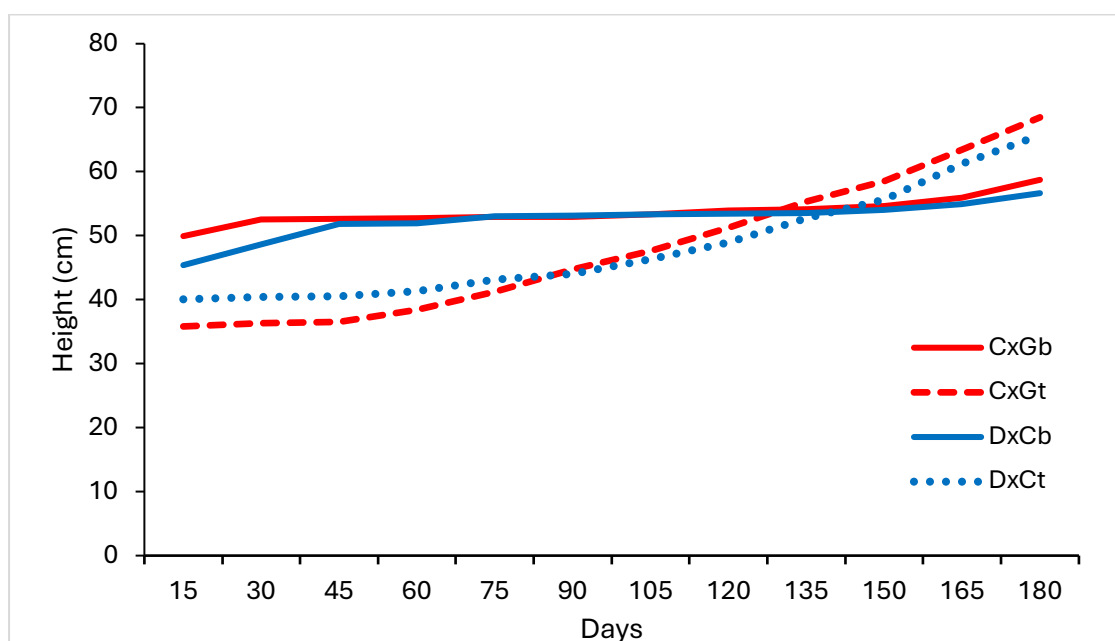


Figure 1. Difference in height attained by oil palm seedlings produced in tube and bag containers in the nursery.

Number of Leaves

Treatments T1 and T3, which used tube containers, recorded higher mean numbers of leaves, 5.9 and 5.8 leaves, respectively, during the 180-day study than treatments using bags (T2 and T4). No significant differences were detected ($p > 0.05$). This result may be related to the type of container in which the seedlings were produced, although the treatments involved different germplasm varieties (Table 4).

Table 4. Comparison of the number of leaves among the four treatments.

Treatments	Means	N	SE	$p > 0.05$
DxCb	1,53	400	0,1	A
CxGb	1,83	400	0,1	A
CxGt	5,82	400	0,1	B
DxCt	5,96	400	0,1	B

Means followed by a common letter are not significantly different ($p > 0.05$); LSD = 0.35718.

Treatments T1 (DxCt) and T3 (CxGt), both using tube containers, recorded the highest mean number of leaves at transplanting, with 12.95 ± 0.11 and 12.38 ± 0.10 leaves, respectively. The bag treatments showed lower numbers of leaves at transplanting: T2 (DxCb) and T4 (CxGb), with means of 10.98 ± 0.10 and 11.08 ± 0.10 leaves, respectively (Table 5).

Table 5. Mean number of oil palm leaves recorded at each measurement and for each treatment.

Days / Treatment	T1	T2	T3	T4
15	6,99±0,06 b	7,60±0,07 c	6,51±0,06 a	7,65±0,07 c
30	7,92±0,06 b	7,83±0,07 b	7,22±0,06 a	7,76±0,06 b
45	8,77±0,17 c	8,19±0,07 b	8,52±0,06 c	7,86±0,07 a
60	9,06±0,07 c	8,86±0,08 b	9,11±0,07 c	8,37±0,07 a
75	9,95±0,10 b	8,93±0,08 a	9,95±0,08 b	8,89±0,07 a

90	10,81±0,11 b	9,00±0,10 a	10,59±0,07 b	9,11±0,08 a
105	10,97±0,10 b	9,21±0,09 a	10,96±0,08 b	9,26±0,08 a
120	11,04±0,11 b	9,45±0,10 a	11,07±0,10 b	9,32±0,08 a
135	11,22±0,10 c	9,94±0,09 b	11,26±0,08 c	9,39±0,09 a
150	11,45±0,10 c	10,69±0,10 b	11,36±0,09 c	10,01±0,09 a
165	11,99±0,10 c	10,98±0,10 b	12,08±0,09 c	10,69±0,09 a
180	12,95±0,11 b	10,98±0,10 a	12,38±0,10 b	11,08±0,10 a

T: Treatments; T1: Deli × Compacta – tube container (DxCt); T2: Deli × Compacta – bags (DxCb); T3: Compacta × Ghana – tube container (CxGt); T4: Compacta × Ghana – bags (CxGb); M: Measurement. Mean ± standard error (SE); means followed by a common letter are not significantly different ($p > 0.05$). The table should be analyzed horizontally (by days of development).

Empirically, it is known that after approximately four months in the nursery, oil palms begin a period of more pronounced growth. By this time, the palms have developed new secondary and tertiary roots and are no longer dependent solely on primary roots. The leaf response observed among treatments is consistent with this pattern because, beginning in the second month, the tube-container treatments increased their number of leaves compared with the bag treatments. As shown in Table 5, during the sixth month T1 and T3 formed an average of 12 leaves, whereas T2 and T4 had approximately 10 leaves, despite receiving the same management.

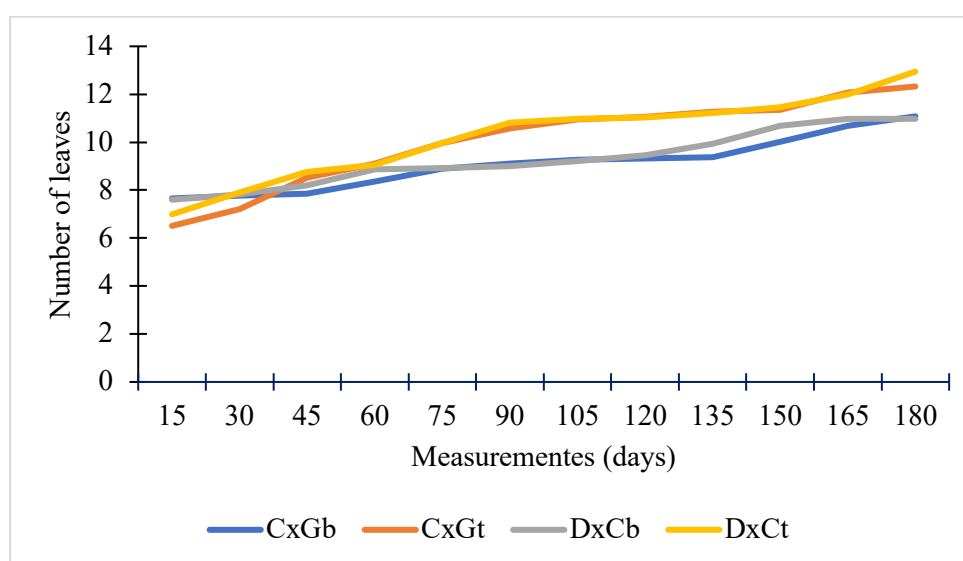


Figure 2. Number of leaves in oil palm seedlings produced in bag and tube containers.

During the 180-day nursery period, T2 and T4 showed staggered leaf emergence and completed the nursery stage with an average of 10 leaves. In contrast, T1 (Deli × Compacta in tube containers) and T3 (Compacta × Ghana in tube containers) showed a greater response in leaf emergence, developing leaves more consistently. Their nursery cycle resulted in more than 12 fully formed leaves, excluding the spear leaf. T1 showed the highest response, followed by T3, T4, and T2 (Table 6).

Table 6. Emission of leaves in oil palm materials.

Treatments	Initial	M1 (O-N)	M2 (N-D)	M3 (D-E)	M4 (E-F)	M5 (F-M)	M6 (M-A)	Leaves formed
T1 (DxCt)	6,99	1,78	1,19	1,02	0,24	0,77	0,96	12,95
T2 (DxCb)	7,60	0,59	0,74	0,28	0,73	1,04	-	10,98
T3 (CxGt)	6,45	2,01	1,44	1,01	0,31	0,82	0,31	12,32
T4 (CxGb)	7,66	0,20	1,03	0,37	0,13	1,31	0,39	11,08

Stipe Diameter

The evaluated treatments showed significant differences according to Tukey's test at $\alpha = 0.05$ ($p < 0.0001$), with an LSD of 0.80016. Regarding stipe diameter, T1 (Deli $\times$ Compacta – tube container [DxCt]) and T3 (Compacta $\times$ Ghana – tube container [CxGt]) showed significantly greater values than T2 (Deli $\times$ Compacta – bag) and T4 (Compacta $\times$ Ghana – bag) after 180 days (Table 7).

Table 7. Significant differences among oil palm treatments for stipe diameter.

Treatments	Means	N	SE	p > 0.05
T4 (CxGb)	0,41	400	0,04	A
T2 (DxCb)	0,58	400	0,04	B
T3 (CxGt)	1,30	400	0,04	C
T1 (DxCt)	1,33	400	0,04	C

Means followed by a common letter are not significantly different ($p > 0.05$); LSD = 0.12748.

For stipe diameter, comparisons between tube and bag containers were decisive. At the end of the nursery period, T1 and T3 had greater diameter than T2 and T4. The bag treatments completed the nursery cycle with an average stem thickness of 20.7 mm, whereas the tube-container treatments T1 and T3 completed the nursery cycle with an average stem thickness of 21.6 mm (Table 8).

Table 8. Growth in stipe diameter (cm) of oil palm cultivars.

Days / Treatment	T1	T2	T3	T4
15	0,87 $\pm$ 0,03 a	0,91 $\pm$ 0,01 a	0,80 $\pm$ 0,04 a	0,87 $\pm$ 0,03 a
30	1,12 $\pm$ 0,01 a	1,02 $\pm$ 0,01 b	1,04 $\pm$ 0,01 b	0,98 $\pm$ 0,01 a
45	0,99 $\pm$ 0,01 a	1,14 $\pm$ 0,01 c	1,05 $\pm$ 0,01 b	1,12 $\pm$ 0,05 a
60	1,13 $\pm$ 0,01 b	1,15 $\pm$ 0,02 b	1,08 $\pm$ 0,01 a	1,07 $\pm$ 0,04 a
75	1,31 $\pm$ 0,01 d	1,24 $\pm$ 0,01 c	1,21 $\pm$ 0,01 b	1,10 $\pm$ 0,01 a
90	1,39 $\pm$ 0,02 c	1,33 $\pm$ 0,02 b	1,39 $\pm$ 0,02 c	1,20 $\pm$ 0,01 a
105	1,56 $\pm$ 0,02 d	1,43 $\pm$ 0,02 c	1,49 $\pm$ 0,02 b	1,31 $\pm$ 0,02 a
120	1,63 $\pm$ 0,02 d	1,51 $\pm$ 0,02 c	1,60 $\pm$ 0,02 b	1,34 $\pm$ 0,01 a
135	1,71 $\pm$ 0,02 b	1,69 $\pm$ 0,02 b	1,68 $\pm$ 0,02 b	1,54 $\pm$ 0,02 a
150	1,80 $\pm$ 0,02 c	1,88 $\pm$ 0,02 c	1,80 $\pm$ 0,02 b	1,69 $\pm$ 0,02 a
165	1,97 $\pm$ 0,02 b	2,09 $\pm$ 0,03 c	1,93 $\pm$ 0,02 b	1,85 $\pm$ 0,02 a
180	2,21 $\pm$ 0,03 c	2,19 $\pm$ 0,03 c	2,11 $\pm$ 0,03 b	1,95 $\pm$ 0,02 a

T: Treatments; T1: Deli $\times$ Compacta – tube container (DxCt); T2: Deli $\times$ Compacta – bags (DxCb); T3: Compacta $\times$ Ghana – tube container (CxGt); T4: Compacta $\times$ Ghana – bags (CxGb); M: Measurement. Mean $\pm$ standard error (SE); means followed by a common letter are not significantly different ($p > 0.05$). The table should be read horizontally (by days of development).

Although significant differences were observed between tube and bag treatments, with the tube treatment performing better, Figure 3 shows some regular growth patterns during the 180-day trial, particularly because all treatments were grown under the same agronomic management conditions.

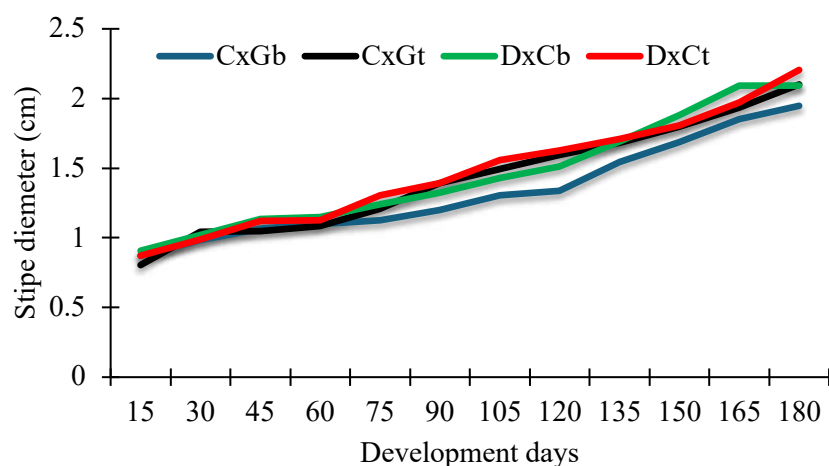


Figure 3. Stipe diameter in oil palm seedlings produced in bag and tube containers.

For plant height (cm) and number of leaves, the seedlings produced in tube containers (T1 and T3) completed six months in the nursery with heights greater than 65 cm and more than 12 leaves. For stipe diameter, T1 and T2, both involving Deli $\times$ Compacta, had greater values in their respective containers than T3 and T4, which involved Compacta $\times$ Ghana (Table 9).

Table 9. Mean values of the variables evaluated in the oil palm materials studied.

Variables	T1. D x C t	T2. D x C b	T3. C x G t	T4. C X G b
Plant height (cm)	65,71 $\pm$ 0,61	54,97 $\pm$ 0,61	68,37 $\pm$ 0,61	58,73 $\pm$ 0,61
Number of leaves	12,95 $\pm$ 0,11	10,98 $\pm$ 0,10	12,38 $\pm$ 0,10	11,08 $\pm$ 0,10
Diameter (cm)	2,21 $\pm$ 0,03	2,19 $\pm$ 0,03	2,11 $\pm$ 0,03	1,95 $\pm$ 0,02

DISCUSSION

All treatments showed significant differences in plant height. However, T3 (CxGt) and T1 (DxCt) had the highest mean heights and were both tube-container treatments. The greatest effect on plant growth was observed significantly 90 days after planting. It is possible that during the first 45 days the seedlings used seed reserves rather than relying directly on nutrients supplied through the soil, although nutritional and management inputs were applied uniformly. At some point, these inputs may have influenced the increase in plant biological components during this developmental stage (20, 21).

In this study, the Compacta $\times$ Ghana material grown in tube containers showed the greatest plant height. However, bulb size was not directly measured in the present experiment; therefore, any association with bulb robustness should be considered cautiously. Cobas-López (22) reported that the tube-container technique helps prevent plant dehydration, maintains substrate conditions, and may facilitate adaptation after transplanting to the field. Together with bulb size (23), these factors may help explain why T3 (CxGt) reached the greatest heights in the present study, where standard management practices were applied across treatments (24).

Regarding number of leaves, the difference among treatments was significant independently of variety ($p > 0.05$), with the tube-container treatment showing higher values from approximately day 90 onward. T1 (DxCt) had the highest number of leaves, supporting the role of the tube container in seedling development. Ibarra-Ruales (25) reported that soil, irrigation, and genetic material influence plant growth; both hybrids and varieties may respond differently according to moisture, nutrient availability, and temperature. The use of tube containers may increase the capacity to avoid stress associated with container materials and promote development of the aerial organs of oil palm seedlings. In the present study, water was supplied for cell growth and maintenance, contributing to optimal varietal development (26).

Stipe diameter has been used as a morphological indicator of seedling quality and may be associated with nutrient status and root development. In the present study, stipe diameter differed among treatments, but nutrient uptake was not directly measured. Producing plants using this method requires careful agronomic management, particularly management of the container itself. In coffee, Herrera (27) estimated that there were no differences among tube or cone-container and bag treatments for plant height and

stem thickness, although cone containers were proposed to reduce growth time, transportation and transplanting costs, allow reuse, and improve the benefit–cost ratio. In oil palm, this approach may contribute to increasing the number of plants per unit area, improving labor and input efficiency, and minimizing risks associated with climatic variations that affect the crop (28).

CONCLUSIONS

Under the conditions evaluated, seedlings produced in tube containers showed greater plant height and number of leaves at the end of the 180-day nursery period. T3 (Compacta × Ghana in tube containers) recorded the greatest plant height, whereas T1 (Deli × Compacta in tube containers) recorded the highest number of leaves. Stipe diameter was highest in T1 and T2, both involving Deli × Compacta. These findings indicate that container type and genetic material both contributed to differences in seedling growth. The results support further evaluation of tube containers as a nursery production option. However, economic performance and post-transplant survival were not evaluated in this study and should be addressed in future experiments before recommending one container system for commercial field establishment.

REFERENCES

1. European Palm Oil Alliance. Historia del aceite de palma. EPOA. 2017. Países bajos.
2. Bastidas-Pérez, S., Peña-Rojas, E., & Reyes-Cuesta, R. Palma de aceite *Elaeis guineensis* Jacq., palma Noli *Elaeis oleifera* (Kunth) Cortés y los híbridos interespecíficos Noli x Palma de aceite (*E. oleifera* x *E. guineensis*). 2013. Corporación Colombiana de Investigación Agropecuaria. Colombia.
3. Sierra-Márquez, J., Sierra-Márquez, L., & Olivero-Verbel, J. Potencial económico de la palma aceitera (*Elaeis guineensis* Jacq.). *Agronomía Mesoamericana*, 2017;28(2):523-534.
4. Producción Agrícola Mundial. Producción mundial aceite de palma 2022/2023/. [En línea]. 2023. Colombia.
5. United States Department of Agriculture. Palm Oil Explorer 2023. Foreign Agricultural Service. 2023. USDA.
6. Gesteiro, E., Galera-Gordo, J., & González-Gross, M. Aceite de palma y salud cardiovascular: consideraciones para valorar la literatura. *Nutrición Hospitalaria*, 2018;35(5):1229-1242. Doi:10.20960/nh.1970
7. Industrializadora Oleofinos. Aceite de Palma RBD. Productos, 2022. OLEOFINOS. México.
8. Consejo Mexicano para el Desarrollo de Palma de Aceite. Estadísticas Mundiales y Nacionales de Aceite de Palma 2020. 2021. COMEXPALMA, México.
9. Isaac-Márquez, R., Sima-Bojórquez, G. E., & Ayala-Arcipreste, M. E. Palma de aceite, reconversión productiva y respuestas campesinas en el uso del suelo. *Tropical and Subtropical Agroecosystems*, 2021;24(51):1-17
10. Ruíz-Romero, R., De la Peña, M., & Romero, H. M. Metodología para evaluar en etapa de vivero la respuesta al déficit hídrico y nutrición de plántulas de *Elaeis guineensis* y de híbridos interespecíficos OxG. *Ceniavances*, 2023;(196):7-7.
11. Agricultural Services & Development. Establecimiento y manejo de viveros de palma aceitera. 2021. ASD Costa Rica.
12. Kouame, N., Beugre-Manehonon, M., Koffi-Ahebe, M. H., Kouassi-N'dri, J., Assidjo-Nogbou, E., & Yatty-Kouadio, J. Comparative Study of the Germination Power and Growth in the Nursery of Two Varieties of Oil Palm in Grand-Lahou (Côte d'Ivoire). *International Journal of Agriculture and Biological Sciences*, 2021;82-92.
13. Adileksana, C., Yudono, P., Heru-Purwanto, B., & Bambang-Wijoyo, R. The Growth Performance of Oil Palm Seedlings in Pre-Nursery and Main Nursery Stages as a Response to the Substitution of NPK Compound Fertilizer and Organic Fertilizer. *Journal of Sustainable Agriculture*, 2020;35(1):89-97.
14. Furcal-Beriguete, P., Robles-Argüello, Z., & Salazar-Díaz, R. Condición nutricional de cultivos en sistemas de producción agroforestal con Palma Africana (*Elaeis guineensis* Jacq.). *Revista Tecnología En Marcha*, 2023;36(2):75–85. doi:10.18845/tm.v36i2.5902
15. Guzmán-Campos, F., Aguirre-Medina, J. F., Villalobos-Villalobos, V., Espinosa-Zaragoza, S., & Aguirre-Cadena, J. F. Estimación de Biomasa y Carbono en *Elaeis guineensis* Jacq. en dos suelos contrastantes de la Planicie Costera de Chiapas. *Tropical and Subtropical Agroecosystems*, 2021;24(12):1-12. <https://www.revista.coba.uady.mx/ojs/index.php/TSA/article/download/3390/1528>
16. Instituto Nacional de Estadística y Geografía. Información por entidad, Clima. 2022. INEGI.
17. Agricultural Services & Development. Guía de variedades. 2015. ASD Costa Rica.

18. Moreno-Echeverry, D., Quiroga, I. A., Balaguera-López, H. E., & Magnitskiy, S. El estrés por boro afecta la fotosíntesis y el metabolismo de pigmentos en plantas. Una revisión. Revista colombiana de ciencias hortícolas, 2016;10(1):137-148.
19. Gremial de Palmicultores de Guatemala. Parámetros de crecimiento: una herramienta objetiva para la gestión de la productividad. Boletín técnico, 2017;3(11). GREPALMA.
20. Purnama, H., & Afrillah, M. Growth Analysis of Seeds Oil Palm on Stage Pre Nursery and Main Nursery at PT. Socfindo. Devotion: Journal of Research and Community Service, 2022;3(5):251-257.
21. Suryanto, T., Wachjar, A., & Supijatno. The Growth of Oil Palm (*Elaeis guineensis* Jacq.) Seedlings at Various Media and Containers in Double Stage Nursery. Asian Journal of Applied Sciences, 2015;3(5):664-671.
22. Cobas-López, M., Sotolongo-Sospedra, R., & Almora-Ramos, Y. Comportamiento de los parámetros morfológicos de calidad de la planta de *Lysiloma sabicu* Benth. en vivero sobre sustratos orgánicos. Revista Cubana de Ciencias Forestales, 2020;8(3):550-561
23. Madrigal-Valverde, A., & Garbanzo-León, G. Uso e residuos agroindustriales en previveros de palma de aceite (*Elaeis guineensis*, Arecaceae): crecimiento y absorción de nutrientes. UNED Cuadernos de Investigación, 2018;10(2):257-266.
24. Mashani-Ahmad, S., Syamsina-Saari, I., Arshad, F., Ismail, A., Mohamed-Salleh, K., & Shahrin-Rahami, M. Factors Influencing The Level Of Acceptance Of Code Of Good Nursery Practice For Oil Palm Nurseries (Copn) Amongst Oil Palm Nursery Operators. Journal Of Sustainability Science And Management, 2022;17(1):177-186. [doi:10.46754/jssm.2022.01.011](https://doi.org/10.46754/jssm.2022.01.011)
25. Ibarra-Rurales, L. N. & Reyes-Cuesta, R. Crecimiento en vivero de las palmas aceiteras *Elaeis oleífera* x *Elaeis guineensis* y *Elaeis guineensis* x *Elaeis guineensis* en Tumaco Colombia Corpoica. Ciencia y Tecnología Agropecuaria, 2015;16(2):239-250.
26. Radin, R., Abu Bakar, R., Ishak, C. F., Ahmad, S. H., & Tsong, L. C. Biochar-compost mixture as amendment for improvement of polybag-growing media and oil palm seedlings at main nursery stage. International Journal of Recycling of Organic Waste in Agriculture, 2018;7(1):11-23.
27. Herrera, J., García, H., & Ure, L. Comportamiento de Plantas de café en Bolsas y Tubetes. Estado Lara. Venezuela. Conocimiento Libre y Licenciamiento, 2015;6(9):132-139.
28. Chaves-Vargas, H., Peraza-Padilla, W., & Sancho-Barrantes, E. Coffee seedlings produced in tubes with different substrates, in Sabanilla de Alajuela, Costa Rica. Perspectivas rurales, 2020;18(35):78-96.

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