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Utilization of Rice Husk Ash From Waste Brick Factory as Silicate Fertilizer Source in Improving Quality of Paddy (Rice) on Rainfed Land

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Abstract

Si is very important element in cereal crops, especially rice. Si sources are found out in straw and rice husk ash as a waste brick factory which until recently was considered as waste that has not been utilized optimally. Rice is a staple food for the people of Indonesia, therefore, rice plays an important role in economic life and the situation of rice indirectly affect the situation of other materials consumption. The use of ash bricks waste are derived from rice husk is a source of nutrients Si that is needed by the rice plant, where it can form a strong plant tissues, so that the plants resistant to the disease which eventually also can improve the yield and quality of rice plants. Rainfed as sub-optimal land which has fundamental problems, fluctuations in soil moisture is very high which causes dryness of land becomes a major problem and the quality of the paddy (rice) became greatly decreased. This study aims to determine the effect of rice husk ash as a source of silicate in improving the quality of grain (rice) on rainfed. Husk ash as a brick factory waste derived from rice husk which contains silicates which have an excellent opportunity to improve the quality of grain (rice). The study focused on the planting of the rice crop in sub-optimal land, using rice husk ash brick factory waste as a source of silicate fertilizer. The results showed that application of waste from rice husk ash brick factory enriched with fertilizer N, P and K can increase production, quality and quantity of grain (rice) in rainfed Vertisol soil.

Keywords: rice husk ash, waste brick factory, the source of silicate fertilizer, grain quality (rice), rainfed

1. Introduction

Si element is very important in cereal crops, especially rice. Si sources are found out in straw and rice husk ash as a waste brick factory which until recently was considered as waste that has not been utilized optimally. Thus giving silicate material is an alternative that may be made in reducing fixation and improve the availability of P in the soil (Mukhlis, 2011).

The role of Si nutrients for plants that can stimulate photosynthesis and translocation of carbon dioxide (CO2) (Yukamgo & Yuwno, 2007). Silica accumulated on rice leaf serves to keep the leaves remain upright so help catching sunlight in the process of photosynthesis and translocation of CO2 into panicles (Fitria, 2010). The elements can also reduce abiotic stresses, such as temperature, light radiation, wind, water, and drought, as well as increasing plant resistance against biotic stresses, such as disease and pest attack. Silica strengthens the plant tissues that are more resistant to disease and pests. This function is similar to the role of K for plants.

The Combination of rice husk ash, azolla, rock phosphate give the highest aggregate stability that improve physical properties of soil (Nurcahyani, 2014). While the chemical content of the burning of rice husk ash (% by weight) are: SiO2 (86.90 to 97.30), K2O (0.58 to 2.50), Na2O (0.00 to 1.75), CaO (0.20 to 1.50), MgO (0.12 to 1.96), Fe2O3 (0.00 to 0.54), P2O5 (0.20 to 2.84), SO3 (0.10 to 1, 13), and Cl (0.00 to 0.42).

Excessive P fertilizer application results in the case of fixation P by Al-active. Of high fertilizer P application that is absorbed by plants is only 13-15%. Ameliorant materials application needed to reduce the influence of Al-active, such as the application of lime, silica, and organic materials. (Uehara & Gilman, 1981) argues that this condition can be done by reducing fertilizer P in large quantities, it can also be done with organic matter, or the application of silicate materials.

Sufficient Si availability in the soil also increases plant resistance to an imbalance of nutrients, such as an excess of N, defficiencies and excess of P, as well as poisoning Na, Fe, Mn, and Al. Excess N elements causes the leaves become soft and not upright, so that the absorption of light for photosynthesis less than optimal. By adding Si, the process of photosynthesis will be maximized.

Si can also replace fixation P by Al and Fe so that P becomes available to plants. Availability of P in the plant affected by the concentration of Fe and Mn. Availability of P in the plant will be reduced if higher concentrations of Fe and Mn. The sufficient Si available can suppress Fe and Mn in the plant so that P becomes more available. In addition, the supply of Si can increase the translocation of P to the panicle so that the role of P is more optimal for the plant. Na toxicity can be reduced by lowering the rate of respiration when Si enough for the plants to prevent poisoning Na in plants.

With these functions of Si, it is absolutely nutrient necessary by plants. Its role as a beneficial nutrient that can be turned into essential nutrients as the development of science and the concept of essential nutrients and nonessential based on the relationship of soil, nutrients, and plants. Lack of information on nutrient sources Si and the level of solubility causes the unfamiliarity with Si fertilizer for rice. Not many experts or specialists who focus on studying Si nutrient and fertilization of Si. However, in order to achieve sustainable agriculture in Indonesia, the research and study should begin fertilizing Si.

The content of Si in the soil in a low condition when SiO2 is less than 600 mg per kilogram of soil. This condition is usually found in soils that have undergone further weathering and rainfed land, also lowland rice land that planted with rice 3 times continuesly in each year.

Burning of husk ash at a temperature of around 600^{o}C (as in a brick burning) will produce white amorphous SiO2 is more available to the crops. While ashing at a temperature of 800^{o}C or more will produce crystalline silica are not available to plants. While burning at low temperature, silica is still bound to an organic compound that is black as charcoal husk.

Rice is a staple food for the people of Indonesia, therefore, rice plays a role in economic life and the situation of rice indirectly affect the situation of other consumption materials (Soemartono, S Bahrin, & Harjono, 1994).

In Indonesia, food is defined as rice. Shortage of rice in the same interpreted as lack of food, the availability of rice on the market in sufficient quantities and affordable by the people's is very big influence on economic stability and the stability of national security and defense. Therefore, efforts to continuously increase rice production to achieve food self-sufficiency in a sustainable manner is a key priority in the development of the agricultural sector. The agricultural sector in national development has a very important role. This sector is required to be increased, grow and become established as an agricultural system that is resilient.

In an effort to increase production of rice, intensification plays a very important. Increased rice production was mainly due to the increasingly widespread effort intensively, which covers most of the rice area in Indonesia (Fagi & Las, 1988). Intensification can be achieved with the implementation of the five farms, where fertilization is one important factor that can not be abandoned (I. Nasution, 1989).

In using of fertilizers, in general, Urea fertilizer that contains nitrogen are the mainstay, so that the use of fertilizers others received less attention so that if it continues then defficiency of other elements will be a very big problem. Excessive use of nitrogen fertilizer will cause the soft tissue so that the plants susceptible to disease that can lead to decreased quality results, if not offset by the addition of other nutrients. The use of ash bricks waste are derived from rice husk is a source of nutrients Si that is needed by the rice plant, where it can form a strong plant tissues so that the plants resistant to the disease which eventually also can improve the yield and quality of rice plants.

Rainfed as a sub-optimal land which has fundamental problems, fluctuations in soil moisture is very high which causes dryness of land becomes a major problem and the quality of the paddy (rice) became greatly decreased.

Based on those above problems it is necessary to use ash from brick factory waste as a source of silicate fertilizer in improving the quality of grain (rice) in rainfed.

2. Research Methodology

The research activities focused on planting rice plants in sub-optimal land, using rice husk ash brick factory waste as a source of silicate fertilizer by testing a dose of waste rice husk ash brick factory on the growth and yield of rice plants. This study was a randomized complete block design with one factor, namely the dosage use of rice husk ash brick factory waste as a source of fertilizer enriched silicate, with 8 level dose of fertilizer each repeated 3 times. The research was carried in rain-fed agricultural land Ngringo village, Jaten, Karanganyar from April to August 2015 on Vertisol soil. The dosage of fertilizer applied is A0 (0 kg rice husk ash), A1 (150 kg / ha), A2 (300 kg / ha) , A3 (450 kg / ha), A4 (600 kg / ha), A5 (750 kg / ha), A6 (900 kg / ha), A7 (1,050 kg / ha). Parameters measured and observed were plant height, number of tillers total per clump, the number of productive tillers per clump, the number of filled grain per panicle, weight of grain per plot, weight of grain per hectare, weight of 1000 seeds, the percentage of grain hollow, the percentage of white green / whitewash , the percentage of broken rice, and the percentage of rice grains of chalk.

3. Result and Discussion

The use of rice husk ash brick factory waste as a source of silicate enriched with fertilizer N, P, and K has been tested in rainfed rice fields, on Vertisol soil. From the observation of growth, production and quality of rice produced, can be described as follows. In the vegetative phase, giving silicate is not so significant, the average plant height of 91.37 cm, the total number of tillers average of 24 stems/clump and a number of productive tillers average of 18 stems/clump. In the generative phase, silicate giving real effect to the highly significant on all parameters, both the quality and quantity of production. Giving silicate can increase average production up to 20% compared to the no fertilizers silicate, ie with a dose of 300 kg / ha of rice husk ash can boost the production of dry grain harvest equivalent of approximately 10 tonnes / ha (treatment A2) than those who were not given fertilizer silicate , whose production is only about 8 tonnes / ha (treatment A0). Giving silicate may increase with the very real number of filled grain per panicle, grain weight per plot, weight of 1000 seeds of grain, as well as greatly reduce the real percentage: grain hollow, green grain, broken rice and lime in grains rice.

In the rain-fed land will generally deficient Si, especially in the Vertisol soil. The content of the original of secondary minerals (minerals Klei) on Vertisol soil is low, as well as Si of primary mineral. Provision of materials that are rich in Si is needed to overcome the defficiency of Si. Silicates in the soil levels are classified as low if SiO2 is less than 600 mg per kg of soil. Husk ash application on agricultural land, in addition to increasing the Si in the soil, may also increase other nutrients in the soil, because husk ash also contains elements K, Na, Ca, Mg, P, S and Cl. Husk ash as well as act as a soil conditioner, because in addition to improving nutrients, also can improving soil physics and neutralize the pH of the Vertisol soil (Chairunnisa, Hanum, & Mukhlis, 2013; Djajadi, 2013; D. Y. Nasution, 2006; Wogo, Segu, & Ola, 2011).

The availability of sufficient silica in the soil will be able to increase the availability of P in the soil, because fixation of P by other compounds will be suppressed. The function of the plant tissue is very much at all, including the increase of photosynthesis, increase plant resistance to pests and diseases, reducing transpiration and increase resistance to drought. So great was the role and function of silicate either in soil or in plant tissue, so the addition of silicate into the soil in certain cases need to be done. Giving silicate on rainfed rice soil can improve the quality and quantity of production of rice in the Vertisol soil.

4. Conclusion

The application of rice husk ash brick factory waste enriched with fertilizer N, P and K can increase production, quality and quantity of grain (rice) in rainfed Vertisol soil. The best results from this study are: the highest grain production 10.58 ton/ha at treatment more than 300 kg/ha husk ash. Being the best quality with the highest filled grain per panicle 139 grains / panicle on the treatment of rice husk ash 750 kg/ha, the highest weight of 1000 grain is 31.28 g on the treatment of 900 kg/ha husk ash, the lowest percentage of empty grain 3.2% in treatment husk ash 900 kg / ha, the lowest percentage of green grains 7.2% in treatment husk ash 1050 kg / ha, the lowest percentage of broken rice 5.4% on the treatment of husk ash 1050 kg / ha, and the lowest percentage of rice grains whitewash 1.08% at treatment husk ash 1050 kg / ha.

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Appendix

The observation of plant parameters

Treat-ment	Plant height (cm)	Total Number of Tillers / Clumps	Tot Productive Tillers / Clumps	Tot Grain Fill / Panicle	Grain weight per plot (g)	Weight of 1000 seeds (g)
A0	92.75	27.17	18.17	105.33	2200	25.07
A1	90.67	21.67	17.17	123.50	2400	25.63
A2	90.25	26.33	19.50	129.50	2667	28.66
A3	90.33	21.67	18.67	132.83	2667	29.53
A4	90.58	25.00	19.00	137.33	2667	30.56
A5	92.43	22.83	17.00	139.33	2633	30.46
A6	92.67	21.17	19.33	135.67	2667	31.28
A7	91.25	25.67	17.00	130.67	2633	30.89

Treat-ment	Weight of 1000 seeds (g)	% Item Vacuum	% Grain Green	% Broken rice	% Rice Grain whitewash
A0	25.07	6.60	11.14	9.28	2.08
A1	25.63	6.43	8.77	6.58	1.21
A2	28.66	6.23	8.50	6.03	1.32
A3	29.53	5.77	8.04	6.37	1.27
A4	30.56	4.27	7.52	5.64	1.13
A5	30.46	4.20	7.58	5.69	1.14
A6	31.28	3.20	7.31	5.48	1.10
A7	30.89	3.37	7.22	5.42	1.08