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The Effect of Hydroponic Fertilizers on The Growth of Aquarium Plants, *Vallisneria natans*

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ABSTRACT: *Vallisneria natans* is one of the favorite aquarium plants for making aquascape. This study aims to determine the effect of hydroponic fertilizer on the growth of *V. natans.* The research used a completely randomized design with 4 treatments and 6 replications. Treatment A without hydroponic fertilizer with a TDS level of 47 mg.L^{-1}, and treatment using hydroponic fertilizer at a TDS level of 87 mg.L^{-1} (B), 127 mg.L^{-1} (C), and 167 mg.L^{-1} (D). *V. natans* was grown for 45 days. The parameters measured include the length growth of leaf and water quality conditions including TDS, temperature and pH. The results showed that the pH and water temperature conditions were still within the tolerable range for the growth of *V. natans*. The water temperature ranged from 26.1 - 29.0 ºC, and the water pH ranged from 5.47 - 7.65. Length growth of leaf in the treatment without fertilizer was 17.67 ± 2.04 cm, while the treatment of hydroponic fertilizer at TDS level of 87 mg.L^{-1}, 127 mg.L^{-1} and 167 mg.L^{-1} produced leaves with length of 20.75 ± 1.67 cm, 20.83 ± 3.82 cm, and 22.42 ± 1.11 cm respectively. Increasing the levels of hydroponic fertilizer tended to increase length growth of leaf according to the logarithmic model (y = 3.1926ln (x) + 17.88; R^2 = 0.9328). Thus, hydroponic fertilizer can be used as liquid fertilizer in *V. natans* cultivation with TDS levels ranging from 87 - 167 mg.L^{-1}.

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KEYWORDS: aquascape, aquatic plant, liquid fertilizer, leaf growth, TDS requirement.

1. INTRODUCTION

Aquatic plants can be divided into 4 groups, including emergent plants, floating leaf plants, free-floating plants, and submerged plants (Srivastava et al. 2008; Lesiv et al. 2020). *Vallisneria natans* belongs to the Hydrocharitaceae family and is a submerged aquatic plant that is rooted in the bottom substrate. In general, *V.natans* reproduces asexually by producing offspring from the roots, while sexual reproduction is by producing microspores (Chen et al. 2006). *V.natans* is also called Tapegrass, because its shape is similar to grass with ribbon-like leaves (Tootoonchi et al. 2019) with a width of 1 cm and a length of up to 60 cm (Hiscock 2003). *V. natans* can live at high densities reaching 90 - 226 clumps/M2 (Chen et al. 2006).

V.natans is one of the favorite aquatic plants for aquariums, which is suitable for planting in the background (Hiscock 2003). *V.natans* is also useful for improving the quality of freshwater ecosystems. The genus Vallisneria is distributed in tropical and subtropical areas in Europe, Asia, Africa, Australia and America (Martin & Mort 2023). *V.natans* is an endemic species and dominant aquatic plant in lakes and riverbanks (Chen et al. 2006; Xu et al. 2023; Liao et al 2024).

The growth of aquatic plants is influenced by the availability of nutrients in their environment. Fertilizers for submerged aquatic plants are generally given to the base substrate, either inorganic or organic fertilizers. The use of N and P fertilizers on the substrate could increased the growth of *V.natans* (Cai et al. 2016; Tang et al. 2019). Likewise, the use of livestock manure compost on the bottom substrate also had a significant effect on the growth of V. natans (Shelar et al. 2012; Tekoğul et al. 2017). According to Oz (2024) Vallisneria can utilize nutrients from the bottom substrate or waters. *V.natans* effectively absorbs nutrients in water (Tang et al. 2019; Li et al. 2021) and at high nutrient content in water, the photosynthesis process increases (Cai et al. 2012).

In general, aquascape uses fertilizers that are specifically produced for aquascapes, which are quite expensive. Hydroponic fertilizers are one alternative fertilizer that is cheaper. The problem in using hydroponic fertilizers for aquatic plants is that the optimal dosage is not yet known to support the growth of aquatic plants. This study aims to determine the effect of hydroponic fertilizers on the growth of *V.natans*.

II. MATERIALS AND METHODS

The study was conducted in April - June 2024 at the aquaculture laboratory of Palangka Raya Christian University. *V.natans* were obtained from aquarium plant farmers in Palangka Raya City. *V.natans* seedlings were pruned so that the leaves were uniform in size, 10 cm long from the base. *V.natans* was planted using a 6 cm diameter plastic pot with a sand substrate, and maintained in an aquarium with a water depth of 25 cm (Cai et al. 2016). The aquarium water media was given fertilizer according to the treatment given. The fertilizer used was AB mix hydroponic fertilizer, Good Plant brand. The aquarium water used initially had a TDS (total dissolved solid) level of 47 mg.L^{-1}.

This study used a completely randomized design with 4 treatments and 6 replications. The treatment was the use of hydroponic fertilizer to grow *V.natans* in the aquarium at different TDS levels. The treatments used were: treatment A (without fertilizer with a TDS level of 47 mg.L-1), B (fertilization at a TDS level of 87 mg.L-1), C (fertilization at a TDS level of 127 mg.L-1), and D (fertilization at a TDS level of 167 mg.L-1). *V.natans* was maintained according to the treatment for 45 days. The fertilizer content in the water medium was observed every week and the TDS level was controlled to match the treatment given. If the TDS level decreases, fertilizer is added, conversely if the TDS level increases, water is added to reduce the TDS level.

The parameters measured were leaf length growth and water quality conditions including TDS, temperature, and pH. Leaf length was measured every 14 days, while water quality was measured every 7 days during maintenance. Leaf length growth data were analyzed using analysis of variance (ANOVA) using the F test and continued with the LSD (least significant difference) test to determine the treatment that showed the best growth performance.

III. RESULTS AND DISCUSSION

V.natans grown in this study were initially pruned so that all leaves were 10 cm long. The pruned leaves did not grow back, but the plant would produce new leaves from the plant tubers. The growth of these new leaves was measured in this study. Treatment A, which was without hydroponic fertilizer, had a TDS level of 47 mg.L^{-1}. The TDS level is the content of ions that are naturally present in groundwater. In treatments B, C, and D, the TDS level was increased by giving hydroponic fertilizer, so that the content of nutrient ions increased. The growth of *V.natans* leaf length during 45 days of maintenance in the treatment without hydroponic fertilizer was 17.67±2.04 cm (A). Meanwhile, the hydroponic fertilizer treatment at TDS levels of 87 mg.L^{-1} (B), 127 mg.L^{-1} (C) and 167 mg.L^{-1} (D) produced leaf lengths of 20.75±1.67 cm, 20.83±3.82 cm, and 22.42±1.11 cm respectively (Figure 1).

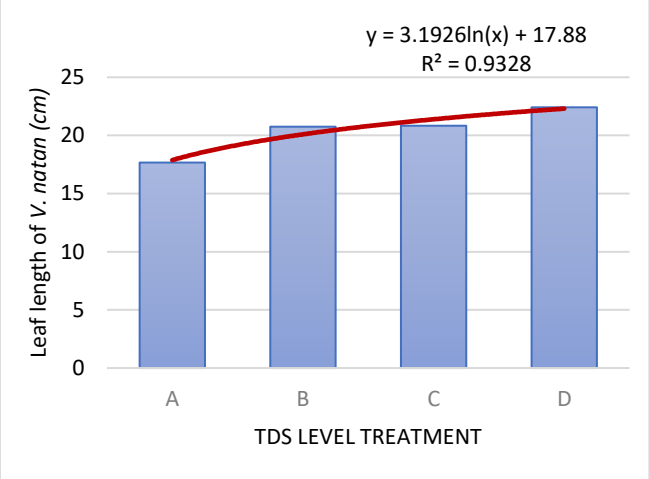

Figure 1. The length growth of *Vallisneria natans* with hydroponic fertilizer treatment at different levels

Xu et al. (2023) grew *V. natans* for 40 days and obtained a length growth of 25.25 - 26.75 cm. While Li et al. (2012) grew it for 7 months and obtained a length growth of 20.44 - 44.52 cm. Oz (2024) grew it for 8 months and obtained a length growth of 18.33 - 44.67 cm. Thus, the growth of leaf length in this study was not much different from other studies. Li et al. (2012) and Xu et al. (2023) stated that the type of substrate affects the growth of *V. natans*. The use of sand substrate in this study turned out to cause slower growth. According to Li et al. (2012) the size of the substrate grain affects the growth of roots and leaves. *V.natans* is better when planted on substrates with fine grain sizes such as mud and clay. Furthermore, according to Hiscock (2003) if the substrate does not contain enough nutrients, *V.natans* will utilize the nutrients in the water.

Based on the analysis of variance (ANOVA) showed that the use of hydroponic fertilizer significantly affected the length growth of *V. natans* ($p < 0.05$). LSD test showed that the length growth of *V. natans* in treatment A was lower than treatments B, C, and D. While treatments B, C, and D were not significantly different ($p < 0.05$). Thus, the use of hydroponic fertilizer at TDS levels of 87 - 167 mg.L^{-1} can increase the growth length of *V.natans*. Figure 1 shows the trend curve of *V.natans* length growth with different hydroponic fertilizer levels. Increasing the level of hydroponic fertilizer tends to increase the length growth of *V.natans*

following a logarithmic curve model with the equation $Y = 3.1926\ Ln(X) + 17.88$ ($R^2 = 0.9328$). where, Y = length growth (cm), and X = TDS level of hydroponic fertilizer ($mg.L^{-1}$). According to Cai et al. (2012), Vallisneria adapts well to high nutrient content, so based on this curve, it is possible that the hydroponic fertilizer levels can be increased further. According to Li et al (2021), *V.natans* is able to absorb large N content compared to other types of submerged aquatic plants.

The condition of water quality parameters during the study is presented in Table 1. TDS was controlled during the study, so that the TDS level was stable according to the treatment given. TDS represents the nutrient content in water, and can fluctuate because nutrients are absorbed by *V.natans* and microalgae that grow in the water. Listia et al. (2021), stated that important factors that influence the growth of Vallisneria in waters are pH, current speed, and temperature. The water temperature in the aquarium ranged from 26.1 - 29.0 ºC and this range was still tolerable to support the growth of *V.natans*. Vallisneria can live in a temperature range of 13-38 ºC. The most optimal temperature for the growth of Vallisneria is 28 ºC (Bartleson et al. 2014; Tootoonchi 2019). The pH of the water during the study ranged from 5.47 to 7.65 with an average pH of 6.36 ± 0.63. The average pH is still tolerable for the growth of *V.natans*. According to Nagy (2019) Vallisneria can tolerate pH 6 - 9. During the maintenance of *V.natans*, there was an increase in pH, this was caused by the release of OH ions by aquatic plants (Shelar et al. 2012).

Table 1. Average values of aquarium water quality parameters with hydroponic fertilizer treatment at different levels.

Treatment	Average value ±SD		
	pH	Temperature (ºC)	TDS ($mg.L^{-1}$)
A	6.79±0.76	27.23±0.82	44.14±4.60
B	6.52±0.64	27.34±0.77	99.57±9.78
C	6.14±0.49	27.47±0.86	130.86±4.49
D	6.00±0.37	27.44±0.71	167.86±5.49

IV. CONCLUSION

The pH and water temperature conditions in this study were still within the tolerable range for the growth of *V.natans.* The water temperature of the maintenance aquarium ranged from 26.1 - 29.0 ºC, and the water pH ranged from 5.47 - 7.65.

The length growth of *V.natans* leaf during 45 days of maintenance in the treatment without fertilizer was 17.67 ± 2.04 cm. The use of hydroponic fertilizer at TDS levels of 87 $mg.L^{-1}$, 127 $mg.L^{-1}$ and 167 $mg.L^{-1}$ resulted in leaf lengths of 20.75 ± 1.67 cm, 20.83 ± 3.82 cm, and 22.42 ± 1.11 cm respectively. Increasing the levels of hydroponic fertilizer tended to increase length growth of leaf according to the logarithmic model ($y = 3.1926\ ln\ (x) + 17.88$; $R^2 = 0.9328$). Thus, hydroponic fertilizer can be used as liquid fertilizer in *V.natans* cultivation with TDS levels ranging from 87 - 167 $mg.L^{-1}$.

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