Effect of saline condition and application of rice husk silica extract on lettuce growth in hydroponics

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Abstract. The development of hydroponic vegetable production in coastal areas is faced with the constraints of irrigation water quality that has high NaCl. The purpose of this research is to study the interaction of NaCl concentration in the planting media and the concentration of silica extract of rice husk on the growth of lettuce plants. The study was conducted in April 2019-June 2019 at the greenhouse Palasari-Cibiru Bandung city with altitude + 800 m above sea level. This study used a factorial complete randomized design consisting of 2 factors with three replications. The first factor is the concentration of NaCl (n1 = 0 ppm, n2 = 1,460 ppm, n3 = 2920 ppm, n4 = 4380 ppm, and n5 5850 ppm) and the second factor is the concentration of silica extract of rice husk (s1 = 0 ml l⁻¹, 30 ml l⁻¹, and 45 ml l⁻¹). Growth parameters observed were plant height, number of leaves, leaf area, root length, and plant fresh weight. The results showed that there was an independent effect on the concentration of NaCl on fresh plant weight. In the condition of saline media with a concentration of NaCl 1,460 ppm-2,920 ppm and the concentration of silica extract of rice husk, 30 ml l⁻¹ lettuce plants can grow in good condition.

1. Introduction

High air temperatures and low humidity generally constrain the development of vegetable cultivation in coastal areas. In addition to weather conditions, sandy soil conditions with water conditions that have high salinity levels inhibit plant growth. The implementation of hydroponic technology to overcome salinity constraints in vegetable farming in coastal areas is faced with water supply constraints that have an electrical conductivity (EC) value of fewer than 0.75 mS cm⁻¹ to dissolve hydroponic nutrients [1]. The element of silica or silicon (Si) is an element that plays a role in reducing biotic and abiotic stress [2,3]. Si fertilizer used is generally industrial-made fertilizer that is ready to use so that the addition of Si fertilizer to the hydroponic fertilizer formula increases production costs. Rice husk is one source of Si from organic material that can be used to reduce or increase plant tolerance to environmental stress [4]. Si elements in rice plants, including functional micronutrients, are nutrients that are needed in small amounts, but if not met, can reduce plant quality and productivity [5].

Lettuce productivity decreases if the EC value of nutrients higher than 2.4 mS cm⁻¹ [6]. Research on the utilization of rice husk silica extract in lettuce plants is still limited. Research on the application of rice husk extract is still limited to rice plants, both conventionally in the field and hydroponically [5,7]. Utilization of rice husk silica extract, which is applied to lettuce planted in saline growing media, is expected to increase growth. This study aims to determine the interaction of salinity conditions at various concentrations of NaCl and the application of various concentrations of rice husk silica extract on the
growth of lettuce plants. In addition, this study will provide recommendations on the salinity limit of NaCl and the concentration of silica rice husk extract, which can increase the growth of lettuce plants.

2. Methods

This research was conducted in April 2019 - June 2019 in Cipadung Village, Cibiru, Bandung City, with a height of +800 m above sea level (asl). The tools and materials used in this study are water pumps, EC meters, pH meters, digital cameras, nipples, emitters, lettuce seed cultivar Kriebo, cocopeat, Ca(NO$_3$)$_2$.NH$_4$.NO$_3$.K$\cdot$EDTA, KH$_2$PO$_4$.Fe$.NH_4$.SO$_4$.Ca(NO$_3$)$_2$.K$_2$SO$_4$.MgSO$_4$.MnSO$_4$.CuSO$_4$.ZnSO$_4$.H$_3$BO$_3$. (NH$_4$)$_6$Mo, NaCl, paddy husk, KOH, and water. The hydroponic nutrition formula used is N: 250 ppm; P:75 ppm; K: 175 ppm; Mg:62 ppm; S:115 ppm; Fe: 5 ppm; Mn: 2 ppm; Cu: 0.1 ppm; Zn: 0.3 ppm; B: 0.7; Mo: 0.05 ppm [8].

The research method used was an experimental study using a completely randomized factorial design. The first factor is the concentration of NaCl consisting of five levels (0 ppm, 1,460 ppm, 2,920 ppm, 4,380 ppm, and 5,850 ppm NaCl). The second factor is the concentration of rice husk silica extract consisting of three levels (0 ml l$^{-1}$, 30 ml l$^{-1}$, and 45 ml l$^{-1}$). Each combination level was repeated three times so that 45 experimental units were obtained. The dependent parameters observed were plant height, number of leaves, leaf area, root length, and plant fresh weight. Data from observations were then analyzed using analysis of variance at 5% significance level and then followed by Duncan's different test at 5% significance level.

3. Results and discussion

The results of the analysis of variance (Table 1) showed no interaction between the concentration of NaCl and the concentration of silica extract of rice husk on all observed parameters. There is an independent effect of NaCl concentration on the fresh weight parameters of the plant, while in other parameters, there is no independent effect of NaCl concentration or the concentration of extra silica rice husk.

Table 1. Matrix of analysis variance (ANOVA) on parameters of lettuce plant growth.

| No  | Parameters               | CV% | P-Value            |
|-----|--------------------------|-----|--------------------|
|     |                          |     | N     | S     | N X S  |
| 1   | Plant Height 42 DAT      | 6.69| 0.233 ns | 0.836 ns | 0.116 ns |
| 2   | Number of leaves 42 DAT  | 14.11| 0.236 ns | 0.820 ns | 0.560 ns |
| 3   | Leaf area 42 DAT         | 6.76| 0.702 ns | 0.619 ns | 0.815 ns |
| 4   | Root length 42 DAT       | 28.25| 0.862 ns | 0.583 ns | 0.607 ns |
| 5   | Plant Fresh Weight 42 DAT| 22.61| 0.005*  | 0.828 ns | 0.137 ns |

Note: CV = Coefficient Variance; N = NaCl concentration; S = Concentration of rice husk silica extract; N X S = Interaction between NaCl concentration and concentration of rice husk; * = significant at level p 0.05; ns = nonsignificant

3.1. Plant height

The results of the analysis of variance (Table 1) show that there was no interaction or independent influence of NaCl concentration and concentration of rice husk silica extract on plant height of 42 DAT. The average plant height of the study results (Table 2) has a plant height following with the description 22 cm - 30 cm. Plant height is a growth parameter that is sensitive to environmental factors such as light and water [9]. At 4,380 ppm NaCl concentration and 5,850 ppm plant height is less than 30 cm. Plants that experience stress due to salinity will inhibit plant growth [10].

3.2. Leaf number

Lettuce is a leaf vegetable so that the number of leaves more than increasing the fresh weight of the plant also affects the appearance of the plant to make it more attractive when displayed at the supermarket. In the parameters of the number of leaves, there was no interaction or independent
influence of NaCl concentration and silica extract concentration of rice husk. Observation of the number of leaves (Table 2) the average treatment produced ten leaves, but in the treatment of 2,920 ppm NaCl concentration produced 11 leaves. These results give a hint of the concentration of Na\(^+\) and Cl\(^-\) at certain levels can help plant growth. Some hydroponic nutrition formulators include the elements Na and Cl in the hydroponic nutrition formula [11].

Table 2. Duncan test results (α = 5%) on the parameters of plant height, number of leaves, leaf area, root length, and plant fresh weight.

| Treatments                  | Parameters 42 Day After Transplanting (DAT) |
|-----------------------------|---------------------------------------------|
|                             | Plant Height | Number of leaves | Leaf area | Root length | Plant Fresh Weight |
| NaCl Concentrations (N)     |              |                  |           |             |                   |
| n1 (0 ppm)                  | 31.28 a      | 10.33 a          | 2073.22 a | 26.64 a     | 121.00 a          |
| n2 (1.460 ppm)              | 31.00 a      | 10.78 a          | 2443.74 a | 26.11 a     | 160.19 b          |
| n3 (2.920 ppm)              | 30.00 a      | 11.67 a          | 2477.85 a | 26.19 a     | 167.94 b          |
| n4 (4.380 ppm)              | 29.36 a      | 10.44 a          | 1927.69 a | 26.56 a     | 129.30 a          |
| n5 (5.850 ppm)              | 29.77 a      | 10.11 a          | 1975.09 a | 23.31 a     | 121.00 a          |
| Rice Husk Silica Extract (S)|              |                  |           |             |                   |
| s1 (0 ml L\(^{-1}\))       | 30.34 a      | 10.46 a          | 2155.39 a | 27.37 a     | 135.87 a          |
| s2 (30 ml L\(^{-1}\))      | 30.47 a      | 10.73 a          | 2379.70 a | 24.85 a     | 141.03 a          |
| s3 (45 ml L\(^{-1}\))      | 30.03 a      | 10.8 a           | 2003.46 a | 25.06 a     | 142.74 a          |

Note: The lower case at the same column is nonsignificant based on Duncan test at significant level 5%.

3.3. Leaf area
The results of the analysis of variance (Table 1) did not occur, nor did the independent effect of NaCl concentration and silica extract concentration of rice husk affect the leaf area of lettuce plants. Table 2 shows the concentrations of 4,380 ppm NaCl and 5,850 ppm, starting to inhibit leaf area growth. Excessive concentration of NaCl can cause salinity stress in plants thereby inhibiting plant growth [10,12].

3.4. Root length
The results of the analysis of variance (Table 1) showed that there was no interaction effect or independent effect of NaCl concentration (saline condition) and the concentration of rice husk silica extract on root length. The growth of root length under the NaCl 5,850 ppm (Table 2) saline condition began to be stunted by root growth. The addition of rice husk silica extract in this study is not in line with previous studies, which showed the addition of Si could increase root length growth both in conditions of plants growing in saline conditions or not [13].

3.5. Plant fresh weight
The results of the analysis of variance (Table 1) showed the concentration of NaCl independently affected the fresh weight of the plant NaCl concentration of 1,460 ppm, and 2,920 ppm had a significant effect (Table 2) on the increase in fresh plant weight compared to without the application of NaCl. The results of this study indicate that plants can maintain their growth under conditions of NaCl concentrations of less than 2,920 ppm. Some hydroponic formulators add the elements Na and Cl into hydroponic nutrition. The aim is to increase plant growth by improving cell turgidity and nutrient transportation [11].
Based on Figure 1, a combination of 2,920 ppm NaCl concentration and without the application of rice husk silica extract produced the highest average fresh weight of 200.23 grams and NaCl 1,460 ppm concentration with the application of 30 ml l\(^{-1}\) rice husk silica extract can produce plants with 194 grams of fresh weight. Figure 1 shows that the application of silica (Si) can maintain the plant so that it can grow in conditions of high NaCl or conditions of salinity stress [14].

4. Conclusions
The results showed that there was an independent effect on the concentration of NaCl on fresh plant weight. In the condition of saline media with a concentration of NaCl 1,460 ppm-2,920 ppm and the concentration of silica extract of rice husk, 30 ml l\(^{-1}\) lettuce plants can grow in good condition.

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