WASTEWATER TREATMENT AT A SEAFOOD PROCESSING FACTORY IN THE MEKONG DELTA, VIETNAM

Luu Thai Danh[1], Le Thanh Phong[1], Le Viet Dung[1] and Paul Truong[2]
[1] University of Can Tho, Can Tho City, Viet Nam
ltdanh@ctu.edu.vn
[2] TVN Director and East Asia and South Pacific Representative,
23 Kimba St, Chapel Hill, Brisbane 4069, Australia
truong@uqconnect.net

Abstract

Due to the effectiveness of VS in treating wastewater and the current trend in water recycling around the world, the seafood processing factory, CAFATEX, was interested in testing VS as a method of phytoremediation to reduce the contaminant levels in the factory effluent. The emphasis is on the low cost and simple VS alternative instead of more costly chemical and engineering solutions.

Cantho City is the capital of the Mekong Delta, which is also the centre of several food processing industries. The seafood processing factories are the major sources of pollution to the region watercourses and farmlands nearby.

Two demonstration trials were set up at the factory as a part of the Wallace Genetic Foundation “Water Quality Improvement program”:

One trial was set up on an area of about 800m^2. The aim of this trial was to determine the treatment time required to retain effluent in the vetiver field to reduce nitrate and phosphate concentrations in effluent to acceptable levels. The experiment started when plants were 7 months old. Water samples were taken for analysis at 24 hour interval for 3 days. Analytical results showed that total N content in wastewater was reduced by 88% and 91% after 48 and 72 hours of treatment, respectively. While the total P was reduced by to 80% and 82% after 48 and 72 hours of treatment. The amount of total N and P removed in 48 and 72 hour treatments were not significantly different.

The other trial was established to determine the capacity of Vetiver grass in absorbing nitrate and phosphate in wastewater under the local conditions. Plant density and field design were similar to those of the above experiment. As this trial was set up 2 months after the above experiment, so experiment started when plants were only 5 month old. Wastewater was pumped into each replicate then water samples were collected for analysis at 24 hour interval for 3 days.

The total N was reduced by 22% after 24 hours of treatment and 62% after 48 and 72 hours. No significant difference between 48 and 72 hours of treatments. Similarly, total P was reduced by 31% after 24 hours and 72% after 48 and 72 hours. No significant difference between 48 and 72 hours of treatments. The lower removal rate of Vetiver in this trial may be due to the fact that plants in this trial was 2 months younger than that of vetiver in above experiment, as they have smaller root system to absorb N and P.

In short, the preliminary results of these experiments showed that this seafood processing company should retain its effluent for 48 hours in the vetiver field before discharging into the nearby creek. However, before Vetiver technology can be actually applied in this factory, intensive monitoring should be repeated several times in order to firmly establish the effectiveness of vetiver grass in absorbing N and P in wastewater. In addition an intensive operational plan in term of harvesting frequency and maintenance schedule has to be set up for the company.

KEY WORDS: Industrial effluent, N and P removal, Mekong Delta

1.0 INTRODUCTION

Application of the Vetiver System (VS) for wastewater treatment is a new and innovative phytoremedial technology, researched and developed in Queensland, Australia (Truong and Hart, 2001). It is a green and environmentally friendly wastewater treatment technology as well as a natural recycling method. Its end-product has several uses including animal fodder, handicraft and material for organic farming.

2.0 SUITABILITY OF VETIVER GRASS FOR WASTEWATER TREATMENT

VS is based on the use of vetiver grass (*Vetiveria zizanioides* L.), which was first recognised early in the 1990s for having a "super absorbent" characteristics suitable for the treatment of wastewater and leachate generated from landfill in Australia (Percy and Truong, 2003). Research has established that vetiver grass has a fast and very high capacity for absorption of nutrients, particularly nitrogen and phosphorus in wastewater (Truong and Hart, 2001; Truong, 2000). (Figures 1 and 2). In addition it has a very high water use rate and tolerant to elevated levels of agrochemicals and heavy metals in the effluent (Cull *et al*. 2000; Truong and Baker, 1998).

In addition to Australia, extensive R&D on wastewater treatment has also been conducted in several countries, particularly China and Thailand (Ash and Truong, 2003; Truong, 2003 and Smeal *et al*, 2003). In China vetiver grass is being used to treat polluted river water in central China. The removal percentage of total P was 93.7% after 2 weeks and more than 99% after 3 weeks. The removal percentage of total N was 58% after 2 weeks, and 71% after 4 weeks. Phosphorous is usually considered to be a key element in water eutrophication (Anon 1997; Zheng *et al*, 1997).

Thai researchers carried out a 'constructed wetland' experiment to purify domestic wastewater. It was found that in the first system with five-day standing and two-day dry period, a total volume of wastewater passed through the system was 33.1m^3/day. The second system with overflow wastewater with one-day standing water in the wetland, the total treated amount of wastewater was 59.99 m^3/day. (Truong 2003).

Figure 1: Vetiver has a much higher capacity to capacity to uptake N and P than other crops and trees

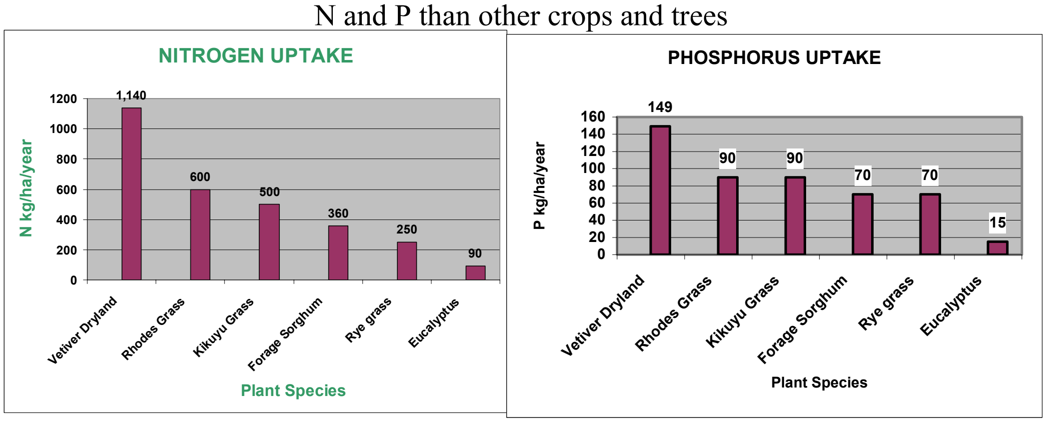
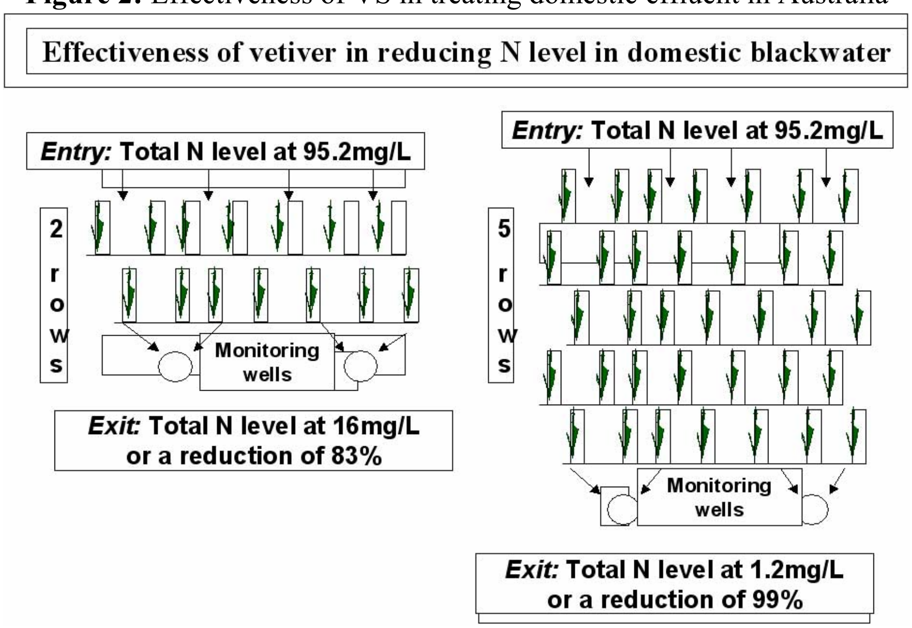


Figure 2: Effectiveness of VS in treating domestic effluent in Australia



Mongkon Ta-oun *et al*. (2003) studied the effect of wetland depth (5, 10, and 15 cm) and flow length (3, 6, and 9m) on the growth of two vetiver varieties and their effectiveness in treating wastewater. Their results show that BOD values at water levels of 5 and 10 cm. were lower than those of 15 cm for all varieties and DO varied from 3-7 mg/L depending on the length of time. When comparing different distances of flow, the results show that the BOD decreased when the distance increased. DO increased when the time increased but at a smaller value when measured with deeper water levels from 5, 10 and 15 centimetres.

As a result of these findings, presently VS has been used successfully for these purposes in Australia, China, Thailand, Vietnam and Senegal

3.0 WASTEWATER TREATMENT AT CAFATEX

3.1 Pollution Source

Cantho City is the capital of the Mekong Delta, which is also the centre of several food processing industries. Among these seafood-processing factories are the major sources of pollution to the region watercourses and farmlands near these factories.

CAFATEX is a medium size seafood (mostly shrimps) processing factory, which exported more than USD65 millions to the US, Europe and Japan in 2004. CAFATEX factory is one of several and much larger factories of this type around Cantho City and Hau Giang province. As the environmental protection standards are being upgraded CAFATEX was looking for a low cost, effective and simple method of reducing the contaminant levels in the factory effluent instead of more costly chemical and engineering solutions. The effluent output of the factory is about 50 000L a day and after the standard procedure of anaerobic and aerobic treatment to control pathogenic organisms in two holding ponds, the effluent is discharged directly to the surrounding creek and rice field and orchards. The nutrient load varies with the seasons, in dry periods they often exceed 10mg/L of N and 5mg/L of P.

3.2 Demonstration Trials

Two demonstration trials were set up at the factory as a part of the Wallace Genetic Foundation “Water Quality Improvement program”:

3.2.1 Trial 1

The aim of this trial was to determine the treatment time required to retain effluent in the vetiver field to reduce nitrate and phosphate concentrations in effluent to acceptable levels. Vetiver was grown in the field with 5% slope and inter row spacing was 1m, and intra row spacing was 15cm. (Fig.3). this trial was established on an area of about 800m^2 and with no replication. Treatments started when plants were 7 months old. Water samples were taken for analysis at 24 hour interval for 3 days.

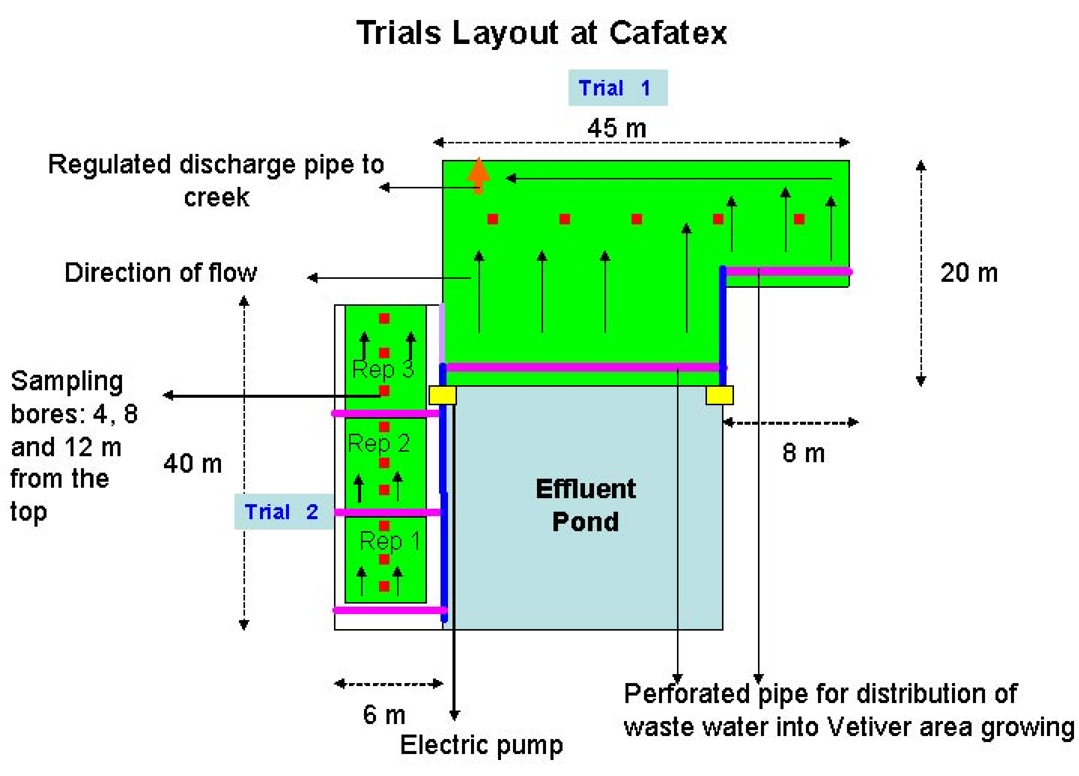
The analysis of water samples showed that total N content in wastewater was reduced from 4.79 mg/L to 0.57 mg/L and 0.44 mg/L (equivalent to 88% and 91% of N reduction) after 48 and 72 hours of treatment, respectively. While the total P was reduced from 0.72 mg/ L to 0.14 mg/ L and 0.13 mg/L after 48 and 72 hours of treatment (equivalent to 80% and

82% of P reduction). The amount of total N and P removed in 48 and 72 hour treatments were not significantly different, suggesting that waste water should be kept in vetiver field for 2 days before discharged into the nearby environment. Similarly COD was reduced by 27% and BOD by 33% after 2 days (Table1 and Fig.3).

Table 1: Analytical results of effluent of trial 1.

Treatments	Analyses							
	COD		BOD		Total N		Total P	
	mgO2/ L	*Reduce %*	*mg/L*	*Reduce %*	*mg/L*	*Reduce %*	*mg/L*	*Reduce %*
Control	**14.01**	-	**5.97**	**-**	**4.79**	**-**	**0.72**	-
Day 1	5.56	60	3.66	39	9.91	**106***	0.83	**15***
Day 2	10.16	27	4.01	33	0.57	**88**	0.14	**80**
Day 3	9.96	29	4.07	32	0.44	**91**	0.13	**82**

* Increase



3.2.2 Trial 2

The aim of this trial is to test the ability of Vetiver grass in absorbing nitrate and phosphate in wastewater. This trial was established with 3 replicates, each has 12.5 m long x 5 m wide. Plant density and field design were similar to those of the above experiment. As this trial was set up 2 months after the first trial, so Treatments started when plants were only 5

months old. Wastewater was pumped into each replicate then water samples were collected for analysis at 24 hour interval for 3 days.
Effluent before treatment contained 4.79 mg/L of total N and 0.72 mg/L of total P. After 24 hours of treatment, the amount of total N was reduced to 3.76 and after 48 and 72 hours to 1.80 and 1.87 respectively, equivalent to 22%, 62% and 61% of N reduction, respectively.

For P, after 24 hours of treatment, the amount of total P was reduced to 0.50 mg/L and after 48 and 72 hours to 0.23 and 0.20 respectively, equivalent to 32%, 68% and 72% of P reduction, respectively. Total P levels were not significantly different after 48 and 72 hours of treatment. Similarly COD was reduced by 20% and BOD by 55% after 3 days (Table 2 and Fig.3).

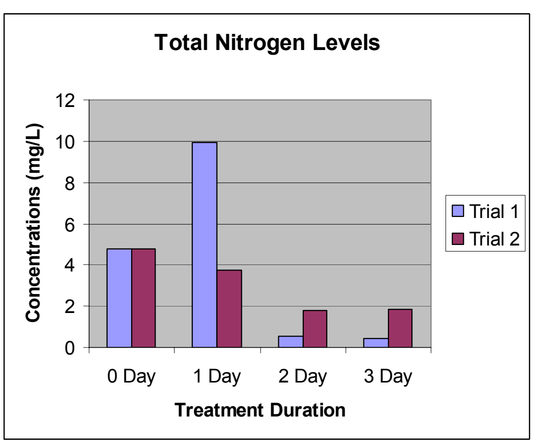
The lower removal rate of Vetiver in this trial may be due to the fact that plants in this trial was 2 months younger than that of vetiver in above experiment, as they have smaller root system to absorb N and P. The high levels of both N and P after 24 hours are most likely due to sampling errors

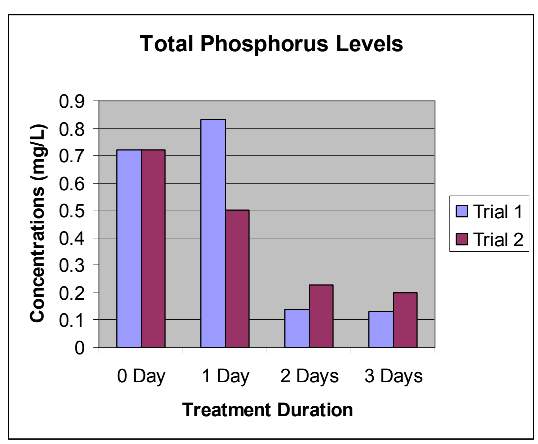
Table 2: Analytical results of effluent of trial 1.

Treatments	**Analyses**							
	COD		**BOD**		**Total N**		**Total P**	
	mgO2/L	*Reduce %*	*mg/L*	*Reduce %*	*mg/L*	*Reduce %*	*mg/L*	*Reduce %*
Control	**14.01**	-	**5.97**	**-**	**4.79**	**-**	**0.72**	-
Day 1	**10.29**	**27**	**3.68**	**38**	**3.76**	**22**	**0.50**	**31**
Day 2	**13.07**	**7**	**3.23**	**46**	**1.80**	**62**	**0.23**	**68**
Day 3	**11.22**	**20**	**2.71**	**55**	**1.87**	**61**	**0.20**	**72**

The two experimental areas were irrigated with the whole factory effluent output of about 50 000 litters daily.

Fig.3: Effluent N and P levels following vetiver treatment





4.0 CONCLUSION AND RECOMMENDATIONS

The preliminary results confirm the findings of works cited in the literature that the Vetiver System is a very effective method of phytoremediation. These results also indicate that this seafood processing factory should retain the 50 000L effluent output for 48 hours in the vetiver field before discharging into the nearby creek. However, before Vetiver technology can be actually applied in this factory, intensive monitoring should be repeated several times in order to firmly establish the effectiveness of vetiver grass in absorbing N and P in wastewater. In addition an intensive operational plan in term of harvesting frequency and maintenance schedule has to be developed for the company.

Five weeks after planting

Five months after planting

Effluent pond and vetiver in the back ground and ready for treatment

5.0 ACKNOWLEDGEMENTS

This project is supported financially by the Wallace Genetic Foundation, the Australia Vietnam Foundation and The Vetiver Network. In kind contributions were received from the University of Cantho and Cafatex. We thank you all for your support.

6.0 REFERENCES

Anon. 1997. A consideration and preliminary test of using vetiver for water ultrophication control in Taihu Lake in China. Proc. Environmental group, Institute of Soil Science, Academia Sinica, Nanjing. Proc. International Vetiver Workshop, Fuzhou, China October 1997.

Ash R. and Truong, P. (2003). The Use of Vetiver Grass Wetland for Sewerage Treatment in Australia. Third International Vetiver Conference, Guangzhou, China, October 2003

Cull R.H, Hunter H, Hunter M and Truong P. 2 000. Application of Vetiver Grass Technology in off-site pollution control. II. Tolerance of vetiver grass towards high levels of herbicides under wetland conditions. Proc. Second Intern. Vetiver Conf. Thailand.

Hart B, Cody R and Truong P. 2003. Efficacy of Vetiver Grass in the Hydroponic Treatment of Post Septic Tank Effluent. Third International Conference on Vetiver, Guangzhou, China.

Mongkon T., Patcharee T., Santibhab P. and Suttipong P. (2003). Vetiver Grass Research: Primary Management of Wastewater from Community Proc. Third International Conference

Percy I, and Truong, P. 2003. Landfill Leachate Disposal with Irrigated Vetiver Grass. Proc. Third International Conference on Vetiver, Guangzhou, China.

Smeal C, Hackett M and Truong P. 2003. Vetiver System for Industrial Wastewater Treatment in Queensland, Australia. Third International Conference on Vetiver, Guangzhou, China.

Truong P. (2003). Clean Water Shortage, an Imminent Global Crisis. How Vetiver System can Reduce its Impact. Third International Conference on Vetiver, Guangzhou, China.

Truong P, and Baker D. 1998. Vetiver Grass System for Environmental Protection. Technical Bulletin N0. 1998/1. Pacific Rim Vetiver Network. Office of the Royal Development Projects Board, Bangkok, Thailand.

Truong P, and Hart B, 2001. Vetiver System for Wastewater Treatment. Technical Bulletin no. 2001/21. Pacific Rim Vetiver Network. Office of the Royal Development Projects Board, Bangkok, Thailand.

Zheng C, Tu C, and Chen H. 1997. Preliminary study on purification of eutrophic water with vetiver. Proc. International Vetiver Workshop, Fuzhou, China October.