

Waste Water Minimization: Utilization of Rubber Latex Residue and Swine Dung as Fertilizer for Para Rubber Seedling Growth

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Abstract

Centrifuged residue of concentrated latex production is the by-product or waste of latex processing of the Hevea tree (*Heveabraziliensis*). The 10-15% residue of fresh latex causes waste disposal cost and environmental problems for factories. Because this residue contains some nutrients (N, P, K) in available forms, it can potentially enhance para-rubber tree growth. However, this centrifuged residue (CR) has some small rubber pieces mixed within that needs to be blended to prevent soil problems. The waste of swine dung or manure (SD) has similar problems on farms. This waste contains some essential plant nutrients, but it requires a period of time for microorganisms to decompose into the available compounds for plant growth. Thus, the blended fertilizer of latex residue with swine dung can potentially act as a preferable blended fertilizer because the nutrients from both wastes can enhance the plant growth from the initial stage. The aim of this study was to study the feasibility and effectiveness of the blended fertilizer at consideration ratio of 1:1 (CR and SD) alone and at nutrient adjustment to equal to chemical fertilizer usage for Hevea tree as a study case. We found that the blended fertilizer was feasible for para rubber seedlings, from the view point of growth enhancement, soil properties and water leachates.

Key words: Rubber Latex Residue/ Swine Manure/ Blended Fertilizer/ Para Rubber Seedling

1. Introduction

Para rubber or Hevea tree (*Heveabraziliensis*) (Nair, 2010) is one of the important economic plants of Thailand, and occupies a total plantation area of 16.89 million rai. About 2,710,000 tons of Para rubber latex production was exported in the year 2007 (Rubber Research Institute of Thailand, 2010). Consequently, large amounts of fertilizers, such as nitrogen, phosphorus and potassium, were introduced for 0.3, 0.05 and 0.18 kg/ plant / year respectively (Rubber Research Institute of Thailand, 2010a). Which Potiwadtuthum (2001) estimated to be worth 1,178 baht/rai.

In order to produce concentrated latex, it is previously necessary to add to the rubber a stabilizing agent (ammonia) to prevent the latex from coagulating. Moreover, to keep a good quality of

natural rubber before delivering to the concentration process, chemicals such as Tetra Methyl Thiuram Disulphide (TMTD), Zinc Oxide (ZnO), Diammonium phosphate (DAP), are added. At the factory process, the aforementioned raw rubber is then forwarded to a centrifuge process to remove water and increase the rubber content or concentration of the latex. This product is called "latex concentrate", while the residue in the centrifuge machine is called "residual latex powder or centrifuged residue (CR)". The CR actually has an average of 10-15 % remaining (Tekprasit, 1999; Rajana, 2006). It was considered as useless material, and mostly remedied by using as landfill. Ubon et al., (2007) report that the nutrient content of CR was as much as 1.02-2.53% (N), 22.15-48.19% (P) and 0.39-0.60% (K), in dry weight. Moreover,

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the authors remarked that even though nutrient structure had instantly existed in available forms for plant growth, there were still some rubber particles remaining in the residual, which probably caused soil problems after prolonged usage. Therefore, blended fertilizers are initiated by blending an amount of CR (could be enhanced plant growth at the started input), with swine dung (SD) (which needs time for microorganisms to convert the nutrient elements into the available form, such as humus-like products and unstable ammonia to stable organic forms (Zhu, 2004). . In particular, the swine manure report (Mala, 2003) mentioned that the nutrient contents were as much as 2.80% (N), 1.36% (P) and 1.18% (K) in dry weight.

Thus, the initial blended fertilizer (CR and SD) was considered for plant growth enhancement of this study. It was expected that the available nutrients in CR could support the growth in earlier stage, and SD at the late stage. This option could

decrease the cost of chemical fertilizer in rubber plantations and also minimize latex concentrate waste (Tekprasit, 1999 and Mala, 2003). It's also an environmental closed loop approach to recycle the unused nutrients into the agriculture chain system again. So, it is the attempt of this study to evaluate the feasibility and effectiveness of the blended fertilizer for plant growth enhancement, as well as to study the impact on soil properties, nutrient budget balance, etc.

2. Materials and Methods

2.1 Conceptual Framework

To approach the objectives of the study, the experiment was designed in a step-by-step fashion as seen in Figure 1. Which chemical fertilizer with N:P:K ratio (20:8:20), dried centrifuged residue, dried swine dung are then mixed into 4 treatments as detailed more in Table 1.

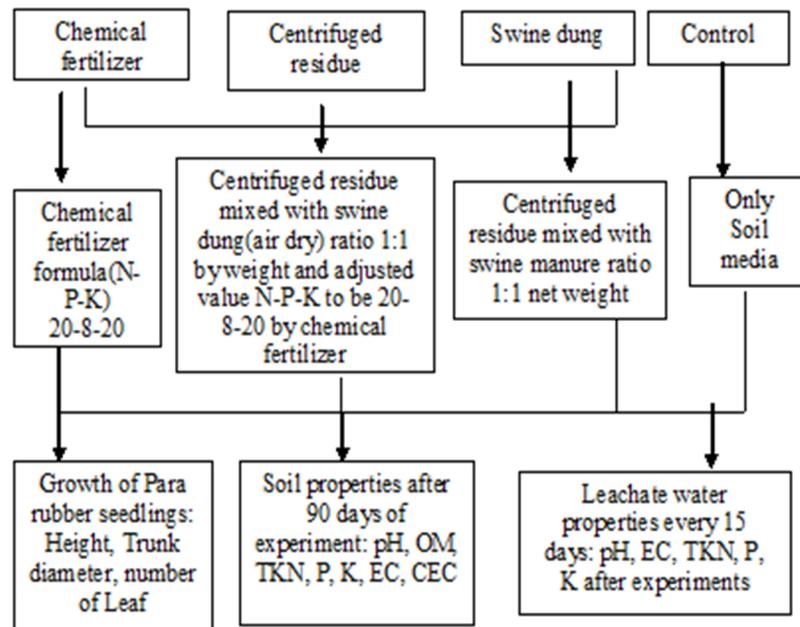


Figure 1 Conceptual framework of the study

Then, the values of 1) the growth enhancement of Para rubber seedling, 2) chemical properties of soil after blends usage, and 3) chemical properties of water leachate, of all 4 treatments are measured and analyzed for the feasibility of the studied blends.

2.2 Para rubber seedling

The bud-grafted seedling of a highly favored variety (RRIM 600) was selected for the study. The quality of all the seedlings for study had to meet the specifications of the Department of Agriculture, which were two months in age, not over 20 cm in height (from the bud-grafted mark to the top of the leaf) and had 2-3 leaf stories (ORRAF, 2010).

2.3 Blended fertilizers for the study

2.3.1 Baseline fertilizer for para rubber at various stages

As Osotspa (2008) suggested that rubber trees in different ages require different amounts of nutrient. For example, the sprout plot (stage 1, 1-2

months) requires fertilizer (N-P-K) equivalent to 0-3-0 or rock phosphate, while the grafting plot (stage 2, 2-5 months) requires fertilizer equivalent to 20-8-20, and the growth acceleration until rubber tapping (stage 3) required fertilizer equivalent to 20-8-20 or 20-10-12, and after tapped (stage 4) required fertilizer equivalent to 30-5-18. Hence, the considered fertilizer formula in this study was 20-8-20, at the input rate of 5 gm/ tree (Kangpidsadarn, 2007).

2.3.2 Wastes to be blended

Centrifuged residue (CR) was collected from Sri Trang Agro-Industry in an amount enough for all the experiments. Also, swine dung (SD) was collected from the farms without Sodium Hydroxide applications. Both the CR and SD had to be dried by sunlight until a constant weight was achieved.

2.3.3 Blended fertilizers for experiment

Blended fertilizers were considered into 4 treatments by 4 formulas as defined in Table 1.

Table1 Blended fertilizers criteria for each treatment

Treatments	Blended fertilizers /formula	Remarks
T1	Chemical (Baseline) fertilizer (N-P-K) in equivalent to 20-8-20	Input 5 gm/bag
T2	Mixing of CR and SD at the ratio of 1:1(wt/wt) and adjusted by enrichment fertilizer to reach N-P-K conc. ratio at 20-8-20	1.The enrichment fertilizers as : - nitrogrn from urea (46-0-0), - nitrogen and phosphorus from diammonium phosphate (18-46-0), - potassium from potassium Chloride (0-0-60) was used to adjust the concentration of nutrient (N-P-K) to reach 20-8-20 2. Input 5 gm/bag
T3	Mixing of CR and SD at the ratio of 1:1(wt/wt) only	1. Mixed only, and not adjusted nutrient concentration. 2. Input 5 gm/bag
T4	Without any nutrient or fertilizer added	As the control: original soil without any nutrient and fertilizer added

2.4 Soil media

In agreement with several studies (ORRAF, 2010; RRI, 2007; LDD, 2005b) soil media for para rubber plantation requires clay loam with good drainage at pH 4.5-5.5. Therefore, the Krabi (Kbi) soil series was selected for this study and samplings were collected from the undisturbed area of Wiang Sa district, Suratthani province, Thailand.

2.5 Experimental procedures in the study

Soil media sampling was taken by the core method at 0-30 and 30-50 cm in depth using the Bulk density test. Also, in the nearby area, the core soil at 0 -30 depth was collected at the appropriate column size for a nursery bag size (31, 37 cm). 15 seedling plantations were used for each treatment: 60 seedling plantations in total. Then they were settled on the stand 30 cm. above the ground with a slant top-roof of 50-60 % sunlight protection. Before the experiment started, 275 ml of water was given to all of these seedling plantations and let them stand overnight. Then 5 gm. of chemical or blended fertilizer was introduced to the nursery bag by scattering spread to cover all of the top soil area in the nursery bag. After that, a morning watering of 275 ml was provided to all plantations every 2 days along the experiment. Next, 1) soil properties analysis was done before and after the experiment; 2) Leachate water was collected and analyzed after watering through nursery bags every 2 days. The growth enhancement of para rubber seedling was estimated by the measurement of the 1) height of seedling; 2) number of leaves; 3) seedling trunk diameter (3 cm. above grafted-bud mark) every 15 days.

Soil properties analysis, before and after the study (90 days), considered the

following parameters: pH, organic matter (OM), total nitrogen (TKN), available phosphorus (P), exchangeable potassium (K), electrical conductivity (EC), cation exchange capacity (CEC) by the standard methods of Land Development Department (Moncharoen, 2001; Burt, 2004). Also, the pass through watering of each 15 days was stored and analyzed with the same set of parameters.

2.6 Statistical data analysis

Statistical data was applied with Analysis of Variance (ANOVA) to analyze statistical difference among the experimental groups under distinct treatments for comparison of each treatment. In case of difference; the procedure would be applied with Tukey' HSD.

3. Results

3.1 Physical properties of soil media, centrifuged residue and swine dung

As Table 2, the soil media (Krabi Series: Kbi) performed the high acidity, and low values of organic matter (OM), electrical conductivity (EC), total Kjeldahl nitrogen (TKN), available phosphorus (P), exchangeable potassium (K), and cation exchange capacity (CEC). CR performed the slightly alkaline and moderate value of CEC. In contrast, the other values (EC, OM, TKN, P, K, CEC) performed in high values which were the fairly similar to values of the Phonphan (2004) study. However, CR from different factories was noted to have variable properties due to rubber varieties, soil conditions, season, etc. Also, SD was slightly alkaline, moderate EC, highly CEC and extremely high in OM, TKN, P, K values, as shown in Table 2.

Table 2 Chemical properties of centrifuged residue, swine dung, soil media.

Parameters	Centrifuged residue (CR)	Swine manure (SD)	Soil media (Krabi series)
pH	7.71±0.02	7.61±0.06	4.62±0.01
EC (µs/cm)	1224±1.58	6848±4.09	40.38±0.38
OM (%)	12.56±0.27	35.32±0.04	0.91±0.05
TKN (%)	9.73±0.05	3.3±0.11	0.14±0.01
P (ppm)	36.23×10 ³	23.20×10 ³	3.1±0.10
K (ppm)	0.21×10 ³	15.51×10 ³	37.28±0.34
CEC (cmole/kg)	13.40	27.40	4.70

Remarks: Each values performed by Mean ± SD, such the high value as P, K and CEC were conducted only one time. And TKN could be converted to be ppm by multiplying with 10³

3.2 Chemical properties of soil media before and after experiments (90 days)

The study found some details (Table 3) as follows:

3.2.1 pH Value

At the end of study period (90 days), the pH value of soil media (T1) performed nearly the same acid value as the initial value of the study (pH 4.62 to be pH 4.76). The pH value of soil (T2 and T3) increased from pH 4.62 to 5.01 (T2) and 4.99 (T3), and was as high as 5.04 in

control (T4). Moreover, there was a non-significant difference (p>0.05) of pH value between soil (T2, T3) and control (T4), but there was a significant difference (p<0.05) between blends input T2, T3 and T1, or with chemical fertilizer input.

3.2.2 Electrical conductivity (EC)

Soil in T1, T2 and T3 performed the EC value in the range of 125.79 – 137.32 µS/cm. All of them had a statistically significant difference (p<0.05) when compared to T4 or control.

Table 3 Chemical properties of soil media at the initial and the end of study by such treatments.

Parameters	Before study	At the end of study			
	Soil media	Treatment 1(T1)	Treatment 2(T2)	Treatment 3(T3)	Control
pH	4.62±0.01	4.76±0.17a	5.01±0.12b	4.99±0.13b	5.04±0.14b
EC (µs/cm)	40.38±0.38	137.3±21.0a	128.8±11.3a	125.7±16.7a	94.1±5.1b
OM (%)	0.91±0.05	0.82±0.09a	0.92±0.07b	0.92±0.07b	0.81±0.08a
TKN (%)	0.14±0.01	0.12±0.02a	0.13±0.02a	0.13±0.01a	0.13±0.01a
P(ppm)	3.1±0.10	37.95±5.31c	5.19±0.40b	3.51±0.23b	na
K(ppm)	37.28±0.34	35.13±4.56c	24.83±2.65b	14.87±1.26a	14.99±1.55a
CEC (cmole/kg)	4.70	5.33±0.13b	5.45±0.21b	5.43±0.22b	5.02±0.07a

Remarks: 1) Each value performed by mean ± SD.

2) The similar English letter (at the horizontal axis only) of each value (4.76±0.17a) performed the indifferent value of statistically significant level at 0.05 by Tukey’s HSD method.

3.2.3 Organic matter (OM)

At the end of study, the residual OM in soil of all treatments showed the values in the range of 0.81 - 0.82%. OM residues of T2 and T3 had fairly similar values to the initial value of study, while the residual values of T1 and T4 had decreased. In statistical analysis, the residual OM in the T2, T3 were higher

than the residual OM of T1 and T4, in the significant difference (p<0.05).

3.2.4 Total Kjeldahl nitrogen (TKN)

The residual TKN of all treatments, had revealed in the range of 0.12 – 0.14 %, or nearly the same values as the soil at the initial of the experiment, with a non-

significant difference ($p>0.05$) in statistical analysis.

3.2.5 Available Phosphorus (P)

Residual P of T1 had the highest value at 37.95 ppm, which was higher than T2, T3 and T4. The residual phosphorus in T1 had a significantly higher difference ($p>0.05$) with T2 and T3. The low value as 3.1 ppm in origin soil media was found to be non available in control or no adding of any fertilizers. So, the chemical fertilizer input had a major influence on phosphorus remaining in soil media.

3.2.6 Available potassium (K)

Residues of available or exchangeable potassium were found in the range of 14.87 – 35.13 ppm. It was again noted that K remaining in T1 performed the highest value as 35.13 ppm, while K remaining in T2, T3 and T4 was lower at values of 24.83, 14.87 and 14.99 respectively. Moreover, the value in T1 had significantly higher values ($p<0.05$) than T2, T3 and T4.

3.2.7 Cation exchange capacity (CEC)

The existence of CEC in the soil of all treatments was found in the range of

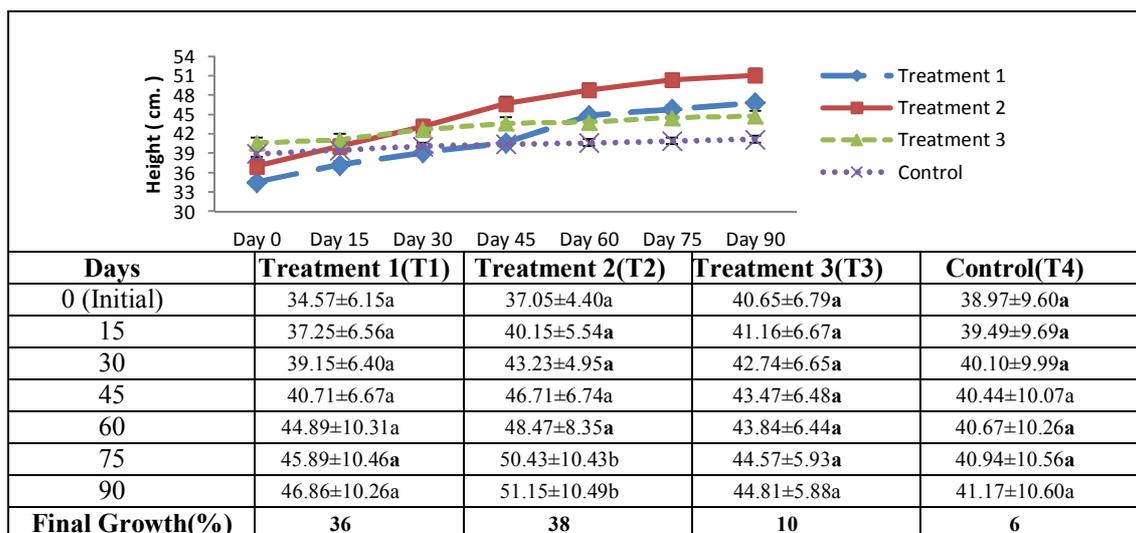
5.02 – 5.45 centimoles per kg (cmol/kg). All treatments performed the higher CEC values with a significant difference ($p<0.05$) to the control (T4).

3.3 Growth development of para rubber seedling

Growth development was estimated through 3 parameters as followed:

3.3.1 Height of Para rubber seedling (cm.) increment

The height of the para rubber seedling on T1 and T2 nearly increased to the same final growth at 36 and 38 percent respectively. This result demonstrates an obvious difference in the final growth with T3 and T4, which had a final growth of only 10 and 6 percent respectively. However, these results were not significant ($p>0.05$) when comparing with the growth increment within the treatment and growth difference for each of the 15 days in T1, T3 and T4. Only T2 showed a significant growth increment at 75 and 90 days ($p<0.05$). The discomposure of SD shows an effect on seedlings' height after 75-90 days passed (Figure 2).



Remarks:1) each value performed by Mean ± SD

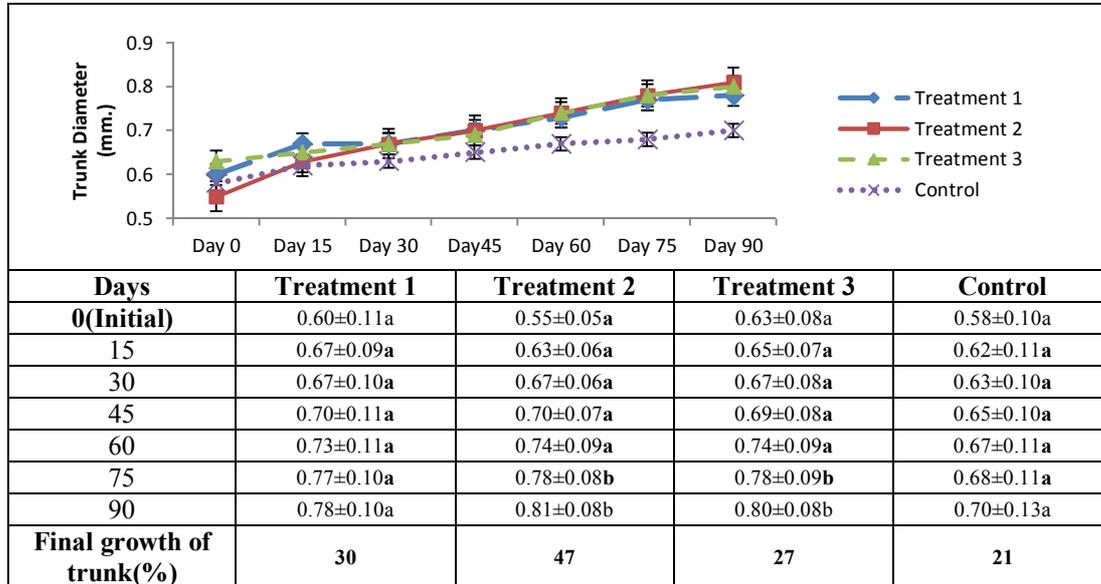
2) The similar English letters.(at the vertical axis only) of each value(34.57±6.15_a) performed the indifferent value of statistically significant level at 0.05 by Tukey's HSD method.

Figure 2 Height of para rubber seedling of each treatment and days.

3.3.2 Trunk Diameter (mm.) increment

In considering the trunk diameter increments among the 4 treatments, T2 performed the highest value of diameter increment at 47 %, which was an

especially higher value compared to the one of T1, which was only 30%. The trunk diameter in T2 and T3 started to have a significant increment ($p < 0.05$) at 75-90 days of plantation (Figure 3).



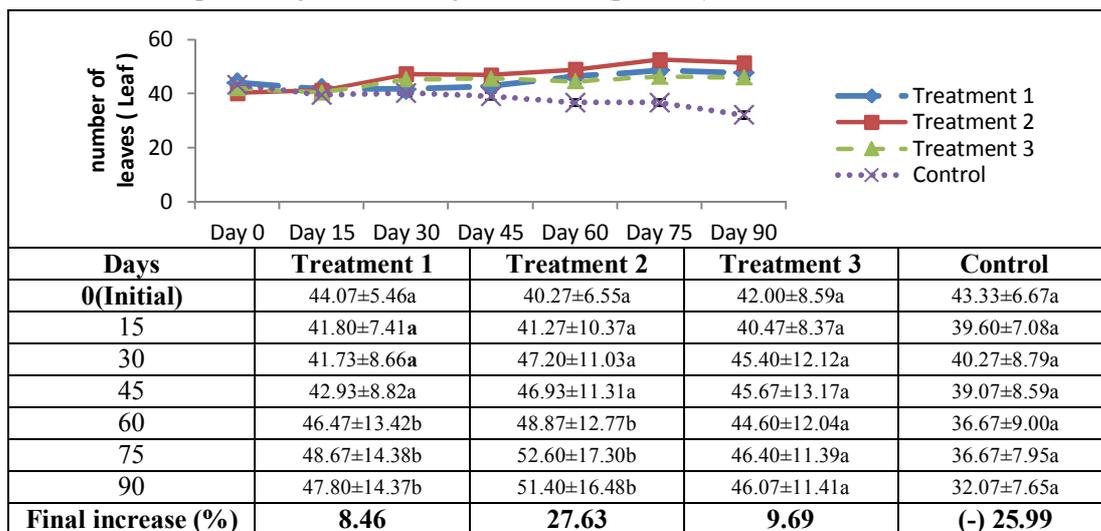
Remarks: Values performed in Mean± SD (n = 15). The English letters (at the vertical axis only) performed the same meaning as figure 2.

Figure 3 Trunk diameter of para rubber seedling in each treatment

3.3.3 Average number of leafs

Among the 4 treatments, T2 obtained the highest number of leaf increase at 27.63 %, with increases of only 8.46 and 9.69 % in T1 and T3 respectively. The study found

the lowest decrease in the number of leafs in T4 at (-) 25.99 %. The number of leafs in T1 and T2 started to have the significant increase 60 to 90 days ($p < 0.05$).



Remarks: Values performed in Mean± SD (n = 15). The English letters (at the vertical axis only) performed the same meaning as figure 2.

Figure 4 The number of para rubber seedling leafs

3.4 Nutrient leachate

During the experiment period, water flow-through from watering was stored and preserved for laboratory analysis every 15 days. The parameters were monitored in terms of pH, EC, TKN, P, and K which are presented in Table 4.

pH

The pH value of water leachate in T1 and T2 was monitored to be more acidic when the time passed, from 6.50 to 6.02 and 6.52 to 6.00 respectively. However, water leachate from T3 and T4 kept the acid condition at the same pH value as the time passed (6.69 to 6.60 and 6.62 to 6.60 respectively).

Electrical conductivity (EC)

The initial value of EC of the water leachate from T1, T2 and T3 was found to be 1406-1462 $\mu\text{s}/\text{cm}$, which was nearly 3 times higher than T4 or the control. However, the gradual decrease of EC was performed only in the water leachate of T1, until 971 $\mu\text{s}/\text{cm}$ or 33.58 % of initial value in 90 days. On the other hand, steep decreases were performed in the water leachate of T2 and T3 of 46.88 and 53.42 % in only 15 days (T2: 1444 to 767 and T3: 1406 to 655 $\mu\text{s}/\text{cm}$) respectively. It was noted at the end of experiment that the leachate water of T1 was as much as 99.3 percent higher than T4, while T2 and T3 had a little higher EC value than T4; as much as 17.5 and 3.2 percent respectively.

Table 4 The chemical properties of leachate water of plantation watering

Days	Treatments	pH	EC ($\mu\text{s}/\text{cm}$)	TKN (%)	Available P(ppm)	Available K(ppm)
0	T1	6.50±0.01	1462±0.09	3.62±0.27	0.18±0.10	7.00±0.38
	T2	6.52±0.01	1444±2.43	1.57±0.32	0.02±0.02	6.83±0.20
	T3	6.69±0.01	1406±2.87	0.37±0.14	0.02±0.01	5.95±0.93
	Control	6.62±0.02	559±2.13	nil	nil	nil
15	T1	6.45±0.01	1447±0.90	2.73±0.44	nil	6.36±0.59
	T2	6.44±0.01	767±1.67	0.49±0.20	nil	5.78±0.44
	T3	6.68±0.01	655±2.16	0.07±0.13	nil	3.45±0.67
	Control	6.62±0.02	552±2.87	nil	nil	nil
30	T1	6.39±0.01	1281±0.90	1.58±0.28	nil	5.68±0.64
	T2	6.40±0.01	746±2.70	0.06±0.12	nil	4.62±1.01
	T3	6.65±0.01	645±1.56	nil	nil	1.66±0.35
	Control	6.62±0.01	537±2.75	nil	nil	nil
45	T1	6.36±0.01	1200±0.90	0.39±0.14	nil	4.49±0.96
	T2	6.36±0.01	705±2.61	nil	nil	1.79±0.33
	T3	6.64±0.01	603±2.26	nil	nil	0.81±0.11
	Control	6.62±0.01	525±2.85	nil	nil	nil
60	T1	6.34±0.01	1143±1.20	nil	nil	3.37±0.85
	T2	6.35±0.01	665±2.19	nil	nil	0.16±0.02
	T3	6.63±0.01	555±1.80	nil	nil	nil
	Control	6.61±0.01	506±2.02	nil	nil	nil
75	T1	6.22±0.01	1029±0.80	nil	nil	1.98±0.62
	T2	6.20±0.01	614±2.50	nil	nil	nil
	T3	6.60±0.03	525±2.18	nil	nil	nil
	Control	6.61±0.01	495±3.21	nil	nil	nil
90	T1	6.02±0.03	971±1.60	nil	nil	0.94±0.52
	T2	6.00±0.01	572±2.75	nil	nil	nil
	T3	6.60±0.01	503±2.16	nil	nil	nil
	Control	6.60±0.02	487±2.17	nil	nil	nil

Remarks: Values performed in Mean±SD, nil = nothing or undetectable

N-P-K leachate

At the 15 days of monitoring mark, the nitrogen had the highest leachate in

T1 (as much as 3.62%), followed by T2 and T3 at 1.57 and 0.37% respectively. However, nitrogen leachate could be

detected for 45 days in T1, but only 30 days in T2, and 15 days in T3. Furthermore, phosphorus leachate was detected in small amounts at only the first 15 days in T1, T2, and T3. Additionally, potassium leachate in T2 and T3 could be detected for only 45 and 60 days respectively and in T1 for 90 days.

4. Discussion

As is commonly known, the waste from some industrial processes has great potential for re-use as sources of mineral nutrients and soil conditioning agents. The organic matter in these materials could improve soil aeration, soil moisture, soil cation exchange, buffering soil pH. This organic matter may also have the particular benefit of enhancing the growth of soil plantation (Silber, 2008; Garcia-Gomez, 2002; Zhang, 2000). However, the use of aforementioned waste has sometimes caused negative effects such as undesirable pH values and excessive leaching of nutrients (Cameron, 1996). Therefore, the waste CR and SD are in case of possibility of nutrients and soil condition agent, for the growth enhancement of para rubber seedling. To this conclusion, the study found the following important results.

4.1 Characteristics of soil media, Centrifuged Residue and Swine Manure

The soil media (Krahi soil Series: Kbi) typically performed the same characteristics as the LDD study (LDD, 2005b), which was high acidity, low organic matter, and electrical conductivity, as well as low values of TKN, CEC, P and K. While CR of the study performed a slightly alkaline in pH, with moderate value of CEC, and a high value of EC, OM, TKN, P and K. These results performed similar values to the Phonphan (2004) study. Also, the SD was

slightly alkaline in pH, with a moderate value of EC and a high value of CEC. However, an extremely high value of OM, TKN, P and K were noted. However, Osotsopar (2008), Wu (2008), Mala (2003) and Shannon (1999) stated that the chemical properties of swine dung derived from different locations were different, according to the quality of animal feeds, environmental culture, age of swine and the swine manure storage condition, etc. So, the performance of such moderate and high values would have been influenced by the many aforementioned factors.

4.2 Soil characteristics after blended fertilizer input

4.2.1 pH value

Regarding soil pH, after 90 days of blended fertilizer input with partly blended fertilizer (T2) and purely blended fertilizer (T3), the study performed a better acid value or moderate acid at pH 5. Kangpidsadarn (2007) stated that a suitable soil for para rubber seedling should have a pH range between 4.5-5.5. However, another study conducted by Härdtle (2004) it was found that pH did not directly affect the para rubber seedling, but directly affected its soluble capability and soil nutrient availability. Therefore, following this rationale, the blended fertilizer of this study was helpful in adjusting soil pH into favorable conditions for Para rubber growth.

4.2.2 Electrical conductivity (EC) value

After the input of blends for 90 days, the value of EC slightly increased. Soil electrical conductivity is influenced by a combination of physical-chemical properties including soluble salts, clay, soil, water content, bulk density, organic matter, and soil temperature, etc. (Corwin, 2005; Eigenberg, 2002). Therefore, the

increasing of EC by blends input meant the increase of soluble nutrients for both cations and anions, and the mineralization of organic matter in soil, all processes that were beneficial for para rubber growth enhancement.

4.2.3 The organic matter (OM)

After the input of the blended fertilizer for 90 days, changes of OM in the soil of T2 and T3 showed a higher value than T1. This result is in agreement with several other studies (Blair, 2006; Rudrappa, 2006; Purakayastha, 2008; Gong, 2009) that apply OM, either alone or in combination with mineral fertilizers, to demonstrate blended fertilizers are more effective in increasing soil organic matter and its fractions than mineral fertilizers alone. Moreover, Casado-Vela (2007) stated that biomass production of crops grown on soils amended with composted sewage sludge (CSS) enhanced physical-chemical properties even when it is applied in low quantities. Our study also shows the effects of CSS on soil and underlines that the nutritional characterization of compost is a necessary prerequisite for an optimal application on agricultural soils, because excessive organic matter application might have a counter-effect on soils.

4.2.4 Total Kjeldahl nitrogen (TKN)

After the 90 days of study, no significant difference of TKN in soil was found in between treatments. This is due to the effective soil drainage characteristic of Krabi soil series (Kbi). It was found by Li (2010) and Huang (2004) that the water flowing through soil could leach soil nutrients or nitrogen. Therefore, the specific characteristics of the blends in this study had less capability to maintain nitrogen in soil media. This means that the blended fertilizers had a similar capability to the chemical fertilizer. However, the studies (Gutiñas, 2011)

that involved the mineralization of organic nitrogen compounds in soil concluded that temperature and moisture affected net nitrogen mineralization in soils.

4.2.5 The exchangeable Potassium (K)

Potassium (K) is one of the three major nutrients (N-P-K) needed by plants, it exists in three different forms, but plants only absorb it in its ion form (K⁺), which is called exchangeable potassium, and is formulated by moist clay particles or organic matter. While fixed potassium form was locked-up in parent materials, as well as, non-exchangeable potassium was an intermediate form between fixed and exchangeable forms. In consideration of the fluctuated values of potassium exchange, Simonsson (2009) had recommended to start the analysis by Soil K balances equation as follows:

$$\text{Soil K}_{\text{balance}} = K_{\text{fertilizer}} + K_{\text{manure}} + K_{\text{deposition}} - K_{\text{harvest}} - K_{\text{leaching}}$$

Variables $K_{\text{fertilizer}}$ and K_{manure} were the matter input in T1, T2 and T3. $K_{\text{deposition}}$ was the K content in soil. K_{harvest} was the K content in plant or the growth of para rubber seedling. Therefore K_{leaching} in Table 4 of this study, T3 (pure blends), T2 (mixture of blends and chemical fertilizer) and T1 (chemical fertilizer alone) had the capacity of maintaining exchangeable K 45-60, 60-75 and over 90 days respectively. However, Arienzo (2009) irrigated the study area with high potassium effluent, and demonstrated the sustained fertility in soils. The effect of disposing high potassium effluents on soil structure could not be explained in the current study, and further research is needed.

4.2.6 The available Phosphorus (P)

The fluctuation value of available phosphorus had to be considered in the phosphorus balance equation the same as potassium equation. Even if we found high phosphorus values in CR and SD, the soil media of the study (Kbi) was acidic. In this case, the phosphorus was fixed in the form of ferric phosphate and aluminum phosphate as explained by Osotsopar (2008), which was not dissolved in water, or available phosphorus for plant. However, in another study conducted by Mozaffari (1994) it was found that the phosphorus retention capacity of most soils was generally high and retained near the soil surface. The loss of phosphorus from soil was particularly true in poorly drained soils with artificial drainage, which therefore affected the phosphorus loading of surface water.

4.2.7 The cation exchange capacity (CEC)

We found that CEC values in each treatments were higher than in the control. This result could be explained by the Oorts (2003) study, in that the biochemical composition of the organic inputs (or the blends inputs of this study) did not have an important effect on the CEC of soil organic matter, and the value was increased with decreasing particle size.

4.3 Nutrient leachate

The values of all indicators were gradually found to be descended in every 15 days. By nutrient balance equation, the nutrient leachate deals within 3 factors, i) initial concentration of blend input, ii) nutrient deposit in soil, and iii) nutrient uptake by plants. However, in the saturated condition, the values have to be dependent only on nutrient uptake by plants. As the growth development, plant

would consume nutrients and cause the lower value of nutrients in leachate. But in the case of lower values of phosphorus at only the 15 days, the study would like to note that this lower value was moreover the uptake by plant, it might be the long stock of leachate for analysis without preservative method.

4.4 Para rubber seedling growths

All indicators, the increment of height (cm.), trunk diameter (cm.) and number of leafs, could presume that T2 gave the highest growth, followed by T1 and T3. It found T2 had startlingly obtained a significant difference in height at 75-90 days. This means that the growth enhancement by blended fertilizer input (T2) had more potential than T1. Also, T1 and T2 showed a significant in the number of leafs, when they were 60 days. But non-significant in the number of leafs showed in T3 and control. Whether the concentration of N-P-K in T1 and T2, which were higher then T3 and control had the effects on number of leafs or not, need more study to make a conclusion. However, all these results concord with Chang (2010), who found that the growth, yield, and cut flower quality of plants receiving organic fertilizer (pea and rice hull compost) were the same as those receiving chemical fertilizer. In particular, this author found a significantly increase of leaf number and new leaf growth area comparing plants receiving organic fertilizer with those that did not.

5. Conclusion

The study highlights that the utilization of the blends (centrifuged residue from Para rubber latex and swine dung) is feasible for para rubber seedling growth enhancement. Also, in the view point of problem soil, which the data had obviously showed quite good

performances, also some physical properties and nutrient contents, in some cases were seen to improve. In particular, blends could obviously be considered as a substitute matter for chemical fertilizer input, as seen by the fact that the growth performance in T2 (blends with nutrient adjustment) and T1 (Chemical fertilizer only) were nearly the same. However, in order to fully understand some differences we recommend further detailed studies on the trend effects of good soil amendments such as water holding capacity, porosity, water-stable aggregation, bulk density and surface crusting of the soil. Which many studies as Tejada (2003), Kwabiah (2003), Walen (2000), Kapkiyai (1999), Diaz-Zorita (1999), Schjonning (1994) and Bell (1993), have shown and discussed.

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7. References

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