ROLE OF COASTAL SEDIMENT ON SOIL NUTRIENT AVAILABILITY AND OIL PALM YIELD AT PEATLANDS

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Submitted : 2016-07-20 Accepted : 2016-11-03

ABSTRACT

Peatlands which is limited in chemical, physical and ecology require appropriate management for oil palm plantation. Coastal sediment as an ameliorant in peatlands increased productivity some crops. This study aims determining the effect of the doses of coastal sediment as ameliorant on peatlands to the availability of N, P, K, Ca, Mg and Na oil palm plantations. This research was performed in the area of oil palm plantation in Kubu Raya district, Borneo, Indonesia. Experimental design employed randomized block design with 4 levels of coastal sediment doses (L), i.e. L0 = 0 t ha\(^{-1}\); L1 = 20 t ha\(^{-1}\); L2 = 40 t ha\(^{-1}\); L3 = 60 t ha\(^{-1}\) with three replication. The results showed that the application of coastal sediment at 40 t ha\(^{-1}\) in oil palm plantations significantly increased soil pH, availability of N, K, Ca and Mg, while P was not significantly different.

Keywords: ameliorant, Kubu Raya, oil palm, peat, soil nutrient

INTRODUCTION

The palm oil has risen to become the most produced and consumed vegetable oil in the world (Hansen et al., 2015). As a major contributor to the economies of several developing countries, the expansion of oil palm cultivation is now a government priority throughout the humid tropics (Sayer et al., 2012). Oil palm plantation was emphasized in Master Plan for Acceleration and Expansion of Indonesia Economic Development (MP3EI) as one of the potential sectors in agriculture (Alwarritzi et al., 2015).

Expansion plans for oil palm plantations in Indonesia have become the subject of political and environmental debates (Obidzinski et al., 2012). Cultivation of oil palm on peat soil has greatly affected the environment in recent time, especially when such practice has been on for several years (Adesiji et al., 2014).

Utilization of peatlands into oil palm plantation requires appropriate management because it has high acidity, high organic matter, but low nutrient content (Istina et al., 2015). Additionally, peat has limitations with consider to the unavailability of potassium (K), sulphur (S), zinc (Zn), and copper (Cu) (Masud et al., 2011; Abat et al., 2012). These conditions do not support the growth and yield plant and supply of adequate nutrient needs for plants, especially alkaline cations such as K, Ca and Mg (Hartatik et al., 2004; Suswati et al., 2011).

Coastal sediment is a natural resource that is quite large and potential to improve the productivity of the poor soil, especially in the peat soil (Suswati et al., 2014). Coastal sediment can be derived from the results of erosion on upland and transported by river flow result of coastal erosion and sea water transported and then deposited on the shoreline (shoreline). Seawater influence on
Material properties of coastal sediment resulted rich in salts such as NaCl, Na₂SO₄, CaCO₃ and MgCO₃ (Tan, 2011). High content of Na caused suppressing acid phenol. According Gogo and Pearce (2009) the cations were strongly bound to the negative exchange sites within functional groups of peat.

One effort to improve peatlands fertility and productivity is by adding ameliorants (Nurzakiah et al., 2013). The alternative amelioration applied to oil palm farms in West Kalimantan peatlands is coastal sediment which is easy to obtain and relatively cheap. Coastal sediment as ameliorant had been shown to increase productivity and production plants in peatland (Suswati, 2009). It application of coastal sediment with chemical properties such as pH neutral, containing the base cations (K, Na, Ca, Mg) and high micro elements (Cu, Zn, Fe, Mn), high Base Saturation (BS) and low CEC, can increase soil pH and BS and reduce CEC in peat soil simultaneously (Suswati, 2012).

Application of coastal sediment at a dose of 40 tons ha⁻¹ of peatlands for production of hybrid corn produced 12 ton ha⁻¹ (Suswati, 2012). Besides high polyvalent cations by the complexation process simple organic compounds into complex compound can reduce toxic organic acids and cations to form a bridge that is highly resistant to decomposition so that the CO₂ emissions can be reduced (Husen et al., 2013). However, excessively addition of coastal sediment as ameliorant can inhibit plant growth because the soil becomes alkaline, it can increase the osmotic pressure in plant root tissues resulting in plasmolysis. While giving too little ineffective due to its ability to reduce soil acidity is low (Sabiham, 1996). The study aims is to determine the effect of coastal sediment dosage to the availability of soil N, P, K, Ca, Mg and Na in peatlands soil at oil palm plantations.

**MATERIALS AND METHODS**

The research was conducted at oil palm plantation in Rasau Jaya III subdistrict in Kubu Raya District of West Kalimantan, from May to Augustus 2014. Coastal sediment (water content 37.49%) used were obtained from Kijing Beach, Mempawah regency. The experiment was conducted by using randomized block design, with triplicates (Gomez and Gomez, 2007). The treatment was the application of coastal sediment for ameliorant which consisted of 4 levels, namely C₀: Control (without coastal sediment), C₁: coastal sediment of 20 Mg ha⁻¹, C₂: coastal sediment of 40 Mg ha⁻¹, and C₃: coastal sediment of 60 Mg ha⁻¹. They were 12 experimental plots with a plot size of 18 x 54 m; each plot consisted of 6 plants (in 2 rows planting) with a spacing of 9 m x 9 m, thus the area of each experimental plot 972 m².

Macro and micro nutrients (N, P, K, Ca, Mg, Na and which micro Zn, Bo and Cu) content were recognized after one g of plant samples (previously dried at 60 °C for 24 h) was digested with concerted H₂SO₄ (for determination of N element) and a combination of concentrated HNO₃ and HClO₄ (for determination other than N), after which the extraction was adjusted using deionized water up to 50 mL. Determination of N was done using semi-micro Kjedahl, P with vanadomolybdate yellow with wavelength 889 nm, while K with the atomic absorption spectrophotometry (AAS) method (Temminghoff and Houba, 2004).

Some physical and chemical properties of ameliorants and soil were performed in the laboratory of soil fertility and chemistry. The coastal sediment texture was carried out using the pipette method (Sarkar and Haldar, 2005). The ameliorants and soil pH were determined in a 1: 2.5 soil: distilled water suspension using a glass electrode. The
content of organic carbon was measured using the Walkley and Black method. Ameliorant and soil cation exchange capacity (CEC) were determined by leaching with 1M ammonium acetate buffer adjusted to pH 7.0 followed by steam distillation (Pansu and Gautheyrou, 2006). Available phosphorus in ameliorants and soil extracted with NaHCO₃ (0.5 M) at pH 8.5 and determined colorimetrically after treating with ammonium molybdate and stannous chloride at a wavelength of 660 nm. The exchangeable base cations were extracted with 1.0 mol L⁻¹ ammonium acetate (Pansu and Gautheyrou, 2006). After extraction, the cations were measured using the atomic absorption spectrophotometry (AA-6200 SHIMADZU).

The data obtained were subjected to a two-way analysis of variance (ANOVA) followed by a Duncan’s test at 5% level. For some parameters the correlations were computed. The data were analyzed using the Statistical Analysis System package (SAS Institute, 2003).

RESULTS AND DISCUSSION

The characteristic of peat soil and coastal sediment

The soil characteristics of the peat can be seen in Table 1. Based on the standards of determining soil chemical properties (Hazelton and Murphy, 2007), this soil had a very acidic (pH 3.34), high organic-C (37.30 %) and total N content 2.30 %. Mostly peat is acidic to very acidic and naturally accumulated under anaerobic conditions (Sabiham et al., 2012).

The available P was low (9.51 ppm), according to Bjorn et al., (2008) that Phosphate elements in peat lands were fixated by Fe or Al causing, not available and only 30% of them can be up taken by crops.

Table 1. The chemical characteristics of peat and coastal sediment

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Peat</th>
<th>Coastal sediment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Texture</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sand (%)</td>
<td>5.31</td>
<td></td>
</tr>
<tr>
<td>Silt (%)</td>
<td>38.22</td>
<td></td>
</tr>
<tr>
<td>Clay (%)</td>
<td>56.47</td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>3.34</td>
<td>7.72</td>
</tr>
<tr>
<td>Organic-C (%)</td>
<td>37.30</td>
<td>1.18</td>
</tr>
<tr>
<td>Total N (%)</td>
<td>2.30</td>
<td>0.9</td>
</tr>
<tr>
<td>Available P (ppm)</td>
<td>9.51</td>
<td>10.2</td>
</tr>
<tr>
<td>Exch. K (cmol(+)/kg⁻¹)</td>
<td>0.52</td>
<td>5.01</td>
</tr>
<tr>
<td>Exch. Ca (cmol(+)/kg⁻¹)</td>
<td>3.85</td>
<td>65.10</td>
</tr>
<tr>
<td>Exch. Mg (cmol(+)/kg⁻¹)</td>
<td>1.83</td>
<td>10.24</td>
</tr>
<tr>
<td>Exch. Na (cmol(+)/kg⁻¹)</td>
<td>0.50</td>
<td>36.03</td>
</tr>
<tr>
<td>Exch. Al (cmol(+)/kg)</td>
<td>1.21</td>
<td>0.00</td>
</tr>
<tr>
<td>Exch. H (cmol(+)/kg)</td>
<td>5.51</td>
<td>0.25</td>
</tr>
<tr>
<td>CEC (cmol(+)/kg⁻¹)</td>
<td>67.31</td>
<td>15.82</td>
</tr>
<tr>
<td>Base Saturated (%)</td>
<td>9.96</td>
<td>&gt;100</td>
</tr>
</tbody>
</table>

Less nutrient of P uptake resulted in abnormal growth and low crop production (Istina et al., 2015). Table 1 showed that the content of potential K, Ca and Mg was low, each 0.52, 3.85 and 1.83 cmol(+)/kg respectively. CEC value was very high (67.31 cmol(+)/kg₁) but bases saturation (BS) was very low (9.96%). It might inhibit equilibrium of nutrients, especially K, Ca and Mg. Content of K, Ca and Mg nutrients were low, which was resulting in the plant deficiency of macro nutrient. The characteristics of peat such as low pH (acidic), poor nutrient, irreversible drying caused low productivity for agriculture (Masril et al., 2014).

Coastal sediment was analyzed for chemical properties (Table 1). It had high pH value (7.72) and very high base saturation (>100%). It consists of 5.31% sand, 38.22% silt and 56.47% clay (clay texture). It had very low available P and potential K with 10.20 mg P₂O₅ kg⁻¹ and 5.01 (cmol(+)/kg⁻¹), respectively. The addition of coastal sediment on peat soil might raise soil pH due to neutralization reaction of H⁺ ions from peat soil by OH⁻ ions from coastal sediment (Suswati et al., 2014).
The effect of coastal sediment application to the properties of peat soil

Properties of peat soil after application of coastal sediment at variety of doses are shown in Table 2. Results of analysis of variance of soil pH at one month after treatment showed that the coastal sediment treatments significantly affected soil pH. Table 2 shows that application of coastal sediment can increase soil pH after incubation. Dosing coastal sediment up to 60 tons ha\(^{-1}\), can increase soil pH after incubation significantly. Seawater influence on material properties of coastal sediment so that the resulting sediment is rich in salts NaCl, Na\(_2\)SO\(_4\), CaCO\(_3\) and MgCO\(_3\) (Tan, 2011) which can neutralize organic acids (Stevenson, 1994) so as to increase the soil pH. In addition, the cations will increase the percentage of base saturation (BS) colloidal complex and directly contributed to the increase in soil pH.

Table 2 shows that the addition of coastal sediment 20 tons ha\(^{-1}\) on peat soil can reduce soil organic C when compared with no addition of coastal sediment. Value of C-organic peat soil decreased with the addition of coastal sediment up to the dose of 60 tons ha\(^{-1}\). Coastal sediment contains a low organic-C 1.18% compared with the untreated peat organic C is 37.30%. Therefore, the addition of increasing coastal sediment up to 60 tons ha\(^{-1}\) would decrease C-organic peat after incubation.

Addition of coastal sediment up to 20 tons ha\(^{-1}\) can lower soil CEC after incubation when compared to no provision of coastal sediment, but with the addition of coastal sediment up to 60 tons ha\(^{-1}\) was able to significantly lower soil CEC. Soil CEC decreased by increasing of dose coastal sediment up to 60 tons ha\(^{-1}\). This is due to the coastal sediment has a low CEC is 15.82 cmol (+) kg\(^{-1}\) compared CEC peat ranged from 67.31 cmol (+) kg\(^{-1}\). Giving ameliorant material which has a lower CEC of peat will lower CEC. The decrease caused by the increased soil CEC increased coastal sediment with low organic-C (1.18%) can reduce soil organic-C.

Soil CEC values are directly related to the amount of soil organic matter. The smaller the proportion of peat in mixing with minerals due to the depletion of the peat layer, the more it will reduce the source of the negative charge of the soil layer (Fahmi et al., 2012). One source of negative charge soil is organic matter; the charge comes from the

Table 2. Peat soil properties with application coastal sediment (CS)

<table>
<thead>
<tr>
<th>Observation period</th>
<th>Dose of CS (ton ha(^{-1}))</th>
<th>Variables</th>
<th>pH</th>
<th>C-org (%)</th>
<th>CEC</th>
<th>Exch-Al</th>
<th>Exch-H</th>
<th>BS Cmol(+) kg(^{-1})</th>
<th>BS (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>after Incubation (2 weeks)</td>
<td>0</td>
<td>3.58d</td>
<td>36.32a</td>
<td>67.86a</td>
<td>0.23b</td>
<td>1.25a</td>
<td>9.89d</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>4.47c</td>
<td>29.61b</td>
<td>56.90b</td>
<td>0.22b</td>
<td>0.62b</td>
<td>44.83c</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>5.16b</td>
<td>25.11c</td>
<td>49.82c</td>
<td>0.20b</td>
<td>0.37c</td>
<td>68.82a</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>60</td>
<td>5.50a</td>
<td>19.20d</td>
<td>46.47c</td>
<td>0.01c</td>
<td>0.29d</td>
<td>61.15b</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td>4.68</td>
<td>27.56</td>
<td>55.26</td>
<td>0.22</td>
<td>0.63</td>
<td>46.17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The end of experiment</td>
<td>0</td>
<td>3.51d</td>
<td>35.94a</td>
<td>64.34a</td>
<td>0.62a</td>
<td>1.02a</td>
<td>9.323c</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>4.40c</td>
<td>28.28b</td>
<td>56.28b</td>
<td>0.31b</td>
<td>0.28b</td>
<td>106.46b</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>5.15b</td>
<td>24.80c</td>
<td>45.28c</td>
<td>0.03b</td>
<td>0.32b</td>
<td>165.73a</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>60</td>
<td>5.49a</td>
<td>18.52d</td>
<td>45.28c</td>
<td>0.03b</td>
<td>0.31b</td>
<td>156.20a</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td>1133.75</td>
<td>26.89</td>
<td>52.80</td>
<td>0.25</td>
<td>0.48</td>
<td>109.43</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Remarks: the value in the column followed by the same letters and the same treatment groups was not different by Duncan’s test 5%.

STJSSA, ISSN p-ISSN 1412-3606 e-ISSN 2356-1424, parent DOI: 10.15608/stjssa
dissociation of functional groups of organic acids. In addition, Wulandari et al. (2014) explain that Na from seawater can decrease the CEC value of peat. Salampak (1999) stated that the addition of cations in peat soil will decrease the activity of organic acids, especially phenolic acids. CEC on peat soil is largely determined by the phenolic and carboxylic acids, phenolic acids; the decrease will cause a reduction in CEC of peat.

Table 2 shows that the application of coastal sediment up to 20 tons ha\(^{-1}\) can increase BS after incubation when compared to without of coastal sediment. The addition of coastal sediment 40 tons ha\(^{-1}\) and 60 tons ha\(^{-1}\) were able to increase the available BS significantly. This is due to the coastal sediment containing alkaline cations such as K, Ca, Mg and Na; it can increase BS of peat reached 44.83 – 68.82%, meanwhile without addition coastal sediment only 9.89% of BS. At the end of the study soil BS tends to increase due to the release of base cations cations such as K, Ca, Mg and Na optimally so that soil BS tends to rise in soil.

Results of analysis variance of exch-Al soil after incubation showed that coastal sediment treatment significantly affected soil exch-Al. Table 2 shows that application of coastal sediment at doses 20 ton ha\(^{-1}\) increase availability exch-Al soil after incubation and decreased compared to without giving coastal sediment. At the end of the study of exch-Al soil tends to decrease as soil pH and increase availability of base cations. Table 2 showed that the coastal sediment treatment significantly affected soil exch-H after incubation. Application of coastal sediment at all doses could decrease exch-H compared with control (without coastal sediment). This is due to increased soil pH, thereby increasing OH- ions in the soil solution to neutralize exch-H (H\(^+\)). At the end of the study exch-H soil tends to decrease as soil pH and availability of base cations also increased.

The effect of coastal sediment application to the availability of nutrient in peat soil

Table 3 shows that the application of coastal sediment at 20 tons ha\(^{-1}\) on peat soil has been able to increase the total soil N after incubation compared to without of coastal sediment. N-total in peat increased significantly with the addition of coastal sediment at 40 tons ha\(^{-1}\). Increasing of N-total derive from decomposition of organic matter, N is an element that largely sourced from the decomposition of organic matter. The contribution of N from the decomposition process is highly dependent on the quality and quantity of organic matter. One of the factors that affect the rate of decomposition is an increase in soil pH (Reddy and Delaune, 2008). Increasing soil pH would increase activity of soil microorganisms, which are active at pH range 6-7 or around neutral soil. Due to the increased activity of microorganisms in the soil, it would lower ratio of C/N in peat soil, so that N would be available to plants. According to Kakei and Clifford. (2000), liming can increase the pH in peat, N availability in the peat were increased by liming. N-total at the end of experiment tends to decrease as compared with soil N-total after incubation, it used by plants for growth and development, although the availability of soil N total tends to decline but still in conditions not unlike the N soil total after incubation.

Addition of coastal sediment until the dose of 60 tons ha\(^{-1}\) of coastal sediment commonly tends to decrease the available soil P after incubation (Table 3). The decline in available soil P occurs due to the condition of the soil pH also increased to 5:50, so that in these conditions the solubility of base cations
Ca ions increased primarily. This allows the binding of phosphate ions by Ca ions are poorly soluble, the higher the Ca\(^{2+}\) or Ca carbonate will be higher the more embedded phosphate so that P is not available (Tisdale et al., 1990). Beside, P is an element that is susceptible to leaching if high concentrations in the soil solution (Sapek et al., 2009) and according to Kurnain (2005) peat soils do not have a strong enough tread sorption binding P so easily leached.

Table 3 shows that the provision of coastal sediment at 20 tons ha\(^{-1}\) on peat soil can increase the available of K peat soil when compared to without coastal sediment. Addition of coastal sediment of 40 tons ha\(^{-1}\) still increase available of K significantly, but at the dose of 60 tons ha\(^{-1}\) where a decline in available K. Increasing available of K by application coastal sediment was up to 40 tons ha\(^{-1}\) caused the coastal sediment containing K, so that when added to the soil will increase soil K availability. Besides coastal sediment was as a source of nutrients K, a high proportion of clay at coastal sediment is added gives a great potential to soil K availability.

Available of K decreased at doses of 60 tons ha\(^{-1}\), this is possible because the C-organic soil also decreased at doses increasing coastal sediment. According to Havlin et al. (2005), dissolved K in the soil is proportional to the organic matter added to the soil. Potassium is mainly contained in the organic matter as dissolved inorganic K so as to supply the K available to plants. At the end of the study soil K tends to decrease as compared with soil K after incubation, as used by plants for growth and development, although exchangeable soil K availability tends to decrease but still in conditions not unlike soil K after incubation. This is due to soil organic C also decreased at the end of the study.

The application of coastal sediment of 20 tons ha\(^{-1}\) can increase the availability of Ca when compared with control and no different with the addition of coastal sediment at the dose of 40 t ha\(^{-1}\) (Table 3). This is due to the coastal sediment containing high Ca is 3.85 cmol (+) kg\(^{-1}\), higher than the content of other base cations (K, Mg, Na), so it can act as a source of Ca. Very important factor in determining of available Ca is soil pH and CEC (Havlin et al., 2005).

Available Mg increased with the addition of coastal sediment 20 tons ha\(^{-1}\) compared to without coastal sediment and no different with dosage 40 tons ha\(^{-1}\) and 60 ton

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**Table 3.** Nutrients content in peat soil with application of coastal sediment (CS)

<table>
<thead>
<tr>
<th>Observation period</th>
<th>Dose of CS (ton ha(^{-1}))</th>
<th>Variables</th>
<th>pH</th>
<th>N (%)</th>
<th>P (ppm)</th>
<th>K (Cmol(+)/kg(^{-1}))</th>
<th>Ca (ppm)</th>
<th>Mg (ppm)</th>
<th>Na (ppm)</th>
<th>S (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>After incubation (2 weeks)</td>
<td>0</td>
<td>3.58d</td>
<td>1.57a</td>
<td>23.44a</td>
<td>0.54d</td>
<td>3.89d</td>
<td>1.81c</td>
<td>0.55d</td>
<td>585.19b</td>
<td></td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>4.47c</td>
<td>1.26b</td>
<td>23.40a</td>
<td>0.58c</td>
<td>19.38c</td>
<td>3.55b</td>
<td>2.08c</td>
<td>1238.53a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>5.16b</td>
<td>1.19c</td>
<td>23.32a</td>
<td>0.68a</td>
<td>24.77b</td>
<td>4.09a</td>
<td>2.27b</td>
<td>1351.32a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>60</td>
<td>5.50a</td>
<td>0.93d</td>
<td>22.39a</td>
<td>0.64b</td>
<td>30.16a</td>
<td>4.07a</td>
<td>2.43a</td>
<td>1369.06a</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td>4.68</td>
<td>1.24</td>
<td>23.14</td>
<td>0.61</td>
<td>19.55</td>
<td>3.38</td>
<td>1.83</td>
<td>1136.03</td>
<td></td>
</tr>
<tr>
<td>The end of experiment</td>
<td>0</td>
<td>3.51d</td>
<td>1.55a</td>
<td>23.28a</td>
<td>3.56c</td>
<td>3.27c</td>
<td>1.78c</td>
<td>0.54b</td>
<td>585.19b</td>
<td></td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>4.40c</td>
<td>1.24b</td>
<td>22.74a</td>
<td>4.50b</td>
<td>45.17b</td>
<td>9.83b</td>
<td>4.43a</td>
<td>1351.53a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>5.15b</td>
<td>1.16b</td>
<td>21.35ab</td>
<td>5.24a</td>
<td>56.16a</td>
<td>10.34a</td>
<td>4.56a</td>
<td>1351.32a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>60</td>
<td>5.49a</td>
<td>0.94c</td>
<td>19.70b</td>
<td>5.33a</td>
<td>56.57a</td>
<td>9.06b</td>
<td>4.11a</td>
<td>1359.96a</td>
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</tr>
<tr>
<td>Mean</td>
<td></td>
<td>4.66</td>
<td>1.22</td>
<td>21.77</td>
<td>4.66</td>
<td>40.29</td>
<td>7.75</td>
<td>3.41</td>
<td>1133.75</td>
<td></td>
</tr>
</tbody>
</table>

Remarks: the value in the column followed by the same letters and the same treatment groups was not different by Duncan's test 5%.
ha\(^{-1}\) (Table 3). This was caused by the coastal sediment containing Mg so it can act as a source of Mg. Addition of coastal sediment will reduce the availability of Mg because it tends to accumulate in soils rich in Clay (Bohn et al., 2001). At the end of the study Mg tended to decline as oil palm crops used for growth and development. Table 3 shows that Na lowest available soil after incubation without coastal sediment treatment. Sodium available was increased by application of coastal sediment up to doses of 60 tons ha\(^{-1}\). This is due to the salty coastal sediment containing Na so it can act as a source of Na.

**Palm Oil Production**

The responses of yield of oil palm were varied from one treatment to another. All of doses of ameliorant gave a better yield than control (without coastal sediment). Average yield of oil palm until the end of the study can be seen in figure 1. The highest increasing of yield oil palm was application of coastal sediment at dose of 40 tons ha\(^{-1}\). This is possible because in these conditions the availability of macro nutrients are in a state of sufficient and balanced, making it possible to absorb oil palm plants.

The application of coastal sediment at the dose of 60 tons ha\(^{-1}\), it production tends to decline. Oil palm plant production depends on the supply of nutrients from the soil, supposedly with the availability of some macro nutrients (N, P, K and Mg) which also tends to decrease at dose of 60 tons ha\(^{-1}\), so that the uptake of macro nutrients also declined. Nutrition is crucial production of oil palm fruits, the nutrients needed different numbers from different parts of the plant (roots, stems, leaves, fruit bunches) (Salmiyati et al., 2014). Such as nitrogen generally has no effect on oil palm yield components, but giving P lowered fruit production, fertilizer Potassium deficiency tends to reduce the mesocarp: fruit ratio, while Mg considerable increase palm oil (Goh et al., 2003).

**CONCLUSIONS and SUGGESTION**

**Conclusion**

1. Application of coastal sediment can improve some chemical properties of peat shown by pH and base saturation.
2. Nutrients availability in peat increased by application of coastal sediment.
3. Doses of coastal sediment of 40 tons ha\(^{-1}\) is optimal dose for increase yield of oil palm in peat, which attain 5.49 tons ha\(^{-1}\).

**Suggestion**

It was shown that application of coastal sediment had positive effect to some peat chemistry properties and nutrients availability in peatlands, which could be potentially, exploited in various soils amelioration strategies without risk to a sustainable agriculture in the tropics area.

**ACKNOWLEDGEMENTS**

This research was supported by Master Plan for Acceleration and Expansion of Indonesia Economic Development (MP3EI) research program in 2014.
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