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Effect of the Chemical Fertilizer and Compost Application on the Biomass of *Stylosanthes guianensis* var. *guianensis* on the Barren Land After Mining in Southern Thailand.

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ABSTRACT The effect of chemical fertilizer and city compost application was evaluated on the biomass of *Stylosanthes guianensis* on the barren land after a tin mining at the Mine Area Rehabilitation Station, Takuapa, Phang-nga, Thailand. Clayey materials were added to every plot at the ratio of 300 m3 ha-1 to prevent plant from mortality and to enhance the nutrient holding capacity. An optimum biomass yield (5.12 t ha-1), which was lower than the maximum yield (6.15 t ha-1) realized through heavy fertilization, was obtained by the application of city compost (6.25 t ha-1) and chemical fertilizer (1.25 t ha-1). The soil fertility was improved at the end of the experiment, through the cultivation of *S. guianensis*.

The amount of precipitation, soil moisture (at 15 cm in depth) and soil temperature (at 0 and 15 cm in depth) was monitored throughout the experiment. The severe drought and over-wetting conditions reduced the biomass yield of *S. guianensis*, significantly. The crude fiber and crude protein content in the stems and leaves showed an appropriate amount as food for cattle.

It can be concluded that the cultivation of *S. guianensis* is one of the promising way of agriculture in Takuapa and very good practice to improve the very low native soil fertility, in combination with the incorporation of clayey materials to diminish the water deficiency problem and to increase the nutrient retention capacity.

Key Words: barren land after mining/*Stylosanthes guianensis* /biomass / clay application / city compost

Soils at mine areas in Thailand are mainly characterized by their coarse texture. During mining operation, clayey materials are washed out to the river and eventually to the ocean, and only gravel deposits are often left in situ. The resultant land becomes barren, because there are little clay left and lack of moisture content in soils results in a severe drought problem in the dry season (Tanpibal and Sahunalu, 1989). Morphological description of the soil profile in this station was given previously for both original soil and barren soil after mining (Sakurai *et al.*, 1989).

The tropical monsoon climate and a high ground water table in the rainy season are the other causes of infertility. Since it brings various amounts of rain throughout the year, every plant is often exposed to severe water stress, i.e., deficiency in the dry season and over wetting due to the stagnation of surface water and high level of ground water in the wet season. As a result, the absence of surface plant cover after the mining operation yields a very high soil temperature that may damage plant roots at the surface layer (Sakurai *et al.*, 1991). In addition to low clay content of these soils, an extremely low organic matter content (less than 0.2 % in weight) leads to a low nutrient holding capacity, and consequently insufficient nutrient supply.

In order to utilize these soils for agriculture, it was indispensable to add some amounts of fine textured soil materials, which turned out to be far more effective for plant growth than the alternate application of organic and/or chemical fertilizers (Sakurai *et al.*, 1991). The application of clay materials, however, can be done only in a shallow depth *in situ*, and therefore, crop plant should have a shallow root system and a strong resistance to drought as well as to over wetting.

The genus *Stylosanthes* with about 44 species and sub-species (Edye *et al.*, 1984) is the important pasture legumes for tropical and subtropical environments. An agronomic advantage of *Stylosanthes* over many other tropical legumes is that they can be grown on soils with low levels of available nutrients particularly phosphorus (Edye and Cameron, 1984). Besides, *Stylosanthes* is efficient in obtaining phosphorus on soils of low phosphorus status (Probert, 1984).

Considering these, and, as a result of a preliminary experiment, *S. guianensis* var. *guianensis* (hereafter abbreviated as *S. guianensis*) was selected for further study. This species has shown its potential climatic and edaphic adaptation in the humid and semi arid tropics. It may have a tolerance to water-logged soils, however, may not have a drought tolerance (Edye *et al.*, 1984).

The quantitative evaluation of the growth of *S. guianensis* in relation to the soil treatments has a practical significance in Takuapa. Thus, the present paper aims at discussing the following aspects; 1) the effectiveness of soil dressings on this barren and abandoned land, i.e., clayey materials, chemical fertilizer, city compost, and their combination, which are all easily available and not too much expensive at Takuapa, 2) the qualification of *S. guianensis* for feeding cattles in terms of the crude fiber and crude protein content in stems and leaves, 3) the fertility status before and after the site preparation and at the end of the experiment caused by the soil treatments and crop cultivation, and 4) the amount and/or distribution of precipitation, air and soil temperature, and soil moisture content throughout the experiment. The fourth aspect can make the interpretation of the data obtained easier and more comprehensive.

EXPERIMENTAL

The experimental site is located at the land tin after mining near the Mine Area Rehabilitation Station, Department of Land Development, Takuapa, Phang-nga, Thailand. The location of the site was described in Sakurai *et al.* (1991). The experiment was conducted during December 1987 to September 1990. Six treatments with four replications in a randomized block design were employed. Each site was 6 m^2 in area (5 m $\times$ 1.2 m in width and length).

The site preparation was made as follows: (1) The 30 cm depth of surface materials (mostly gravel) on our experimental site was collected, (2) A swamp deposit with fine texture

Table 1. Application rates of clayey materials (m^3 ha^{-1}), chemical fertilizer and city compost (t ha^{-1}).

Plot	TS1	TS2	TS3	TS4	TS5	TS6
Clayey materials	300	300	300	300	300	300
Chemical fertilizer	0	0	1.25	1.25	1.25	1.25
City compost	0	6.25	0	6.25	12.5	25.0

and a soil before the mining operation along the swamp were collected from the adjacent part of our experimental site and mixed together. Then (1) and (2) were mixed thoroughly. The amount of the material (2) was at a rate of 300 m^3 ha^{-1}, corresponding to 10 % of the total material in volume. The mixed soil material was returned to the experimental plot.

After site preparation, city compost was mixed with the surface 10 cm of soil at the rate of 6.25 t ha^{-1} (TS2 and TS4), 12.5 t ha^{-1} (TS5), and 25.0 t ha^{-1} (TS6). Chemical fertilizer was similarly added to TS3, TS4, TS5, and TS6 at a rate of 1.25 t ha^{-1}. Treatments conducted are summarized in Table 1. Before (original deposit in each block) and after site preparation (including fertilizer application), soil samples were taken in 3 replications at the depth of 0-10 and 10-30 cm, and subsequently, seeds of *S. guianensis* were planted in 30 cm×30 cm spacing (13.3 g $plot^{-1}$), on May, 1988.

To investigate effects of fertilizers on plant growth, the addition of clayey materials was an indispensable practice, otherwise any plant could not have survived at all even if some fertilizers were applied. In a strict sense, this experiment had no "control plot," but the addition of clayey materials without neither chemical fertilizer nor compost was considered as the control plot here.

Throughout the experiment, the soil moisture content and the amount of precipitation was monitored at the depth of 15 cm once a week, using gypsum blocks in 3 replications for every 6 treatment (total 18 blocks). The average value of all blocks was used for the discussion because there was no significant difference among 6 treatments. The air temperature and soil temperature at the depth of 0 and 15 cm were recorded close to our plot once a week. The first cutting was done when *S. guianensis* was in a flowering stage (its age of about 100 days) at 15 to 20 cm height from the soil surface. The subsequent regular cutting was done every 60 day after the first cutting. Chemical fertilizer was applied after each cutting at the rate of 1.25 t ha^{-1}. Fresh and dry (75℃ for 24 hours) weights were measured for each sample. For the 10th (last) cutting on February 20, 1990, all parts of the plant including roots were harvested and measured, similarly. Subsequently, the third soil sampling was conducted. Soil chemical properties and crude fiber and crude protein contents were analyzed at the Division of Soil Analysis, Department of Land Development, Bangkok, Thailand. Analytical items (abbreviation in this text) and methods are as follows: pH in water (pHw), 1: 5 of soil: solution ratio, 1 hr shaking; organic matter (OM), rapid dichromate oxidation techniques (Walkley-Black procedure); available phosphorus (Av-P), phosphorus soluble in dilute acidfluoride (Bray method); exchangeable potassium (Ex-K), 1 M-ammonium acetate (pH 7.0) extraction; cation exchange capacity (CEC), 1M-ammonium acetate (pH 7.0) saturation and 10 % NaCl extraction procedure. These methods were mostly based on the Methods of Soil Analysis, Part 2 (ASA and SSSA, 1982). Crude fiber and crude protein content were analyzed according to the A.O.A.C. method (1980).

RESULTS AND DISCUSSION

Dry weight of S. guianensis

Table 2 shows the summary of dry weight of the biomass yield (including stems and leaves) at each sampling period (ten times) throughout the experiment and the whole plant after the final cutting including roots.

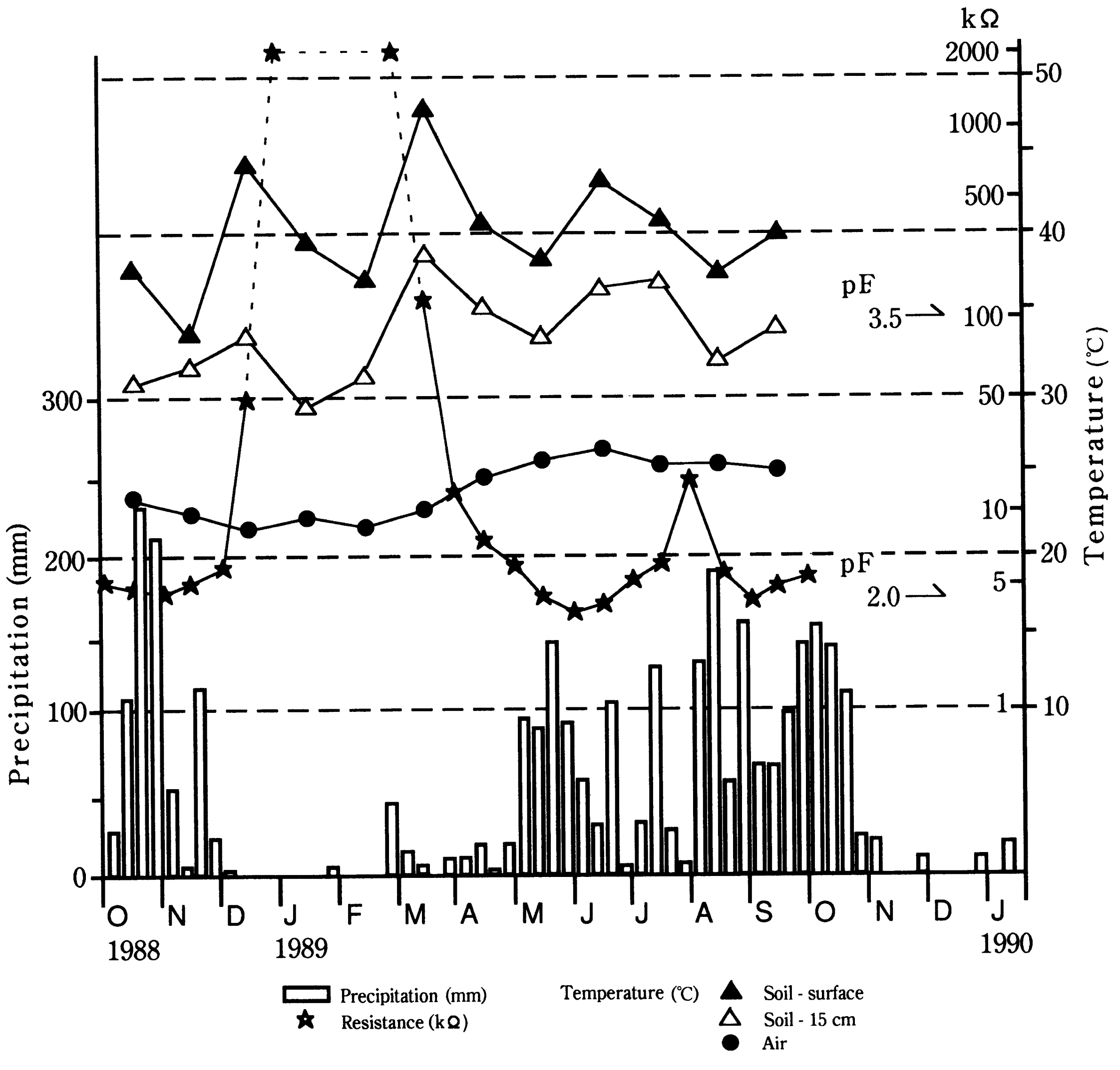

Fig. 1. Precipitation, air temperature, soil temperature, and soil moisture content during the experiment.

The average yield at every cutting depicts the fluctuation of biomass yield throughout the experimental period. The third cutting (15, Aug., 1992) gave the maximum yield of 4.40 t ha^{-1}, followed by the first and 6th cuttings, whereas the 5th cutting gave the minimum of 2.72 t ha^{-1}, followed by the 8th, 7th, and 10th cuttings. This trend can be interpreted in terms of climatic factors, such as precipitation, air temperature, soil temperature, and soil moisture content (Fig. 1). The electric resistance of the gypsum block becomes higher as drying proceeds reflecting the lack of water in soils. Using a calibration curve (not shown here) between the reading for electric resistance of the gypsum block and the pF value, the value of the electric resistance of 4.6 and 100 k ohm corresponds to around pF 2.0 and 3.5, respectively. Judging from these data, the moisture content during 17, Oct. to 15, Dec., 1988 seemed to be optimum for plant growth. The severe water deficiency started after this period, and the yield also decreased correspondingly. At the end of the dry season (April, 1989), the yield fell to a minimum. On the other hand, once the rainy season started, the yield became lower again probably because of the over wetting condition in soils and also less sun shine. There was a heavy rain after 17, Oct., 1988, but it did not last long. After that period, moisture and temperature might have returned to the level that could support moderate plant growth. These results suggest that the appropriate amount of soil moisture content assures the optimum growth of *S. guianensis,* and that both of water stresses of drought and over wetting with less sunshine may decrease the biomass yield.

Growing condition of the roots is another possible factor that may affect the yield of above ground biomass. Every root at the first and second cutting was still in a vigorous growing stage and could absorb nutrients from the soil actively. On the other hand, at the 5th cutting (April 20, 1989), the root system might be at a dormant stage because of water

Table 2. Dry weight (t ha^{-1}) of each cutting and total biomass at the end of the experiment.

Sampling No.	Date	TS1	TS2	TS3	TS4	TS5	TS6	Total	Average
		Plot							
Above ground biomass*									
1	Aug 16 (1988)	0.07	0.25	3.25	8.57	6.75	7.14	26.03	4.34
2	Oct 17	0.08	1.55	3.78	5.34	6.33	7.03	24.11	4.02
3	Dec 15	0.17	1.94	3.47	6.66	7.02	7.16	26.42	4.40
4	Feb 21 (1989)	0.12	1.05	2.95	5.20	6.34	6.80	22.46	3.74
5	Apr 20	0.87	1.62	2.75	3.18	3.35	4.54	16.31	2.72
6	Jun 23	0.22	1.75	3.95	5.20	6.34	7.80	25.26	4.21
7	Aug 24	0.63	1.58	2.40	4.58	4.81	4.92	18.92	3.15
8	Oct 20	0.63	1.58	2.40	3.58	4.31	4.92	17.42	2.90
9	Dec 18	0.75	1.81	2.36	4.54	5.83	6.35	21.64	3.61
10	Feb 20 (1990)	0.32	1.22	3.39	4.40	4.82	4.87	19.02	3.17
Sub-total		3.86	14.35	30.70	51.25	55.90	61.53	217.59	
Average		0.38	1.43	3.07	5.12	5.59	6.15		3.62
Residues*		2.79	3.29	3.77	8.18	6.81	7.48	32.32	5.39
Total biomass***		6.65	17.64	34.47	59.43	62.71	69.01	249.91	41.65

* Above ground means the 15 to 20 cm above the ground part of plant where every sample was cut and collected.
** Residues means stems and roots left after 10th cutting.
*** Total biomass was calculated as a sum of Sub-total and residues.

Table 3. Variation of the total yield of *S. guianensis* within blocks (10 cuttings).

Block	TS1	TS2	Plot TS3	TS4	TS5	TS6	Total	Average
1	0.47	1.37	2.76	4.86	5.50	6.68	21.64	3.607
2	0.45	1.34	3.30	5.04	5.06	5.72	20.91	3.485
3	0.38	1.35	3.10	5.41	6.07	6.26	22.57	3.762
4	0.25	1.68	3.12	5.17	5.74	5.94	21.90	3.650
Total	1.55	5.74	12.28	20.48	22.37	24.60	87.02	
Average	0.388	1.435	3.070	5.120	5.593	6.150		3.623

shortage, and therefore, resulting in the minimum yield of 2.72 t ha^{-1}. The environmental data in Fig. 1 supports this result, i. e., a very low soil moisture, a high soil temperature and a high air temperature of 30-40℃ during day time. Therefore, the product from photosynthesis might have been used for respiration rather than the development of plant body. The average dry weight of *S. guianensis* slightly decreased to about 3 t ha^{-1} after the 7th cutting (1 year after the first cutting). Roots of *S. guianensis* might become less resistible against the severe environmental condition encountered in the dry season.

Quantitative relationship between the amounts of fertilizers and the growth of S. guianensis

Table 3 shows the total biomass yield of *S. guianensis* from 10 cuttings in each block. A statistical analysis was conducted using these data. The result of analysis of variance (ANOVA) and the Duncan's multiple range test are summarized in Tables 4, 5, and 6. Within the blocks (4 replications), the yield of *S. guianensis* is not significant at both 1 and 5 % level. Whereas, within the treatments, it is at 1 % level (Table 4). According to the Duncan's multiple range test (Table 6), most of the treatments showed significant differences, except TS6 vs. TS5 at 1 % level and TS4 vs. TS5 at both 1 and 5 levels.

TS1 without any fertilizer addition gave an average dry weight (from 10 cuttings) of 0.38 t ha^{-1}. When 6.25 t ha^{-1} of city compost was added (TS2), average yield increased to 1.43 t ha^{-1}, whereas, when 1.25 t ha^{-1} of chemical fertilizer was added (TS3), it amounted to 3.07 t ha^{-1}. Thus, it can be concluded that chemical fertilizer promoted plant growth more effectively than city compost. Once both chemical fertilizer and city compost were applied (TS4), the biomass yield was greater than the sum of the yield in TS2 and TS3 by 0.62 t ha^{-1}. When larger amounts of city compost were applied (12.5 t ha^{-1} in TS5 and 25.0 t ha^{-1} in TS6),

Table 4. Analysis of variance (ANOVA).

Factor	DF	SS	NS	F value
Total	23	113.836		
Blocks	3	0.235	0.078	0.88
Treatments	5	112.260	22.452	252.27**
Error	15	1.341	0.089	

**Significant at 1 % level

Table 5. Determination coefficient for the Duncan's multiple range test.

p	r=	2	3	4	5	6
0.05		3.01	3.16	3.25	3.31	3.36
		x0.149	x0.149	x0.149	x0.149	x0.149
		0.448	0.471	0.484	0.493	0.501
0.01		4.17	4.37	4.50	4.58	4.64
		x0.149	x0.149	x0.149	x0.149	x0.149
		0.621	0.651	0.671	0.682	0.691

$Sx = (0.089/4)^{1/2} = 0.149$

Table 6. Duncan's multiple range test between plots with the different treatments adopted.

Mean value	X1 (0.388)	X2 (1.435)	X3 (3.070)	X4 (5.120)	X5 (5.593)	X6 (6.150)	
X6	5.762**	4.715**	3.080**	1.030**	0.557*	——	a
X5	5.205**	4.158**	2.523**	0.473	——		b
X4	4.732**	3.685**	2.050**	——			b
X3	2.682**	1.635**	——				c
X2	1.047**	——					d
X1	——						e

*Significant at 5 % level (p=0.05). **significant at 1 % level (p=0.01).
The mean values shown as X1 to X6 correspond to the treatment of TS1 to TS6, respectively. Figures in parentheses present the mean dry weight (t ha^{-1}) of leaves and stems collected from ten cuttings. Small letters (a to e) in the right most column denote the groups separated.

increase in the yield was not significant between TS4 and TS5, whereas it was significant between TS5 and TS6 at 5 % level. These data can be interpreted to mean that increase in the amount of compost applied can not be considered the best way to get an optimum input/output balance. In other words, application of both chemical fertilizer and city compost as in TS4 is more effective and economical than the alternate application of these two fertilizing materials and than the large amounts of compost application with chemical fertilizer.

Changes in soil properties between before and after site preparation and at the end of experiment.

The results are shown in Table 7. The surface soil from 0 to 10 cm was mixed with fertilizer at the beginning of experiment. On the other hand, the subsurface soil had not undergone fertilization and there was little change in the subsurface horizon during the experiment in every plot. Thus, discussion will be done mainly for the surface soils unless otherwise mentioned.

pH in water (pHw) The pHw values before fertilizer application ranged from 5.4 to 5.6. At the end of the experiment, when only compost was applied (TS2), the pHw value increased slightly to 6.0, affected by the high pHw value of this material itself. Whereas, when only chemical fertilizer was applied (TS3), the value of pHw decreased to 4.3. Once chemical fertilizer and compost were applied together (TS4), pHw values were almost unchanged during the experiment probably because the soil pHw was determined as a balance

Table 7. Selected soil properties before (B) and after (A) the site preparation and at the end of the experiment (E).

Treatment Depth (cm)	pHw B	pHw A	pHw E	Organic matter — % — B	A	E	Av-P – $mg\ g^{-1}$ – B	A	E	Ex-K — $mg\ g^{-1}$ — B	A	E	CEC — $cmol\ kg^{-1}$ — B	A	E
TS1 0-10	5.5	5.6	4.9	0.16	0.14	0.35	4	8	3	13	12	8	0.12	1.05	1.44
10-30	5.6	5.5	5.4	0.13	0.16	0.20	4	8	1	17	13	3	0.11	1.11	1.18
TS2 0-10	5.4	6.5	6.0	0.17	0.33	0.52	4	29	13	17	35	12	0.15	1.26	1.85
10-30	5.6	5.7	5.6	0.15	0.37	0.21	4	10	2	11	16	10	0.13	1.38	1.44
TS3 0-10	5.4	5.0	4.3	0.17	0.18	0.72	4	60	55	9	132	22	0.22	1.27	1.75
10-30	5.5	5.2	4.2	0.18	0.19	0.02	4	8	10	9	15	10	0.18	1.28	1.03
TS4 0-10	5.4	5.7	5.4	0.13	0.36	0.76	4	136	97	10	324	32	0.07	1.64	2.06
10-30	5.5	5.2	5.1	0.15	0.22	0.30	6	7	17	12	16	12	0.28	1.37	1.64
TS5 0-10	5.4	5.5	6.2	0.17	0.33	1.35	4	114	220	7	70	43	0.30	1.39	2.67
10-30	5.5	5.4	5.4	0.19	0.22	0.25	4	12	13	11	22	15	0.17	1.42	1.34
TS6 0-10	5.5	6.3	6.6	0.13	0.42	1.39	4	79	216	11	141	49	0.12	1.31	3.14
10-30	5.5	5.5	6.4	0.15	0.21	0.25	6	12	8	12	19	13	0.11	1.24	0.98

Nomenclature of the analytical items was same as used in the text.

of these fertilizing materials. As the amount of the applied compost (TS4, TS5, and TS6) increased, pHw values became higher. Generally, effect of fertilizer application on the pHw was not observed in the subsurface layer, but the highest application rate of compost in TS6 might have caused an increase in pHw, due to the transportation of the substances from the upper layer into the deeper part of the soil profile.

Organic matter (OM) The original level of OM was very low ranging from 0.13 to 0.19 %. At the end of the experiment, it increased greatly, ranging from 0.35 to 1.39 depending on the treatments applied. Similar to compost application, cultivation of *S. guianensis* surely contributed to an increase in organic matter content due to dead roots, stems, and leaves. This can be seen clearly from the difference between TS1 and TS3 where no compost was applied. The difference in the OM content between TS1 and TS3 is attributed to the relative growth of the *S. guianensis,* i. e., better plant growth leads to an increase of soil organic matter content (see also Table 2.)

There was not any clear difference in the OM content between TS5 and TS6, although the application rate of compost was two times larger in TS6 than in TS5. Accumulation of dead plant, therefore, might have increased the soil organic matter content greatly than the compost application.

In the subsurface horizon of TS6, no increase in organic matter can be observed, though the pH increased greatly due to the large amount of compost application. Only water soluble alkaline fraction may move down and retained by the subsurface soil.

Available phosphorus (Av-P) The original level of available phosphorus was extremely low, ranging from 4 to 6 $mg\ g^{-1}$. After the crop cultivation, the amount of Av-P increased when some fertilizers were applied. Comparing TS2 and TS3, chemical fertilizer was found to be more effective in causing an increase in Av-P level. Migration and accumulation of phosphorus into subsurface layer was not prominent.

Exchangeable potassium (Ex-K) The original level of Ex-K was very low, ranging from 7 to 17 mg g^{-1}. After the site preparation, the amount of Ex-K increased significantly, but at the end of the experiment, it decreased again. This may be partly due to plant uptake and leaching during the rainy seasons. However, the level of Ex-K could be increased by the end of the *S. guianensis* cultivation. As is generally known, potassium moved down more readily than phosphorus.

Cation exchange capacity (CEC) Before the site preparation, the CEC was extremely low because of little amounts of organic matter and clay. After the site preparation including clayey material incorporation, the CEC increased to more than one at every site. Irrespective of the compost application in TS2, TS4, TS5, and TS6, the difference in the values of CEC was very small. This may be due to the low surface area of compost at the beginning, thus could not work as an effective cation exchanger. On the other hand, at the end of the experiment, the CEC became greater in every plot. Even though there was no compost application in TS1 and TS3, the CEC increased in the surface layer. Since most of roots were concentrated on the surface 10 cm, dead roots as well as stem and leaf litter might have played a very important role as a cation holding material in this soil.

Contents of crude protein and crude fiber in S. guianensis

One of good measures to assess the quality of food for livestock was the amount of crude protein and crude fiber as sources of nitrogen and energy. Their content in stems and leaves were determined with reference to the response of different fertilization on its quality. Samples of *S. guianensis* at the second cutting were collected from every block, i.e., four samples from each treatment. Table 8 shows the results including total, average, and standard deviation of crude protein and crude fiber contents.

Table 8. Percent content of Crude fiber and crude protein of *S. guianensis* from samples at the second cutting.

Plot	TS1	TS2	TS3	TS4	TS5	TS6
Crude fiber						
Block 1	25.05	29.52	37.74	29.43	26.71	28.69
2	31.53	27.92	31.38	31.18	31.42	29.98
3	25.51	31.53	32.74	33.56	28.37	28.96
4	22.84	25.65	30.45	33.40	28.54	29.35
Total	104.93	114.62	132.31	127.57	115.04	116.98
Average	26.23	28.66	33.08	31.89	28.76	29.25
SD	3.719	2.489	3.248	1.968	1.956	0.560
Crude protein						
Block 1	12.69	12.75	12.94	15.44	17.44	14.81
2	11.12	11.31	15.75	14.75	14.44	16.50
3	9.62	10.33	13.19	13.00	13.75	12.56
4	10.56	9.94	12.25	14.56	15.00	14.06
Total	43.99	44.33	54.13	57.75	60.63	57.93
Average	11.00	11.08	13.53	14.44	15.16	14.48
SD	1.287	1.252	1.531	1.030	1.605	1.638

Average percentages of crude protein and fiber from different treatments were 13.28 and 29.64, respectively. Mc.Ilroy (1972) showed the crude protein of *S. guianensis* as 10.55 % in the dry season, and 18.05 % in the rainy season. The crude protein content derived from our experiment was in between these two values. Analyzed samples were collected during the rainy season on October 17, 1988 at the second cutting (at the maturing stage) and the biomass yield of *S. guianensis* at this time was higher than the average value throughout the experiment. Nutrient content of plant at the maturing stage is generally higher than at the dormant stage and lower than at the younger stage. Thus, the protein content can be expected as moderate within the whole experimental period. The most economically promising treatment (TS4) in terms of biomass production resulted in 14.43 % of crude protein content. A clear difference could be seen on plant growth between TS2 (compost application) and TS3 (chemical fertilizer application), which was true for the crude protein and fiber contents of the plant. The chemical fertilizer promoted both total biomass and crude protein and crude fiber contents more than compost. There were no remarkable differences in crude protein and fiber contents depending on the amount of compost applied (TS3 to TS6). Compared with the crude protein content of mixed native grasses in Indonesia ranging from 7.6 to 13.0 % (Johnson & Djajanegara, 1989), that of *S. guianensis* in our experiment was higher, except for TS1 and TS2 with low biomass yield.

Generally, the crude fiber content increased with maturity of plant, which was in a reverse trend with crude protein content. It is very difficult to discuss this value without considering the growing stage of cattle. However, oxen need crude fiber as an energy source and to maintain the ruminant activity.

Percent content of the crude fiber (a) and the crude protein (b) in the dry matter of the other feeding materials for cattle was reported as follows: *Centrosema* sp., (a) 30.7, (b) 16.9 (Mc.Ilroy, 1972); alfalfa (fresh), (a) 27.4, (b) 19.3; rice bran, (a) 12.1, (b) 14.8; sorghum grain, milo, (a) 2.2, (b) 12.4 (Neumann, 1977). Compared with these values, *S. guianensis* in our experiment showed acceptable value. Crop species manageable here is very limited because of soil constraints, and therefore, cultivation of *Stylosanthes* was promising and should be studied more, including other species such as S. *hamata*, which has been attempted extensively in the Northeast Thailand for these 10 years (Humphreys, 1984).

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南タイの鉱山跡の不毛土壌における化学肥料，都市ゴミコンポストの施用が *Stylosanthes guianensis* var. *gianensis* のバイオマスに与える影響

タイ国，パンガ県，タクアパにある鉱山跡地回復試験場で，不毛土壌における化学肥料および都市ゴミコンポストの施用が *S. guianensis* var. *gianensis* のバイオマスに与える影響を評価した。植物の枯死を防ぎ，養分供給容量を高めるために，粘土質の材料を300– ha^{-1} 添加した。

最高量を施肥した時に得られるバイオマス量は 6.15 t ha^{-1} であったが，コンポスト 5.12 t ha^{-1} と化学肥料 1.25 t ha^{-1} を投与した時に最適バイオマス量 6.15 t ha^{-1} が得られた。実験終了時の土壌肥沃度は *S. guianensis* の栽培によって改善された。

実験中の降水量，土壌水分 (地中15 ㌢)，土壌温度 (地表および地中15 ㌢)を測定した。厳しい旱魃や過飽和状態が *S. guianensis* のバイオマス量を著しく減少させた。茎葉中の粗繊維，粗蛋白質の含有量は家畜の飼料として適当であった。

Stylosanthes guianensis の栽培はタクアパの農業にとって有望なものであり，水分欠乏を減じ，養分保持能を高めるために粘土質の材料を添加することと組合わせると，自然状態での低い土壌肥沃度を改善するのには，良い方策であると言うことができる。