

MORPHOLOGICAL RESPONSE OF OIL PALM (*ELAEIS GUINEENSIS* JACQ.) IN SOCFINDO DXP YANGAMBI (Y) SEEDS AGAINST SALINITY STRESS AT THE PRE NURSERY STAGE

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Abstract

Salinity stress is one of the environmental factors that can affect the growth and development of oil palm, particularly during the nursery stage. This study aimed to evaluate the morphological responses of oil palm (*Elaeis guineensis* Jacq.) seedlings of the Socfindo DXP Yangambi (Y) variety to different salinity levels during the *pre nursery* stage. The experiment was conducted in the greenhouse and laboratory of the Indonesian Oil Palm Institute of Technology (ITSI), Medan, using a Randomized Block Design with one factor consisting of three salinity treatments, namely S0 (0 mmhos), S1 (5–6 mmhos), and S2 (6–7 mmhos), with three replications. The observed parameters included plant height, stem diameter, number of leaves, chlorophyll content, root volume, shoot volume, root length, shoot length, root fresh weight, shoot fresh weight, root dry weight, and shoot dry weight. The results showed that salinity treatment had no significant effect on plant height, stem diameter, number of leaves, chlorophyll content, shoot volume, root length, shoot length, root fresh weight, shoot fresh weight, root dry weight, and shoot dry weight. However, salinity significantly affected root volume, with the highest value obtained under the S1 treatment (5–6 mmhos), reaching 0.67 cm³. The results indicate that oil palm seedlings of the Socfindo DXP Yangambi (Y) variety possess good adaptability to salinity stress up to 7 mmhos during the *pre nursery* stage.

Keywords: morphology, oil palm seedlings, pre nursery, salinity, Socfindo DXP Yangambi.

INTRODUCTION

Oil palm (*Elaeis guineensis* Jacq.) is one of the strategic plantation commodities that makes a big contribution to Indonesia's economy. Its high productivity and ability to produce vegetable oil make Indonesia the largest producer and exporter of palm oil in the world. In 2023, the area of Indonesia's palm oil plantations reached 16.83 million hectares with a palm oil production of 46.99 million tons, making this sector important for supplying raw materials to the food, cosmetics, pharmaceutical, and renewable energy industries (Oil World, 2022; Dataloka, 2024). Besides earning foreign exchange, the palm oil industry also contributes to job creation and rural economic development (Corley and Tinker, 2016).

The productivity of oil palm plants is influenced by various environmental factors, one of which is salinity stress. Salinity is the condition of high accumulation of dissolved salts in the soil, which can hinder the absorption of water and nutrients, thus affecting plant growth (Isayenkov and Maathuis, 2019). This condition is often found in coastal areas due to seawater intrusion or dissolution of salts in the soil (Kim et al., 2016). The National Research and Innovation Agency reported that around one million hectares of farmland in Indonesia have been affected by salinity, while about 12.02 million hectares of Indonesia's land area are considered vulnerable to salt intrusion (Karolinoerita and Annisa, 2020). Salt stress can reduce the rate of photosynthesis, slow down growth, and decrease the accumulation of plant biomass (Acosta-Motos et al., 2017; Hasanuzzaman et al., 2022).

MORPHOLOGICAL RESPONSE OF OIL PALM (*ELAEIS GUINEENSIS* JACQ.) IN SOCFINDO DXP YANGAMBI (Y) SEEDS AGAINST SALINITY STRESS AT THE PRE NURSERY STAGE

Fadly Himawan et al

The nursery stage, especially the pre-nursery, is a critical phase that determines the growth quality of oil palm plants in the next stage. Seedlings that grow optimally in the early stage will produce more vigorous and productive plants in the field (Lubis, 2013). However, information about the response of Socfindo DXP Yangambi (Y) oil palm seedlings to salinity stress is still limited. Therefore, research on the morphological response of oil palm seedlings in the pre-nursery stage to various salinity levels needs to be carried out as a basis for developing oil palms on marginal lands and areas that have the potential for salt intrusion.

RESEARCH METHOD

The research was conducted in the laboratory and greenhouse of the Indonesian Oil Palm Technology Institute (ITSI) in Medan, from July to September 2025. The plant materials used were 81 oil palm seedlings of the Socfindo DXP Yangambi (Y) variety in the pre-nursery phase. The growing medium used was topsoil and compost, placed in 15 × 20 cm polybags. The study used a one-factor Randomized Block Design (RBD) with three levels of salinity treatments, namely S₀ = 0 mmhos NaCl (control), S₁ = 5–6 mmhos NaCl, and S₂ = 6–7 mmhos NaCl. Each treatment was repeated three times, resulting in nine experimental units.

Salinity treatment was applied by watering with a NaCl solution for eight weeks. The parameters observed included plant height, stem base diameter, number of leaves, leaf chlorophyll content, root length, shoot length, root volume, shoot volume, fresh root weight, fresh shoot weight, dry root weight, and dry shoot weight. The observation data were analyzed using analysis of variance (ANOVA) at a 95% confidence level. If there were significant differences, the testing continued with Duncan's Multiple Range Test (DMRT) at the 5% level. All data analyses were done using SPSS software.

Material

The materials used in this study included 81 zero-month-old Socfindo DXP Yangambi (Y) oil palm seedlings, NaCl solutions with salinity levels of 0 mmhos (control), 5–6 mmhos, and 6–7 mmhos, topsoil as the planting medium, compost, 15 × 20 cm polybags, and basic fertilizers such as urea and NPK.

Tool

The tools used include a hoe, watering can, sieve, machete, measuring cup, bucket, tape measure, rope, oven, digital caliper, electrical conductivity meter (EC meter), digital chlorophyll meter (SPAD), spectrophotometer, digital scale, and hand sprayer.

RESULTS AND DISCUSSION

Plant Height

The results of plant height observations (cm) can be seen in Table 1.

Table 1. Height of oil palm seedlings (cm) at 1–8 WAP

Observation Time	Treatment		
	S ₀	S ₁	S ₂
WAP 1	9.37	9.50	9.63
WAP 2	11.94	12.11	12.96
WAP 3	15.33	15.76	16.54
WAP 4	18.73	18.84	19.52
WAP 5	20.9	20.86	21.32
WAP 6	21.64	22.6	22.88
WAP 7	24.71	25.35	25.54
WAP 8	27.1	28.86	28.31

Note: Based on the results of variance analysis, salinity treatment did not have a significant effect on the plant height observed at the 5% level.

Table 1 shows that the height of oil palm seedlings increased across all treatments during the observation period. At the end of the observation, the plant height in treatment S₀ reached 27.10 cm, while treatments S₁ and S₂ reached 28.86 cm and 28.31 cm, respectively. The analysis of variance results showed that salinity stress treatment did not have a significant effect ($P > 0.05$) on the height of Socfindo DXP Yangambi (Y) oil palm seedlings. In fact, salinity treatment didn't really affect plant height, indicating that salinity levels of 5–7 mmhos can still be tolerated by oil palm seedlings in the pre-nursery phase. This condition is thought to be due to the

MORPHOLOGICAL RESPONSE OF OIL PALM (*ELAEIS GUINEENSIS* JACQ.) IN SOCFINDO DXP YANGAMBI (Y) SEEDS AGAINST SALINITY STRESS AT THE PRE NURSERY STAGE

Fadly Himawan et al

plant's ability to maintain osmotic balance and metabolic activity, so cell division and elongation can still occur normally. Plants that can maintain water and nutrient uptake under salty conditions generally don't show a significant drop in growth. The results of this study are in line with Firmansyah's (2018) research, which reported that oil palm seedlings are still able to maintain vegetative growth under certain stress levels. Isayenkov and Maathuis (2019) also stated that a plant's response to salinity is influenced by its ability to maintain ion balance and osmotic pressure within cells. Therefore, salinity up to 7 mmhos has not negatively affected the height growth of Socfindo Dxp Yangambi (Y) oil palm seedlings during the pre-nursery phase.

Stem Diameter

The observations of stem diameter (mm) can be seen in Table 2.

Table 2. Base stem diameter of oil palm seedlings (mm) at age 1–8 WAP

Observation Time	Treatment		
	S ₀	S ₁	S ₂
WAP 1	4.27	3.76	3.98
WAP 2	4.29	4.04	3.85
WAP 3	4.97	4.51	4.42
WAP 4	5.32	4.86	4.87
WAP 5	5.91	5.7	5.86
WAP 6	6.56	6.24	6.26
WAP 7	7.19	7.04	6.84
WAP 8	7.66	7.53	7.30

Note: Based on the results of variance analysis, salinity treatment did not have a significant effect on the plant height observed at the 5% level.

Table 2 shows that the base diameter of the oil palm seedlings increased across all treatments over the eight-week observation period. At the end of the observation, the highest base diameter was found in the S₀ treatment at 7.66 mm, followed by the S₁ treatment at 7.53 mm and the S₂ treatment at 7.30 mm. The analysis of variance results showed that the salinity stress treatment did not have a significant effect ($P > 0.05$) on the base diameter of Socfindo Dxp Yangambi (Y) oil palm seedlings.

It turns out that salinity treatment doesn't really affect the stem base diameter, which indicates that the level of salinity given is still tolerable for the plants in the pre-nursery phase. Stem diameter is one of the vegetative growth indicators influenced by cell division and enlargement activity as well as the accumulation of photosynthesis products. Under stress conditions that are still tolerable, plants can maintain osmotic balance so that water and nutrient uptake continues optimally. As a result, the process of forming stem tissue doesn't experience significant obstacles.

The results of this study are in line with Isayenkov and Maathuis (2021), who stated that plant responses to salinity stress are greatly influenced by the level of stress and the plant's ability to maintain ion homeostasis in its tissues. In addition, Alam et al. (2021) reported that plants with salinity tolerance can still maintain normal vegetative growth at moderate salinity levels. Therefore, applying salinity up to 7 mmhos has not caused a decrease in the basal stem diameter growth of Socfindo Dxp Yangambi (Y) oil palm seedlings during the pre-nursery phase.

Number of Leaves (Sheets)

The results of the observation of the number of leaves (sheets) can be seen in Table 3.
Table 3. Number of leaves of oil palm seedlings (sheets) at the age of 1–8 MST

MORPHOLOGICAL RESPONSE OF OIL PALM (*ELAEIS GUINEENSIS* JACQ.) IN SOCFINDO DXP YANGAMBI (Y) SEEDS AGAINST SALINITY STRESS AT THE PRE NURSERY STAGE

Fadly Himawan et al

Observation Time	Treatment		
	S ₀	S ₁	S ₂
WAP 1	1.93	1.74	1.87
WAP 2	2.04	2.04	2.07
WAP 3	2.44	2.37	2.48
WAP 4	2.59	2.59	2.78
WAP 5	2.14	2.05	2.14
WAP 6	3.19	3.15	2.96
WAP 7	3.52	3.56	3.37
WAP 8	3.85	3.93	3.85

Note: Based on the results of variance analysis, salinity treatment did not have a significant effect on the plant height observed at the 5% level.

Table 3 shows that the number of leaves on oil palm seedlings kept increasing throughout the observation period across all treatments. At the end of the observation, the highest number of leaves was found in the S1 treatment with 3.93 leaves, while the S0 and S2 treatments produced 3.85 leaves each. The analysis of variance results showed that the salinity stress treatment did not have a significant effect ($P>0.05$) on the number of leaves of the Socfindo DXP Yangambi (Y) oil palm seedlings. Apparently, salinity treatment didn't affect the number of leaves, showing that the salinity level given is still tolerable for oil palm seedlings in the pre-nursery phase. Leaf formation is the result of shoot meristem activity, which is influenced by water availability, nutrients, and photosynthesis. Under stress conditions that are still within the tolerable range, plants can maintain physiological activity, so new leaf formation continues normally.

The results of this study are in line with Firmansyah (2018), who reported that salinity stress at certain levels has not been able to significantly reduce the vegetative growth of oil palm seedlings. Zribi et al. (2023) also stated that plants that can maintain leaf formation under saline conditions show good physiological adaptation mechanisms to environmental stress. Moreover, Isayenkov and Maathuis (2021) explained that a plant's ability to maintain ion balance and osmotic pressure plays an important role in sustaining the growth of vegetative organs. Thus, giving salinity up to 7 mmhos hasn't negatively affected the formation of leaf numbers in Socfindo DXP Yangambi (Y) oil palm seedlings during the pre-nursery phase. This indicates that the variety has a pretty good ability to adapt to saline conditions in the early growth stage.

Leaf Chlorophyll Content

The results of observations on the chlorophyll content of oil palm seedling leaves (SPAD) at 4–8 WAP can be seen in Table 4.

Table 4. Chlorophyll content of oil palm seedling leaves (SPAD) at 4–8 WAP

Observation Time	Treatment		
	S ₀	S ₁	S ₂
WAP 4	42.9	40.4	44
WAP 5	47.21	46.04	46.01
WAP 6	50.1	50.2	49.4
WAP 7	51.5	51.4	50.6
WAP 8	53.4	54	52.9

Note: Based on the results of variance analysis, salinity treatment did not have a significant effect on the plant height observed at the 5% level.

Table 4 shows that the chlorophyll content in oil palm seedling leaves increased across all treatments during the observation period. By the end of the observation, the highest chlorophyll content was found in treatment S1 at 54.00 SPAD, followed by treatment S0 at 53.40 SPAD and treatment S2 at 52.90 SPAD. The analysis of variance results showed that salinity stress treatment had no significant effect ($P>0.05$) on the chlorophyll content of Socfindo DXP Yangambi (Y) oil palm seedling leaves. In fact, salinity treatment had no effect on chlorophyll content, indicating that the level of salinity applied was still within a range that oil palm seedlings can tolerate. Chlorophyll content is an important indicator that reflects the plant's ability to maintain photosynthetic activity.

MORPHOLOGICAL RESPONSE OF OIL PALM (*ELAEIS GUINEENSIS* JACQ.) IN SOCFINDO DXP YANGAMBI (Y) SEEDS AGAINST SALINITY STRESS AT THE PRE NURSERY STAGE

Fadly Himawan et al

Under stress conditions that are still tolerable, plants can maintain ion balance within their cells, which helps minimize chlorophyll degradation and allows photosynthesis to continue normally. The results of this study are in line with Zribi et al. (2023), who stated that plants with tolerance to salinity can maintain chlorophyll content so that photosynthetic activity does not experience significant disturbance. Isayenkov and Maathuis (2021) also explained that a plant's ability to maintain ion homeostasis is one of the important mechanisms to reduce damage to the photosynthetic system caused by salinity stress. In addition, Hasanuzzaman et al. (2022) reported that plants that can maintain chlorophyll content under saline conditions generally can still sustain normal vegetative growth. Thus, providing salinity up to 7 mmhos has not caused a decrease in the leaf chlorophyll content of Socfindo DXP Yangambi (Y) oil palm seedlings in the pre-nursery phase, so the plant's physiological functions, especially the photosynthesis process, can still run well.

Final Morphology of Oil Palm Seedlings After Uprooting

The results of the final morphological observation of oil palm seedlings after being dug up can be seen in Table 5.

Table 5. Final morphological parameters of oil palm seedlings after being dug up

Observation Parameters	S0	S1	S2
Root volume (cm ³)	0.34 _a	0.67 _b	0.55 _b
Header volume (cm ³)	5.67	6.22	5.50
Dry root weight (g)	0.19	0.22	0.19
Canopy dry weight (g)	0.82	0.80	0.74
Root length (cm)	21.16	19.36	22.87
Title Length (cm)	27.67	27.94	28.97
Wet root weight (g)	0.82	0.74	0.79
Wet weight of the canopy (g)	3.99	3.50	3.44

Note: Numbers followed by the same letter in the same row indicate no significant difference according to the 5% DMRT test.

Table 5 shows that salinity treatment had a significant effect on root volume, while other morphological parameters, such as shoot volume, root length, shoot length, fresh root weight, fresh shoot weight, dry root weight, and dry shoot weight, did not show significant differences ($P > 0.05$). The highest root volume was found in treatment S1 (5–6 mmhos) at 0.67 cm³, followed by treatment S2 (6–7 mmhos) at 0.55 cm³, while the lowest root volume was observed in the control treatment at 0.34 cm³. These results indicate that moderate salinity stress can still stimulate root system development as a plant adaptation mechanism to improve water and nutrient uptake. According to Atta et al. (2023), plants experiencing mild to moderate salinity stress generally increase root growth to maintain water balance within plant tissues. The canopy volume across all treatments shows relatively uniform values, ranging from 5.50–6.22 cm³. Salinity treatments had no real effect on canopy volume, indicating that the development of the above-ground vegetative parts is still going on normally. This suggests that the salinity levels applied were not high enough to hinder the formation of leaves and leaf sheaths, which are important for photosynthesis. Chowdhury et al. (2021) stated that plants still able to maintain canopy growth under saline conditions indicate that the plant's physiological activities have not experienced significant disruption.

Root length and shoot length also didn't show any significant differences between treatments. The longest roots were found in the S2 treatment at 22.87 cm, while the longest shoots were also in the same treatment at 28.97 cm. The lack of noticeable differences in these two parameters shows that oil palm seedlings are still able to maintain the growth of both their below-ground and above-ground organs even under saline stress conditions. According to Wagino, Tarigan, and Eka Bobby Febrianto (2018), the root length growth and vegetative development of oil palm seedlings are highly influenced by the plant's ability to utilize the available water and nutrients. Plants that can still maintain their physiological balance tend not to experience a significant decline in growth due to environmental stress.

The fresh weight of roots and the fresh weight of shoots across all treatments also showed relatively uniform values. The fresh weight of roots ranged from 0.74–0.82 g, while the fresh weight of shoots ranged from 3.44–3.99 g. This uniformity suggests that the plants are still doing well at absorbing and retaining water in their tissues. Hasanuzzaman et al. (2022) explained that salinity stress that hasn't exceeded the plant's tolerance usually doesn't significantly hinder water uptake, so the water content in plant tissues can still be maintained.

MORPHOLOGICAL RESPONSE OF OIL PALM (*ELAEIS GUINEENSIS* JACQ.) IN SOCFINDO DXP YANGAMBI (Y) SEEDS AGAINST SALINITY STRESS AT THE PRE NURSERY STAGE

Fadly Himawan et al

The same thing can be seen in the dry weight of roots and shoots, which did not show any significant differences between treatments. Root dry weight ranged from 0.19–0.22 g, while shoot dry weight ranged from 0.74–0.82 g. The lack of effect of salinity treatment on these parameters indicates that the process of biomass accumulation from photosynthesis is still occurring normally. According to Mahmud et al. (2022), plants that can maintain biomass formation under saline conditions show that the process of photosynthesis and the distribution of photosynthates to various plant organs is still functioning well. Therefore, salinity up to 7 mmhos has not had a significant impact on the morphological growth of Socfindo Dxp Yangambi (Y) oil palm seedlings during the pre-nursery phase, except for root volume, which shows an adaptive response to salinity stress conditions. Besides that, Eka Bobby Febrianto et al. (2020) stated that the morphological characteristics of oil palm on saline media are largely influenced by the plant's ability to adapt in maintaining root growth and the plant's physiological balance. So, salinity up to 7 mmhos hasn't had a significant impact on most morphological parameters of Socfindo Dxp Yangambi (Y) oil palm seedlings, except for root volume, which shows an adaptive response to salinity stress.

CONCLUSION

Salinity stress treatments in the pre-nursery phase generally do not have a significant effect on plant height, stem base diameter, number of leaves, chlorophyll content, canopy volume, root length, shoot length, fresh root weight, fresh shoot weight, dry root weight, and dry shoot weight of Socfindo Dxp Yangambi (Y) oil palm seedlings. Salinity treatment only significantly affected root volume, with the highest value obtained in the S1 treatment (5–6 mmhos) at 0.67 cm³. The study results show that Socfindo Dxp Yangambi (Y) oil palm seedlings have a fairly good ability to adapt to salinity stress up to 7 mmhos during the pre-nursery phase.

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MORPHOLOGICAL RESPONSE OF OIL PALM (*ELAEIS GUINEENSIS* JACQ.) IN SOCFINDO DXP YANGAMBI (Y) SEEDS AGAINST SALINITY STRESS AT THE PRE NURSERY STAGE

Fadly Himawan et al

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