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NUTRIENS STUDY OF CALCIUM, POTASSIUM AND MAGNESIUM IN THE RUBBER PLANTATION (HEVEA BRASILIENSIS MUELL. ARG) ON THE VARIOUS OF RUBBER PRODUCTION LEVEL

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***ABSTRACT**--Nutriens of calsium (Ca), potassium (K) and magnesium (Mg) play an important role in various plant metabolisms. The status of those cations is thought to be related to the ability of rubber plants to metabolize latex. This study intends to determine the status and ratio of base cations Ca, K and Mg which influences production of rubber estate (Hevea Brasiliensis Muell. Arg) was conducted in the rubber field of PTPN III on PB 260 and RRIM 712 clones, aged 6-7 years and Ultisol soil types. High production criteria were set at Sarang Giting Estate; medium in Dusun Hulu Estate and low production in Bandar Betsy Estate with production of latex were consecutinely 1,8053.3, 1,364.89 and 1,242.44 kg / ha / year base and pproduction in 2017. This research was conducted using study methods on the various of rubber production level has never been done. This study was carried out to determine the nutriens status of Ca, K and Mg in rubber field that have different levels of product latex and aims to compare the status of base cautions in rubber field in three locations of production status. The soil samples at a depth of 0-30 cm and 30-60 cm from each estates were studied as ten points. The results showed that Ca-exc in the depth of 0-30 cm obtainedeach at high, medium and low latex production of 0.41 me / 100 g, 0.55 me / 100 g and 0.18 me / 100 g. In the depth of 30-60 cm, it was obtained that each at high to low production were consecutively 0.14, 0.79 and 0.24 me / 100 g. The results showed that K-exc in the depth of 0-30 cm were obtained thateach at high to low production 0.40 me / 100 g, 0.38 me / 100 g and 0.18 me / 100 g.In the depth of 30-60 cm, it was obtained that each at high, medium and low latex production of 0.14 me / 100 g, 0.79 me / 100 g and 0.24 me / 100 g. The result of soil analysis in the depth of 30 cm is K-exc obtained in each level namely 0.40 me/100 g, 0.38 me/100 g, and 0.18 me/100 g. in the depth 0f 30-60 cm, it was obtained in each level 0.40 me/100 g, 0.38 me/100 g, and 0.18 me/100 g. The results of K-excdepth at 0-30 cm obtainedeach at high, medium and low production 0.32 me / 100 g, 0.17 me / 100 g and 0.15 me / 100 g. In the depth of 30-60 cm each obtained each at high to low production of 0.23 me / 100 g, 0.24 me / 100 gand 0.35 me / 100 g. In general, latex production from these three gardens is influenced by potassium content.Hara kalsium (Ca), kalium (K) dan magnesium (Mg) banyak*

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berperan dalam berbagai metabolisme tanaman. Status kation-kation tersebut diduga berkaitan dengan kemampuan tanaman karet dalam metabolisme lateks. Penelitian ini bertujuan untuk mengetahui status dan rasio kation-kation basa Ca, K dan Mg yang berpengaruh terhadap produksi dilahan perkebunan karet (Hevea brasiliensis Muell.Arg) di lingkup PTPN III pada klon PB 260 dan RRIM 712, umur 6 – 7 tahun dan jenis tanah Ultisol pada status produksi tinggi dikebun Kebun Sarang Giting, sedang di Kebun Dusun Hulu dan rendah di Kebun Bandar Betsi, dengan produksi berturut-turut 1.8053,3, 1.364,89 dan 1.242,44 kg/ha/tahun berdasarkan produksi lateks tahun 2017Penelitian ini dilakukan dengan menggunakan metode survey pada berbagai tingkat produksi karet dan belum pernah dilakukan. Studi ini dilakukan untuk mengukur status nutrisi Ca, K dan Mg di perkebunan karet yang memiliki tingkat produksi lateks yang berbeda. Pengambilan sampel tanah pada kedalaman 0-30 cm dan 30-60 cm masing-masing kebun sebanyak sepuluh titik. Hasil analisis Ca-exc pada kedalaman 0-30 cm diperoleh masing-masing pada produksi tinggi sampai rendah sebesar 0,41 me/100 g, 0,55 me/100 g dan 0,18 me/100 g. Pada kedalaman 30-60 cm diperoleh masing-masing pada produksi tinggi sampai rendah sebesar 0,14 me/100 g, 0,79 me/100 g dan 0,24 me/100 g. Hasil analisis tanah pada kedalaman 0-30 cm adalah K-exc, diperoleh masing-masing pada produksi tinggi sampai rendah sebesar 0,40 me/100 g , 0,38 me/100 g dan 0,18 me/100 g. Pada kedalaman 30-60 cm diperoleh masing-masing pada produksi tinggi, sedang dan rendah sebesar 0,40 me/100 g, 0,38 me/100 g dan 0,18 me/100 g. Hasil analisis tanah pada kedalaman 0-30 cm adalah K-exc, diperoleh masing-masing pada produksi tinggi sampai rendah sebesar 0,32 me/100 g, 0,17 me/100 g dan 0,15 me/100 g. Pada kedalaman 30-60 cm diperoleh masing-masing pada produksi tinggi sampai rendah sebesar 0,23 me/100 g, 0,24 me/100 g dan 0,35 me/100 g. Secara umum bahwa produksi lateks dari ketiga kebun tersebut dipengaruhi oleh kandungan kalium.Kata Kunci : Kalsium, Kalium, Magnesium, Tingkat Produksi Karet dan Tanaman Karet

Keywords-- *Calcium, Potassium, Magnesium, Rrubber Production level and Rubber Plant*

I. INTRODUCTION

Rubber (*Hevea brasiliensis* Muell.Arg) was a commodity that has been developed in the world to supply various industries. The productivity of smallholder plantations rubber plantations was still low with an average rubber production per hectare of 700 - 900 kg / ha / year or in average of 820 kg / ha / year. This productivity is still very low compared to the productivity of large Plantations of the country which was an average of 1,299 kg / ha / year and private plantations of 1,542 kg / ha / year or smallholder rubber productivity in other countries (Ditjenbun 2016). Overall,the production according to research and development of industrial plants (Litbangtri, 2015) was not optimal because the potential production of PB 260 / RRIM 712 clones can reach 1,500 - 2,335 kg / ha / year.

One reason why rubber production is lower than the potensial production is due to that most of rubber field were not fertile as they are cultivated on Ultisol soil type. Ultisols soils that were generally less fertile for agricultural cultivation. ±24.3% of the land area of Indonesia was Ultisols (Subagyo, et al, 2000). Ultisol soils with low pH (acid) that is <5.0 with high Al saturation which was>42%, low organic matter content that was<1.15%, low nutrient content N around 0.14%, P at 5.80 ppm, low base saturation at 29% and also low CEC at 12.6 me/100 g were acidic which nutrient poor due to intensive alkaline washing interfere with plant growth (Alibasyah, 2016).

Type soil of Sarang Giting estate of PTP Nusantara III was Ultisol with the texture of clay to loam with acidic pH 4.5 - 5 (Romanosa, et al. 2018). Reciprocally, the soils in the Dusun Hulu Estate and Bandar Betsi Estate

have the same characteristic as the soil in Sarang Giting Estate (Adiwiganda, 1998). Soil fertility is more focused on soil chemical content, namely the presence of macro elements such as N, P, K which were absorbed by many plants. But, there are other influencing factors, base cations such as Ca and Mg. These elements affect the low fertility of the soil characterized by the low content and imbalance of Ca, Mg and K.

Calcium (Ca) play a role in the formation of middle lamella of cells, cell elongation, meristematic tissue development, protein synthesis, and neutralizing harmful compounds. Low calcium element caused plants not only inhibit neutralizing the harmful compounds but also triggered the disruption of vessel communication between latex cells then resulting in cell damage (Leiwakasbessy et al., 2003).

Magnesium was a part of the chlorophyll molecule that could activate photosynthetic enzymes, respiration, and needed for protein synthesis (Taiz and Zerger, 2002). The decreased latex results due to Mg deficiency was differ from those caused by K. In Mg deficiency, photosynthesis and the process of starch formation were disrupted. The disruption starch formation process causedthe reduction of latex because photosynthetic sucrose was the raw material for forming latex (Jacob et al., 1989). Mg played an important role in phosphate transportation in plants. It is also associated with many enzyme systems, especially in phosphate metabolism and thus in respiration (Shorrocks, 1964).

The cation balance was the nutrient balance in the soil that affects the availability of nutrients and the adequacy of each soil cation (K, Ca, Mg) to support the achievement of optimum plant production. If the amount of each nutrient was insufficient to support plant growth and its development, the balanced ratio becomes meaningless.The balance of Base Cations such as Ca, K and Mg was to fulfill the needs of nutrient base cation on the soil in sufficient and balanced quantities. The balance must be considered in determining fertilizer requirements for plants. This was due to the addition of nutrients through fertilization will make a shift in nutrient balance in the soil which often affected the availability of nutrients in the soil. In general, the concept of nutrient balance can be reviewed through two aspects,nutrient balance in the soil and nutrient balance in plant tissues (Winarna and Sutarta 2009).

The balance nutrient in the soil affects the nutrient availability, while nutrient balance in plant tissue affects the plant growth and production. Likewise, the balance of base cations, Ca and Mg. Mg exchanged in soil that was not balanced with Ca will cause deterioration of the physiological characteristics of the root and caused the decreasing plant production (Loide, 2004).The efforts to achieve base cation balance in the soil were carried out by Ginting (2013) which stated that the production data that has been choppedwere divided into high production groups and production groups. To find the nutrient ratio (K, Ca, Mg) in the soil that was considered balanced for oil palm plants, foremost looking for the relationship model between the ratio of each nutrient andchopped plant production, then the base cation balance is achieved.

The productivity of rubber plants suspected to be related with the cations in the top soil and subsoil. A survey for determining the correlation among cation factors to the rubber production needs to be carried out. This study was carried out to determine the nutriens status of Ca, K and Mg in rubber field that have different levels of product latex and aims to compare the status of base cations in rubber field in three locations of production status, so that nutrient cations could be known to have a major effect on production, both to spur growth and to increase plant productivity.

II. MATERIALS AND METHODS

This study was carry out by doing a survey to collect data on the status of base cations at different rubber plantation locations based on the 2017 latex production criteria at a state owned rubber plantation disignated by PT. Perkebunan Nusantara 3 (PTPN 3). Three estate used for this study were Sarang Giting Estate, Dusun Hulu Estate and Bandar Betsi Estate each of which representing high (1,853.30 kg/ha/ yr), medium (1,364.89 kg/ha/ yr) and low (1242.44 kg/ha/yr). The rubber field were Ultisol soil types grown with the rubber clones of PB 260 and RRIM 712 clones planting year 2010-2011.Soil samples were taken from each plantation in the depth of 0-30 cm and 30-60 cm. The Soil samples were collected using a random drill and each sampling was repeated a total of ten replications from each estate location.

The data were analyzed using the results of the analysis of Ca, Mg and K cation contents. The design used was a non-factorial randomized design. The observation data were analyzed with the F test, if in the statistical test the data obtained were significant, the test was continued with the DMRT test (Duncan's Multiple Range Test) (Gomez, K.A and Arturo A. Gomez, 2007) and using t-test based on analysis with SPSS

III. RESULT AND DISCUSSION

3.1. Status of Base Cations in Rubber Field

The base cations status at a depth of 0-30 cm and 30-60 cm layer at various levels of rubber production is presented on Table 1. The status of calcium and magnesium base cations was not different in the three estate locations, but the status of the potassium base cation was different among the estate surveyed. The nutrient status of Ca and Mg in the three plantations classified as low based on the chemical analysis criteria of soil, plants, water and fertilizer (Staff of the Palm Oil Research Center, 1990).

The status of K content was low and rather low in the respective fields at Dusun Hulu Estate and Bandar Betsi Estate which have medium and low production status. Mean while, Sarang Giting Estate with high rubber production criteria and has medium K status (Table 1).

Based on Table 1 on the depth layer above 0-30 cm , Ca-exc analysis results were obtained 0.41 me/100g at high production ; 0.55 me/100g at medium production and 0.18 me/100g at low production. In Mg-exc analysis obtained : 0.32 me/100g at high production, 0.17 me/100g at medium production, and 0.15 me/100g at low production and all three categorized at the very low Mg-exc nutrient status. K-exc analysis results obtained by 0.40 me/100g at high production, 0.38 me/100g at medium production and categorized at rather low K-exc nutrient and 0.18 me/100g at low production and categorized as low K-exc nutrient status.

Tabel 1: Soil base cations analysis at the depth soil layer 0-30 cm and 30-60 cm in the rubber plantation (*Hevea brasiliensis* Muell. Arg) on various production status

Location Of Production	Average Nutrition Status

	Ca-exc	Mg-exc	K-exc
	---------- me/100g ----------		
	Depth Soil Layer 0-30 Cm		
Sarang Giting Estate	0,41 (Low)	0,32 (Low)	0,40 (Medium)
Dusun Hulu Estate	0,55 (Low)	0,17 (Low)	0,38 (Rather Medium)
Bandar Betsi Estate	0,18 (Low)	0,15 (Low)	0,18 (Medium)
	Depth Soil Layer 30-60 Cm		
Sarang Giting Estate	0,14 (Low)	0,23 (Rather Low)	0,53 (Medium)
Dusun Hulu Estate	0,79 (Low)	0,24 (Rather Low)	0,44 (Medium)
Bandar Betsi Estate	0,24 (Low)	0,35 (Rather Low)	0,30 (Rather Low)

On the depth layer above 30-60 cm, the analysis results obtained Ca-exc of 0.14 me/100g at high production locations, 0.79 me/100g at medium production and 0.24 me/100g at low production locations. The results of Mg-exc analysis obtained values of 0.23 me/100g at high production sites, 0.24 me/100g at medium production sites, and 0.35 me/100g at low production sites and all three were categorized at rather low Mg-exc nutrient status.

Based on Figure 1, both at 0-30 cm layer depth and 30-60 cm layer depth it can be seen that the comparison among the three plantation locations based on production, namely the Sarang Giting Estate (High), Dusun Hulu Estate (Medium), and Bandar Betsi Estate (Low), have rather low to rather medium K-exc. The effect of K-exc content to the production was evident at low production sites on medium to high production locations, but has a difference in nutrient status which was rather low to medium and has an increasing value. This wasdue to soil potassium nutrients affect plant uptake.

Based on Figure 2, both at 0-30 cm layer depth and 30-60 cm layer depth it can be seen that the comparison among the three plantation locations based on production, namely the Sarang Giting Estate (High), Dusun Hulu Estate (Medium), and Bandar Betsi Estate (Low), have low Ca-exc. The effect of Ca-exc content on production is clearly visible in medium production sites both at depth of layer 0-30 cm and depth of layer 30-60 cm. But in the depth layer of 30-60 higher Ca-exc content.

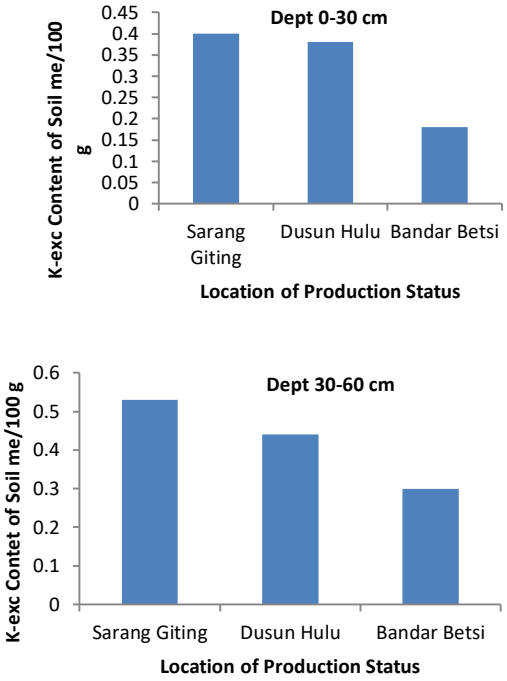
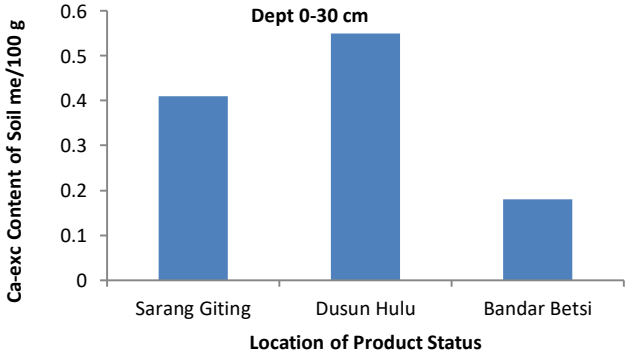


Figure 1: K-exc status at dept of 0-30 cm and 30-60 cm in rubber plantations at various levels of production

Based on Figure 3, both at 0-30 cm layer depth and 30-60 cm layer depth it can be seen that the comparison among the three plantation locations based on production, namely the Sarang Giting Estate (High), Dusun Hulu Estate (Medium), and Bandar Betsi Estate (Low), have rather low to low Mg-exc. The effect of Mg-exc content on production is clearly seen at high production locations at depth layers of 0-30 cm and whereas at layer depths of 30-60 cm the highest content of Mg-exc at low production status locations.

The most case it can be seen that the comparison between the three plantation locations based on production have a K-exc content which indicated a significant difference between three production status locations and have a different nutrient status, which was rather low to medium. This was because soil potassium nutrients affect plant uptake and were more dominant on rubber plant production.



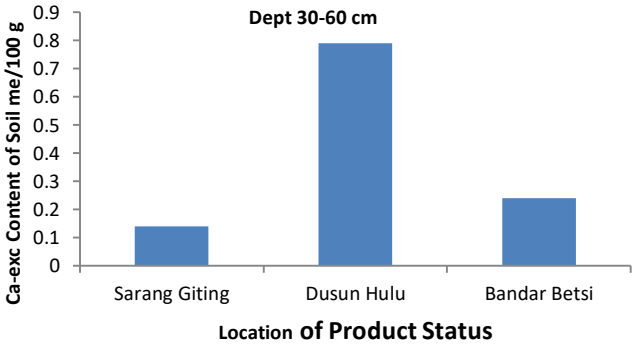


Figure 2: Ca-exc status at dept of 0-30 cm and 30-60 cm in rubber plantations at various levels of production

From Table 2 above, the results of t-test analysis of Ca-exc content at 0-30 cm layer depth, obtained significant results in the comparison of the production of Siting Giting Estate with Dusun Hulu Estate, Sarang Giting Estate with Bandar Betsi Estate and Dusun Hulu Estate with Bandar Betsi Estate. The results of t-test analysis of K-exc content, obtained significant results in the comparison of the production location of Sarang Giting Estate

with Bandar Betsi Estate, Dusun Hulu Estate and Bandar Betsi Estate. The comparison test among Sarang Giting Estate and Dusun Hulu Estate was not significant. The results of t-test analysis of Mg-exc content at layer depth of 0-30 cm, obtained significant results in the comparison of the production location of Sarang Giting Estate with Bandar Betsi Estate. The comparison test among Sarang Giting Estate and Dusun Hulu Estate and Dusun Hulu Estate with Bandar Betsi Estate was not significant.

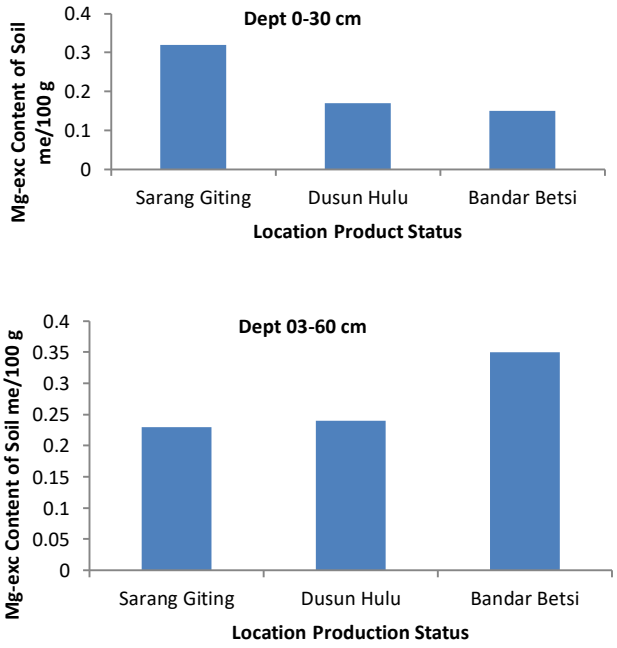


Figure 3: Mg-exc status at dept of 0-30 cm and 30-60 cm in rubber plantations at various levels of production

The results of t-test analysis of Ca-exc content at 30-60 cm layer depth, obtained significant results in the comparison of the production of Dusun Hulu Estate with Bandar Betsi Estate. The results of t-test analysis of K-exc content, obtained significant results in the comparison of the production location of Sarang Giting Estate with Dusun Hulu Estate and Dusun Hulu Estate with Bandar Betsi Estate. The comparison test among Sarang Giting Estate with Dusun Hulu Estate was not significant. The results of t-test analysis of Mg-exc content, obtained significant results in the comparison of the production location of Sarang Giting Estate with Bandar Betsi Estate. The comparison test among Sarang Giting Estate and Dusun Hulu Estate and Dusun Hulu Estate with Bandar Betsi Estate was not significant.

Tabel 2: t-test base cation Ca, K and Mg soils in soil layers depth 0-30 cm and 30-60 cm in rubber plantations (Hevea brasiliensis Muell. Arg) on various production status

Location Of Production	Paired Samples Correlations	
	Significance	
Depth Soil Layer 0-30 Cm		
Sarang Giting Estate x Dusun Hulu Estate Ca-exc	0,072	s
Sarang Giting Estate x Bandar Betsi Estate Ca-exc	0,369	s
Dusun Hulu Estate x Bandar Betsi Estate Ca-exc	0,085	s
Sarang Giting Estate x Dusun Hulu Estate K-exc	0,517	ns
Sarang Giting Estate x Bandar Betsi Estate K-exc	0,259	s
Dusun Hulu Estate x Bandar Betsi Estate K-exc	0,462	s
Sarang Giting Estate x Dusun Hulu Estate Mg-exc	0,517	ns
Sarang Giting Estate x Bandar Betsi Estate Mg-exc	0,265	s
Dusun Hulu Estate x Bandar Betsi Estate Mg-exc	0,953	ns
Depth Soil Layer 30-60 Cm		
Sarang Giting Estate x Dusun Hulu Estate Ca-exc	0,876	ns
Sarang Giting Estate x Bandar Betsi Estate Ca-exc	0,739	ns
Dusun Hulu Estate x Bandar Betsi Estate Ca-exc	0,094	s
Sarang Giting Estate x Dusun Hulu Estate K-exc	0,251	s
Sarang Giting Estate x Bandar Betsi Estate K-exc	0,778	ns

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Dusun Hulu Estate x Bandar Betsi Estate K-exc	0,448	s
Sarang Giting Estate x Dusun Hulu Estate Mg-exc	0,816	ns
Sarang Giting Estate x Bandar Betsi Estate Mg-exc	0,188	s
Dusun Hulu Estate x Bandar Betsi Estate Mg-exc	0,525	ns

Note: - The number followed by the Significant (S) is significantly different and Non significant (ns) at the 5% level based on the t test based on SPSS

3.2. Determining the Base Cation Ratio in Rubber Plantation (Hevea brasiliensis Muell. Arg) on Various Production Status

The analysis result of alkaline base soil ratio based on the base cation on the rubber plantation land (*Hevea liensis* Muell. Arg) on the status of low, medium and high production at 0-30 cm soil depth can be seen in Table 3.

Tabel 3: Soil Base Cations Ratio in Soil Depth 0-30 cm and 30-60 cm in rubber plantation land (*Hevea brasiliensis* Muell. Arg) on various production status

Location of Production Status	Average Nutrient Status			
	Ca-exc	Mg-exc	K-exc	Ratio
	---------- me/100g ----------			Ca : Mg : K
Depth Soil Layer 0-30 Cm				
Sarang Giting Estate	0,41	0,32	0,40	1 : 1 : 1
Dusun Hulu Estate	0,55	0,17	0,38	3 : 1 : 2
Bandar Betsi Estate	0,18	0,15	0,18	1 : 2 : 1
Depth Soil Layer 30-60 Cm				
Sarang Giting Estate	0,14	0,23	0,53	1 : 2 : 4
Dusun Hulu Estate	0,79	0,24	0,44	3 : 1 : 2
Bandar Betsi Estate	0,24	0,35	0,30	1 : 2 : 1

Based on the Table 3, it can generally be seen that the ratio of Ca: Mg and K which was more influential on production was the value of Ca and Potassium in the layer 0-30 cm. The excess of Mg exchanged in soil that was

not balanced with Ca will cause deterioration of the root physiological characteristics and cause a decrease in plant production and this was evident from the above ratio even though the nutrient status was still below low to medium.

The ratio of Ca: Mg and K which further influenced production was the Calsium and Potassium value in the 30-60 cm layer. This was almost the same as the dynamics that occurred in the 30-60 cm layer and nutrient status was still below low to medium.

IV. DISCUSSION

Based on the Base Cations analysis result, namely calcium, magnesium and potassium, the ratio between the three plantation locations based on production was low to medium. There was no significant difference Ca-exc and Mg-exc content in the three production location statuses, while K-exc content obtained a significant difference between low production status with high and medium production status, whereas in high and medium production status there was no significant difference.

The effect of K-exc content with production was evident at low production sites towards medium to high production locations, while K-exc content between medium to high production sites has no significant effect, but has a difference in nutrient status, which was rather low to medium and has an increasing value.

The analysis result of soil towardsexchanged base cation content (Ca-exc, Mg-exc and K-exc) indicated that in general, base cation content was exchanged on the three rubber estate areas were classified as rather low to medium, especially Ca-exc and Mg-exc, whereas K-exc was generally medium either at the 0-30 cm or 30-60 cm layer. This inflicted the production results on high-yielding rubber plantation land according to PT. Perkebunan Nusantara 3 data, namely Sarang Giting Estate, was 1,853.30 kg / ha / year, but it was not optimal due to the production potential of PB 260 / RRIM 712 clones averages 1,500-2,335 kg/ha/year (Litbangtri, 2015).

The Ca and Mg cations content were included in the rather low to low criteria. If viewed from the Ca and Mg contents, then the soils from the three garden locations were categorized as less fertile so fertilization was need to be conducted especially those which contained Ca and Mg nutrients while the K cation content was included in low to medium criteria. When viewed from the K content, the soils from the Dusun Hulu Estate and Bandar Betsi Estate locations were categorized as less fertile so fertilization was necessary especially those containing K nutrients, but at a high production location (Sarang Giting Estate) with medium status, there was no needed to add fertilization, especially those which contained K_2O. According to Thomas et.al.(2011) which stated that rubber plants require fertilization if the nutrient content of Ca and Mg was at a low to very low level.

Based on the above circumstances, the medium potassium content in the plantation location with high production status (Sarang Giting Estate) could be interpreted that the effect of potassium availability could increase the rubber production compared to the medium and low production locations (Dusun Hulu Estate and Bandar Betsi Estate) which has low to medium potassium content. This was caused by the soil potassium nutrients affected the plant uptake. Potassium indicated a positive response affecting productivity at Sarang Giting Estate.

Potassium was very important in many ways for plant productivity; not only carried outthe plant physiological functions but also increased the efficiency of nitrogen use. Potassium was very important in many ways for plant productivity. The role of potassium was to regulate stomata holes associated with potassium deficiency in plants. If potassium was lacking then the signaling mechanism that leads to translocation of K + ions

which the mobilized from old leaves to new leaves will run (Prajapati and Modi, 2014).Halim (2012) in Matana and Mashud (2015) stated that K fertilization in the form of KCl can increase the leaf K nutrient content in all oil palm varieties tested. According to the increase of K nutrient content can increase the plant height accretion, leavesquatities and oil palm stems diameter.

The Potassium (K), Calcium (Ca), and Magnesium (Mg) nutrients were macro nutrient that have been much studied. This wasdue to the three nutrients were interactedeach other in the soil, in other words the concentration of one nutrient that was too high may cause other nutrients to become depressed. Kasno et al. (2004) and Loide (2004) in Ginting, et al. (2013) said that Ca and Mg2 + ions can compete effectively with K in the soil sorption complex so that it can affect the availability of K in the soil. The excess of Mg exchanged in soil that was not balanced with Ca will cause deterioration in the physiological characteristics of the roots and cause the decreasing plant production.

Based on the result of data analysis, both the result of 0-30 cm and 30-60 cm layer soil analyzes, it was obtained that most of the base cations in the soil, especially Ca-exc and Mg-exc less than the ideal availability, so that the possibility of a deficiency cations due to ionizing competition were very possible. When viewed in more detail, it can be seen that one of the ions that can provide competition against fellow base cations was K-exc. The levels of K-exc on rubber plantation land in these three locations mentioned above were in the low to medium criteria, so that they will compete with Ca, and Mg which generally have a very low content. This competition will hamper the plant ability to absorb calcium (Ca) and magnesium (Mg) (Sufardi, et al. 2017).

On the results of the analysis at the study location, base cations ratio was in an unbalanced condition, causing inefficient fertilizer application, even it can caused the antagonism of these cations. In accordance with the opinion of Landon (1984), he states that among basic ions K, Ca, Mg, or Na, there were antagonistic properties in terms of absorption by plants. If one element was more numerous, then the absorption of the other elements will be disturbed.

The competition was related to the physico-chemical properties which were similar to each other resulting in a scramble for places on the ground sorption sites or root surfaces. Therefore, the ratios of K / Na, K / Ca, K / Ca + Mg, K / Ca + Na + Mg, can often provide an overview of alkaline status in the soil.

Based on the cationratios analysis at the three plantation locations based on production and 0-30 cm and 30-60 cm soil layer, it indicates an imbalance condition, according to Westerman (1990) alhough K, Ca and Mg or Na element have antagonistic properties but the percentage of cationssaturation were exchangeable which ideal for various crop commodities was 65% Ca, 10% Mg and 5% K or Ca: K = 13: 1 and Mg: K = 2: 1.

V. CONCLUSION

The highest production from the criteria that has been set by PT. Perkebunan Nusantara III was Sarang Giting Estate based on the results of soil analysis on the 0-30 cm layer, the K-exc content was 0.40 me/100 g (Medium).The lowest was at the Bandar Betsi Estate location , 0.18 me/100g K-exc content (Low) was obtained and significantly affected the production.The Ca-exc and Mg-exc content obtained from soil analysis results in the 0-30 cm layer at three estate locations, Sarang Giting Estate, Dusun Hulu Estate and Bandar Betsi Estate, had no significant effect and were very low in nutrient status.

The highest production from the criteria that has been set by PTPN 3 was Sarang Giting Estate based on the results of soil analysis on the 30-60 cm layer, obtained K-exc content of 0.53 me/100 g (Medium) and the lowest was Bandar Betsi Estate obtaining 0.30 me/100g(Low) of K-exc content and significantly influenced production.

The ratio of Ca: Mg: K in the 0-30 cm soil layer in various different production locations in PTPN III plantation area at Sarang Giting Estate was 1: 2: 1, Dusun Hulu Estate is 3: 1: 2, and Bandar Betsi Estate was 1: 2: 1.The ratio in the 30-60 cm soil layer at various different production locations in the PTPN III plantation areas at Sarang Giting Estate was 1: 1: 4, Dusun Hulu Estate was 3: 1: 2, and Bandar Betsi Estate was 1: 2: 1.

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