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DYNAMICS AND DISTRIBUTION OF PEAT WATER MACRO NUTRIENTS (N, P, K, Ca, Mg AND S) IN OIL PALM PLANTATION BASED ON SEASON, PEAT THICKNESS, CHANEL DISTANCE AND PLANT AGE

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SUMMARY

Peatland that has been converted to other land uses such as oil palm plantation has to be well managed. Fertility of peatland will influence oil palm productivity. Macro nutrients such as nitrogen, phosphorus, potasium, magnesium and sulfur is required by oil palm for optimal growth and production. Naturally, oil palm requirement of the nutrients could not be supplied sufficiently from the soil so that fertilization is needed. Fertilizing has to be well carried out in order to increase nutrient absorbtion efficiency. The objective of the research is to study peat water macro nutrients (N, P, K, Ca, Mg and S) distribution in oil palm plantation based on season, peat thickness, channel distance and plant age. Result of the research showed that content of dissolved P, K, Ca, Mg and S were higher in dry season whereas N was higher in rainy season. In shallow peat, content of dissolved N, P, K, Ca and Mg were higher than that in deep peat however S was lower. Dissolved N, P, K, Ca Mg and S tendedto increase by distance from channel. Dissolved N, P, K, Ca, Mg and S were higher in more than 15 years old oil palm than that in 6-15 years old oil palm.

***Keywords**: peatland, peat water macro nutrients, distribution, oil palm*

INTRODUCTION

The utilization of peatland for oil palm plantations has been increasingly widespread due to the limited availability of mineral land. Peatland area in Indonesia is about 14.93 million ha and about 15.1% in the form of peat that has been cultivated as farmland (annual crops, plantations and industrial plants) (Wahyunto, 2013). Approximately 1.54 million hectares or 20% of the total area of oil palm plantations in Indonesia are on peatlands (Ritung *et al.*, 2012). Utilization of peatlands for oil palm plantations become a major challenge not only related to the amount of input that should be given, but also related to specific management of peatlands in order to avoid land degradation.

Utilization of peatland for oil palm plantations will not only be challenged by problems of oil palm production, but also by efforts for preserving the environmental balance. Peatland management into productive land must comply to the principles of sustainability by utilizing environmentally friendly and low emission technologies. These technologies are including water management, setting up drainage network, amelioration, and fertilization (Las *et al.*, 2012).

Peatland that has been converted to other land uses such as oil palm plantation has to be well managed. Fertility of peatland will influence oil palm productivity. Tropical peatland usually has low fertility. Macro nutrients such as nitrogen, phosphorus, potasium, magnesium and sulfur is required by oil palm for optimal growth and production. Naturally, oil palm requirement of the nutrients could not be supplied sufficiently from the soil so that fertilization is needed. In oil palm plantation, fertilization is given regularly in the form of macro nutrients and micronutrients fertilizer. Fertilizer is given higher in older oil palm than younger oil palm. Nutrients from fertilizer are easily diluted and leached to the ground water due to high porosity of peat. Fertilizing has to be well carried out in order to increase nutrient absorbtion efficiency.

Objective of the research is to study peat water macro nutrients (N, P, K, Ca, Mg and S) distribution in oil palm plantation based on season, peat thickness, channel distance and plant age.

METHODS

The study was carried out at Kimia Tirta Utama Oil Palm Plantation Company at Siak Regency, Riau Province, Indonesia (0^0 43’ 33” - 0^0 46’ 9” N and 101^0 44’ 24” - 101^0 46’ 22” E). The study was conducted in rainy season (March) and dry season (August) of 2015 in peatland. The peatland used in this study was shallow (thickness

less than 3 meters) and deep (thickness more than 3 meters) peat, with hemic level of decomposition stage (rate of 33 – 66 %) and clay substratum. The oil palm plantation used in this study were in two ages, ie 6 – 15 and more than 15 years old plantation. Fertilizer is given about 57 kg N, 7 kg P, 40 kg K, 15 kg Ca kg, 15 kg Mg , 0 S kg/ha/year and about 115 kg N, 41 kg P, 105 kg K, 17 kg Ca kg, 15 kg Mg , 6 S kg/ha/year for 6-15 and more than yers old plantation respectively. The observations were done in varies distances from chanel, those are 10, 25, 50, 75, 100, 150 meters by installing piezometer (Figure 1).

Peat water samples in piezometers were collected at 1 meter deph from surface. Peat water samples were analized to determine peat water macro nutrients (N, P, K, Ca, Mg and S). N was determined by micro Kjeldahl. P was extracted by Bray 1 and determined using UV Vis. K was determined using flame fotometer. Ca, Mg were determined using atomic absorption spectrophotometer and S was determined using UV Vis. The data were analyzed by descrptive analysis to understand distribution trend of the data.

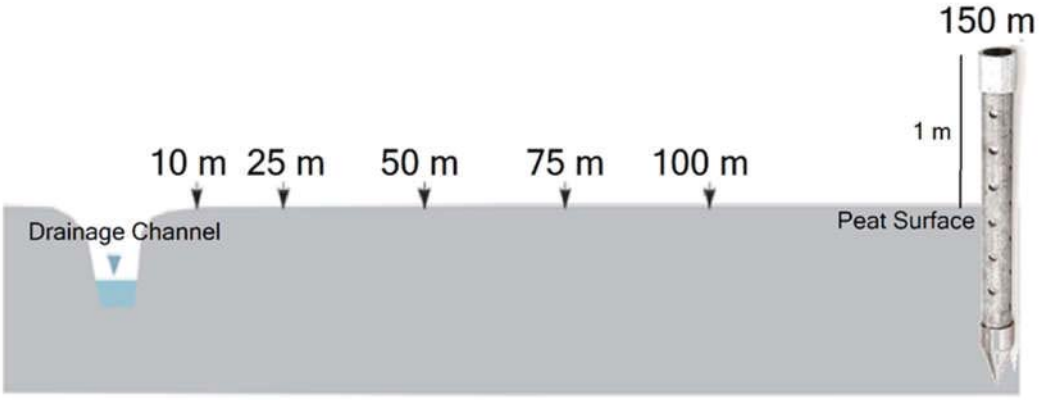

Figure 1: Peat water colection from piezometers installed based on distance from chanel.

RESULTS AND DISCUSSION

Results of the research showed that content of dissolved P, K, Ca, Mg and S were lower in dry rainy season compare to that in dry season (Table 1). Contrary to these results dissolved N was higher in rainy season (Table 1). Oil palm plantation was fertilized with almost complete nutrients, especially those that contain N, P, and K. These results suggested that N fertilizer in peatland was easily subject to leaching such that dilution of nutrients in rainy season was not causing lower N concentration in peat soil water. On the other hand, other studied nutrients in particular P and K were subject to dilution in rainy season as indicated by their low concentration in rainy season compare to that in dry season.

Table 1: Peat water macro nutrient of oil palm plantation in dry and rainy seasons.

Season	N (ppm)	P	K	Ca	Mg	S	(n)
Rainy	23.40 (13.45-53.82)	0.68 (0.08-2.29)	2.80 (0.37-9.38)	5.46 (2.01-12.04)	1.16 (0.44-4.80)	1.92 (0.35-5.26)	24
Dry	21.95 (13.45-53.82)	1.64 (0.1-5.87)	4.14 (0.25-17.41)	9.15 (1.54-12.04)	1.91 (0.43-16.02)	2.03 (0.42-4.42)	24

In shallow peat, content of dissolved N, P, K, Ca and Mg were higher, except dissolved S that was lower compare to that in deep peat (Table 2). There are two reasons that might explain these results. Firstly, shallow peat has shallow mineral soil substratum such that some parts of the nutrients supplied by this mineral substratum. Secondly, water and water movement in deep peat are expected to be in higher amount and more dynamic compare to that in shallow peat such that dilution effect was higher in deep peat which in turn resulted in lower concentration of nutrients in the water of the deep peat. Sulfur is an exception probably due to the amount of S fertilization was lower compare to fertilization of other nutrients.

Table 2: Peat water macro nutrient of oil palm plantation in deep and shallow peat.

Peat Thickness	N (ppm)	P	K	Ca	Mg	S	(n)
Shallow	24.08 (13.45-53.82)	1.49 (0.08-5.87)	3.67 (0.25-17.41)	5.52 (1.61-12.04)	1.93 (0.44-16.92)	1.92 (0.35-7.30)	24
Deep	21.64 (13.45-53.82)	0.88 (0.1-5.10)	3.29 (0.37-11.73)	4.58 (1.54-12.04)	1.14 (0.43-16.02)	2.02 (0.42-4.42)	24

Dissolved N, P, K, Ca Mg and S are in general tended to increase by distance from channel (Table 3). The data, however, very fluctuated. The channel networks in oil palm plantation on peatland functioned more as a controlled and limited drainage of excess water in the land. Sites that is closer to the channel was expected to experienced higher leaching that accompany the drainage process to the channel, in particular in rainy season. This higher tendency of losing nutrient content in the site closer to the channel has resulted in the tendency of lower nutrient concentration of peat water closer to the channel.

Table 3: Peat water macro nutrient of oil palm plantation based on distance from channel.

Distance from Channel (m)	N (ppm)	P	K	Ca	Mg	S	(n)
0	17.94 (13.45-40.36)	0.13 (0.08-0.23)	2.41 (0.25-7.04)	2.51 (1.54-3.77)	0.64 (0.43-0.95)	1.78 (0.56-3.72)	8
10	21.14 (13.45-40.36)	1.69 0.13-5.87()	5.06 (0.86-10)	6.02 (3.55-17.04)	1.96 (0.71-11.67)	1.55 (0.35-4.07)	8
25	23.54 (13.45-53.82)	2.13 (0.13-5.10)	4.89 (0.75-11.73)	5.89 (1.88-7.26)	1.28 (0.55-16.02)	1.55 (0.63-4.91)	8
50	26.91 (13.45-40.36)	0.57 (0.13-1.50)	2.36 (0.37-6.03)	5.54 (2.21-12.44)	0.84 (0.58-1.88)	2.37 (0.84-5.26)	8
75	23.06 (13.45-53.82)	0.81 (0.12-2.29)	3.24 (0.37-8.27)	4.88 (3.05-7.72)	1.50 (0.51-5.21)	2.26 (0.77-4.91)	8
100	23.06 (13.45-40.36)	0.64 (0.17-1.88)	2.67 (1.74-6.67)	4.36 (2.93-7.06)	1.77 (0.44-4.80)	2.23 (0.42-4.21)	8
150	17.94 (13.45-40.36)	0.81 (0.21-1.90)	1.91 (0.62-3.82)	7.45 (2.01-9.07)	1.67 (0.54-5.94)	1.94 (1.05-4.42)	8

Dissolved N, P, K, Ca, Mg and S were higher in more than 15 years old oil palm than that in 6-15 years old oil palm (Table 4). Fertilization of nutrient on oil palm plantation of > 16 years old oil palm was higher than fertilization on oil palm plantation of 6 – 15 years old. This is the cause of higher dissolved nutrients in peat water of the > 16 years old oil palm plantation.

Table 4: Peat water macro nutrient of oil palm plantation in 6-15 years old and more than 15 years old.

Oil Palm Age (year)	N (ppm)	P	K	Ca	Mg	S	(n)
6-15	18.35 (13.45-40.36)	0.88 (0.1-4.71)	2.46 (0.37-9.38)	4.47 (1.54-8.36)	1.47 (1.45-6.79)	1.35 (0.35-2.53)	24
>16	27.58 (13.45-53.82)	1.49 (0.08-5.87)	4.72 (0.62-17.41)	5.54 (1.22-12.44)	1.51 (1.44-16.92)	2.72 (0.7-4.91)	24

CONCLUSION

Dissolved P, K, Ca, Mg and S were higher in dry season whereas N was higher in rainy season. In shallow peat content of dissolved N, P, K, Ca and Mg were higher than that in deep peat however S was lower. Dissolved N, P, K, Ca Mg and S tended to increase by distance from channel. Dissolved N, P, K, Ca, Mg and S were higher in more than 15 years old oil palm than that in 6-15 years old oil palm.

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