Vetiver Grass Research: Primary Management of Wastewater from Community

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Abstract: An experiment to study the potential of vetiver grass in managing wastewater was carried out using 2 types of the vetiver grass i.e. upland type (var. Roi Et and Prajoub Kirikhan) and lowland type (var. Songkhla 3 and Sri Lanka) grown at 3 depths of waste water level 5, 10, and 15 cm. It was found that plant tillering and dry weight of vetiver grass var. Songkhla 3 were significantly higher than those of var. Sri Langka, Prajoub Kirikhan, and Roi Et, respectively. The results also showed that BOD values at water levels of 5 and 10 cm were lower than those of 15 cm. for all varieties. The BOD values were 10-13, 15-22 and 27-29 mg/L, respectively. Against the BOD, it was found that the shallower depths the higher values of DO. The DO varied from 3-7 mg/L depending on the length of time. The change of temperature and pH was not significant. Electrical Conductivity increased when water consumption of vetiver grass increased. The results also showed that lowland types of vetiver grass consumed more water than upland types about 30-70%. Upland types presented higher tendency on the change of wastewater quality. Moreover, the upland types could tolerate at water levels 10-15 cm. for only 10 weeks whereas at the level of 5 cm. the upland types still presented normal growth.

Potential of Vetiver grass cv. Songkhla-3 in remedying wastewater at different lengths of flows and water depths was also investigated. It was revealed that various levels of flow lengths and water depths directly affected wastewater properties. BOD increased when measured at deeper levels from 5, 10, and 15 centimeters. The values ranged from 5.23-7.57, 3.80-3.93, and 3.10-3.73 mg/L when measured at 15, 30, and 60 days, respectively. When comparing among different lengths of flows, the results showed that the BOD decreased when the distance was increased from 3 to 6 and 9 meters. The values ranged from 9.70-3.50, 3.63-2.33, and 6.10-2.03 mg/L when measured at 15, 30, and 60 days, respectively. DO rose up when the time increased but it would be smaller value whenever measured at deeper water level from 5, 10, and 15 cm. The DO values ranged from 5.00-3.20, 6.39-3.39, and 6.63-3.23 mg/ L. However, the DO would increase whenever the length of flow was increased. The patterns of DO changing were 3.86-4.75, 4.80-5.07, and 5.77-6.11 mg/L when measured at 15, 30, and 60 days, respectively. Electrical conductivity increased simultaneously with experimental duration. Water reaction was slightly changed. Growth rate of vetiver grass was decreased when the length of flow and water depth were increased.

Key words: vetiver grass, wastewater management

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1 INTRODUCTION

At present, environmental problems become more important problem, which should be urgently improved and prevented altogether with country development. Thus, natural resources and environmental conservation are challenging tasks to overcome, particularly wastewater disposal such as water pollution

pollution to several water resources. Vetiver grass becomes an alternative choice to be applied in wastewater remedy because it has complex fibrous root system that can absorb water and elements very well. Besides, vetiver grass also can protect soil surface from soil erosion. Previous studies revealed that its root grows vertically as a wall and also has capability for soil moisture conservation. Hence, vetiver grass cultivation is useful and practical for environmental and ecological system conservation (Department of Land Development, 1984; Mongkon and Santibhab, 2002). Growing vetiver grass near water resources will be beneficial for forming barriers to capture sediment and wastes from contaminating water resources and controlling water pollution effectively. Moreover, vetiver grass root system will absorb dissolved elements and collect it in the root system (Mongkon *et al*., 1996). Besides, the root of vetiver grass can increase soil pH (Patcharee and Mongkon, 2001) that will be an effective factor for crop growth and soil conservation.

In this research study, vetiver grass was used to treat wastewater. It is the primary aim was to determine the ability of different types of vetiver grass to grow in wastewater at different water levels. Besides, its ability to change water quality for wastewater remedy is al so concerned. In addition, the growth rate of vetiver grass and wastewater absorption at different depths of wastewater level and lengths of wastewater flow were discussed.

2 MATERIALS AND METHODS

The experiment was divided into two parts as followings:

1. To study the change of wastewater quality and the growth rate of vetiver grass toward water remedy. Vetiver grass upland type and lowland type were grown for 5 months until 20 tillers developed and the height was approximately 50 cm. The experiment started using 4 types of vetiver grass and three replications at 3 depths of wastewater level 5, 10 and 15 cm. The relationship among wastewater depths, growth rate of vetiver grass, the change of wastewater quality were discussed.

2. To study on the potential of vetiver grass in wastewater remedy at different lengths of flows. Vetiver grass variety Songkhla-3 was grown in 80 cm diameter cement boxes with three depths of wastewater level 5, 10 and 15 cm and then let the wastewater passed through cement boxes and wastewater samples were collected from plastic tubes, which were set in every 3 m for all cement boxes for comparative study on the change of wastewater quality.

Wastewater samples used in this experiment were collected from Taparak community, Fishery Net Industry Khonkaen, Khonkaen Rama Hospotal, Samliam community and Khonkaen Railway station community in the downtown of Khonkaen province, in Northeast Thailand. The general parameters of the wastewater quality were investigated such as pH, EC, DO, BOD (Mongkon *et al*., 1995; Ayers and Westcot, 1985). Growth rate of all types of vetiver grass was also measured.

3 RESULTS AND DISCUSSION

3.1 Study on the Change of Wastewater Quality and the Growth of Vetiver Grass.

3.1.1 General observation

The upland vetiver grass (Roi-Et and Prajoub Kirikhan varieties) grown in the depths of wastewater level 10, 15 cm showed their low growth potential in wastewater because their leaves became yellowish, dark and then died within 10 weeks whereas vetiver grass in the depth of wastewater level 5 cm still normally grew up and died one year later. However, the depths of the wastewater level at 15, 10 and 5 cm did not affect the growth of the lowland vetiver grass types (Songkhla-3 and Srilangka varieties).

3.2 Wastewater Quality as Affected by Vetiver Grass

3.2.1 pH

pH value of wastewater was slightly changed in all vetiver grass treatments. Generally, upland vetiver grass (RoiEt and Prajoub KiriKhan) had higher tendency to induce the change of pH values of wastewater than the lowland types (SongKhla 3 and Srilangka). Besides, the results also revealed that the shallower depths the more changeable pH.

3.2.2 Electrical conductivity (EC)

Electrical conductivity (EC) decreased with the length of times and increased with the depth of wastewater level of 5 cm. For all types of vetiver grass at the level of 5 cm, EC value would be higher than that of at the level 10 and 15 cm. It seems that lowland vetiver grass inclined to affect EC value of the wastewater much more than up-land types. EC value was changed by vetiver grass growing in wastewater because vetiver grass can grow in the salinity ranged from 1-10 mS/cm (Patcharee and MongKon, 2001; Cook 1993; Chaweevan *et al.*, 1996; Nanakorn *et al.*, 1996).

3.2.3 Dissolved oxygen (DO)

Upland vetiver grasses (Roi-Et and Prajoub Kirikhan) showed the tendency to change DO value of wastewater much more than low-land type (Songkhla-3 and Srilangka), particularly when grown in the shallower depths as displayed in Table 1.

Table 1 Dissolved oxygen (DO) of wastewater (mg/L)

Vetiver grass	Wastewater level (cm)	Week 1 [ns]	3 *	5 *	7 *	9 [ns]
Roi Et(A)	15	4.08	6.63	3.19	4.57	5.36
	10	4.34	8.62	4.31	4.67	6.00
	5	4.41	7.25	4.70	7.31	8.15
Prajoub Kirikhan (B)	15	5.25	5.60	3.05	4.41	7.42
	10	5.56	7.33	5.13	4.42	7.38
	5	5.66	8.51	6.55	5.60	7.67
Sri Langka(C)	15	3.54	6.88	3.56	3.68	4.78
	10	4.22	7.50	3.70	4.98	5.36
	5	4.29	7.22	3.69	4.90	5.02
Songkhla(D)	15	4.39	5.43	3.72	3.15	5.45
	10	.54	6.31	4.41	4.35	5.54
	5	.35	6.53	5.23	4.58	6.03
LSD(0.05)		-	0.716	0.646	0.733	-
Vetiver grass	Vetiver grass	*	*	*	*	*
upland type	Roi Et(A)	4.27	7.50	4.07	5.52	6.50
upland type	Prajoub Kirikhan(B)	5.49	7.15	4.91	4.81	7.49
Lowland type	Sri Lanka(C)	4.02	7.20	3.65	4.52	5.05
Lowland type	Songkhla(D)	4.43	6.03	4.45	4.03	5.68
LSD(0.05)		0.206	0.413	0.373	0.424	0.716
	Wastewater level (cm)	*	*	*	*	*
	15	4.31	6.14	3.38	3.95	5.76
	10	4.66	7.39	4.39	4.61	6.07
	5	4.68	7.38	5.04	5.60	6.72
LSD(0.05)		0.178	0.358	0.323	0.367	0.620
CV (%)		5.62	7.35	10.84	11.13	14.38

* not significantly different at 95 % of confident level by DMRT

ns not significantly different at 95 % of confident level by DMRT

3.2.4 Biochemical oxygen demand (BOD)

BOD values tended to be changed with the DO level. Accordingly, upland vetiver grasses (Roi-Et and Prajaob Kirikhan) effected BOD value of wastewater much more than lowland vetiver grasses (Songkhla-3 and Srilangka) as indicated in Table 2.

3.2.5 Temperature

The change of wastewater temperature depended on the depth of wastewater level. At the level of 5 cm, the temperature showed higher tendency to be changed than at the levels of 10 and 15 cm, respectively. Moreover, lowland types gave lower temperature because of they contain more advantage in phenotype as bigger and higher in physical performance than the upland types; therefore, they could provide a better buffer to protect sun light and temperature change of wastewater. Besides, vetiver grass can grow well in low temperature ranging from –15 to 45_; thus, this property is an advantage to be used in environmental management (Technology, 1991; BOSTID, 1993).

Table 2 Biochemical oxygen demand (mg/L)

Vetiver grass	Wastewater level (cm)	Week 4	Week 8	Week 12
Roi Et(A)	15	27	28	24
	10	24	22	21
	5	14	13	12
Prajoub Kirikhan (B)	15	26	30	29
	10	19	16	14
	5	11	10	9
Sri Langka(C)	15	26	28	28
	10	22	19	15
	5	15	14	12
Songkhla(D)	15	32	31	27
	10	23	15	13
	5	13	11	10
LSD(0.05)		-	-	-
Vetiver grass	Vetiver grass			
Upland type	Roi Et(A)	21.7	21.0	19.0
Upland type	Prajoub Kirikhan(B)	18.7	18.7	17.3
Lowland type	Sri Langka(C)	21.0	20.3	18.3
Lowland type	Songkhla(D)	22.7	19.0	16.7
LSD(0.05)		-	-	-
	Wastewater level (cm)			
	15	27.8	29.2	27.0
	10	22.0	18.4	15.8
	5	13.2	12.0	10.8
LSD(0.05)		-	-	-
CV (%)		-	-	-

3.3 Vetiver Grass and Water Consumption

It was found that lowland types had higher potential in wastewater consumption approximately 30-70% higher than lowland types. The Srilangka type consumed the largest amount of wastewater and then Songkhla-3, Prajaob Kirikhan, and Roi-Et, respectively and it was also found that the shallower water depths the more consumption (Table 3). Normally, the growth of vetiver grass will depend on soil would have their highest response to nitrogen fertilizer application. In case of low soil moisture content, the application of nitrogen would not significantly increase growth rate.

Table 3 Wastewater consumption (liter)

Vetiver grass	Wastewater level (cm)	Week 1 ns	3 *	5 *	7 ns	9 ns
Roi Et(A)	15	2.59	2.17	1.96	1.64	1.54
	10	2.98	2.27	2.34	1.94	1.70
	5	3.45	2.75	3.74	2.06	1.92
Prajoub Kirikhan (B)	15	2.21	2.08	2.85	1.65	1.50
	10	2.49	2.74	3.40	1.85	1.59
	5	3.07	3.34	4.18	2.14	2.00
Sri Langka(C)	15	3.25	3.05	4.41	2.57	2.17
	10	3.52	3.45	5.23	2.94	2.57
	5	3.95	3.94	6.16	3.07	2.87
Songkhla(D)	15	2.91	2.81	4.52	2.26	2.25
	10	3.16	3.37	5.04	2.45	2.30
	5	3.97	3.54	5.28	2.72	2.42
LSD(0.05)		-	0.154	0.278	-	-
Vetiver grass	Vetiver grass	*	*	*	*	*
Upland type	Roi Et(A)	3.00	2.39	2.68	1.88	1.72
Upland type	Prajoub Kirikhan(B)	2.59	2.72	3.48	1.88	1.70
Lowland type	Sri Langka(C)	3.57	3.48	5.26	2.86	2.53
Lowland type	Songkhla(D)	3.34	3.24	4.95	2.48	2.32
LSD(0.05)		0.145	0.089	0.161	0.078	0.117
	Wastewater level (cm)	*	*	*	*	*
	15	2.74	2.53	3.44	2.03	1.86
	10	3.04	2.95	4.00	2.30	2.04
	5	3.61	3.39	4.84	2.50	2.30
LSD(0.05)		0.129	0.077	0.139	0.067	0.101
CV (%)		5.93	3.73	4.87	4.27	7.5

* not significantly different at 95 % of confident level by DMRT
ns not significantly different at 95 % of confident level by DMRT

3.4 Effect of Wastewater on the Growth of Vetiver Grass

The results showed that lowland types (Songkhla-3 and Srilangka) had bigger number of tillers than the upland types (Roi-Et and Prajaob Kirikhan). Tillering, plant height, stem and root weights were better when grown in the shallower water depths, particularly at the depth of wastewater level of 5 cm. The upland types were more sensitive to water depths than the upland types.

3.5 Effect of the Length of Flow on Vetiver Grass

3.5.1 General observation

From general observation, it was found that throughout the experimental period, vetiver grass showed good growth rate and high tillering, particularly in the short length of flow and the temperature of wastewater under vetiver grass system would be slightly lower. Some types of algae and aquatic plants were obviously observed.

BOD increased when measured at deeper levels from 5, 10, and 15 cm. The values ranged from 5.23-7.57, 3.80-3.93, and 3.10-3.73 mg/L when measured at 15, 30, and 60 days, respectively. When comparing among different lengths of flow, the results showed that the BOD decreased when the distance was increased from 3, 6, and 9 m.

BOD sampled from community wastewater prior to the experiment was 113-126 mg/L. The results indicated that vetiver grass had high potential of wastewater remedy because BOD values in the experiment under vetiver grass were lower than the BOD values in control treatment without vetiver grass as indicated in Table 4.

Table 4 BOD and DO of wastewater at different depths, lengths of flow and period of experiment

Depth	Flow length	BOD (mg/L)			DO (mg/L)		
(cm)	(m)	15 days	30 days	60 days	15 days	30 days	60 days
5	3	8.40	5.40	4.70	4.02	5.80	5.86
	6	4.20	3.60	2.70	4.20	6.20	6.10
	9	3.10	2.40	1.90	4.82	6.39	6.63
10	3	9.30	5.20	6.60	3.97	5.20	5.67
	6	6.20	3.20	4.00	5.00	5.20	5.60
	9	4.20	2.20	2.40	5.00	4.83	5.70
15	3	11.40	5.70	7.00	3.60	3.39	5.77
	6	8.10	3.70	2.40	3.25	4.00	5.89
	9	3.20	2.40	1.80	4.42	4.00	6.00
Control	3	19.30	16.60	14.10	4.03	4.00	3.23
5 cm depth	6	16.20	13.90	12.40	3.20	4.10	3.41
	9	8.90	9.90	7.70	4.00	4.22	3.38
	Average	14.80	13.47	11.40	3.74	4.11	3.34
Mean	5 cm	5.23	3.80	3.10	4.35	6.13	6.20
Depth	10 cm	6.57	3.53	4.33	4.66	5.08	5.66
	15 cm	7.57	3.93	3.73	3.76	3.80	5.89
	Average	6.46	3.76	3.72	4.25	5.00	5.91
Mean	3 m	9.70	5.43	6.10	3.86	4.80	5.77
Flow length	6 m	6.17	3.50	3.03	4.15	5.13	5.86
	9 m	3.50	2.33	2.03	4.75	5.07	6.11
	Average	6.46	3.76	3.72	4.25	5.00	5.91

3.5.3 Dissolved oxygen (DO)

DO rose up when the time increased but it would be smaller value whenever measured at deeper water level from 5, 10, and 15 cm. The DO values ranged from 5.00-3.20, 6.39-3.39, and 6.63-3.23 mg/L. However, the DO would increase whenever the length of flow was increased. The patterns of DO changing were 3.86-4.75, 4.80-5.07, and 5.77-6.11 mg/L when measured at 15, 30, and 60 days, respectively (Table 4).

3.5.4 pH

pH of wastewater using vetiver grass was lower than wastewater without vetiver. pH value ranged from 6.9-7.4 through the duration of experiment. However, when comparing at 15, 30, and 60 days under different lengths of flow 3, 6, and 9 m, it was found that pH values ranged from 7.13-7.20, 7.27-7.33, and 6.97-7.00, respectively.

3.5.5 Electrical conductivity (EC)

Electrical conductivity (EC) increased simultaneously with experimental period. At 15 days, the treatment, 1.40-1.63 mS/cm. EC values seemed to be changeable in shallower treatments. It was also found that the EC decreased when the length of flow increased. They were 1.42-1.48, 1.67-1.70, and 1.75-1.88 mS/cm at 15, 30, and, 60 days respectively.

3.5.6 Vetiver grass growth (Songkhla-3) in wastewater treatment

At the age of 4 months, vetiver grass var. Sonkhla-3 was cut back to 30cm high. Dry weight was measured. It was found that dry matter of vetiver grass grown at 5 cm of wastewater depth showed significantly higher dry weight than that grown at 10 and 15 cm depths. The dry weights at the lengths of flow 3 to 9 m were 25.60-36.90, 21.25-32.50, and 20.00-31.25 tons/ha respectively. It was also found that the shorter lengths of flow the better growth rate of grass i.e. 33.55, 24.77, and 22.41 t/ha for the length 3, 6, and 9 m, respectively. Fresh weight of Songkhla-3 stem contained 45-55 percent moisture content while root contained that of 25-35% (Table 5).

Table 5 Growth rate of vetiver grass (tons/ha of stem dry weight) at the age of 3 months

Depth		Length of flow (m)^{NS}			Average **
(cm)	(m)	3	6	9	
5	3	36.90	29.19	25.60	30.56 a
10	6	32.50	21.25	21.63	25.13 b
15	9	31.25	23.86	20.00	25.04 b
Average **	5 cm	33.55a	24.77b	22.41c	26.91
CV= 6.40 %					

** not significantly different at 99 % of confident level by DMRT
ns not significantly different at 95 % of confident level by DMRT

4 CONCLUSIONS

Wastewater management by using vetiver grasses could solve the disposal problem and improve quality of wastewater discharged from communities, because BOD value is decreased while DO and pH values are increased. However, EC is increased because the water consumption of the grass, particularly when applying to lowland varieties, which consume more water than upland types. However, both upland and lowland types grow well in the depth of wastewater level at 5 cm within 6 months. Besides, lowland type could grow well even in the level 15 cm or deeper. The Songkhla-3 can improve wastewater quality by decreasing BOD and increasing DO when the lengths of the flow are longer but the depths are shallower. pH values of wastewater generally are almost neutral while EC values are low when measured in deeper levels and longer experimental periods and lengths of flow. The vetiver grass can grow well when grown at shorter flow lengths.

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A Brief Introduction to the First Author

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