The Effect of Rice Husk Silicate Extract on Plant Height, Electrical Conductivity and pH of Paddy Hydroponics

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Abstract. Fluctuations in rice production due to conversion of paddy field to other various land use defected the rice production in Indonesia, and in turn it may endanger the food security. Efforts to utilize hydroponics as a technology of vegetable production in limited land availability has developed. However, the practice of hydroponics in rice plants is still limited due to the availability of special nutrient. This study aims to determine the benefits of silicate rice husk extract on the growth of rice hydroponics. The research design used was complete randomized block design. The observed growth parameters are: plant height, electrical conductivity of nutrients and pH. The observed data were analyzed using variance analysis. If the results of variance analysis are significant, the analysis will be proceed with Duncan multiple range test. The results showed that application of rice husk silica extract of 20 ml/L through leaves gave the same response with sodium silicate (Na₂O₃Si) application through nutrient solution, but had significant effect on the change of electrical conductivity value and pH of nutrient solution. The results showed that silicates derived from organic materials can replace the role of silicates derived from inorganic materials on paddy hydroponic.

1. Introduction
In Indonesia, rice is a staple food source for most of Indonesia daily meal. Based on statistical data released by Center for Agricultural Data and Information Systems [1] that the growth of paddy field in Indonesia achieve saturation point with approximately 0.31% in Java Island. The future of rice production challenges are not only constrained by wetland availability, but climate change increase gap between rice production and demand [2]. Imbalance between rice production and supply require technological innovation as a step to maintain rice supply [3]. The application of hydroponics technology to increase rice production by utilizing unproductive lands is still rare due to economic and technical value considerations.

Hydroponics of rice in terms of economic aspects are still less economical when compared with cheaper and faster rice imports. According to [4] rice import policy is less appropriate if still taken as a long-term policy to overcome fluctuations in rice production. Community competence of rice hydroponic is rare when compared to hydroponic vegetable and fruit. Characteristics of paddy crops as silicate accumulators (Si) should be considered in hydroponic nutrient generation [5]. Application of hydroponic nutrients adjusted to planted varieties may increase yield even though nutrient application is not the only one factor of hydroponic cultivation success [6]. Si content in paddy field is abundant but in hydroponic silicate source must be supplied through nutrition application in the form of AB Mix. Nutrition of hydroponic plants that have been distribution to the farmer generally for vegetables without Si enrichment.

Element of Si in paddy plants as functional micro elements [7]. The growth and yield of paddy crops with added Si fertilizer is higher than that without the addition of Si (control) fertilizer [8]. In conventional rice cultivation the Si requirement is entirely supplied from the soil, but in the hydroponic system Si element have to add to the rice nutrient formulation. Utilization of local wisdom as a source...
of Si fertilizer is by utilizing rice husk as Si source. Si potency in rice husk according to Chandra et al. [9] about 17%, the yield of rice husk as a byproduct of rice mill 20-22% [10]. An abundant Si source from rice husks is an opportunity to replace Si fertilizer derived from synthetic fertilizers.

The utilization of rice husk as a source of Si can be done by various methods such as by composting, fermentation and extraction process. The process of composting and fermentation of rice husks takes longer time due to the high Si content and the large area due to rice husks was voluminous. The method of extraction of Si is chosen with the consideration of time required more quickly, Si extract produced in the form of concentrate to facilitate the distribution and application by farmers.

Si content from rice husk silicate extract according to laboratory analysis of Laboratory of Soil and Plant Nutrition [11] Universitas Padjadjaran is 0.68 %. Utilization of rice husk silicate extract on hydroponics rice potential as an alternative source of Si which is cheap and availability to increase the growth of paddy plants.

2. Materials and Methods
This research has been conducted in April-June 2018 in Cileunyi District, Bandung Regency (+ 689 m above sea level). Materials and tools used in research, namely: nutrient container, netpot, Styrofoam, paddy seed (Ciherang varieties), sprayer, EC meter, pH meter, KOH 1.5%, rice husk and rockwool.

The research design used was a complete randomized design. Factor Si source consist of two levels, namely: A = Silica rice husk extract 20 ml/L and B = inorganic silica (Na$_2$O:Si) Each treatment was repeated 10 times. Parameters measured, i.e. plant height, electrical conductivity (EC) of nutrients and pH of nutrients. The observed data were then analysis using analysis of variance at 5% level, if the F test result significant, the data then analysis with Duncan multiple range test at 5% level.

The research procedure stage, respectively: making of rice husk silicate extract, making of plant nutrient AB Mix, making hydroponics installation (Fig 2), seeding, transplanting and maintenance. The stage of preparation of silicate extract and hydroponic nutrient preparation is an important stage of all stages of research. The preparation of the silicate extract of paddy (Fig 1) begins by smoothing the rice husk size into flour, then add 50 g of husk into the pot with addition KOH 1.5% as much as 100 ml, add water 500 ml then heated to boiling [12]. Cooling process of rice husk extract then filtered so that macro particles do not destruct the sprayer at the time of silicate application.

![Figure 1. Stages of Silicate Rice Silicate Extraction Process](image-url)

The AB Mix nutrient preparation carried out in this study consisted of two formulations i.e. formulation of Peckenpaugh (2004) for paddy crops was used as the basis for making nutrient AB Mix paddy (in units of ppm), namely: N (249); P (58); K (80); Mg (65); Ca (317); S (87); Si (100); Fe (5); Mn (3); B(0.7); Zn (0.4); Cu (0.07) and Mo (0.05). Based on the calculation of Qurrohman (2017) [6] based on the reference of nutrient formulation obtained calculation of fertilizer requirement (in grams unit), namely: Fertilizers A ( Ca(NO$_3$)$_2$ (1.444 g); KNO$_3$ (213 g); Fe-EDTA (38 g) ), Fertilizer B ((KH$_2$PO$_4$ (260 g); MgSO$_4$.7H$_2$O (673 g); MnSO$_4$.4H$_2$O (12 g); CuSO$_4$.5H$_2$O (0.28 g); ZnSO$_4$.7H$_2$O (1.8 g); H$_3$BO$_3$ ( 4 g); (NH$_4$)$_6$Mo$_7$O$_24$ (0.1 g); Na$_2$O:Si (329 g) ).
3. Results and Discussion

3.1. Plant Height
Based on the results of the F test, silicate rice husk extract and synthetic silicate (Na$_2$O$_3$Si) were not significant effect with the plant height parameters (Table 1). The result of paddy height hydroponic (Ciherang variety) modified wick system at 21 day after planting (DAP) is lower than Amrullah et al. [8] on rice (Ciherang variety) aged 12 DAP (48.67 cm) and 28 DAP (73.40 cm) in the control treatment without silicate application. The height of paddy plants in this study is shorter compared to conventional paddy growth.

Application of paddy plant nutrition in accordance with the growth phase in this research have not gain expected growth results. Hydroponic technology according is one technology to increase growth and yield [14, 15]. The cultivation of hydroponic paddy according to Köhl has considerable difficulty compared to vegetable hydroponics [16]. Basically paddy plants have a high adaptability to low oxygen content and high Fe$^{2+}$ content. In this study modification of wick system installation and silicate application has not resulted an optimum growth response.

| Treatments | Average (cm) |
|------------|--------------|
| A          | 19.96$^{ns}$ |
| B          | 21.85$^{ns}$ |

Coefficient of Variance (CV) 12.17 %

Table 1. Average Height Parameter at 21 DAP

Remarks: $^{ns}$ = non-significant at 5 % significant level F test

The visual appearance of the plants in this study (Fig.3) the leaves showed symptoms of chlorosis, stunted growth and roots that grew with “browning symptoms” of brownish roots. Paddy plants with healthy growth have a dark green leaves appearance and white roots. Based on diagnostic key for identifying nutrient deficiencies in rice from Dobermann & Fairhurst paddy plants show symptoms of N and Fe deficiency [17]. The symptoms of N deficiency in this study were suspected because N and Fe uptake were inhibited, the nutrient source used in this study used a N-total formulation of 249 ppm lower than that of rice nutrition used by Júnior, et al. N-total formulation of 263 ppm [18]. The inhibition of N uptake in this study was influenced by the average pH of the treated nutrient A (6.17) and B (6.71). Recommended pH optimum for hydroponic rice growth according to Ying-Hua et al. [19] the level of acidity of nutrient maintained at pH 5.5.
The results of this study confirm the results of previous studies show that plant height is affected by pH and EC value. Hydroponic technology has many advantages over conventional cultivation but not automatically produce quality plant [20].

![Figure 3. The condition of the hydroponic rice plant](image)

The growth of paddy crops in this study has not gain expected results. The use of rockwool as a planting medium in paddy plants has not been optimal in supporting plant growth. Utilization of organic planting medium is expected to help plant growth. The research results show that composting and rice husk charcoal medium (1:1 v/v) can increase plant growth [21].

### 3.2. Nutrient solution pH value

Water quality is critical to the successful plants production in hydroponics [22]. Adjustment pH value and EC value of the nutrient solution affect the nutrient uptake by plants. The pH value is an indicator of the acidity or alkalinity of the nutrient solution, the acid nutrient solution causes the plant cannot absorb macro elements maximally otherwise if the nutrient solution alkaline plant can absorb macro elements excessively and uptake of micro elements by the plant is inhibited neither acid or alkaline but close to neutral. The optimum pH value (5.5-6.5) required by the plant to absorb nutrients adequately according to its growth phase [20]. The optimum pH hydroponic paddy plants is in the range of pH values of 5.6 ± 0.2 [18]. The initial pH values (treatments A and B) used in this research were 6.5, after 21 DAP pH value change in the nutrient container (Table 2).

| Table 2. Change of pH of Nutritional Solution after 21 DAP |
|----------------------------------------------------------|
| Treatments | Average of pH value<sup>)</sup> |
| A           | 6.17 a                       |
| B           | 6.71 b                       |
| Coefficient of Variance (CV)                           | 2.23 %                       |

Note : <sup>)</sup> The numbers followed by the same letters (lowercase letters vertical in column) indicate no significant difference according to Duncan Multiple Range Test at 5% level

The addition of inorganic Si (Na<sub>2</sub>O<sub>3</sub>Si) significantly affected the change of pH of the solution after 21 DAP. The addition of Na<sub>2</sub>O<sub>3</sub>Si compounds is suspected cause a higher uptake of nutrient-enriched nutrient absorption than without Na<sub>2</sub>O<sub>3</sub>Si, so that the OH concentration increases.

### 3.3. Electrical Conductivity (EC)

EC values are widely used as parameters in hydroponic plant nutrition. The increase in EC values is affected by the concentration of ions in the concentrated solution. The concentration of nutrient solution
of EC value increases and vice versa [23]. Fluctuations in EC values other than temperature-induced are also affected by decreased bicarbonate (HCO$_3^-$) during the process of photosynthesis (in Furtbach condition becomes evident uptake CO$_2$ for primary biomass during photosynthesis that reduction bicarbonate [24].

The initial EC value assigned to each treatment was 2 mS/cm (EC = 2). EC value after 21 DAP has increased (Table 3). The increase in EC values in this research was thought to be influenced by an increase in the temperature of the nutrient solution, the condition confirming the statement [25] that the value of EC will increase along with the increase in temperature. The EC’s value of nutritional oceans should theoretically decrease because the ions present in the nutrient solution are absorbed by the plant. Increasing the value of EC compared to the initial EC value is a sign that plants experience barriers in absorbing nutrients. This condition is visually reinforced by the plants undergoing chlorosis and the addition of inhibited height (Figure 3). The variation of EC values on mustard plants (dicotyl) have an effect on plant height but in the rice plant (monocot) various EC value un-significant affect vegetative phase.

| Table 3. Change of EC value after 21 DAP |
|------------------------------------------|
| Treatments                  | Average |
| A                          | 2.758 b |
| B                          | 2.442 a |
| Coefficient of Variance (CV)| 5.20 % |

The numbers followed by the same letters (lowercase letters vertical in column) indicate no significant difference according to Duncan Multiple Range Test at 5% level

4. Conclusions
The application of 20 ml/L rice husk silica extract can be used as an alternative source of Si for paddy plants. The role of Si element in vegetative phase do not affect paddy plant growth especially plant height.

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