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Growth Characteristics of Vetiver Grass (*Vetiveria zizanioides*) on Saline Soils

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Abstract: Vetiver is widespread in saline areas. Only a few studies have reported that they are sufficiently tolerant of salt. The primary mechanism of salt tolerance in vetiver is still not known with certainty. This study aims to determine salinity's effect on early growth of vetiver (*Vetiveria zizanioides* L.) seedlings. This research was conducted in a greenhouse, Faculty of Agriculture, Universitas Sumatera Utara, Medan. This study used a non-factorial randomized block design (RBD), namely the salinity stress (S) which consisted of 3 levels: EC salinity levels of 0 (distilled water), 4 dsm^{-1} and 8 dsm^{-1}. The salinity stress treatment showed a significant effect of reducing the growth parameters of plant height, leaf area, chlorophyll a and chlorophyll b. Salinity stress treatment gave significantly better effect in conditions without salinity stress.
Keywords: chlorophyll; salinity; salinity stress; seedling; *Vetiveria zizanioides*

INTRODUCTION

Vetiver grass (*Vetiveria zizanioides* (L.) Nash.) belongs to the Poaceae family and is known in Indonesia as vetiver (Lim, 2016). Vetiver has long been cultivated for its essential oil; repel pests; insects and microbes; fabric making; drug; food and crafts, Vetiver is also able to improves soil properties (phytoattenuation) from heavy metal contamination (Yeh & Lin, 2014). One of the problems that occur in agricultural land today is salinization. Salinization is a process where there is an increase in high soluble salts (NaCl, Na2CO3, Na2SO4) in the soil, so that it affects plant growth and development (Nugroho & Lestari, 2021). Salinity is one of the main environmental stresses more than 800 million ha of land globally are exposed to saline, causing huge losses in agricultural productivity (Ledesma et al., 2016). One approach to increasing saline land use is to identify new plant species that are saline resistant. To date, biotechnology has not developed saline tolerant cultivars for agricultural purposes (Himabindu et al., 2016) perhaps because saline tolerance is a complex trait determined by many genes that interact strongly with environmental factors (Munns et al., 2012). Therefore, the development of saline tolerant plants is highly dependent on screening of plant species with high salinity tolerance and understanding of tolerance mechanisms (Feng et al., 2014).

Agronomically, the root length of vetiver grass can reach 5.2 m and has tillers clustered on the soil surface, making it suitable as a slope strengthening plant, preventing erosion and reducing runoff. Vetiver is resistant to flooding and grows well in soils with high salinity, sodic, acid, and tolerant of heavy metal (Yeh & Lin, 2014; Cuong et al., 2015; Lim, 2016). Vetiver grass is also indicated to be relatively fire resistant and does not spread fire. The inhibited water absorption will then disrupt the photosynthesis process, namely closing the stomata so that the supply of C02 in the chloroplasts will decrease (Junandi et al., 2019).

The vegetative phase is the phase of growth of organs, such as increasing the number of tillers, plant height and leaf area. This phase is very vulnerable to changes in tense environmental conditions. Stress is a change in plant conditions that causes plant responsiveness to be lower (Sugiharto et al., 2017). Salinity stress has an impact on plant growth both morphologically, physiologically and biochemically. The high

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salt content in the planting medium/soil causes plants to experience ionic stress and oxidative stress. The accumulation of salt in the root area reduces the ability of plants to absorb air. In addition, the absorption of salt elements in excessive amounts will cause poisoning for plants. The absorption of the constituent elements of salt in excessive amounts will reduce plants' ability to absorb water besides that, and it also causes poisoning to plant (Nasyirah et al., 2015). Thus, This research is needed to determine the growth characteristics of vetiver grass under salinity stress conditions.

METHODS

This research was conducted in the greenhouse of the USU Faculty of Agriculture, Medan, Indonesia from December 2020 to February 2021. This study used a non-factorial completely randomized design, namely saline soil consisting of 3 factors, namely: S0 (0 dsm^{-1}), S1 (> 4 dsm^{-1}) and S2 (8 dsm^{-1}). Each repeated 3 times, then obtained 9 treatment combinations. If the effect of treatment is significantly different on the variance, then a follow-up test with Duncan's multiple distance test is carried out.

The linear model used is as follows:

$Yij = + Ti + Bj + \varepsilon ij$; i = 1, 2, 3 ... t …. (1)

j = 1, 2, 3 ... r

Where:

Yij= response or observation from treatment to i and repetition to j

μ= common mean

Ti = the effect of the i-th treatment

Bj = the effect of the j-th block

ε ij = the effect of experimental error from the i-th treatment and the j-th replication

If there is a significant difference, a further test of DNMRT is carried out at a 5% significance level.

RESULTS AND DISCUSSION

The saline soil treatment had a significant effect on the observation of the initial growth of vetiver seedlings which included plant height, leaf area, chlorophyll a and b can be seen in Table 1. Treatment without salinity (S0) increased the observed parameters compared to administration of four dsm-1 (S1) and eight dsm-1 (S2) salinities for 8 WAP observations.

Morphological characteristics of vetiver can be seen that Vetiver Grass does not have a tooth or rhizome. Well structured and massive roots can grow very quickly. It can reach 3-4m in length in the first year. These deep roots make Vetiver great when the season is dry and it is difficult to be carried away by strong currents. Its rigid and erect stems are able to remain standing even in deep currents. Resistant to pests, disease and fire When planted tightly, the dense hedges serve as an effective sediment filter and water dispersal. New shoots that develop from its underground crown make Vetiver resistant to fire, snow, traffic and heavy grazing pressure. New roots grow from the saplings when they are buried by trapped sediment.

Vetiver will continue to grow with silt (sediment at the bottom of the river) that collects and eventually forms terraces, if the trapped sediment is not removed. In this study, salinity affects leaf morphology and transpiration rate and reduces total chlorophyll content such as increasing salt concentration. Salinity has a very significant effect on the average plant height. Treatment without salinity (S0) increased plant height compared to salinity 4 dsm-1 (S1) and 8 dsm-1 (S2) The same thing was stated by (Novita et al., 2019) which stated that under conditions of salinity stress increased chlorophyll a and b. Salinity causes changes in leaf morphology such as leaf size and leaf area.

The high Na ion causes a decrease in the availability of Cu, Mg and K elements. Salin is also inhibited due to the osmotic and toxic effects of excessive salt ions (Taufiq et al., 2016).

Physiological characteristics of vetiver can be seen that the vetiver plant is tolerant of salinity at a certain salinity level, besides

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climate differences such as prolonged drought, flooding, submersion and extreme weather from -14 degrees Celsius to +55 degrees Celsius. Able to regrow rapidly after being affected by drought, frost, saline and adverse conditions after favorable weather conditions or after soil ameliorant has been added. Tolerant to a wide range of soil pH from 3.3 to 12.5 without soil tillage. High tolerance to herbicides and pesticides.

Table 1. Average plant height, leaf area of chlorophyll a and chlorophyll b on salinity stress.

Treatment	Plant Height *(cm)*	Leaf Area *(mm)*	Chlorophyll a *($mg.g^{-1}bs$)*	Chlorophyll b *($mg.g^{-1}bs$)*
Salinity Stress				
S0 (0 dsm^{-1})	71,80a	22,96a	2,27a	0,77a
S1 (4 dsm^{-1})	46,83b	18,13b	1,77b	0,67b
S2 (8 dsm^{-1})	44,97c	17,61c	1,40c	0,53b

The number in the same column and row followed by the same letter are not significantly different at the 5% level based on the LSD test.

Highly efficient in absorbing soluble soil nutrients such as N and P and heavy metals in polluted water. Very tolerant of acidity, alkalinity, salinity, solidity and magnesium in medium to high levels. Very tolerant of Al, Mn and heavy metals such as As, Cd, Cr, Ni, Pb, Hg, Se and Zn.

Plants need water, when plants experience a lack of water, absorption and transportation will be hampered, which causes cell division to be disrupted and hampered. Azarmi et al (2010); Sobir & Helmi (2018) along with the increase in the salinity content of food, there was a significant decrease in tomato plant height, this was done as a form of adaptation in reducing evaporation. Absorption of salt constituent elements in excessive amounts will reduce the ability of plants to absorb water while also causing poisoning to plants (Nasyirah et al., 2015).

Ecological characteristics of vetiver plants can be seen that vetiver plants are very tolerant of some extreme soil and climatic conditions as mentioned above, such as grasses, Vetiver is not tolerant of shade. Shade will reduce its growth and in extreme cases may kill Vetiver. Therefore Vetiver should be planted in an open environment and free of weeds. Weed control may be necessary during the early stages of growth. On erodible and unstable soils, Vetiver will reduce erosion first, stabilize eroded soils (especially steep slopes), then due to stored moisture and nutrients, improves the microenvironment so that other crops or from other sown seeds can be planted later. Due to these characteristics, Vetiver can be called a nurse plant on diseased soil.

CONCLUSION

The growth characteristics of vetiver grass under salinity stress had a significant effect in reducing the initial growth of vetiver grass on plant height, leaf area, chlorophyll A and chlorophyll B.

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