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Salinity Stress Test for Several Local Rice Varieties from South Tapanuli During the Vegetative Phase

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A B S T R A C T

Salinity stress is one of the main limiting factors in rice cultivation, especially in coastal and lowland areas that are vulnerable to sea air intrusion. Local rice varieties have diverse genetic characteristics that potentially support adaptation to stressful environments; therefore, their response to salinity stress needs to be evaluated from the early stages of growth. This study aims to analyze the effect of salinity on the growth of several local rice varieties from South Tapanuli in the early vegetative phase. The study used a factorial Completely Randomized Design with salinity levels (0, 3, and 6 g/L NaCl) and rice varieties (Inpari 49, Siporang, Silatihan, and Silottik). Salinity stress significantly affected growth parameters, especially plant height and number of leaves.

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INTRODUCTION

Salinity stress is one of the major limiting factors in rice cultivation, particularly in coastal and lowland areas that are vulnerable to seawater intrusion. Local rice varieties possess diverse genetic characteristics that potentially support adaptation to stressful environments; therefore, their responses to salinity stress need to be evaluated from the early stages of growth.

This study aims to analyze the effect of salinity stress on the growth of several local rice varieties from South Tapanuli during the early vegetative phase. The research was conducted in a greenhouse from May to July 2025 using a factorial **Completely Randomized Design (CRD)** with two factors: salinity levels (0, 3, and 6 g/L NaCl) and rice varieties (Inpari 49, Siporang, Silatihan, and Silottik).

The observed parameters included germination percentage and germination rate, plant height, number of leaves, and chlorophyll index. Salinity stress significantly affected several rice growth parameters, particularly plant height and number of leaves during later vegetative stages, while varietal effects varied during the early growth phase. The chlorophyll index tended to decrease as salinity levels increased across all tested varieties.

Overall, salinity stress limited the vegetative growth of rice, and local rice varieties exhibited different adaptive responses without showing absolute tolerance to high salinity levels.

The results further indicated that salinity stress significantly affected several rice growth parameters, particularly plant height and leaf number during the later vegetative stage. The effect of variety varied during the early growth phase, while the interaction between salinity and variety generally did not show a significant effect on growth parameters. The chlorophyll index tended to decline with increasing salinity levels across all tested varieties. In general, salinity stress restricted vegetative growth in rice, and local rice varieties demonstrated varying adaptive responses without exhibiting absolute tolerance to high salinity levels.

LITERATURE REVIEW

Salinity is one of the major limiting factors in crop production systems, particularly in rice (**Oryza sativa L.**). Salinity is defined as a condition characterized by increased concentrations of soluble salts in soil or irrigation water that negatively affect plant growth and yield. Salinity stress occurs due to the accumulation of salts in the soil originating from natural processes or human activities, including seawater intrusion, the use of saline irrigation water, poor drainage systems, and increased evapotranspiration associated with climate change.

In agrarian countries such as Indonesia, salinity problems are not only found in coastal areas but have also expanded into non-coastal agricultural lands due to land degradation and unsustainable water management.

Rice is a strategic food crop that plays an important role in national food security; however, it is sensitive to salinity stress, especially during the early stages of growth. High salt concentrations in the growing medium disrupt ionic balance, reduce photosynthesis rates, and inhibit the growth of vegetative organs

such as stems and leaves. The vegetative phase is a critical stage because the root system, stem, and leaf canopy develop to support photosynthesis and biomass accumulation. Growth disturbances during this phase caused by salinity stress can reduce the plant's capacity to enter the generative phase optimally and ultimately decrease yield.

Several local rice varieties cultivated in South Tapanuli, including **Silatihan, Siporang, and Silottik**, as well as the improved national variety **Inpari 49**, possess different morphological and physiological characteristics, resulting in varying responses to salinity stress. These differences form an important basis for selecting varieties that are suitable for specific environmental conditions.

In the context of climate change and land degradation, the utilization of local rice varieties that are adaptive to environmental stresses, including salinity, represents an important strategy for sustainable agriculture. However, scientific information regarding the responses of South Tapanuli local rice varieties to salinity stress, particularly during the vegetative phase, remains limited, indicating the need for systematic evaluation.

METHODOLOGY

The study was conducted in a greenhouse from May to July 2025 using a factorial Completely Randomized Design (CRD) with two factors, namely salinity level and rice variety. The salinity treatments consisted of S0 = 0 g/L NaCl, S1 = 3 g/L NaCl, and S2 = 6 g/L NaCl, while the rice varieties included V1 = Inpari 49, V2 = Siporang, V3 = Silatihan, and V4 = Silottik.

This study aimed to analyze the effect of salinity stress on the growth of several local rice varieties from South Tapanuli during the early vegetative phase. The observed parameters included germination percentage and germination rate, plant height, number of leaves, and chlorophyll index.

Growth data were analyzed using analysis of variance (ANOVA) followed by Duncan's Multiple Range Test (DMRT) at a 5% significance level. The interaction between salinity and variety was evaluated for growth parameters, while chlorophyll index data were analyzed descriptively. The responses of several local rice varieties to salinity stress were evaluated from the early growth stage.

RESEARCH RESULTS

The results showed that salinity stress significantly affected several rice growth parameters, particularly plant height and number of leaves during the later vegetative stage. Salinity stress had a significant influence on growth parameters, while varietal effects varied during the early growth phase. This indicates that each rice variety exhibited a different response under salinity stress conditions. However, the interaction between salinity and variety generally did not show a significant effect on the observed growth parameters.

The responses of several local rice varieties from South Tapanuli to salinity stress were evaluated from the early growth stage through germination percentage and germination rate, plant height, number of leaves, and chlorophyll index. The results confirmed that salinity stress significantly affected several rice growth parameters, particularly plant height and leaf number during the later

vegetative stage, while varietal effects varied during the early growth phase. These findings indicate that salinity stress limited vegetative growth across all salinity treatments, while varietal responses differed during early development.

The chlorophyll index tended to decrease as salinity levels increased in all tested varieties, including Inpari 49, Siporang, Silatihan, and Silottik. This reduction occurred consistently with increasing salinity levels, indicating that higher salinity reduces physiological performance in all varieties. Increased salinity levels reduced rice growth performance, particularly plant height and leaf development, while varietal differences reflected variations in adaptive capacity among the local rice varieties from South Tapanuli.

The interaction between salinity and variety generally did not show significant effects on growth parameters, suggesting that the impact of salinity stress on vegetative growth occurred similarly across all varieties. Overall, salinity stress limited rice vegetative growth, and the local rice varieties showed different adaptive responses without demonstrating absolute tolerance to high salinity levels.

In general, the results indicate that increasing salinity levels significantly reduced rice growth performance, limited vegetative growth, and decreased chlorophyll index values across all tested varieties. Although local rice varieties from South Tapanuli exhibited different adaptive responses during the vegetative phase, none demonstrated absolute tolerance to high salinity levels. These findings indicate that increasing salinity levels reduce rice growth performance and that varietal differences reflect variations in adaptive responses under salinity stress during the vegetative stage.

DISCUSSION

This study demonstrates that salinity stress significantly affects the vegetative growth of rice, particularly plant height and number of leaves during the later vegetative stage. These findings indicate that increasing salinity levels reduce rice growth performance and restrict vegetative development during the early growth period. The reduction in plant height and leaf number under salinity stress indicates that increasing salt concentrations in the growing medium inhibit normal growth processes and limit the development of vegetative organs.

Since the vegetative phase is critical for the formation of roots, stems, and leaf canopy, growth limitations during this stage suggest a reduced capacity of plants to maintain optimal development under saline conditions.

The chlorophyll index tended to decrease with increasing salinity levels across all tested varieties, indicating reduced physiological performance under salinity stress conditions. The consistent reduction in chlorophyll index in Inpari 49, Siporang, Silatihan, and Silottik suggests that increasing salinity levels reduce photosynthetic capacity and plant vigor. These physiological limitations are consistent with the reductions observed in vegetative traits, particularly plant height and leaf number, confirming that salinity restricts vegetative growth across all treatments. The decline in chlorophyll content also indicates that salinity stress affects the development of functional leaves, which are essential for biomass accumulation during the vegetative phase.

The effect of variety varied during the early growth phase, indicating that each rice variety exhibited different adaptive responses to salinity stress conditions. Differences among the tested varieties reflect variations in adaptive capacity between the local rice varieties from South Tapanuli and the improved variety Inpari 49. These results confirm that local rice varieties possess diverse genetic characteristics that may support adaptation to stressful environments.

However, although the local rice varieties exhibited different adaptive responses, none showed absolute tolerance to high salinity levels, indicating that varietal adaptation remains limited under increasing salinity stress. The presence of varietal differences mainly during the early growth stage suggests that genetic potential influences early growth responses before salinity effects become dominant during later vegetative stages.

The interaction between salinity and variety generally did not show significant effects on growth parameters, suggesting that the influence of salinity stress on vegetative growth occurred similarly across all varieties. This indicates that salinity acts as a primary limiting factor determining the reduction in vegetative growth, while varietal differences are mainly expressed in baseline growth performance rather than differential tolerance across salinity levels. The absence of significant interaction also indicates that increasing salinity levels consistently reduced growth performance across all tested varieties, reinforcing the conclusion that none of the evaluated varieties demonstrated absolute tolerance to high salinity conditions.

Overall, the results confirm that salinity stress significantly affects growth parameters, limits vegetative growth in rice, and reduces chlorophyll index values as salinity levels increase across all tested varieties. Local rice varieties from South Tapanuli exhibit different adaptive responses during the vegetative phase, but none demonstrate absolute tolerance to high salinity levels. These findings indicate that increasing salinity levels reduce rice growth performance and that varietal differences reflect variations in adaptive responses rather than strong tolerance.

This study highlights the importance of evaluating local rice germplasm under salinity stress during the vegetative stage to identify adaptive potential and support the selection of rice varieties suitable for salt-affected environments.

CONCLUSIONS AND RECOMMENDATIONS

Salinity stress significantly affected the vegetative growth of rice, particularly by reducing plant height and leaf number during the later vegetative stage. Varietal differences were observed in response to salinity stress, especially in plant height, reflecting variations in adaptive capacity among the tested rice varieties. However, the interaction between salinity and variety generally did not show a significant effect on most vegetative growth parameters.

The chlorophyll index tended to decrease with increasing salinity levels across all varieties, indicating a decline in physiological performance under saline conditions. Overall, salinity stress limited the vegetative growth of rice, and local rice varieties from South Tapanuli exhibited different adaptive responses without demonstrating absolute tolerance to high salinity levels.

Further research is recommended to include replication in chlorophyll index measurements so that the data can be statistically analyzed and provide stronger quantitative conclusions. Additional evaluation extending to the generative phase is also recommended to assess rice tolerance to salinity not only based on vegetative growth but also on yield performance. Local rice varieties that demonstrate better tolerance may be considered genetic resources in breeding programs aimed at developing salinity-tolerant rice varieties. Further observations of additional physiological parameters are also recommended to strengthen the understanding of salinity tolerance mechanisms in rice.

FUTURE RESEARCH

Further research is required to strengthen the evaluation of salinity tolerance in local rice varieties from South Tapanuli. Replication in chlorophyll index measurements is necessary so that chlorophyll data can be statistically analyzed and provide stronger quantitative conclusions. Evaluation of rice performance under salinity stress should also be extended to the generative phase to assess tolerance not only in terms of vegetative growth but also yield performance.

Local rice varieties that show better vegetative adaptation under salinity stress can be further evaluated as genetic resources for breeding programs of salinity-tolerant rice. Additional physiological parameters are also needed to improve the understanding of salinity tolerance mechanisms in rice.

Further studies integrating vegetative growth responses and physiological traits under salinity stress will provide more comprehensive information for the selection and development of rice varieties adapted to salt-affected environments.

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