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Growth Response of Oil Palm (Elaeis guineensis Jacq.) DXP Socfindo LaMe Variety to Salinity Stress during the Pre-Nursery Stage

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Abstract

This study was designed to analyze the effects of salinity stress on the vegetative growth and adaptation of oil palm (*Elaeis guineensis*) seedlings of the DxP Socfindo LaMe variety during the pre-nursery phase. The experiment was conducted at the Laboratory and Greenhouse of the Indonesian Palm Oil Technology Institute from July to August 2025. Using a Randomized Block Design (RBD), three levels of salt concentration were tested: S0 (0 mmhos) as the control, S1 (NaCl 5-6 mmhos), and S2 (NaCl 6-7 mmhos), each with three replications. The parameters measured included plant height, stem diameter, number of leaves, chlorophyll content, biomass weight, and root structure. Data were analyzed using ANOVA and Duncan's Multiple Range Test (DMRT) at the 5% significance level. The results indicated that salt exposure elicited varying growth responses in the seedlings. Significant effects were observed at 8 weeks after planting (WAP) for plant height, at 9 and 11 WAP for leaf number, and at 11 WAP for chlorophyll concentration. Biomass and root system parameters exhibited significant to highly significant sensitivity. Interestingly, the S2 treatment (highest salt concentration) yielded the most optimal results for the majority of variables. These findings confirm that Socfindo LaMe DxP seedlings possess considerable tolerance to certain saline conditions, providing valuable insights for the plantation industry in utilizing marginal lands.

Keywords: Biomass, Chlorophyll, Physiological Adaptation, Roots, Plant Tolerance

1. Introduction

The oil palm (Elaeis guineensis) is a strategic plantation commodity in Indonesia that makes a significant contribution to the national economy, particularly as a source of foreign exchange and employment. Indonesia is the world's largest palm oil producer, with production steadily increasing each year. In addition to serving as a leading export commodity, oil palm also contributes to improving the welfare of farmers and communities in plantation areas. The success of oil palm cultivation is greatly influenced by the quality of the seeds used from the initial nursery stage (BPDPKS, 2025).

The nursery stage is a crucial phase in determining the quality of oil palm plants during the productive period. One of the initial stages of the nursery is the pre-nursery stage, which involves planting seedlings in small polybags for approximately 3 months before being transferred to the main nursery (Rahmawati & Susanto, 2022). During this phase, strict seedling selection is carried out to obtain healthy, uniform seedlings with optimal growth. Environmental factors such as planting medium, watering, drainage, and fertilization significantly influence seedling growth during the pre-nursery stage. The development of oil palm seedlings in the *pre-nursery stage* is highly sensitive to the quality of the substrate or planting medium used (Titiaryanti et al., 2021).

A common problem in oil palm cultivation in Indonesia is increasing soil salinity, particularly in coastal areas, tidal swamps, and marginal lands. Salinity can result from seawater intrusion or poor drainage, leading to salt accumulation in the soil. Saline conditions can cause osmotic stress and toxicity of Na^+ and Cl^- ions, which inhibit water and nutrient uptake by plant roots (Manurung, 2022). Consequently, physiological processes such as

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photosynthesis, cell division, and vegetative growth are disrupted. Research (Nurhermawati & Supena, 2023) shows that salinity conditions significantly reduce root growth and alter oil palm root morphology.

Salinity stress is a major limiting factor in oil palm cultivation on marginal land. This high sensitivity is caused by the plant's root system not yet fully developed, so exposure to extreme environmental conditions, such as high salt levels, can trigger reduced growth rates, inhibit leaf formation, and even reduce stem diameter (Wicaksono et al., 2023). Research (Avivi & Soeparjono, 2022) explains that water stress and nutrient imbalances in the pre-nursery phase significantly impact the early growth of oil palm seedlings.

In fact, varieties such as DxP Socfindo LaMe play an important role as high-quality commercial seeds due to their superior production capacity and vegetative growth (Azahra, 2023). However, information on the tolerance level of the DxP Socfindo LaMe variety to salinity stress in the pre-nursery phase is still very limited. So far, previous research mapping has been dominated by general themes such as growth media manipulation, mycorrhizal introduction, the role of plant growth regulators, and root morphological analysis (Duka, 2025). Investigations that specifically evaluate the tolerance level of the DxP Socfindo LaMe variety to salinity stress in the early nursery phase are still relatively rare.

Previous research by Firmansyah (2017) focused solely on changes in oil palm root morphology due to salinity and waterlogging, without examining the responses of specific varieties in the pre-nursery phase. Research by Titiaryanti et al. (2021) focused on the effects of growing media and tofu waste on oil palm seedling growth, while research by Febrianto et al. (2019) focused more on the use of natural and synthetic growth regulators in pre-nursery cultivation. Therefore, research on the effects of salinity stress on the growth of the DxP Socfindo LaMe variety during the pre-nursery period remains a research gap that warrants further study. The novelty of this research lies in the use of the DxP Socfindo LaMe variety as the research object and the focus of the study on the seedling growth response to salinity stress during the pre-nursery phase.

To fill this scientific gap, this study was conducted with the aim of analyzing the effects of salinity stress on the growth of DxP Socfindo LaMe seedlings in the *pre-nursery phase*. Other specific objectives were to measure the seedling tolerance index and identify the morphological parameters most susceptible to disturbance, including vegetative height, number of leaves, and stem circumference. The practical contribution of this study is expected to enrich the scientific knowledge related to oil palm nursery management in land with high salinity and serve as a guide in the expansion of marginal agricultural areas.

2. Material and Methods

This research is scheduled to take place from July to August 2025, located in the Greenhouse and Laboratory of the Indonesian Palm Oil Technology Institute (ITSI) Medan Campus. Geographically, this location is at coordinates ±3°35' N and 98°40' E with an elevation of ±25 meters above sea level (masl). The experimental design is a Randomized Block Design (RAK) that tests three levels of salinity: S0 (0 mmhos) serves as a control, S1 uses a 5–6 mmhos NaCl solution, and S2 uses a 6–7 mmhos NaCl solution. Each treatment unit tests 10 seed samples replicated in 3 replication groups, so that the total number of observed plants is 90 units. The additive linear pattern in this design is formulated through the equation:

$$\mathbf{Yijk = \mu + \pi i + \beta j + €ijk}$$

Information:
Yijk = observation value in the i-th treatment and j-th group
μ = general mean value
πi = effect of treatment i
βj = influence of the jth group
€ijk = experimental error

The observation data were analyzed using Analysis of Variance (ANOVA) at the 5% level and continued with Duncan's Multiple Range Test (DMRT) using the IBM SPSS Statistics application version 26.0 (Gomez & Gomez, 1984).

The supporting materials for this research include DxP PPKS Socfindo LaMe cultivar oil palm seedlings, NaCl compounds, topsoil, compost organic materials, 15 × 20 cm polybags, and nutrient intake in the form of urea and NPK fertilizers. Meanwhile, the instrumentation equipment prepared includes standard agricultural tools (hoes, shovels, watering cans, buckets) and high-precision measuring instruments: rulers, Krisbow brand digital calipers (capacity 0–150 mm, accuracy 0.01 mm), Camry digital scales (capacity 5 kg, accuracy 0.01 g), Minolta SPAD-502 Plus SPAD meter instruments to detect leaf chlorophyll levels, and Thermo Scientific Genesys 10S UV-Vis spectrophotometers to measure proline concentrations in plant tissue.

The study implementation process began with land clearing and growing media conditioning, filling polybags, planting seedlings, maintenance management (weed sanitation and routine watering), random sampling, introduction of salt stress (salinity), and measurement of morphological and physiological parameters. Observation variables collected included plant height, stem diameter, leaf quantity, root length and volume, proline and chlorophyll concentrations, and plant biomass in the form of fresh weight and dry weight of the canopy. Evaluations were conducted periodically throughout the *pre-nursery stage* and into the final phase of the study to identify the adaptation patterns of oil palm seedlings to salinity stress (Taiz et al., 2015).

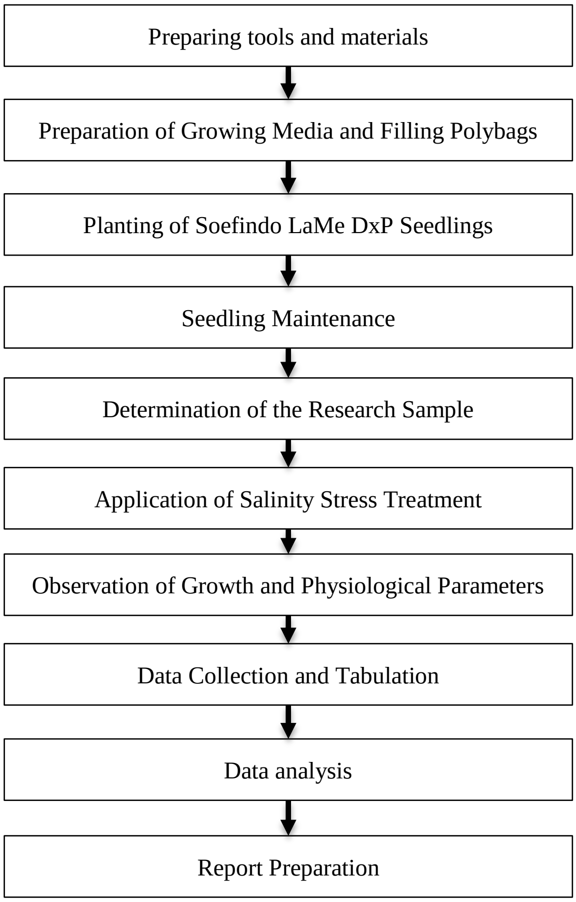

Figure 1. Research flow diagram

3. Results and Discussion

The results of the analysis of variance (ANOVA) showed that the application of NaCl irrigation had a significantly different effect on the height of oil palm seedlings. To assess the significance of performance differences among the treatment groups, the evaluation continued with Duncan's Multiple Range Test (DMRT) at the 5% confidence level.

Based on the research results in Table 1, the development of vegetative height of oil palm seedlings shows a graph that continues to climb in all treatments from the 5th week to the 12th week after planting (WAP). The S2 salinity group achieves the highest value for this plant height indicator. At the final observation (12 WAP), the height of seedlings in the S2 treatment reached 26.37 cm, superior to the S1 treatment, which was 24.89 cm and the control group (S0), which was only around 23.98 cm. Thus, the application of S2 provides a height advantage of 2.39 cm, equivalent to an acceleration of 9.96% above the control.

The results of the analysis of variance showed that the effect of NaCl administration was significant only at 8 weeks after planting; no statistically significant differences were observed at other stages. This indicates that oil palm's sensitivity to saline stress varies with plant growth chronology. There are certain stages in which plants become highly sensitive to disturbances in the osmotic pressure of the medium due to the high salt concentration in the root zone (Estate, 2020).

Figure 1 shows that the growth curve for treatment S2 tended to be higher than the other treatments, especially in the mid- to late-stage observations. This indicates that salinity levels of 6–7 mmHg are still within the tolerance limits of oil palm seedlings, allowing the plants to maintain physiological activity and vegetative growth.

The results of this study differ from those of Patitis (2025) on oil palms treated with high salinity and flooding. The study showed that increasing salinity consistently reduced oil palm growth, including plant height and root development. The study explained that high salinity disrupted water absorption due to high osmotic pressure, thus inhibiting plant growth.

The difference in research results is thought to be due to varying levels of salinity stress. In this study, the salinity concentration used was within the tolerance level of oil palm seedlings, thus not causing severe physiological damage. In contrast, research (Firmansyah, 2017) using a combination of high salinity and flooding, which causes double stress, shows that plant growth declines more.

Research (Avivi & Soeparjono, 2022) showed that oil palm seedlings grew 18.44 cm in optimum media conditions with a 70% water content. The results of this study showed that plant height reached 26.37 cm in the S2 treatment, indicating that the seedlings were still able to grow well even in moderate salinity conditions.

The increase in plant height in the S2 treatment is thought to be related to the plants' ability to adjust osmotically, thus maintaining cell turgor pressure. This allows for normal cell division and elongation. Furthermore, nitrogen in the growing medium plays a crucial role in the formation of chlorophyll and proteins, which support vegetative plant growth.

Table 1. Average Height of Oil Palm Seedlings (cm) at 5–12 WAP

Treatment	Average Plant Height (MST) Observation							
	5	6	7	8	9	10	11	12
S0	10.04 ± 0.15 a	11.63 ± 0.20	14.97 ± 0.51 a	17.42 ± 0.31	19.13 ± 0.32	19.13 ± 0.32 a	22.34 ± 0.48 a	23.98 ± 0.14 a
S1	9.81 ± 0.21 a	12.53 ± 0.32	15.69 ± 0.37 a	18.12 ± 0.38	19.18 ± 0.37	19.18 ± 0.30 a	23.78 ± 0.50 a	24.89 ± 3.15 a
S2	10.09 ± 0.22 a	12.70 ± 0.29	15.70 ± 0.30	18.27 ± 0.36	19.61 ± 0.40	19.61 ± 0.42 a	24.86 ± 0.52 a	26.37 ± 0.13 a

Description: Numbers followed by different letters in the same column indicate a significant difference in the 5% DMRT test.

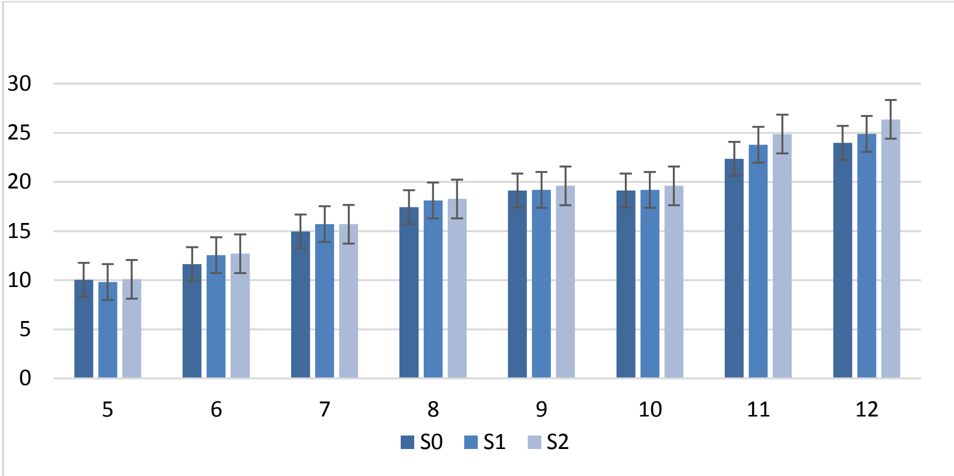

Figure 1. Average Height of Seedling Plants *of Oil P*alm with salinity application of 5 to 12 MST

Figure 2. Plant Height

Table 2. Average Stem Base Diameter (mm) at 5–12 WAP

Treatment	Observation of the Average Diameter of Plant Stumps (MST)							
	5	6	7	8	9	10	11	12
S0	4.48 ± 0.15 a	5.19 ± 0.16 a	5.56 ± 0.17 a	6.04 ± 0.19 a	6.36 ± 0.16 a	6.61 ± 0.15 a	7.41 ± 0.14 a	8.16 ± 0.31 a
S1	4.54 ± 0.15 a	4.94 ± 0.19 a	6.07 ± 0.16 b	6.49 ± 0.17 b	6.36 ± 0.15 a	7.22 ± 0.13 b	7.98 ± 0.12 a	8.61 ± 3.15 a
S2	5.00 ± 0.13 a	5.59 ± 0.19 a	6.33 ± 0.20 c	6.72 ± 0.20 c	7.39 ± 0.17 b	7.42 ± 0.16 c	8.26 ± 0.15 b	8.85 ± 0.13 a

Description: Numbers followed by different letters in the same column indicate a significant difference in the 5% DMRT test.

Based on the research results in Table 2, it is known that the stem base diameter increased in all treatments during the observation period. Treatment S2 produced the highest stem base diameter, at 8.85 mm at 12 weeks after planting, compared with 8.61 mm for treatment S1 and 8.16 mm for the control. Thus, treatment S2 increased stem diameter by 0.69 mm, or approximately 8.45%, compared to the control.

DMRT test results showed a significant effect at several observation ages, namely 7, 8, 9, 10, and 11 WAP. This indicates that stem diameter is more sensitive to environmental changes than plant height.

Figure 2 shows that treatment S2 produced a larger stem diameter than the other treatments. This indicates that the plants were still able to maintain stem cell enlargement activity even under certain salinity conditions.

The results of this study are in line with research (Idris et al., 2020) that shows oil palm plants can maintain root and stem growth under certain salinity conditions through morphological adaptation mechanisms. The study explains that plants develop physiological adaptations to reduce the negative effects of Na^+ and Cl^- ions on plant tissue.

However, Firmansyah's research also states that continuous high salinity can cause a decrease in stem diameter growth due to disruption of the ion balance within plant cells. Excessive Na^+ ions can inhibit the absorption of essential elements such as K^+ and Ca^{2+}, which are essential for plant tissue formation. Leaf number is an important indicator of photosynthesis and plant growth. Leaf number increases with plant growth, as shown in Table 3.

The number of oil palm seedling leaves increased gradually across all treatments throughout the study period. Treatment S2 produced the highest number of leaves at 12 weeks after planting (WAP), with 3.93, compared to 3.90 for treatment S1 and 3.63 for the control. Treatment S2 increased the number of leaves by 0.30, or approximately 8.26%, compared to the control.

The analysis results showed that salinity treatment had a significant effect at 9 and 11 weeks post-planting (WAP). This indicates that this phase is the active phase of leaf formation, making the plants more responsive to environmental changes.

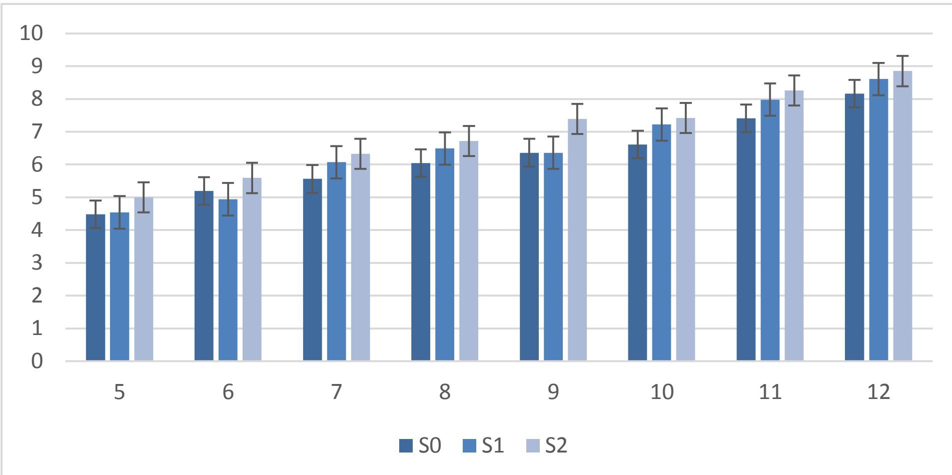

Figure 3. Stem Base Diameter (mm)

Figure 4. Plant stump

Table 3. Average Number of Leaves (strands)

Treatment	Observation of the Average Number of Plant Leaves (MST)							
	5	6	7	8	9	10	11	12
S0	2.00 ± 0 a	2.00 ± 0 a	2.60 ± 0.09 a	2.87 ± 0.04 a	3.00 ± 0 a	3.00 ± 0 a	3.63 ± 0.08 a	3.63 ± 0.08 a
S1	2.00 ± 0 a	2.00 ± 0 a	2.87 ± 0.06 a	2.93 ± 0.04 a	2.93 ± 0 a	3.00 ± 0 a	3.90 ± 0.05 b	3.90 ± 0.05 a
S2	2.03 ± 0.03 a	2.03 ± 0.03 a	2.83 ± 0.07 a	3.03 ± 0.03 a	3.03 ± 0.07 b	3.17 ± 0.07 b	3.93 ± 0.04 c	3.93 ± 0.04 a

Description: Numbers followed by different letters in the same column indicate a significant difference in the 5% DMRT test.

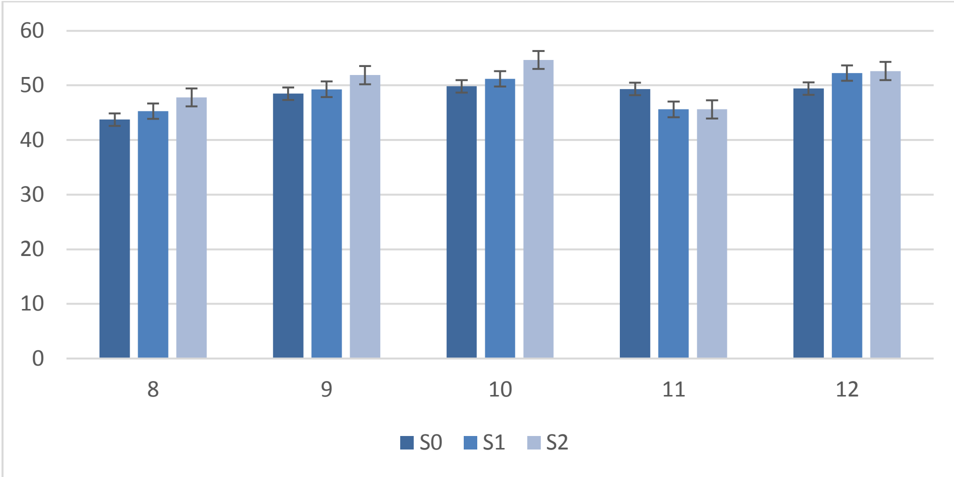

Figure 5. Number of Leaves

Figure 3 shows that treatment S2 produced the highest number of leaves. This indicates that the plants are still capable of photosynthesis even under moderate salinity conditions.

The results of this study differ from those of Setiowati et al. (2021), which showed that high salinity causes a decrease in leaf number due to disruption of plant physiological processes. The study stated that increased salt levels cause osmotic stress in plants, inhibiting leaf formation.

Research on the effect of NaCl on plant growth by Mardhiansyah et al. (2024) also showed that increasing NaCl concentration caused a decrease in the number of leaves and dry weight of plants due to disruption of cell metabolism.

The increase in the number of leaves in the S2 treatment indicates that the salinity level given has not reached the toxic limit for oil palm seedlings, so that photosynthesis activity can still take place optimally. The chlorophyll content of leaves shows variations in values between treatments as presented in Table 4 below

Figure 6. Leaf Blade of a Plant

Table 4. Chlorophyll Content (SPAD)

Treatment	Observation of the Average Chlorophyll Content of Plant Leaves (MST)				
	8	9	10	11	12
S0	43.74 ± 0.81 a	48.48 ± 0.81 a	49.83 ± 081 a	49.34 ± 0.82 a	49.42 ± 1.10 a
S1	45.27 ± 0.99 a	49.28 ± 0.78 a	51.19 ± 1.86 a	45.61 ± 0.61 b	52.26 ± 0.85 b
S2	47.79 ± 1.01 b	51.88 ± 0.81 a	54.64 ± 2.01 b	48.93 ± 0.99 b	52.62 ± 1.85 b

Description: Numbers followed by different letters in the same column indicate a significant difference in the 5% DMRT test.

Leaf chlorophyll content increased across all treatments during the observation period. Treatment S2 produced the highest chlorophyll content, at 52.62 SPAD, compared to 49.42 SPAD for the control treatment. This represents an increase of 3.20 SPAD, or approximately 6.47%, compared to the control.

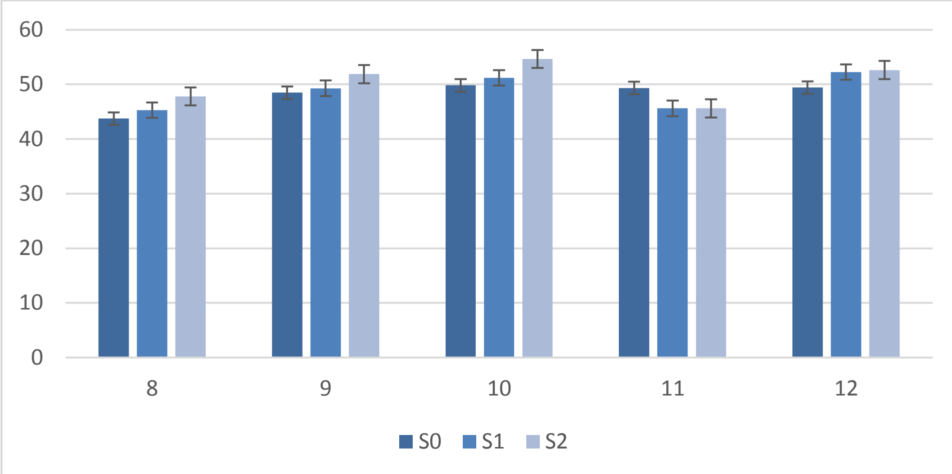

Figure 7. Leaf Chlorophyll Content (SPAD)

The increase in chlorophyll content indicates that the plant can still maintain photosynthetic activity under certain salinity conditions. This indicates that the accumulation of NaCl ions has not damaged the plant's chloroplasts. The results of this study are in line with previous research (Yazdani & Tavakoli, 2017), which shows that salinity at certain concentrations can increase the accumulation of chlorophyll pigment before decreasing at higher concentrations. Research (Maya et al., 2024) also states that salinity-tolerant plants can maintain proline and chlorophyll content as an adaptation to osmotic pressure. Parameters of wet weight and dry weight of shoots and roots are presented in Table 5 below:

Table 5. Wet and Dry Weight of Plants

Treatment	Header Wet Weight	Dry weight of the header	Root Wet Weight	Root Dry Weight
S0	2.52 ± 0.11 a	0.63 ± 0.03 a	0.53 ± 0.06 a	0.18 ± 0.01 a
S1	2.63 ± 0.10 b	0.69 ± 0.02 a	0.53 ± 0.05 a	0.20 ± 0.01 a
S2	3.30 ± 0.17 b	0.79 ± 0.03 b	0.81 ± 0.06 b	0.21 ± 0.01 a
F test	**	**	**	tn.

Description: Numbers followed by different letters in the same column indicate a significant difference in the 5% DMRT test.

Based on the research results in Table 5, it shows that the NaCl irrigation treatment had a significant to very significant effect on the parameters of the wet weight of the shoot, dry weight of the shoot, and wet weight of the root, but did not have a significant effect on the dry weight of the root. The S2 treatment produced the highest value in all plant biomass parameters compared to other treatments. The wet weight of the shoot in the S2 treatment reached 3.30 grams, while the S0 treatment was only 2.52 grams and the S1 treatment was 2.63 grams. This shows that the S2 treatment increased the shoot wet weight by 0.78 grams, or about 30.95%, compared to the control.

For the canopy dry weight parameter, the S2 treatment produced a value of 0.79 grams, while the control treatment only produced 0.63 grams. This represents a 25.39% increase compared to the control. The increase in dry weight indicates that the plants were able to accumulate photosynthetic products in the form of biomass more optimally in the S2 treatment.

Root wet weight also showed a significant increase in the S2 treatment, reaching 0.81 grams compared to the control treatment of 0.53 grams, representing an increase of approximately 52.83%. However, root dry weight showed no significant effect, although the S2 treatment still produced the highest value, at 0.21 grams.

Figure 5 shows that the S2 treatment produced the highest plant biomass. This indicates that salinity levels of 6–7 mmHg are still tolerable for oil palm seedlings, allowing plant physiological activity to continue well. The high fresh and dry weights of the plants indicate that photosynthesis, photosynthate translocation, and nutrient absorption are still optimal.

The results of this study align with research in Plant Physiology by Nadir (2023), which states that increased plant biomass under moderate salinity conditions indicates the plant's ability to adapt to osmotic stress. The study reported that plants that can survive salinity conditions have a higher dry weight than plants that are sensitive to salt. In this study, plant dry weight increased by 18–22% under low to moderate salinity conditions. The results of this study showed a 25.39% increase in canopy dry weight, indicating a relatively better adaptation response.

Research by Zirrazaq et al. (2024) on oil palm seedlings showed that increasing salinity to a certain level can still increase plant fresh weight due to osmotic adjustment mechanisms in plant cells. However, at high salinity concentrations, biomass decreases due to disruption of ion balance and water absorption by plant roots.

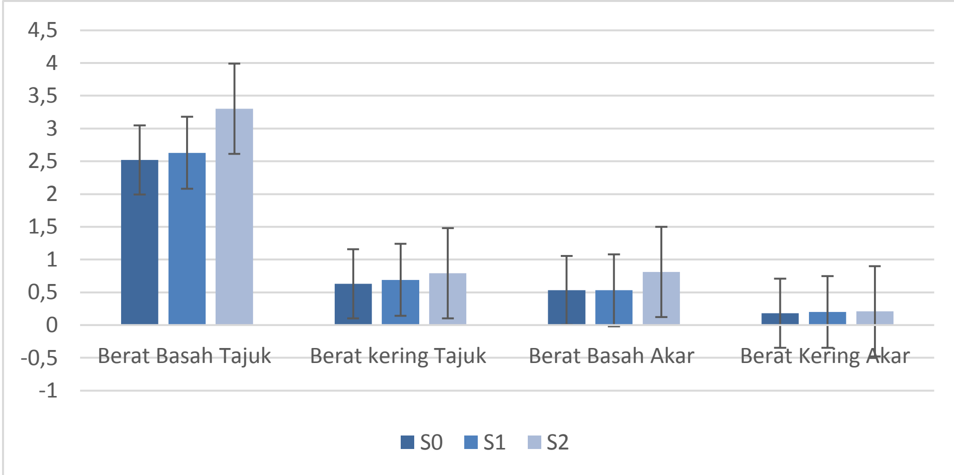

Figure 8. Wet and Dry Weight (grams)

The increase in biomass in the S2 treatment is thought to be related to the plants' ability to maintain cell turgor pressure, allowing cell division and enlargement to continue. A better root system allows plants to absorb water and nutrients more efficiently, thus supporting biomass formation.

Based on the research results in Table 6, it shows that the NaCl irrigation treatment had a significant to very significant effect on the leaf volume and root volume of oil palm seedlings. Treatment S2 produced the highest leaf volume, at 6.10 cm³, while treatment S1 produced 5.45 cm³ and the control treatment only 5.10 cm³. Thus, treatment S2 increased leaf volume by 19.60% compared to the control.

In terms of root volume, the S2 treatment produced the highest value at 0.86 cm³, while the control treatment produced only 0.45 cm³. This represents a 91.11% increase in root volume compared to the control. The increase in root volume indicates that the plants are adapting morphologically to salinity stress by expanding their root systems.

Figure 9. Wet and Dry Leaf Volume

Figure 6 shows that treatment S2 produced higher root and leaf volumes than the other treatments. This indicates that oil palm seedlings are still capable of optimal vegetative growth even under moderate salinity conditions.

The results of this study align with Kadapi's (2023) research, which states that plants tolerant of salinity stress generally exhibit increased root growth as an adaptation to improve water absorption efficiency. In that study, root volume increased by 40–70% in the moderate salinity treatment. Meanwhile, in this study, root volume increased by 91.11%, indicating a high level of adaptability in oil palm seedlings.

Research by Nufus et al. (2022) also indicates that increased root volume is closely associated with a plant's ability to maintain water balance within its tissues. A larger root system allows plants to obtain water and nutrients more effectively in media experiencing osmotic stress from salinity. Leaf volume and root volume are presented in Table 6.

Figure 10. Wet and Dry Root Volume

Table 6. Root and leaf volume

Treatment	Leaf Volume	Root Volume
S0	5.10 ± 0.22 a	0.45 ± 0.06 a
S1	5.45 ± 0.26 b	0.42 ± 0.04 a
S2	6.10 ± 0.20 c	0.86 ± 0.07 b
f test	*	**

Description: Numbers followed by different letters in the same column indicate a significant difference in the 5% DMRT test.

The increase in leaf volume in the S2 treatment indicates that leaf cell division and enlargement are still occurring effectively. This condition relates to the plant's ability to maintain cellular water content and optimal photosynthesis. Root length and crown length parameters are presented in Table 7.

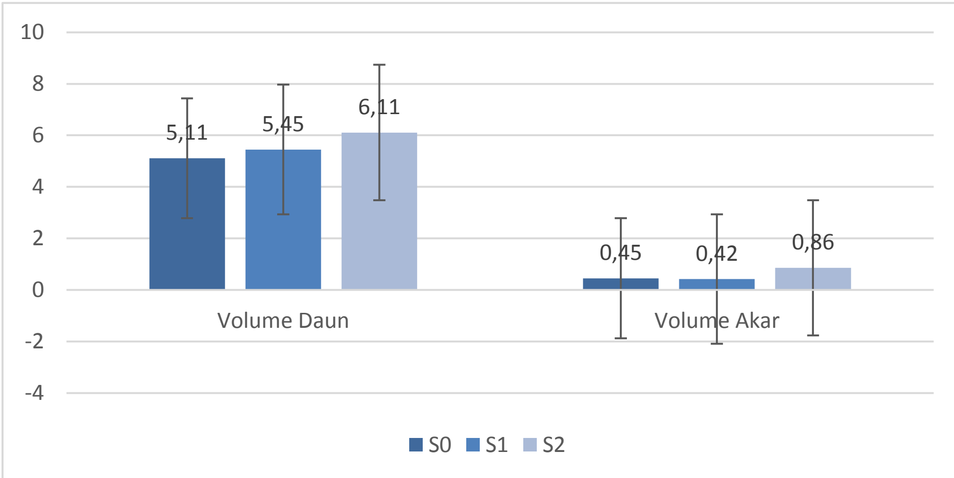

Figure 11. Root and Leaf Volume (cm3)

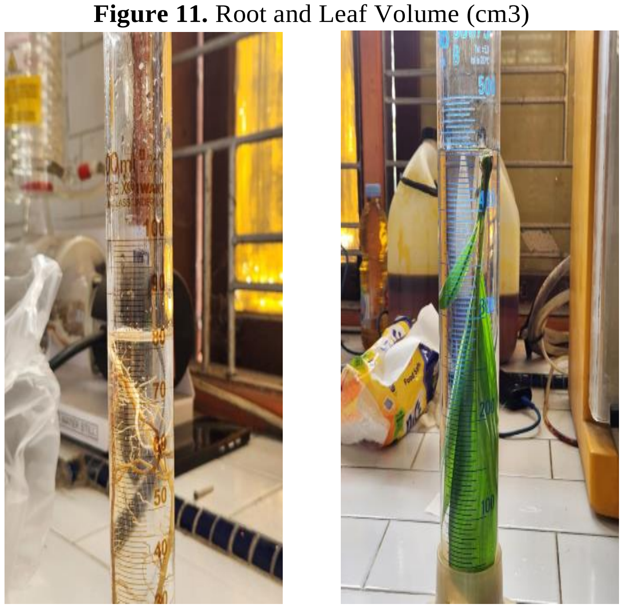

Figure 12. Root and Leaf Volume

Table 7. Length of roots and shoots

Treatment	Title Length	Root Length
S0	25.04 ± 0.71 a	19.53 ± 0.06 a
S1	22.86 ± 0.55 a	22.86 ± 0.05 a
S2	26.71 ± 0.84 a	24.90 ± 0.06 b
f test	tn.	**

Description: Numbers followed by different letters in the same column indicate a significant difference in the 5% DMRT test.

The results of the study in Table 7 show that the NaCl treatment had no significant effect on plant crown length, but did significantly affect root length. Treatment S2 produced the highest root length (24.90 cm) compared to the control (19.53 cm). Thus, treatment S2 increased root length by 5.37 cm, or approximately 27.49%, compared to the control.

In the canopy length parameter, the S2 treatment also produced the highest value, namely 26.71 cm, compared to the control treatment of 25.04 cm. However, the results of statistical tests showed that the difference was not significant.

Figure 7 shows that the increase in root length is more dominant than the increase in crown length. This indicates that the plant prioritizes root system growth as a form of adaptation to salinity stress.

The results of this study align with research by Sembiring (2024), which states that plants experiencing salinity stress will increase root growth to expand the area for water and nutrient absorption. In that study, root length increased by 20–25% under moderate salinity conditions. Meanwhile, in this study, root length increased by 27.49%, indicating a fairly strong adaptive response.

Research by Irawan et al. (2025) also shows that salinity stress causes plants to allocate more growth energy to the root system than to the shoot. This is intended to maintain water and nutrient supply in environments experiencing high osmotic pressure. Na^{+} concentrations in the growing medium can disrupt the absorption of Ca^{2+} and K^{+} , thus inhibiting plant growth. However, salinity-tolerant plants are generally able to maintain root growth to maintain water balance in plant tissues (Tester & Munns, 2008).

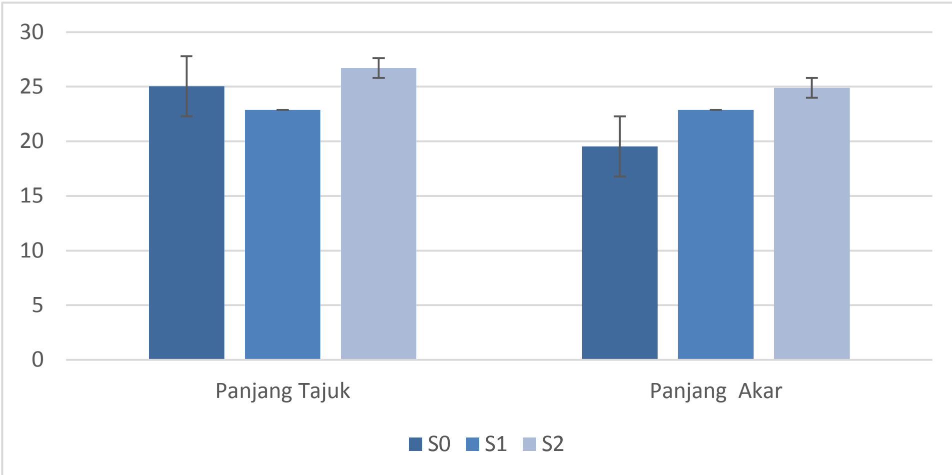

Figure 13. Crown and Root Length (cm)

Figure 14. Root Length

Figure 15. Header Length

4. Conclusion

Based on the research results, the NaCl irrigation treatment with salinity levels S0, S1, and S2 showed that most of the oil palm seedling growth parameters did not have a significant effect, except at certain observation times. A significant effect was seen in plant height at 8 WAP, number of leaves at 9 and 11 WAP, and chlorophyll content at 11 WAP. In yield parameters such as wet and dry weight of the crown, wet weight of the root, leaf volume, root volume, and root length, the NaCl treatment showed a significant to very significant effect.

Treatment S2, with a dose of 6–7 mmhos NaCl, produced the highest average values for various growth parameters, including plant height, stem diameter, leaf number, chlorophyll content, biomass, and root system. This indicates that oil palm seedlings can adapt and continue to grow well at this salinity level, although not all parameters showed significant differences.

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