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INCREASING RICE PRODUCTIVITY BY MANIPULATION OF CALCIUM FERTILIZER IN USTIC ENDOAQUERT

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ABSTRACT

National rice production needs to be improved and maintained to meet the demands of fast growing population. One of the ways to meet this demand is through cultivating the rain fed land in many areas which its physical characteristics are challenging factor. This research aims at finding out the feedback of the rice production on the calcium fertilizer following the administration of river sand, beach sand, coco peat, and banana peat in ustic endoaquert. This research is implemented in rain fed field composed of vertisol soil in Sidomukti village of Mootilango Gorontalo, Indonesia. The subjects are randomly chosen and the treatments are separately implemented in two sub-group of vertisol soil. There are five treatments that were repeated three times, thus, there are 15 pieces of trials in each sub-vertisol groups. This research reveals that the administration of K fertilizer following the administration of river sand, beach sands, coco peat, and banana trunks fiber has significant effect on the number of grain, the weight of 1000 grains and the total weight of the grains. Meanwhile, the administration of K fertilizer following the administration of beach sand, coco peat and banana peat has significantly influenced the number of stalk, the length of stalk, and the total weight of the grains.

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INTRODUCTION

The 2% population growth rate per year has caused the increased demands on rice. Up to 2006, the national rice consumption was 36,350,000 tons (BPS RI, 2007), thus Indonesia has to import the rice because our national production was only 57,157,435 tons of grains or equal to 32,304,029 tons (Deptan RI, 2007). From that number 54,199,693 tons of the grains (94,83%) comes from the irrigated rice fields and the rest are the product of the dry land farming. Although our current rice production is sufficient, considering our population growth rate, this rice production needs to be maintained and increased. Rain fed rice field is a rice field ecosystem that water source rely dominantly on rain water and is the second biggest producer of rice after irrigated field. This rain fed rice field amount to 2.1 million ha (Toha and Pringadi, 2004). The areal of rain fed rice field in Paguyaman, province of Gorontalo are dominated by vertisol soil that developed from lacustrine sediments (Hikmatullah *et al.* 2002; Prasetyo 2007; Nurdin 2010). Chemically, this vertisol soil is rich with high nutrition (Deckers *et al.,* 2001). However, its physical characteristics are challenging factors for the development of the crop and the crops ability to yield more. The characteristics of vertisols soil are have a high content of clay mineral, easy to shrink and swell, low water permeability, and slow draining (Mukanda and Mapiki 2001). Consequently, the growth and yield of the plants are obstructed. Soil ameliorant is needed to improve these soil characteristics. Sand is one of the ameliorant in high clay soil. In Ravina and Magier report (1984); Narka and Wiyanti (1999) showed that administration of sand had significant positive influence in lowering the value of cole and plasticity index, increasing the soil permeability, and reducing the moisture level. However, the rice farming in rain fed field need medium permeability with sufficient water available, thus, another soil ameliorant is needed to improve both characteristics, and the ameliorants needed for these are coco peat and banana peat.

Coco peat has been used as water storage medium in farming (Subiyanto *et al*. 2003). Meanwhile, the banana peat is still rarely used regardless to this dry banana peat has interrelated pores (Indrawati, 2009). The administration of those three ameliorants is suspected to be able to improve the physical characteristics of the vertisols soil in rice farming at rain fed field. Hence, the productivity of the rain fed farming as the second biggest producer of rice can be increased. This research aims at finding out the feedback of the rice product on calcium fertilizer following the administration of river sand, beach sand, and coco peat and banana peat in endoaquert ustic.

METHODOLOGY

This research is conducted in rain fed field composed of vertisols soil in Sidomukti village of Mootilang sub-district, District of Gorontalo, Gorontalo province. The object of this research is vertisols soil that has been previously treated with river sand, beach sand, coco peat and banana peat as ameliorants.

This research uses random group design method administered separately in two sub-group of vertisols soil. There are five levels of treatments. Each treatment is repeated three times, thus, there are 15 experiment plots for each sub-vertisols group and in total, there are 30 plots trial. (Table 1).

Table 1. Treatment of each Kalium fertilization in vertisols soil

Treatments		Ustic Endoaquerts	
Symbol	KCl Fertilizer Levels	0 DAP	30 DAP
	(kg ha^{-1})		
K0	0	0	0
K1	50	25	25
K2	100	50	50
K3	150	75	75
K4	200	100	100

DAP = day after plantings

Before the planting, the basic fertilizers are weighed. The lists of the fertilizers are in Table 2 below.

Table 2. Basic fertilizer, source, and day of fertilizer for ages after planting

Fertilizers as Starter	Source of Fertilizer	Recommendation of Fertilizer	Ages/Level of Fertlizing	
			0 DAP	60 DAP
		(kg ha^{-1})		
N	Urea (46% of N)	125	62,5	62,5
P	Phonska (15% of P2O5)	100	50,0	50,0

The farmland uses as the plot trials are the lots used in the first phase of the research. The Mekonga is the rice variety used in this research and it has been previously seeded for 21 days and planted with 25 cm x 25 cm spacing and 3 seeds are planted in one planting hole. The N, P and K fertilizers are given twice, half dosage in day 0 after the planting (HST) and on the 60th day after the planting. The irrigation is first done when the plants are ± 5 cm high up to when the plants are 10 days old. The next irrigation is regulated based on the growth and development of the crops. The weeding is done manually when the crops are 15 days old, and next weeding is determined by the weed condition in the field. Viruses, diseases, harmful insects are managed through understanding the relationship among environments, pests, natural enemies, host plants to help determine what action necessary. The harvesting time is when the crops are ± 115 days old. Physical appearance of ready to harvest crops is when > 95% of the crops have turned yellow.

The harvesting is done manually by cutting the upper half of the crop that contains the rice stalk. The rice then dried under the sun for 3-5 days to reach the 15% moisture level. After that, the rice then weighed per trial plot to gain the parameter of the rice crops yield. Those parameters are:

1. Number of stalk

This parameter is calculated per bunch in each treatment. The number then add together to find the mean of the number of stalks per bunch of crops for each treatment.

2. Length of stalk (cm)

This parameter is calculated in cm per bunch in each treatment. The result of this measurement then add together to find the mean of stalk length per bunch for each treatment.

3. Number of grain

This parameter is calculated per stalk in each treatment to find out the mean of number of grain per stalk for each treatment.

4. The weight for 100 dried grains (kg)

This parameter is calculated by weighing 100 dried grains using the digital scales for each treatment. The result then added to find the mean weight for 100 dried grains for each treatment.

5. The weight of dried grains (kg ha -1)

This parameter is obtained by weighing the dried grains using the digital scales for each treatment. The result then added up to find the mean of dried grains weight for each treatment. The weight then converted to weight of dried grains per ha.

All the obtained data, whether from calculation, measurement, and weighing processed and analyzed statistically. The presentation on the data on the influence of ameliorants administration on the crops yield is presented in tables and graphs. The data are further analyzed using the variance randomized block design analysis. If there is a significant difference, then the least significance difference test is conducted with the 5% level test.

FINDINGS AND DISCUSSION

Rice Crops Yields with K Fertilizer in Endoaquert Ustic following the administration of river sand, coco peat, and banana peat**.** The variance result shows that the K fertilizer does not give significant influence on the number of stalk and the length of stalk, however, it gives significant influence on the number of grain, the weight of 1000 grains and the total weight of the grains in Endoaquert ustic. The average yield of rice crops using K fertilizer in endoaquert ustic with Least Significant difference (P>0.05) is presented in Table 3 below.

Table 3. The mean of rice crops yields component using K fertilizers in endoaquert ustic following the administration of river sand, coco peat, and banana peat

Treatments	Number of stalk	Length of stalk (cm)	Number of grain	The weight for 100 dried grains (g)	The weight of dried grains (g)
0 kg ha^{-1} (K0)	15.83^{ns}	24.47^{ns}	103.42a	18.00a	356.70a
50 kg ha^{-1} (K1)	13.16	24.73	140.00b	20.66a	652.30ab
100 kg ha^{-1} (K2)	16.58	24.44	135.83b	25.00b	690.30ab
150 kg ha^{-1} (K3)	17.16	23.34	167.42c	25.33b	478.30ab
200 kg ha^{-1} (K4)	16.58	23.98	177.67c	26.66b	758.00b
LSD (0,05)			23.50	2.68	368.44
CV (%)	14.67	4.50	8.61	6.16	33.32

Note: Number that following by same latter in same column did not significantly different at LSD level of 0.05; ns=not significant effect at F level test 0.05; LSD=least significant different; CV=coefficient of variant.

The highest amount of stalks (17.16 stalks) are obtained in 150 kg ha-1 administration of K fertilizer (K3) and the least amount of stalks are obtained in 50 kg ha-1 administration of K fertilizer (K3). The longest stalk is obtained in K1 where the longest stalk is 24.73 cm and the shortest stalk is found in the administration of 150 kg ha-1 of K fertilizer (K3). It appears that the variety of numbers and length of stalks tend to fluctuate. It is assumed due to K fertilizer may not play a role in the growth and development of stalks. The number of grains in the administration of 200 kg ha-1 of K fertilizer (K4) significantly yields more grains (177.67 grains) than any other treatments. This is due to the Calcium (K) nutrient that is widely available in treatment K4, thus, the development and grain filling processes are not obstructed. Calcium (K) is one of important macro nutrients for the crop due to this nutrient plays direct roles in some physiological processes such as, (1) biophysical aspect of the Calcium plays important role in managing the osmotic and turgor pressure of the cell and to stabilize the pH, and (2) biochemical aspect, calcium plays a role in enzyme activities in carbohydrate and protein, and increasing the translocation of photosynthesis out of the leaves (Marschener, 195).

The heaviest weight of 1000 grains is shown in the administration of 200 kg ha-1 of K fertilizer (K4) and the significant difference of K fertilizer administration in K0 and K1 but there are no significant difference in K2 and K3. This shows that the 100-200 kg ha-1 of K fertilizer (K2-K4) have shown significant weight difference in 1000 grains. The more the K fertilizer given, the heaviest the 1000 grains would be. Further, this highest total weight of grains is shown by the administration of 200 kg ha-1 K fertilizer (K4) and only significantly differs with K0 treatment. It appears that the variety of total grains weight have fluctuate pattern.

The result of the regression analysis shows that there is a positive and linier correlation between the numbers of stalks with all the applied treatments, meanwhile, the length of stalks shows a reversed pattern, however, both have positive correlation with all treatments (Figure 1). It appears that the increase in the dosage of K fertilizer administration would be followed by the increase of stalks number, but the reverse happened with the length of stalks. Meanwhile, the number and weight of 1000 grains tend to be positively linier with strong positive correlation (Figure 2).

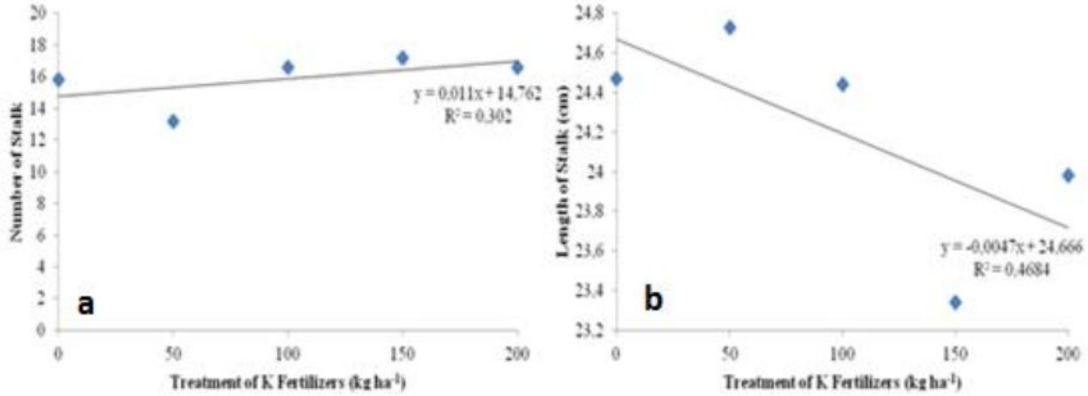

Figure 1. Regression between number of rice stalks **(a)** and length of stalks with the administration of K fertilizer in endoaquert ustic **(b)**

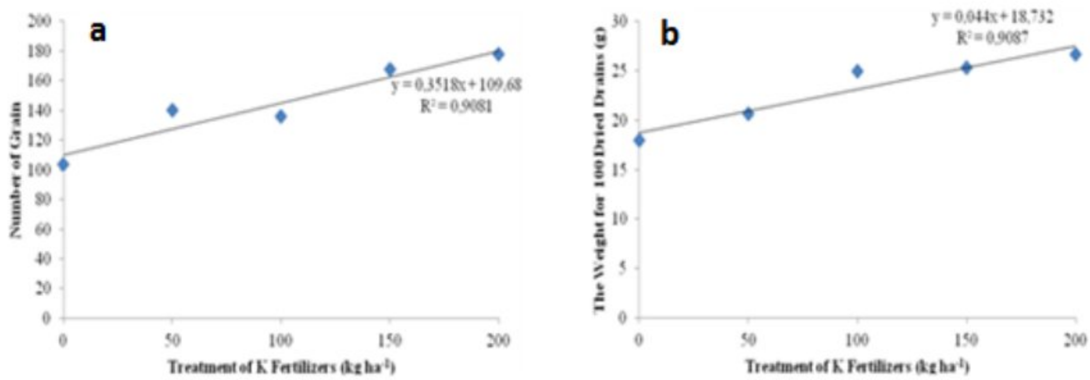

Figure 2. Regression correlation between number of grains **(a)** and weight of 1000 grains **(b)** in administration of K fertilizer in Endoaquert Ustic

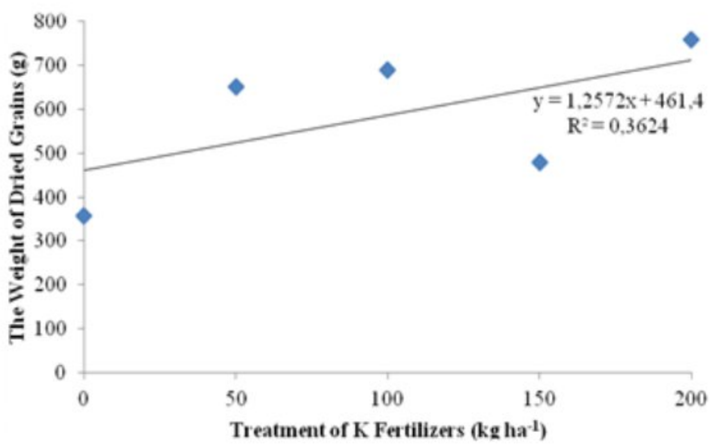

Figure 3. Regression correlation between the total weight and the K fertilizer administration in Endoaquert Ustic

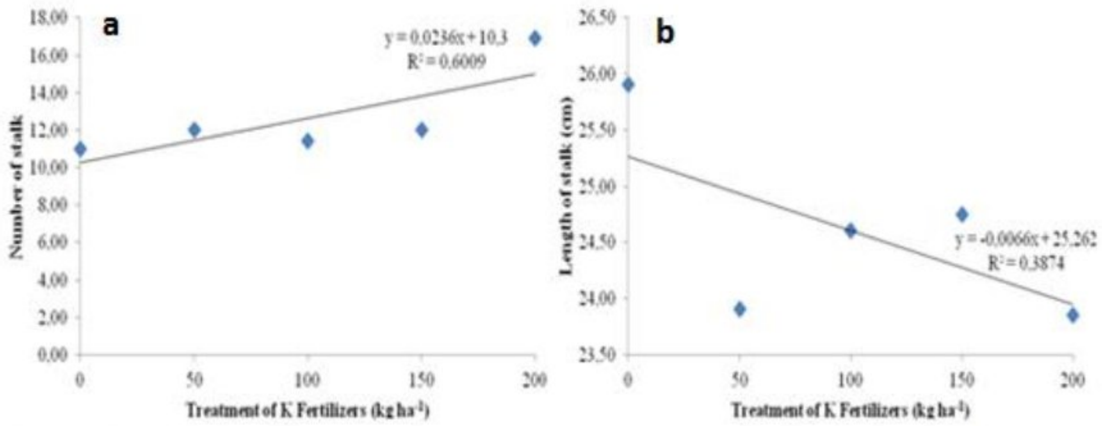

Figure 4. Regression correlation between number of rice stalk **(a)** and length of rice stalks **(b)** on administration of K fertilizer in Endoaquert Ustic

Correlation between administration of K fertilizer and the total weight shows positive and linier pattern (Figure 3). It appears that the increase in one unit of K fertilizer administration will yield 36 grams increase in the total weight of the grains. The rest is influenced by other factors such as washing, dissolved in water and fixated in the crystalized clay mineral). The variance result shows that administration of K fertilizer only has significant difference on number of stalk and in length of stalk and total weight of the grains in endoaquert ustic. The rest do not have significant difference on the length of stalk and the weight of 1000 grains. The average rice crop yield in endoaquert ustic with Least significant difference test ($P > 0.05$) is presented in table 4 below.

Table 4. Average rice crops yield of K fertilizer in Endoaquert Ustic following the administration of beach sand, coco peat and banana peat

Treatments	Number of stalk	Length of stalk (cm)	Number of grain	The weight for 100 dried grains (g)	The weight of dried grains (g)
0 kg ha^{-1} (K0)	11.00a	25.91a	127.16^{ns}	24.00^{ns}	418.00a
50 kg ha^{-1} (K1)	12.00a	23.91b	125.50	23.66	634.67b
100 kg ha^{-1} (K2)	11.41a	24.61ab	118.58	24.33	677.00b
150 kg ha^{-1} (K3)	12.00a	24.75ab	116.75	24.00	699.00b
200 kg ha^{-1} (K4)	16.91b	23.85b	111.50	25.00	615.00b
LSD (0,05)	1.51	1.72			137.24
CV (%)	10.55	3.71	7.75	5.08	12.81

Note: Number that following by same latter in same column did not significantly different at LSD level of 0.05; ns=not significant effect at F level test 0.05; LSD=least significant different; CV=coefficient of variant.

Administration of 200 kg ha-1 K fertilizer shows the most stalks and the most significant difference than the other treatments. The length of stalk in no fertilizer treatment (K0) shows the longest stalks and significantly differs from K2 and K4 treatments. Meanwhile, the total weight in K3 treatments significantly heavier than other treatments and significantly different from K0 treatment.

The result of regression analysis shows that there is a positive and linier correlation between number of rice stalks and all the applied treatments. However, the length of stalks have a reversed correlation with the treatments, regardless, both length and number of stalks have positive correlation with all treatments (Figure 4). It appears that the increase of K fertilizer dosage will be followed by the increase of number of stalks but not the length of stalks. on the other hand, the number of grains and the weight of 1000 grains have a reversed pattern compared to the number of stalks and the length of stalks (Figure 5).

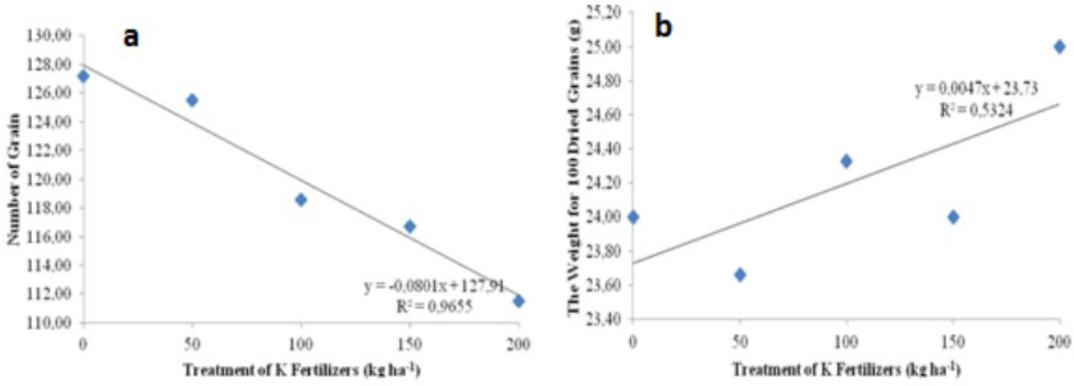

Figure 5. Regression correlation between number of rice grains **(a)** and the weight of 1000 rice grains on administration of K fertilizer **(b)** in Endoaquert Ustic

It appears that the administration of one unit of K fertilizer would decrease as much as 96.5 grains and administration of K fertilizer can increase the total weight of 1000 rice grains into 25 grams. Therefore, the dosage of K fertilizer administration should be adjusted to the need of K nutrient in rice crops, thus it would not decrease the number of grains into an extreme amount.

In addition, the correlation between the total weight and the administration of K fertilizer shows a strong positive and linier correlation (Figure 20). This shows that the administration of one unit of K fertilizer will would increase the 42.1 grams of the total weight. However, 200 kg ha-1 dosage of K fertilizer (K4) have a decreasing effect on the total rice grains weight.

CONCLUSION

The study concluded the following: (1) Administration of K fertilizer after the administration of river sand, coco peat and banana peat has significant influence on the number of rice grains, the weight of 1000 grains, and the total weight of the grains and (2) Administration of K fertilizer after the administration of beach sand, coco peat and banana peat has significant influence on the number of stalks, the length of stalks, and the total weight of the grains.

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