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Effectiveness of Ameliorant Humic Acid and Silica Based on Availability of Sandy Soil Nitrogen for Rice

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ABSTRACT

Sandy soils generally have high macro pores and a low ability to provide water and plant nutrients. This condition is caused by the soil matrix which has almost no negative charge, so there is no strong adsorption capacity for ions and water. The next impact is that nutrients and water are easily lost because they are washed or evaporated. Nitrogen loss has been reported to reduce rice production by 6.10%. The purpose of the study was to examine the effectiveness of ameliorants based on humic acid and silica in improving nutrient availability and sandy soil water. Humic acid from compost and silica from husk charcoal is expected to increase the negative charge of the soil (cation exchange capacity) so that it can adsorb and fix (chelate) nutrient ions such as nitrogen. The study was structured using a factorial Completely Randomized Design (CRD). The first factor is silica dose with a level of 0 ton/ha, 0.5 ton/ha, 1 ton/ha, and 1.5 ton/ha. The second factor is the dose of humic acid with a level of 0 kg/ha, 20 kg/ha, 40 kg/ha, and 60 kg/ha. Rice plants are used as growth indicators. Observation parameters include the availability of N in the soil, the growth of rice plants which includes plant length and the number of tillers, and plant chlorophyll. The results showed that the combination of humic acid and silica had no significant effect on plant length, the number of tillers, and nitrogen availability in the soil. However, it has a significant effect on plant chlorophyll.

Keywords: Humic acid, silica, rice, nitrogen

Introduction

Sandy soil is one of the soils that require the management of soil chemical properties. The dominant sandy soil has macrospores, and high porosity, and the ability to hold water and nutrients is low so that the nutrients in it become easily lost (Lumbanraja & Harahap, 2015), one of which is nitrogen. Nitrogen is needed by plants in large quantities during the vegetative period of plants but nitrogen in the soil is easy to move so its presence changes quickly and is easily lost. Nitrogen loss is caused by volatilization, denitrification, leaching, erosion, and loss with the harvest. Rice production in East Java decreased by 6.10% compared to 2018 (BPS, 2020). One of the causes of the decline in rice production is the loss of nitrogen nutrients so that nutrient uptake is less than optimal (Liu et al., 2019). The existence of these problems, then efforts are made to improve it, such as the provision of soil improvement materials that have the potential to overcome the problem, namely acid humic and silicon oxide.

Acid humic is an organic acid that makes up humus substances that can increase the ability of the soil to bind, chelate, and absorb nutrients thereby reducing nutrient loss due to leaching (Ali & Mindari, 2016). This ability is inseparable from the presence of active groups possessed by acid

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humic and high cation exchange capacity to absorb nitrogen, phosphorus and potassium nutrients thereby increasing absorption, quality, and rice production (Mahmood et al., 2019). The provision of humic acid and NPK fertilizers can increase nutrient uptake, especially nitrogen in rice plants (Nuraini & Zahro, 2020).

Silicon oxide is a chemical compound that is found in several natural materials, such as minerals, vegetables, and so on. Silicon oxide application can reduce nutrient loss, increase nutrient availability, increase cation exchange capacity (CEC) (Kristanto, 2018), increase nutrient uptake such as nitrogen (Alsaeedi et al., 2019), increase rice plant growth, and affect the translocation of nutrients from roots to plant shoots (Greger et al., 2018). Based on the background of the problem, it is necessary to conduct further research on soil enhancers that have the potential to improve the properties of sandy soils such as acid humic and silicon oxide, and their doses on nitrogen availability and optimal growth of rice plants.

Material and Methods

The research was conducted from March 2021 to September 2021 in the greenhouse and land resource laboratory of the Faculty of Agriculture, National Development University "Veteran" East Java. The study was structured using a factorial Completely Randomized Design (CRD). The first factor is the dose of silicon oxide (S) with a level of 0 ton/ha (S0), 0.5 ton/ha (S1), 1 ton/ha (S2), and 1.5 ton/ha (S3). The second factor is the dose of acid humic (H) with a level of 0 kg/ha (H0), 20 kg/ha (H1), 40 kg/ha (H2), and 60 kg/ha (H3). The research was carried out in several stages, namely preparation, treatment application, planting, plant maintenance, routine observation, and harvesting. The preparation stage includes the extraction of soil enhancers, namely the extraction of acid humic from compost and the extraction of silicon oxide from rice husks. The next preparation is the preparation of planting media, namely sandy soil, by inserting 7 kg of soil into each pot. The soil used in this study is sandy loam textured soil. In the treatment application stage, the pot containing the growing media was then given acid humic and silicon oxide in combination according to a predetermined experimental design. media planting media that has been applied treatment are incubated for 5 days. In the planting stage, the seeds of the Cibolo variety of rice plants that have been sown and aged 17 days are transferred to pots that have been treated. In the maintenance phase, the maintenance carried out includes watering, weeding, and controlling plant-disturbing organisms. In the observation stage, observations were carried out once a week for the parameters of plant length and number of tillers. Meanwhile, sampling of nitrogen parameters was available at 0 DAP and 15 DAP. The data obtained were analyzed using analysis of variance (ANOVA) and performed with the F test at an error rate of 5%, to determine the effect of the applied treatment. Then, if there is a significant difference from the treatment, a further test of Honest Significant Difference (BNJ) is carried out at an error rate of 5%.

Results and Discussion

The results of the study (Table 1) showed that the administration of silica had a significantly different effect on NH_4^+ when the plants were 15 DAP. This shows that NH_4^+ adsorbed by silica is not immediately released into the soil solution and silica can slow down the process of converting NH_4^+ to NO_3^- (Nainggolan et al., 2009) to reduce nutrient loss in sandy soils (Kristanto, 2018). The interaction of humic acid and silica also had a significantly different effect on the availability of nitrogen in sandy soils at the age of 15 DAP. This shows that the application of soil enhancers by combining humic acid and silica can provide high nitrogen nutrients and reduce nitrogen loss (Mahmood et al., 2019) so that plants can utilize nitrogen nutrients for optimal growth.

Table 1. Effect of acid humic and silicon oxide on nitrogen availability 0 DAP and 15 DAP

Treatment	F-Calc.			F-Table	
	NH_4^+	NO_3^-	N-Available	5%	1%
	--- 0 DAP ---				
Silicon oxide	0.528ns	2.447ns	2.889ns	3.197	5.185
Acid Humic	1.985ns	0.412ns	0.766ns	3.197	5.185
Silica and Humic Acid Interaction	1.786ns	0.433ns	0.470ns	2.494	3.682
	--- 15 DAP ---				
Silicon oxide	3.201*	2.383ns	0.546ns	3.197	5.185
Acid Humic	1.094ns	0.935ns	2.191ns	3.197	5.185
Silicon oxide and Acid Humic Interaction	1.061ns	2.067ns	3.233*	2.494	3.682

*Notes: ** Very Significant, * Significant, ns Not Significant*

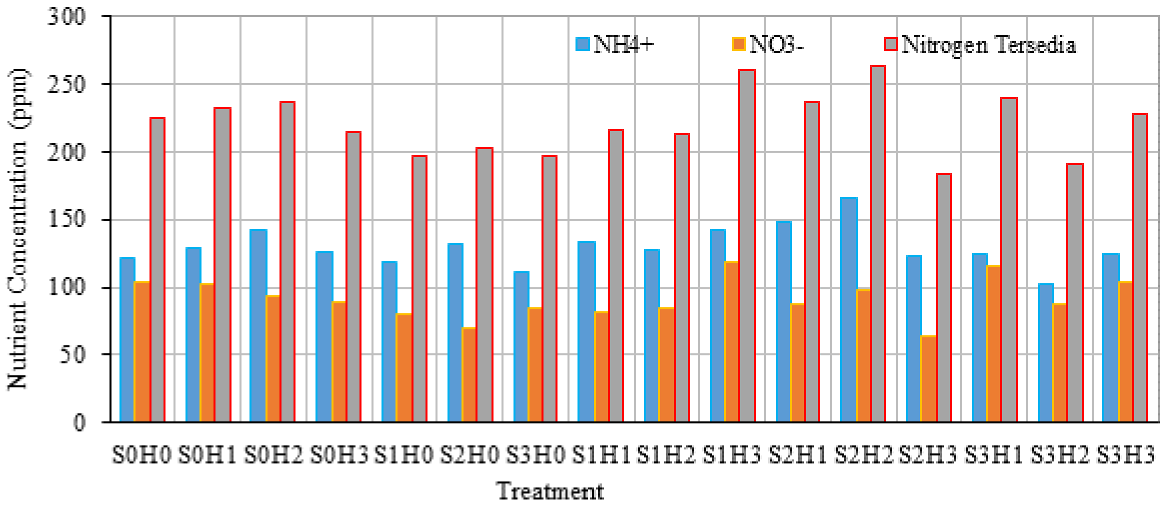

Figure 1. Effect of combination of acid humic and silicon oxide on nitrogen availability in the soil the dose combination of acid humic and silicon oxide gives different effects

Figure 1 shows that the best combination dose of soil enhancer is silicon oxide 1 ton/ha and acid humic 40 kg/ha (S2H2), where the highest nitrogen nutrient availability is 263.55 ppm compared to other combinations. The application of acid humic 40 kg/ha can increase the availability of nitrogen in the soil and the application of silicon oxide from rice husk ash 1 ton/ha can increase the nitrogen value in the soil (Nwite et al., 2019).

Plant height

The results of the analysis of variance (Table 2) showed that the treatment of silicon oxide, acid humic, and their interaction did not give a significant effect on the height of rice plants at the age of 0, 7, and 14 DAP. It is suspected that the administration of silicon oxide and acid humic doses has not been able to increase the availability of nutrients and result in the height of rice plants up to the age of 14 DAP.

Table 2. The effect of acid humic and silicon oxide on nitrogen availability in 0 DAP (days after planting) and 15 DAP

Treatment	F-Calc.			F-Table	
	NH_4^+	NO_3^-	N-Available	5%	1%
--- 0 DAP ---					
Silicon oxide	0.528ns	2.447ns	2.889ns	3.197	5.185
Acid Humic	1.985ns	0.412ns	0.766ns	3.197	5.185
Silicon oxide and Acid Humic Interaction	1.786ns	0.433ns	0.470ns	2.494	3.682
--- 15 DAP ---					
Silicon oxide	3.201*	2.383ns	0.546ns	3.197	5.185
Acid Humic	1.094ns	0.935ns	2.191ns	3.197	5.185
Silicon oxide and Acid Humic Interaction	1.061ns	2.067ns	3.233*	2.494	3.682

*Notes : ** Very Significant, * Significant, ns Not Significant*

Figure 2 shows that the soil amendment treatment that gave the best response to the length of rice plants at the age of 7 DAP and 14 DAP was the dose of silicon oxide 1 ton/ha and acid humic 0 kg/ha (S2H0) compared to the other treatments. This statement is the same as Singh et al. (2005) who revealed that the administration of silicon oxide can increase growth in rice plants.

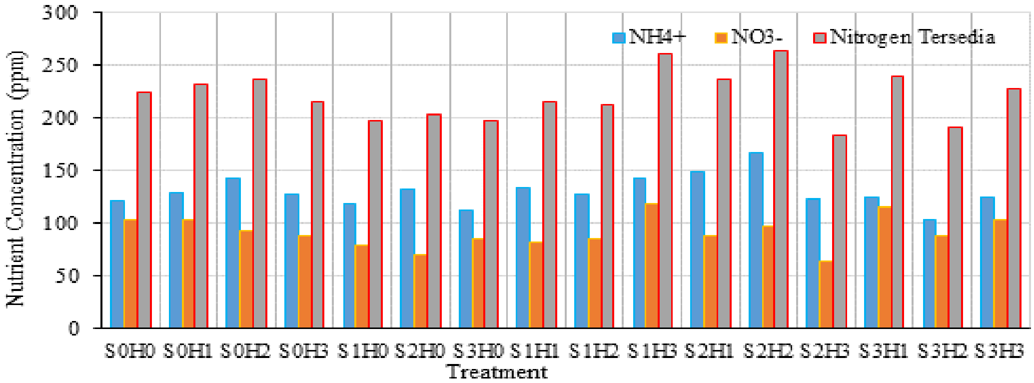

Figure 2. Effect of combination of acid humic and silicon oxide on nitrogen availability in soil

Several tillers Figure 3 shows that the number of tillers at the age of 0 and 7 DAP was the same, namely 3 pieces. This shows that rice plants at that time were still adapting after the transplanting process. However, at 14 DAP, it began to show an increase in the number of tillers. The soil ameliorant treatment that gave the best effect on the number of tillers of 14 DAP was the treatment with a dose of silicon oxide 1 ton/ha and acid humic 40 kg/ha (S2H2). This indicates that the rice plant began to absorb the nitrogen nutrients needed for plant growth in line with the condition of the highest nitrogen nutrient availability in the S2H2-treated soil (Figure 1).

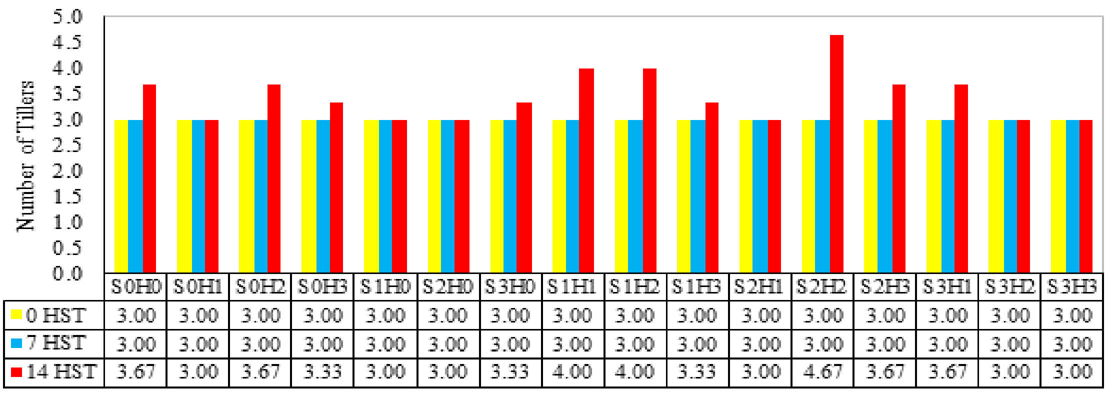

Figure 3. Effect of the combination of acid humic and silicon oxide on the number of tillers of rice plants

Conclusion

Based on data analysis from research that has been done, it can be concluded that:

1. The combination of acid humic and silicon oxide did not significantly affect the length of the plant and the number of tillers but had a significant effect on the availability of nitrogen in the soil.
2. The combination of silicon oxide 1 tons/ha with acid humic 40 kg/ha (S2H2) can increase nitrogen availability in sandy soil and the number of tillers in rice plants.
3. Silicon oxide dose of 1 ton/ha gave the best response for the parameter of rice plant height compared to other treatments.

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