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### RESEARCH ARTICLE

#### THE EFFECT OF AMENDMENT APPLICATION TO SOIL QUALITY OF NEW PADDY FIELDS IN TEUREUBEH VILLAGE, ACEH BESAR DISTRICT.

Muhammad Nasir<sup>1</sup>, Muyassir<sup>2</sup> and Syakur<sup>2</sup>.

1. Post Graduated Student, Department of Land Resources Conservation, Syiah Kuala University, Darussalam-Banda Aceh, Indonesia 23331.
2. Soil Science Department, Faculty of Agriculture, Syiah Kuala University, Darussalam-Banda Aceh, Indonesia 23331.

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#### Abstract

Rice (*Oryza sativa* L.) are the main food crops in Indonesia because most of Indonesia's population consumes rice as a staple food. The need for rice which continues to increase is not balanced with optimal land availability. The conversion of land, especially rice fields which are residential areas is one of the government's obstacles in increasing rice production. In addition, a decrease in the quality of soil in terms of soil chemical properties also becomes a problem that must be solved. In this study, an experiment was conducted on the use of various types of ameliorant in new rice fields in Teureubeh Village, Aceh Besar District. This study used the Factorial Randomized Block Design. The first factor is a new type of rice variety (V) consisting of 3 levels, namely Sanberasi U1 (V1), Sanberasi U3 (V2), and Inpari 30 (V4). The second factor is soil amelioration material (A) which consists of 3 levels namely control (A0), rice husk biochar (A1), rice straw compost (A2), and repeated 3 times so that there are 27 units of experimental units. The results show that there is no significant effect on improving the quality of new rice fields, however there was a significant effect on the growth of new type of rice local variety.

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#### Introduction:-

Rice (*Oryza sativa*) is a staple food for most people in various parts of the world. The consumption of rice in the international community is estimated to reach 35% of the entire human population, while in Indonesia alone it covers 90% of the population relying on this source of energy (Mahraban et al. 2008). Meanwhile, the national average rice production has only reached 74.11 million tons ha<sup>-1</sup> with a total production of 78.81 million tons year<sup>-1</sup> (Ministry of Agriculture, 2018). This number was estimated to not be able to meet national food needs so the government takes a policy of importing rice to ensure national food availability. As an illustration, in 2017 and 2018 the government has imported 2.25 million tons of rice from Thailand, Pakistan, Myanmar, India, China and the State of Vietnam (BPS, 2018).

To improve rice production, the Indonesian government has also developed an extensification program through new paddy field printing activities achieved in the period 2010 - 2014 covering an area of 2 million hectares, however,

**Corresponding Author:-Muhammad Nasir.**

Address:-Post Graduated Student, Department of Land Resources Conservation, Syiah Kuala University, Darussalam-Banda Aceh, Indonesia 23331.

the productivity of the new paddy fields is still very low due to limited water and soil acidity problems, like Al and Fe toxicity. There are some obstacles in the effort to develop paddy fields in Indonesia, namely: 1) low soil pH so it must be increased (pH 7) and limited soil nutrient availability; 2) increase in Fe solubility and poisoning problems; 3) potassium deficiency; 4) fertilizer recommendations are applied globally at each different location/land; 5) lack of fertilizer recommendation research in specific locations; 6) large water requirements for slumping and; 7) land productivity is still low (Efendi, 2010).

The use of various ameliorants for improving the quality of rice fields has been carried out and has shown positive results in Indonesia. The results of Zuraida (2013) stated that the administration of ameliorant materials on peat soils significantly increased the pH of H<sub>2</sub>O, K-exch, Na-exch, Ca-exch, Mg-exch, and base saturation, while there were not many uses of ameliorant in rice fields.

Another strategy for utilizing sub-optimal rice fields is to use varieties that are tolerant to local environmental conditions. Appropriate handling efforts in managing new open fields, such as the use of site-specific tolerant varieties, the use of balanced fertilizers and pest control can increase yields in the new open fields (Mildaerizanti and Handoko, 2016). There are various local rice varieties in Aceh that are resistant to various environmental checks but, the production is low (1.5-2.5 tons ha<sup>-1</sup>) and the age is extensive (4-5 months).

The genetic properties of these varieties have been successfully reassembled through various breeding programs so that new variety of mutant strains that produce the same are obtained, even exceeding the production of national varieties with short lifespan (105-120 days). This local variety are able to live and produce in environmental stress conditions, but this mutant strain still needs more in-depth study of its agronomic characteristics in various environmental stress conditions such as suboptimal new rice fields.

The interaction of environmental stress conditions by the agronomic characteristics of the new type of mutant line will be the basis for formulating its management technology in new rice fields. The purpose of this study is that the productivity of new rice fields can be improved by using the right type of mutant lines so that government investment in extensification programs becomes meaningful, and supports the increase in national rice production and can reduce food imports by the government.

## **Research Method:-**

### **Experimental Field**

The research was conducted in the community's new rice field opened in 2016 in Teureubeh Village, Kota Jantho District, Aceh Besar District. Analysis of soil samples was carried out at the Soil and Plant Research Laboratory of the Faculty of Agriculture, Syiah Kuala University.

### **Materials:-**

The material used in this study was compost made from rice straw which was decomposed by EM4, biochar made from rice husk, and the seeds used were new local rice variety seeds, namely Sanberasi U1, Sanberasi U3, and Inpari 30 derived from Seed Laboratory Faculty of Agriculture, Syiah Kuala University, Banda Aceh, Indonesia.

The equipment used in this study were: pH, hoes, rakes, digital scale, rulers, plastic bag and glass were.

### **Experimental Design**

The design used in this study is the factorial randomized group design. The first factor is a new local rice variety (V) consisted of 3 levels, namely Sanberation U1 (V1), Sanberation U3 (V2), and Inpari 30 (V4). The second factor is soil amelioration material (A) which consisted of 3 levels namely control (A0), rice husk biochar (A1), rice straw compost (A2). Each treatment was repeated 3 times so that there were 27 experimental units. The results were analyzed by the F test. If the analysis of variance shows a significant effect between treatments, the analysis is continued with the Least Significant Difference Test (LSD) at the level of 5%.

### **Experimental Procedure**

The analysis of the soil samples was done by taking a composite sample of soil from several locations of the experimental site. The analysis of soil chemical properties was carried out in the laboratory for the parameters of soil pH, cation exchange capacity (CEC), organic C, total N and C / N ratio of soil.

Soil preparation is carried out one month before the experiment started, the soil tillage process included: clearing, cleaning up weed and ploughing the soil until the soil is ready to be planted with new local rice varieties. The size of the beds (plots) is 1.2 m x 3 m. Each group or block is made a water channel to control and control irrigation in the experimental plot.

### Planting

Planting was carried out when the seedlings age 12 days, planting is done by transplanted the seedling to the field with a predetermined spacing. Two weeks before planting the rice field was treated with soil amendment the form of rice straw compost, husk charcoal (rice husk biochar). The compost and biochar requirements of 20 tons ha<sup>-1</sup> and it is equivalent to 7.20 kg plot<sup>-1</sup> or 259.20 kg for 27 experimental plots.

### Fertilization

The doses of basic fertilizer were: 200 kg Urea ha<sup>-1</sup>, SP-36 and KCL each 100 kg ha<sup>-1</sup>. Fertilization is carried out twice, in the first fertilizer is applied at transplanting, namely Urea, SP-36 and KCL each doses of 100 kg/ha is equivalent to 36 grams plot<sup>-1</sup> or 3.89 kg for the entire experimental plot and in the second, based on the results of reading the leaf color chart of rice, and is only given urea by 100 kg ha<sup>-1</sup>.

## Results And Discussion:-

### Effect of Ameliorant on Soil Chemical Properties

#### Soil pH

The results of variance showed that the application of ameliorants and the new local rice variety had no significant effect on the pH of the new field rice as shown in Table 1.

**Table 1:-** Average pH of new open paddy fields due to the administration of ameliorant materials and new local rice variety

Rice Variety	Ameliorants			
	Control	Biochar	Straw Compost	Average
Sanberasi U1	5.71	6.02	5.78	5.84
Sanberasi U3	5.86	5.77	5.88	5.84
Inpari 30	5.86	5.86	5.72	5.81
Average	5.81	5.89	5.80	

The average soil pH due to the treatment of ameliorants and new local rice variety carried out in new open fields ranged from 5.71 to 6.02, although there was an increase in acidic pH status to be somewhat acidic. However, statistically the change of pH is not generated by the treatment of types of ameliorants or new local rice variety.

It is suspected that the ameliorant material provided is sourced from rice straw and husks which are relatively resistant to weathering, so that in the first planting season period it has not shown any significant effect on the pH of new rice field. Steiner et al., (2007) stated that the decrease in pH was related to the addition of biochar to alkaline soils caused by a decrease in the concentration of alkali metal oxides (eg. Ca<sup>2+</sup>, Mg<sup>2+</sup> + and K<sup>+</sup>) because of the alkaline ash content in biochar. Chairunnisya et al., (2017) also mentioned that rice fields in general are sandy clay with little clay content, causing the ability of the soil to support low pH and less ion exchange reactions, so that the application of organic matter and biochar does not provide a significant increase of soil pH.

### Cation Exchange Capacities (CEC)

The results of variance analysis showed that the application of ameliorant and new local rice variety did not affect CECs of new paddy fields, as shown in Table 2.

**Table 2:-** The average of CEC of new open paddy fields due to the application of ameliorant and new local rice variety.

Rice Variety	Ameliorants			
	Control	Biochar	Straw Compost	Average
	.....cmol kg <sup>-1</sup> .....			
Sanberasi U1	18.67	22.00	20.93	20.53
Sanberasi U3	19.73	21.47	22.93	21.38

Inpari 30	18.93	18.27	23.47	20.22
Average	19.11	20.58	22.44	

The average soil CEC due to the treatment of ameliorant and new local rice variety carried out on new open field rice fields ranged from 18.27 kg<sup>-1</sup> cmol to 23.47 cmol kg<sup>-1</sup>, although there was no significant effect of the treatment of ameliorant on the status of CEC, it was seen that there was an increase in the CEC status categorized in medium range. Statistically, the CEC status of the soil is not caused by the application of ameliorant or new rice variety. Bohn et al., (2005) stated that one that affects the value of soil CEC is the content of soil humus and types of clay minerals. Soils dominated by Al and Fe oxides fraction usually have a low negative charge on the colloidal surface (Sposito, 2010). So the value of the soil CEC is usually low.

Jamilah (2014), also states that cation exchange capacity is strongly influenced by the type and amount of colloid, the texture and content of organic matter given also determines the CEC value. The value of CEC on tropical soils also depends on the value of soil pH, low soil pH is one of the causes of low CEC values (Hartati, 2010).

### Organic C

The results of variance analysis showed that the application of ameliorant and new local rice variety did not affect soil C-organic of new rice fields, as shown in Table 3.

**Table 3:-** The average C-organic of new open paddy fields due to the application of ameliorant materials and new local rice variety.

Rice Variety	Ameliorants			Average
	Control	Biochar	Straw Compost	
	..... % .....			
Sanberasi U1	1.47	1.60	1.57	1.55
Sanberasi U3	1.45	1.78	1.39	1.54
Inpari 30	1.46	1.34	1.36	1.39
Average	1.46	1.57	1.44	

The average soil C-organic due to the application of ameliorant and new local rice variety ranged from 1.34% to 1.78%, although the status of soil C-organic is still in the low category, but statistically the soil C-organic status was not caused by the application of ameliorant or new local rice variety.

According to Hasibuan and Syafriadiman (2013), the content of low organic matter in the soil indicates the slow process of decomposition of organic matter that occurs. According to Boyd (2003) the sufficient organic carbon content for cultivation ranges from 1 - 3%.

### N-Total

The results of variance analysis showed that the application of ameliorant and new local rice variety did not affect N-total soil, as shown in Table 4.

**Table 4:-** Average of N-total at new open paddy fields due to the application of ameliorant and new local rice variety.

Rice Variety	Ameliorants			Average
	Control	Biochar	Straw Compost	
	..... % .....			
Sanberasi U1	0.11	0.14	0.10	0.12
Sanberasi U3	0.12	0.18	0.13	0.14
Inpari 30	0.11	0.11	0.09	0.10
Average	0.11	0.14	0.10	

The average of N-total soil due to the application of ameliorant and new local rice variety ranged from 0.09% to 0.18%, although it appears that an increase in N-total soil status from very low to low.

According to Hasanudin (2003), an increase in N-total soil is obtained directly from the results of the decomposition of organic matter which will produce ammonium ( $\text{NH}_4^+$ ) and nitrate ( $\text{NO}_3^-$ ). Furthermore, Brady and Weil (1999), stated that organic matter is a source of elements N, P, and S.

### C / N Ratio

The results of variance analysis showed that the application of ameliorant and new local rice variety did not affect the C/N ratio, as shown in Table 5.

**Table 5:-** Average C / N ratio of new open paddy fields due to the application of ameliorant and new local rice variety.

Rice Variety	Ameliorants			Average
	Control	Biochar	Straw Compost	
	..... % .....			
Sanberasi U1	15.29	11.99	16.87	14.72
Sanberasi U3	13.58	11.15	11.03	11.92
Inpari 30	14.60	12.57	15.74	14.30
Average	14.49	11.90	14.55	

The average soil C/N ratio due to the application of ameliorant and new local rice variety ranged from 11.03% to 16.87%, although there was an apparent increase in the status of the C/N soil ratio from being high, but the trend of increasing decomposition time in straw compost was not statistically caused by the application of ameliorant or new local rice variety.

According to Allison (1973), during the process of decomposition of plant residues, an acid release occurs, including carbonate, nitrate, phosphate sulfate, citrate, acetate, butyrate. Most are weak acids which are present in very low concentrations and organic acids which immediately break down into carbon dioxide and water.

### Effect of Ameliorant on New Types of Local Rice Variety Growth

#### Height Of Rice Plants at 15 And 30 Days After Planting (DAP)

The results of variance analysis showed that the application of ameliorant and local rice variety had significant interactions on the height of rice plants at 15 DAP and singularly had a very significant effect on plant plant height at 30 DAP as shown in Table 6 and Table 7.

**Table 6:-** Average plant height of 15 DAP due to the application of ameliorant and new local rice variety

Rice Variety	Ameliorants		
	Control	Biochar	Straw Compost
	..... cm .....		
Sanberasi U1	24.93 b B	23.03 a A	25.33 a BC
Sanberasi U3	22.83 a A	24.33 ab AB	27.13 a C
Inpari 30	24.53 ab A	24.87 b AB	26.60 a B
LSD <sub>(0.05)</sub> = 1.82			

Description: Numbers followed by the same letter are different not significantly in the LSD test 0.05. Lowercase letters are read vertically, while uppercase letters are read horizontally.

The parameters of plant height at 15 DAP showed that, showed that an interaction at the initial observation of the growth of 15 DAP age which appeared not uniform and as of some seeds could not grow properly. This is suspected to be the effect of stress conditions such as the results of the study of Hussein et al. (2007) that stress can affect plant growth.

At the beginning of the observation, there was a significant interaction between the treatments, but the results of the observations showed that not too many differences occurred. Interaction with ameliorants still shows the same analysis results. According to Steiner (2007), the use of biochar husk is an alternative material for improving soil

fertility as well as for environmental improvements that are cheap, sustainable and environmentally friendly. Biochar can improve the chemical, physical and biological properties of the soil and the use of biochar husk can reduce nitrogen loss.

**Table 7:-** Average plant height at 30 DAP due to ameliorant application

Ameliorant Material	Plant Height (cm)
Control	42.43 a
Biochar	44.31 b
Straw Compost	43.64 b
LSD <sub>(0.05)</sub> = 0.73	

Description : Numbers followed by the same letters are not significantly different from the LSD test at the level of 5%.

Table 7 shows that the effect of application of ameliorant on plant height shows that biochar treatment and compost of rice straw have the highest yield. This is in line with the results of Jumakir and Bobihoe (2008), that the application of rice straw as an organic fertilizer can improve soil fertility, improve the physical, chemical and biological properties of the soil.

#### Number of Tillers at 45 And 60 Days After Planting

The results of variance analysis showed that the application of ameliorant and new lokal rice variety had significant interaction effect on number tillers at 45 and 60 DAP, as shown in Table 8.

**Table 8:-** Average number of tillers at 45 and 60 DAP due to the application of ameliorant materials and new local rice variety

#### Tillers 45 DAP

Rice Variety	Ameliorants		
	Control	Biochar	Straw Compost
..... Tillers .....			
Sanberasi U1	22.43 a A	24.00 a C	22.77 a B
Sanberasi U3	22.87 a A	23.77 a B	24.03 b B
Inpari 30	22.90 a A	23.57 a A	23.33 ab A
LSD <sub>(0.05)</sub> = 0.84			

#### Tillers 60 DAP

Rice Variety	Ameliorants		
	Control	Biochar	Straw Compost
..... Tillers .....			
Sanberasi U1	32.10 a A	33.83 a B	33.77 a B
Sanberasi U3	33.20 b A	34.83 b B	33.20 a AB
Inpari 30	32.70 ab A	35.17 b C	33.80 a B
LSD <sub>(0.05)</sub> = 0.90			

Description: Numbers followed by the same letter are different not significantly in the LSD test at the level of 5%. Lowercase letters are read vertically, while uppercase letters are read horizontally.

Table 8 shows that a very significant interaction effect occurred due to application ameliorant and new local rice variety to tillers 45 DAP found in a combination of Sanberasi with rice straw compost treatments with an average number of tillers of 24.03 tillers, whereas the tillers at 60 DAP was found in inpari 30 variety with rice husk biochar treatment combinations with an average number of tillers of 35.017 tillers.

This is caused by the application of biochar husk and rice straw compost which was able to provide nutrients optimally so that rice can be utilized for their growth. Application of biochar husk and rice straw compost showed a significant effect on the parameters of the number of tillers. This is because the source of organic matter provided has been decomposed completely so that nutrients are available and can be utilized by rice, especially organic materials sourced from rice straw.

### Productive tillers

The results of variance analysis showed that the treatment of ameliorant and new local rice variety showed a significant interaction effect on number of productive tillers as shown in Table 9.

**Table 9:-** Average number of productive tillers due to application of ameliorant and new local rice variety

Rice Variety	Ameliorants		
	Control	Biochar	Straw Compost
	.....Tillers.....		
Sanberasi U1	24.03 a A	23.70 ab A	25.23 a A
Sanberasi U3	23.53 a A	25.93 b A	23.03 a A
Inpari 30	25.07 a A	22.43 a A	25.10 a A
LSD <sub>(0.05)</sub> = 3.07			

Description: Numbers followed by the same letter are different not significantly in the LSD test at the level of 5%. Lowercase letters are read vertically, while uppercase letters are read horizontally.

The table shows that the average number of productive tillers due to the treatment of straw and compost ranges from 20 stems per clump to 30 stems per clump. The average number of productive tillers is thought to be influenced by the genetic nature of new rice variety, but not significantly affected by the treatment of biochar and straw compost, this due to the nutrients available in the soil are still sufficient for plants. Plants will grow and produce optimally if planted in a place that meets growth requirements such as environmental factors, namely climate factors and soil properties such as soil pH, nutrient availability, CEC and others. If growing environmental factors are in optimal conditions, growth and yield will be limited by their genetic traits (Sufardi, 2010).

### Stover Weight Plant

The results of variance analysis showed that the application of ameliorant and new of local rice variety had a very significant interaction effect on the fresh stover weight and dry stover weight as shown in Table 10.

**Table 10:-** Average fresh and dry stover weight as a result of application of ameliorant and new local rice variety.  
Fresh Stover Weight

Rice Variety	Ameliorants		
	Control	Biochar	Straw Compost
	..... g .....		
Sanberasi U1	379.27 b A	522.43 c C	477.17 c B
Sanberasi U3	445.30 c B	499.93 b C	328.67 a A
Inpari 30	322.50 a B	275.77 a A	386.90 b C
LSD <sub>(0.05)</sub> = 16.11			

### Dry Stover Weight

Rice Variety	Ameliorants		
	Control	Biochar	Straw Compost
Sanberasi U1	96.11 a A	141.99 b B	141.06 c B

Sanberasi U3	117.72 b B	148.78 c C	84.31 b A
Inpari 30	119.20 c C	75.34 a A	82.29 a B
LSD <sub>(0,05)</sub> = 1.82			

Description: Numbers followed by the same letter are different not significantly in the LSD test at the level of 5%. Lowercase letters are read vertically, while uppercase letters are read horizontally.

The significant interaction effect due to the treatment of ameliorant and the local rice variety for fresh **stover weight** was found in a combination treatment of sanberasi U1 variety with biochar amelioran which was 522.43 g, while in dry stover weight it was found in a combination treatment of sanberasi U3 variety with ameliorant biochar with a value of 148.78 grams.

This is thought to be caused by the treatment effect on plant weight, so that the rice growth is quite good although there are several environmental factors as limiting factors, such as high Fe<sup>+</sup> concentrations and low soil pH during planting. Based on the measurement data and the results of variance analysis, it was found that the ameliorant of biochar and straw compost application in the new type of local rice significantly increased the dry weight of plants.

### Conclusion:-

The ameliorants in the form of rice straw compost and biochar from rice husk for the the dosage of 20 tons ha<sup>-1</sup> were not able to improve the quality of new rice field in the first planting period. Compost of rice straw and biochar can increase the growth of new types of local rice grown in new rice fields. The new type of local rice variety sanberasi U1 showed the growth response of local rice varieties due to the addition of rice straw compost and biochar.

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