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An Improvement of Yasothon Soil Fertility (Oxic Paleustults) Using Municipal Fermented Organic Compost and *Panicum maximum* TD 58 Grass

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Abstract: An investigation on the improvement of Yasothon soil (Oxic Paleustults) fertility by Khon Kaen's municipal fermented waste was carried out at Khon Kaen University for the treatments with and without sowing *Panicum maximum* TD 58 grass. The results showed that Khon Kaen's municipal waste had a tremendous effect in improving Yasothon soil fertility. Decomposition rate of organic compost in soil was most rapid due to high environmental temperature. The improvement of soil fertility was greater for treatments with the growth of *Panicum maximum* TD 58 grass than those without. An increase in the amount of organic compost added to the soil increased the percentages of soil nitrogen, soil available P and exchangeable K. Municipal organic compost increased soil pH, but a greater result was found for treatments with the growth of *Panicum maximum* TD 58 grass. Municipal waste contented the majority of plant materials and garbage and they should be sorted out daily and recycled as a fermented compost to improve soil fertility for better crop production and sustainable agriculture.

Key words: Solid waste, municipal organic compost, soil fertility, *Panicum maximum* TD 58 grass

Introduction

In Northeast Thailand, soil deterioration has become a real problem for growers of the region. It has one third of both population and land area and most of the population engaged in agricultural activities for their own living conditions. Nevertheless, the annual agricultural crop yields were relatively low due to poor soil fertility as a result of deforestation, soil erosion and leaching. However, nutrient contents such as macro and micro elements could be relatively low particularly of those land areas with the slope of 2-20 % (Anon., 1998). Therefore, soil fertility programme and some appropriate technologies are urgently needed if this soil type must be used for high sustainable crop production within the coming decades.

In improving soil fertility, it has been advocated that the addition of some large amounts of organic matter to the agricultural soils from time to time could be a useful method for most tropical soils, since decomposition process takes place more rapidly with time due to high environmental temperature, rapid leaching rate and run off by monsoon rainwater (Suksri *et al.*, 1989, Miller and Donahue, 1990; Suksri, 1992 and 1999). The improvement materials for soil fertility programme could be numerous, e.g. crop residues from farms, municipal wastes from large town or city and others. These materials could possibly be used for the improvement of soil fertility programme in most soils of the tropics. Solid wastes from large town or city are enormously produced daily due to the rapid expansion of town and population. For instance, during 1998 solid wastes of Thailand as a whole amounted up to 13.6 million tones or being produced at the rate of 37,250 tones daily (Anon, 2000). Most of the municipal wastes are the mixture of different kinds of litters and they extremely degrade environmental conditions whether being destroyed by open burning or even open damping in unattended land areas. Therefore, it could be of tangible value to make use of this daily solid waste particularly those derived from plant materials and garbage for use in improving the soil condition for sustainable agriculture for years to come. This could be considered as one useful way in getting rid of the waste products and preventing the degrading condition of man living environments.

Materials and Methods

Collection of municipal wastes of Khon Kaen Province from an open dumping site approximately 18 km away from Khon Kaen was carried out three times in November 1995. The attained solid wastes were analyzed for some physical and chemical contents (Table 1). The solid wastes were physically sorted out for indigestible materials and then those organic wastes were allowed to ferment for five months in a constructed compost bin and finally the compost was again sieved away with those indigestible particles using a 2x2 cm^2. sieve. The compost was analyzed for pH, nitrogen, phosphorous, potassium percentages, and C:N ratio with the mean values of 7.21, 0.08, 0.44, 1.18, and 19.6, respectively. The experimental site of Yasothon soil series (Oxic Paleustults) being chosen was an Experimental Field of the Department of Land Resources and Environment, Khon Kaen University. The soil texture was a sandy loam with the bulk density of 1.51 g/cm^3, while initial mean values of soil pH, organic matter percentages were determined by the method of Black (1965), available phosphorous by Drilon (1980), exchangeable potassium by Cottenie (1980) and the results attained were 5.15, 0.49%, 3.21 ppm, and 48.88 ppm respectively. The total nitrogen was also determined by Kjeldahl method of Black (1965). The experiment was laid in a randomized complete block design with four replications. The rates of fermented organic compost being applied to the soil were 0, 12.50, 25.00, 37.50, and 50.00 tones/ha for treatments with and without sowing of *Panicum maximum* TD 58 grass and they were used as treatments. Soil analysis was carried out at six-month intervals after the application of fermented organic matter. The data obtained were statistically analyzed using a computer programme of Nissan (1988).

Table 1: Initial values of physical composition and chemical contents (fresh weight basis) of Khon Kaen's municipal solid waste being collected for three days in November 1995.

Composition materials	Sample collected dates		
	Nov. 10, 1995	Nov. 11, 1995	Nov.12, 1995
1. Physical composition (%)			
1.1. Plant materials and garbage	48.5	43.2	43.2
1.2. Paper	17.4	14.1	23.2
1.3. Plastic	14.3	16.4	28.1
1.4. Rubber	0.1	-	0.1
1.5. Leather	-	-	-
1.6. Textile	1.6	0.4	0.9
1.7. Wood	3.3	13.7	0.1
1.8. Glass	2.4	1.6	2.1
1.9. Metal	0.2	0.5	-
1.10. Stone/Ceramic	6.1	1.2	0.7
1.11. Plastic foam	0.9	1.6	1.3
1.12. Others	5.2	7.3	0.3
2. Chemical composition (%)			
2.1. Nitrogen content	0.63	0.67	0.86
2.2. Volatile solid	89.03	87.32	86.44
2.3. Ash content	10.97	12.88	13.56
2.4. Carbon	49.46	48.51	48.02
2.5. Hydrogen	5.94	5.82	5.76

Results and Discussion

Municipal waste of Khon Kaen Province contented the highest amount of plant materials and garbage up to 48.5 % compared with other waste bodies and resulted in high amount of chemical compositions particularly nitrogen. The results indicated some tangible value of the municipal litters being collected daily, i.e. the plant materials and garbage within the collected waste should be useful for soil fertility programme for most of the agricultural land areas instead of burning or buried in soils where the plants could hardly make use of them. Therefore, all plant materials and garbage collected in municipal waste should be fermented in a compost bin where the fermented materials could be used for the improvement of agricultural lands. From the data on soil analysis, Yasothon soil series (Oxic Paleustults), one of the major soil series in Northeast Thailand has contented some small amount of most macro nutrients particularly phosphorous (P) and low percentages of soil organic matter with some moderate degree of soil acidity. This type of soils could possibly be classified as a poor agricultural soil for high crop production.

After the application of fermented organic compost, the results showed that there have been some significant increase in the amount of organic matter percentages in soil with an increase in the amount of organic compost levels. The increase was highest with the highest level of organic compost. The results suggest that the greater the amount of organic compost added to the soil the better the percentages of soil organic matter although, in most cases, the percentages of soil organic matter in all added levels decreased with time and became similar at the final sampling period (Table 2). The results indicated that decomposition rate of soil organic matter was relatively high hence additional amount of organic compost must be frequently applied to the soil in order to maintain high percentages of soil organic matter. The results confirm the work reported by Thanyawadee *et al.* (1990) and Ratnapradipa (1996). Similarly, an increase in the amount of organic compost to the soil together with the growth of *Panicum maximum* grass increased soil organic matter and the decomposition rate was also most rapid as compared to the treatments without *Panicum maximum* grass (Table 3). The results evidently indicated that decomposition rate of organic compost in tropical environment could be most rapidly performed. Therefore, this soil type requires high frequency in applying organic compost as to maintain high percentage of soil organic matter. That is the highest rate of municipal organic compost should be applied annually or perhaps every six months.

An increase in the amount of municipal organic compost, in most cases, significantly increased the soil nitrogen percentages over the control (Table 4). The percentages of soil nitrogen slightly decrease with time for 25 tons/ha treatment whilst the rest remain similar at the final sampling period. The results indicated the rapid decomposition process in all treated levels of organic compost hence there values were similar at the final sampling period. For those treated with the growth of *Panicum maximum* grass, the results evidently indicate that an increase in the amount of municipal compost, in most cases, significantly increased soil nitrogen percentages over the control treatment. However, with the third sampling period, nitrogen percentages were similar for all added levels of compost even with the final sampling period although there has been slight decrease with 25 t. treatment (Table 5). The growing of grass plants assisted better the remaining level of N % than those without. The results suggested some contribution of the grass to soil nitrogen perhaps due to the added amount of some grass materials to the soil. It was evidently shown that even 12.5 t. of municipal organic compost added to the soil was considerably adequate enough to provide high level of nitrogen in the soil with the contribution of *Panicum maximum* grass. For available phosphorous (P), the results revealed that an increase in organic compost level significantly increased available soil phosphorous (Table 6). However, the available amount for both organic compost and Yasothon soil was initially small and it was more or less inadequate for growth of most crop plants, e.g. adequate available P for crop plants should reach the minimum value of 20 ppm as stated by Suksri (1992, 1999). Similarly, with the growth of *Panicum maximum* grass treatments, there have been some increases in the amount of available P but again not adequate enough for growth of most economic crop plants (Table 7).

In most cases, exchangeable K initially increased with an increase in organic compost and later decreased with time (Table 8). The decrease could be attributed to the high leaching rate of soil nutrient as a result of rainwater. Nevertheless, the amount of exchangeable K found with this work seems adequate for growth of the crop plants. A similar result was found for the growth of *Panicum maximum* grass treatments, i.e. an increase in the amount of municipal organic compost level increased soil exchangeable K and the amounts were greater than those without the growth of *Panicum maximum* grass plants. The results suggested some advantages in growing the grass plants together with the added organic compost, i.e. it helps to retain high level of exchangeable K with time (Table 9).

For the improvement of soil pH, the results showed that, in most cases, an increase in the amount of municipal organic compost increased the soil pH significantly. However, only the

Table 2: Changes in average amount of soil organic matter (%) of Yasothon soil series (Oxic Paleustults) with time as influenced by application of Khon Kaen's municipal fermented organic compost

Organic compost (tones/ha)	Sampling period (month)				F-test	C.V.(%)
	1(Apr. 96)	6(Oct. 96)	12(Apr.97)	18(Oct. 97)		
0	0.60C*a*	0.53 C*bc*	0.49 B*c*	0.56 *a*	*	6.18
12.50	1.13 B*a*	0.61 B*b*	0.50 B*c*	0.54 *c*	**	3.60
25.00	1.13 B*a*	0.55 B*cb*	0.50 B*b*	0.54	**	3.55
37.50	1.18 B*a*	0.58 B*cb*	0.51 B*c*	0.57 *bc*	**	5.28
50.00	1.29 A*a*	0.83 A*b*	0.58 A*c*	0.58 *c*	**	3.96
F-test	**	**	*	NS		
C.V. (%)	2.82	5.15	5.11	4.69		

*, ** Indicate confidential limits at P = 0.05 and 0.01, respectively.
Capital letters indicate Duncan's Multiple Range Test of vertical rows while the italic ones represent the horizontal rows.

Table 3: Changes in average amount of soil organic matter contents (%) of Yasothon soil series (Oxic Paleustults) with time after the application of Khon Kaen's municipal fermented organic compost together with the growth of *Panicum maximum* TD58 grass

Organic compost (tones/ha)	Sampling period (month)				F-test	C.V. (%)
	1(Apr. 96)	6 (Oct. 96)	12 (Apr. 97)	18 (Oct.97)		
0	0.56 C*c*	0.57 C*bc*	0.60 C*ab*	0.65 C*a*	*	4.61
12.50	1.14 B*a*	0.53 C*c*	0.63 C*b*	0.69 B*cb*	**	4.38
25.00	1.14 B*a*	0.56 C*c*	0.66 C*b*	0.73 B*b*	**	6.30
37.50	1.27 A*a*	0.65 B*c*	0.76 B*b*	0.82 A*b*	**	3.41
50.00	1.23 A*a*	0.74 A*b*	0.84 A*b*	0.80 A*b*	**	6.11
F-test	**	**	**	**		
C.V. (%)	3.27	5.58	5.30	3.51		

*, ** Indicate confidential limits at P = 0.05 and 0.01, respectively.
Capital letters indicate Duncan's Multiple Range Test of vertical rows while the italic ones represent the horizontal rows.

Table 4: Changes in average amount of soil nitrogen contents (%) of Yasothon soil series (Oxic Paleustults) after the application of Khon Kaen's municipal fermented organic compost.

Organic compost (Tones/ha)	Sampling period (month)				F-test	C.V. (%)
	1 (Apr.96)	6 (Oct.96)	12 (Apr.97)	18 (Oct.97)		
0	0.03 D*a*	0.02 B*b*	0.02 *b*	0.02 B*b*	*	7.62
12.50	0.05 C*a*	0.03 A*b*	0.03 *b*	0.03A*b*	**	8.27
25.00	0.05 C*a*	0.02 B*c*	0.03 *b*	0.02 B*c*	**	2.17
37.50	0.06 B*a*	0.03 A*b*	0.03 *b*	0.03 A*b*	**	6.40
50.00	0.07 A*a*	0.03 A*b*	0.03 *b*	0.03 A*b*	**	5.46
F-test	**	*	NS	**		
C.V. (%)	7.66	10.33	8.71	6.37		

*, ** Indicate confidential limits at P = 0.05 and 0.01, respectively.
Capital letters indicate Duncan's Multiple Range Test of vertical rows while the italic ones represent the horizontal rows.

Table 5: Changes in average amount of soil nitrogen contents (%) of Yasothon soil series (Oxic Paleustults) after the application of Khon Kaen's municipal fermented organic compost together with the growth of *Panicum maximum* TD58 grass.

Organic compost (Tones/ha)	Sampling period (month)				F-test	C.V. (%)
	1(Apr.96)	6 (Oct.96)	12 (Apr.97)	18 (Oct.97)		
0	0.02 D*b*	0.02 C*b*	0.03 B*a*	0.03 B*a*	**	5.09
12.50	0.03 C*b*	0.02 C*c*	0.04 A*a*	0.04 A*a*	**	5.37
25.00	0.05 B*a*	0.03 B*c*	0.04 A*b*	0.03 B*c*	**	5.51
37.50	0.06 A*a*	0.04 A*b*	0.04 A*b*	0.04 A*b*	**	3.00
50.00	0.06 A*a*	0.04 A*b*	0.04 A*b*	0.04 A*b*	**	4.02
F-test	**	**	**	**		
C.V. (%)	4.35	4.85	5.56	7.78		

*, ** Indicate confidential limits at P = 0.05 and 0.01, respectively.
Capital letters indicate Duncan's Multiple Range Test of vertical rows while the italic ones represent the horizontal row

Table 6: Changes in average amount of available phosphorous (ppm) of Yasothon soil series (Oxic Paleustults) as influenced by Khon Kaen's municipal fermented organic compost.

Organic compost (tones/ha)	Sampling period (month)				F-test	C.V. (%)
	1 (Apr.96)	6 (Oct.96)	12 (Apr.97)	18 (Oct.97)		
0	3.86 E*b*	4.22 D*a*	3.22 B*d*	3.45 D*c*	**	2.58
12.50	8.52 D*a*	4.77 B*b*	3.20 B*d*	3.69BC*c*	**	0.94
25.00	8.86 C*a*	4.51 C*b*	3.25 B*d*	3.63 C*c*	**	0.59
37.50	10.73B*a*	5.52 A*b*	3.25 B*d*	3.77 A*bc*	**	0.57
50.00	11.16A*a*	5.52 A*b*	3.46 A*d*	3.86 A*c*	**	1.20
F-test	**	**	**	**		
C.V. (%)	0.68	2.16	0.88	1.39		

*, ** Indicate confidential limits at P = 0.05 and 0.01, respectively.
Capital letters indicate Duncan's Multiple Range Test of vertical rows while the italic ones represent the horizontal rows.

Table 7: Changes in average amount of available phosphorous (ppm) of Yasothon soil series (Oxic Paleustults) with time as influenced by Khon Kaen's municipal fermented organic compost.

Organic compost (tones/ha)	Sampling period (month)				F-test	C.V. (%)
	1 (Apr.96)	6 (Oct.96)	12 (Apr.97)	18 (Oct.97)		
0	3.71 E*a*	3.65 E*ab*	3.41 D*c*	3.51 C*bc*	*	2.15
12.50	6.17 D*a*	4.11 D*b*	3.56 D*c*	3.74 C*c*	**	2.19
25.00	6.71 C*a*	5.67 C*b*	5.52 B*b*	3.76 C*c*	**	1.68
37.50	7.49 B*a*	7.06 B*b*	4.44 C*d*	6.30 B*c*	**	0.91
50.00	11.60A*a*	8.63 A*d*	11.00 A*b*	10.28 A*c*	**	2.43
F-test	**	**	**	**		
C.V. (%)	1.15	1.51	4.94	2.50		

*, ** Indicate confidential limits at P = 0.05 and 0.01, respectively.
Capital letters indicate Duncan's Multiple Range Test of vertical rows while the italic ones represent the horizontal rows.

Table 8: Changes in average amount of exchangeable potassium (ppm) of Yasothon soil series (Oxic Paleustults) as influenced by Khon Kaen's municipal fermented organic compost.

Organic compost (tones/ha)	Sampling period (month)				F-test	C.V. (%)
	1 (Apr.96)	6 (Oct.96)	12 (Apr.97)	18 (Oct.97)		
0	57.12 E*b*	53.30 E*c*	59.48 E*a*	43.20 B*d*	**	1.26
12.50	85.57 D*a*	58.73 C*c*	78.04 B*b*	44.03 B*d*	**	1.07
25.00	129.08C*a*	55.99 D*c*	67.00 D*b*	43.92 B*d*	**	0.42
37.50	186.71A*a*	67.55 B*c*	75.47 C*b*	45.29 A*d*	**	0.48
50.00	184.40B*a*	120.61A*b*	80.80 A*c*	45.62 A*d*	**	0.76
F-test	**	**	**	**		
C.V. (%)	0.39	0.90	1.13	1.30		

*, ** Indicate confidential limits at P = 0.05 and 0.01, respectively.
Capital letters indicate Duncan's Multiple Range Test of vertical rows while the italic ones represent the horizontal rows.

Table 9: Changes in the average amounts of exchangeable potassium (ppm) of Yasothon soil series (Oxic Paleustults) as influenced by Khon Kaen's municipal fermented organic compost.

Organic compost (tones/ha.)	Sampling period (month)				F-test	C.V. (%)
	1 (Apr. 96)	6 (Oct. 96)	12 (Apr.97)	18 (Oct.97)		
0	53.39 E*c*	46.89 D*d*	63.51 D*a*	56.32 C*b*	**	0.95
12.50	65.68 C*b*	48.76 C*d*	67.75 B*a*	58.32 B*c*	**	0.90
25.00	63.12 D*b*	49.98 B*d*	65.84 C*a*	58.51 B*c*	**	1.31
37.50	113.77B*a*	50.67 B*d*	65.82 C*b*	63.64 A*c*	**	1.19
50.00	244.71A*a*	68.89 A*c*	83.33 A*b*	58.37 B*d*	**	0.90
F-test	**	**	**	**		
C.V. (%)	0.97	0.70	1.20	1.44		

*, ** Indicate confidential limits at P = 0.05 and 0.01, respectively.
Capital letters indicate Duncan's Multiple Range Test of vertical rows while the italic ones represent the horizontal rows.

Table 10: Changes in average soil pH values of Yasothon soil series (Oxic Paleustults) as influenced by Khon Kaen's municipal fermented organic compost.

Organic compost (tones/ha)	Sampling period (month)				F-test	C.V.(%)
	1 (Apr. 96)	6 (Oct. 96)	12 (Apr. 97)	18 (Oct. 97)		
0	5.12	5.11C	5.25A	5.10	NS	3.62
12.50	5.08	5.35B	5.13C	5.14	NS	2.95
25.00	5.07	5.57A	5.17C	5.15	NS	3.74
37.50	5.20*b*	5.59A*a*	5.30B*b*	5.40*ab*	*	2.35
50.00	5.10*b*	5.70A*a*	5.20BC*b*	5.25*b*	*	3.17
F –test	NS	**	*	NS		
C.V. (%)	2.23	1.44	1.12	2.09		

*, ** Indicate confidential limits at P = 0.05 and 0.01, respectively.
Capital letters indicate Duncan's Multiple Range Test of vertical rows while the italic ones represent the horizontal rows.

Table 11: Changes in average soil pH values of Yasothon soil series (Oxic Paleustults) with time as influenced by Khon Kaen's municipal fermented organic compost together with the growth of *Panicum maximum* grass TD 58.

Organic compost (tones/ha)	Sampling period (month)				F-test	C.V. (%)
	1 (Apr.96)	6 (Oct. 96)	12 (Apr. 97)	18 (Oct. 97)		
0	5.09	5.27	5.32B	5.39C	NS	2.78
12.50	5.09*c*	5.28*b*	5.10C*c*	5.54BC*a*	**	1.62
25.00	5.12*c*	5.45*ab*	5.42B*b*	5.58B*a*	**	1.35
37.50	5.07*c*	5.45*b*	5.48B*b*	5.92A*a*	**	2.46
50.00	5.16*c*	5.65*b*	5.96A*ab*	6.07A*a*	**	2.95
F –test	NS	NS	**	**		
C.V. (%)	2.55	3.09	1.93	1.54		

*, ** Indicate confidential limits at P = 0.05 and 0.01, respectively.
Capital letters indicate Duncan's Multiple Range Test of vertical rows while the italic ones represent the horizontal rows.

highest two levels of municipal compost remain similar, but better than the rest, at the third sampling period and later no differences were observed at the final sampling period (Table 10). The increase in soil pH values could be attributed to the release of some basic cations such as K, Ca, and Mg from the compost to the soil (Olsen and Barber, 1977; Panichsakpatana *et al.*, 1988 and Vityakon *et al.*, 1988). The increase in soil pH values could have favoured massively the growth of the grass plants (Panchaban *et al.*, 1989). The decline in soil pH values at final sampling period could be due to the loss of some soluble amount of calcium through leaching. On the contrary, soil pH values for those treatments with the growth of *Panicum maximum* grass the results indicated that an increase in the amount of organic compost added to the soil, in most cases, increased soil pH throughout the sampling period (Table 11). The results suggested that the grass plants could possibly act as covered crop to protect soil surface from high leaching rate and also help in preventing the soil erosion by numerous amounts of the plant roots (Chantawat, 1983; and Panchaban *et al.*, 1989). Hence soluble calcium could have remained in a large quantity in soil.

To sum up, plant materials and garbage available in municipal waste has a tremendous effect in improving soil property if sorted out and fermented to be used as organic compost. An increase in municipal compost increased Yasothon (Oxic Paleustults) soil organic matter percentages. Decomposition rate of organic compost was most rapid due to high environmental temperature. The improvement of soil property was greater for treatments with the growth of *Panicum maximum* TD 58 grass than those without. To maintain high percentages of soil organic matter, the highest rate of organic compost should be added annually or every six months and legume crops may be used to protect soil deterioration. An increase in the amount of organic compost added to the soil increased percentages of soil nitrogen and did soil P and K. Soil exchangeable K was moderately available whilst soil P was relatively small and inadequately available. Municipal organic compost increased soil pH, but a greater result was found for treatments with the growth of *Panicum maximum* grass. Municipal waste particularly plant materials and garbage sorted out should be recycled as a fermented compost to improve the soil fertility for better crop production and sustainable agriculture.

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