VETIVERIM

A Quarterly Newsletter of the Pacific Rim Vetiver Network

Number 75 **ISSN 0859 – 8878** **January 2016**

Editor: Narong Chomchalow
Asst.Editor: Samran Sombatpanit
Advisors: Sumet Tantivejkul
Manoon Mookpradit
Jirapan Davivongs
John Greenfield

Country Representatives:

Australia	Paul N.V. Truong
Brunei	Nur Judy Abdullah
Cambodia	Hong Tuon Van
China	Liyu Xu
Cook Islands	William Wigmore
Fiji	Jai Gawander
Guam	Mohammad Golabi
Indonesia	David Booth
Japan	Tsutomu Fujihara
Lao PDR	Boonkong Sengthavon
Malaysia	P.K. Yoon
New Caledoni	Georges Donskoff
New Zealand	Don Miller
Papua New Guinea	Rob Shelton
Philippines	Edwin A. Balbarino
Samoa	Walter Vermullen
Taiwan	Yue-Wen Wang
Thailand	Weerachai Nanakorn
Tonga	Siosiua Halavatau
Vanuatu	Henry Kathecau
Vietnam	Tran Tan Van

Publisher:
Office of the Royal Development Projects Board (ORDPB)
2012 Arun Amarin 36
Bang Yi Khan, Bang Phlat
Bangkok 10700, Thailand
Tel.: (66-2) 447 8500
Fax: (66-2) 447 8543
E-mails: vetiver@rdpb.go.th; Foreign_rdpb@yahoo.com
Homepage: http://prvn.rdpb.go.th
Editor's E-mail: narongchc@au.edu

Editorial

Using Vetiver Seed for Multiplication

From the early days of vetiver planting for soil and water conservation around 1979, asexual propagation has been used. Vetiver multiplication employs various vegetative parts, namely: tiller, slip, culm, clump and cutting. It was considered that such parts are safe to be used as planting materials since they do not create a problem of turning into weeds as they normally do not produce viable seeds. In addition, such parts are normally produced abundantly by the selected clones of vetiver. So far - so good!

Recently, however, it has been considered that asexual propagation is a tedious job requiring a lot of labor – from digging vetiver planting material from the soil and transporting them to the nursery, soil preparation, packing the soil in the polybags, etc. It also requires a large amount of budget for such operation - and to bring the polybags to the planting site, which may be a long way in the rugged terrain.

The idea of sexual propagation of vetiver through the use of seeds has recently been thought of as it is far easier and spend much less expense. In addition, it has been observed that vetiver plant grown from seeds do not normally produce viable seeds, or even if the seeds germinate, the resulting plants do not grow well as compared to the ones from asexual propagation. Also in normal practice, it has been recommended that cutting down the clump of vetiver plants every 3 or 4 months should be done to rejuvenate the clumps – thus, there is no way that seeds will be reproduced. In its natural habitat, vetiver reproduces through both sexual and asexual means, and this does not create any problem of their becoming weeds. This is because of their strict habitat requirement.

In addition to the above reasoning, the other advantage of growing vetiver from seeds has been considered, i.e. such a practice facilitates the chance of breeding to obtain better clones for planting, especially in hazard habitats or in new environments. It is also much easier to carry seeds as compared to asexual parts to the planting sites, especially if a nursery can be established at the site to grow vetiver from seeds and to take care of the seedlings until the time of planting in the field.

An Urban Wastewater Solution Using African Vetiver Grass in Ghana

The world is witnessing a water quality crisis, mainly brought about by rapid population growth, industrialization, food production practices and poor water-use strategies. As population increases, so does wastewater output. In developing countries, about 90 per cent of all wastewater is discharged untreated directly into rivers, lakes and oceans.

The impact of wastewater on the environment and human health is not only striking but frightening. A report by the United Nations Environment Programme (UNEP) and UN-HABITAT in partnership with members of UN Water indicates that two million tons of sewage, industrial and agricultural waste are discharged into the world's waterways and at least 1.8 million children under five die as a result every year. That is, one child lost every 20 seconds due to water related diseases.

Inadequate infrastructure and lack of financial resources are largely to blame for the wastewater menaces that plague most developing countries, especially their cities. In these countries, septic tanks receive the faecal waste of most urban dwellers, while other household liquid wastes are directed into the nearest drains.

Because drainage system costs are frequently prohibitively high, the majority of urban drains are open, lending themselves to misuse and sometimes serving as defecation points for households without adequate sanitation facilities. Industrial wastewater - from breweries and other sources such as the textile, mining, chemical and pharmaceutical industries - is usually discharged into these open drains or into water bodies without any pre-treatment, posing health hazards.

The quest for a cost effective technology

Managing wastewater in an efficient and sustainable way calls for a multifaceted approach. Various measures including behavioural change approaches towards combatting water pollution and the use of appropriate infrastructure and technologies will help reduce the impact of wastewater on the environment and on humankind.

The quest for an immediate approach to wastewater treatment in developing countries has spurred research within the scientific community. Among that research is a project being carried out by the United Nations University Institute for Natural Resources in Africa (UNU-INRA) in partnership with Ebonyi State University in Nigeria.

The project is assessing the potential of an African vetiver grass species, *Chrysopogon nigritana*, in treating industrial effluents and wastewater from domestic origins, which have been major sources of contamination. In Africa wastewater is increasingly becoming important resource for various uses including irrigation in urban and peri-urban agriculture. This wastewater is often high in toxic heavy metals including arsenic, cadmium and manganese as well as components of nutrient pollution such as phosphates and nitrates.

The general findings of this vetiver project reveal that the African vetiver can reduce these contaminants in industrial effluents and domestic wastewater. For example, in one case, samples were taken of leachate from a dumpsite and treated with *C. nigritana* for seven days. Laboratory analysis of the chemical properties of the treated leachate indicated that phosphate, which was at a pre-treatment level of 92.9, was reduced to 19.71 mg l^{-1}, while chemical oxygen demand (COD) dropped from 151.78 to 50.57 mg l-1. These levels are far below the United States Environmental Protection Agency's (USEPA) permissible limits of 50 and 75 mg l^{-1} for these respective chemical properties in water.

Similarly, laboratory results showed that arsenic and cadmium contents, which were both initially at pre-treatment levels of 0.2mg l^{-1}, were completely removed from sample effluents taken from a fertilizer company after a six-day vetiver grass treatment contaminates after treating the

effluents with the vetiver grass is very satisfactory because the World Health Organisation / Food and Agriculture Organisation's (WHO/FAO) acceptable levels for arsenic and cadmium in water are 0.10 mg $l^{-1}$and 0.005 mg l^{-1} respectively.

Additionally, analysis of a sample slaughter house wastewater treated for seven days by the vetiver showed about 88 percent reduction in manganese (from 1.03 mg l^{-1} to 0.12 mg l^{-1}) -- a reduction well below the WHO/FAO's safety standard of 0.20 mg l^{-1} for manganese in water.

Dr. Effiom Oku, Senior Research Fellow for Land and Water Resources at UNU-INRA and the research project's manager explains that, the results are significant and offer many developing countries, including those in Africa, a unique window of opportunity for reducing the impact of wastewater on human health. Dr. Oku noted that heavy metals such as arsenic can cause cancer of the skin, lungs, liver and bladder - and exposure to high levels of metals like cadmium can severely damage these organs and may ultimately cause death. "Irrigation of edible crops with untreated wastewater can result in the transmission of various infections including intestinal nematode and bacterial infections for both the consumer and the farmer as a result of the heavy metals in the wastewater, and the ability of the African vetiver species in treating these domestic and industrial contaminated liquids will help reduce the health implications of consuming these crops among consumers," stated Dr Oku. He added that the use of untreated waste-water for crop irrigation affects not only human health but that cattle grazing on pastures irrigated this way can become heavily infested with the larval stage of the tapeworm *(Taenia saginata)*.

Applying Vetiver Technology

In explaining how the cost-effective vetiver technology works, Dr. Oku reiterated that the vetiver grass is cost-effective and highlighted simple ways to treat wastewater with the grass:

- After growing in soil for about 12 weeks, the mature vetiver grass can be dug up and separated into individual plants.
- The roots are then trimmed and the shoots are pruned to about 15-20 cm.
- The grass is then transferred to a "floater"-- a planting device that will allow the grass to float on the surface of water. The water has to be supplemented with nutrients such as fertiliser, cow dung or poultry waste (hydroponic agriculture).
- The plants are allowed to grow in their floaters for another 8-12 weeks before being transferred with their floaters to the wastewater in need of treatment.
- The plants are then left in the wastewater to grow and the roots and leaves are periodically pruned.

Dr Oku explained that once the vetiver plants are put in the wastewater, the grass will start removing the contaminants in the water through the roots to the leaves, hence the need to prune the roots and the leaves regularly. He added that, "this is a green technology that leaves behind no carbon footprint since it does not use conventional energy such as oil, gas or coal".

Dr Elias T. Ayuk, the Director of UNU-INRA, also speaking on the relevance of the research, acknowledged that future demand for water cannot be met unless wastewater management is revolutionized. He added that in its role as a natural resources management think tank of the United Nations and its member states in Africa, UNU-INRA conducts studies such as this one to help inform policy formulation and implementation. Dr Ayuk said findings from these studies will help direct efforts towards the judicious use of natural resources for development.

Indeed, the development of many countries will depend on investment in sanitation and water treatment. As revealed in the UNEP report, every dollar invested in safe water and sanitation has a payback ranging from US$3 to US$34 depending on the region and the technology deployed. It has therefore become imperative to meet wastewater management challenges with cheaper technologies like the vetiver grass option to ensure a healthy environment and sustainable development.

Request for Training on Vetiver Handicraft

Dear Narong,

I am an engineer work for the Government of Sri Lanka and an engage in an urban development project. Mrs. Sureka is a social development officer. As a part of our project we are going to use a large number of vetiver plants to purify a polluted Beira Lake in Colombo. At the same time some families were resettled and they are very poor. There are women in need of employment. So we have plans to train them to use vetiver leaves for income generation as social safeguards. Here in Sri Lanka there are handicrafts made from reed, but not vetiver. We have learned about many uses of the vetiver plants through The Vetiver Network International (TVNI) website. Dale Rachmeler from TVNI advised me to contact you to get the best training opportunity. We will be very thankful to you, if you can advise us and help arrange a vetiver handicraft training program in Colombo, Sri Lanka. We understand that you have trained people in this topic, and you are well experienced in this training programme. Many thanks.

Chandanie
Eng. Mrs. Chandanie Jayatilake, Senior Engineer/ PMU
Metro Colombo Urban Development Project
Ministry of Megapolise and Western Development, New Building, Sethsiripaya,
Battaramulla, Sri Lanka

Dear Mrs. Jayatilake,

I have forwarded your request to the Office of the Royal Development Projects Board (ORDPB) that coordinates the activities on vetiver in Thailand. I am sure they will provide a positive reply to your request. Although ORDPB does not have facilities to conduct such a training by itself, it can ask other agencies which have such facilities. There is one that I know of, which has offered such a training course, both in Thailand and abroad – it is the PTT Public Company.

Narong Chomchalow, Editor, Vetiverim

Abstracts of Vetiver Research Papers

Title: "Comparative Growth and Distribution of Zn, Cd and Pb in Rice, Vetiver and Sunflower Grown in Contaminated Soils"
Author: Nualchawee Roongthanakiat, Kasetsart University, Bangkok, Thailand
Published in: Kasetsart Journal (Natural Science) 49: 1-13 (2015)
Abstract:

The effect of soil heavy metal (Zn, Cd and Pb) concentration on the growth and concentration in the plant parts of rice, vetiver and sunflower was comparatively investigated in pot experiments. Each plant species was grown soils contaminated with four levels of heavy metals, based on a completely randomized design with three replications. Vetiver plants were harvested at 120 days after planting. Rice and sunflower plants were harvested at the yield stage. The results indicated that heavy metal in the soil showed an adverse effect on plant growth performances especially in rice. On moderately and highly contaminated soils, rice could not produce seed, while leaf chlorosis was observed at the tillering stage. In general, the concentration of Zn, Cd and Pb in plant parts increased as the contamination levels in the soil increased and they accumulated more in the roots than in above-ground parts. However, the Cd concentration in sunflower seed was above the maximum level tolerated by livestock. The ability of plants to translocate heavy metal from the

roots to the shoots as indicated by their transfer factor (TF) was in the order of: rice<vetiver<sunflower. Vetiver and Sunflower could move Zn more than Cd and Pb. However, only sunflower had the Zn TF values greater than 1 for all levels of contamination soil. Therefore, sunflower was a promising plant for Zn decontamination.

Title: "Phytoremediation Potential of Vetiver System Technology for Improving the Quality of Palm Oil Mill Effluent"

Authors: Negisa Darajeh [1/], Azni Idris [1/], Paul Truong [2/], Astimar Abdul Aziz [3/], Rosenani Abu Bakar [4/], and Hasfalina Che Man [5/] [[1/] Department of Chemical and Environmental Engineering, Faculty of Engineering, Universiti Putra Malaysia, Serdang, Selangor, Malaysia; [2/] The Vetiver Network International, Asia and Oceania, Brisbane, Australia; [3/] Malaysian Palm Oil Board, Agro Product Unit, Engineering and Processing Division, Selangor, Malaysia; [4/] Department of Land Management, Faculty of Agriculture, Universiti Putra Malaysia, Serdang, Selangor, Malaysia; [5/] Department of Biological and Agricultural Engineering, Faculty of Engineering, Universiti Putra Malaysia, Serdang, Selangor, Malaysia]

Publishes in: This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. 2014.

Abstract:

Palm oil mill effluent (POME), a pollutant produced by the palm oil industry, was treated by the Vetiver System Technology (VST). This technology was applied for the first time to treat POME in order to decrease biochemical oxygen demand (BOD) and chemical oxygen demand (COD). In this study, two different concentrations of POME (low and high) were treated with vetiver plants for two weeks. The results showed that vetiver was able to reduce the BOD up to 90% in low concentration POME and 60% in high concentration POME, while control sets (without plant) only was able to reduce 15% of BOD. The COD reduction was 94% in low concentration POME and 39% in high concentration POME, while control just shows reduction of 12%. Morphologically, maximum root and shoot lengths were 70 cm, the number of tillers and leaves was 344 and 86, and biomass production was 4.1 kgm^{-2}. These results showed that VST was effective in reducing BOD and COD in POME. The treatment in low concentration was superior to the high concentration. Furthermore, biomass of plant can be considered as a promising raw material for biofuel production while high amount of biomass was generated in low concentration of POME.

A Dialogue on Vetiver and Termites

Several dialogues have been made recently that vetiver can protect termites. It will be wonderful if it is true. A dialogue below between Mark Meaker <meaker@gmail.com> and Prof. Gregg Henderson <GRHenderson@agcenter.lsu.edu>, introduced by Jason Fox <bigislandsoil @gmail.com> of Vetiver Farms Hawaii LLC Papaikou, HI 96781 (808) 756-8725 provides the answer.

Hi Jason,

Heard you say on the Sustainable World Radio podcast that vetiver can protect against termites. Unfortunately this is not true. I was hoping it was true, based on some things I'd seen on the internet, but after contacting the guy who published the initial hopeful studies, I was disappointed. See correspondence below. Thought you need to know.

Mark Meaker

<meaker@gmail.com>
Queensland, Australia
January 24, 2014

Prof. Henderson,

Writing to you from Australia, I'm considering whether to surround my home with a 2-deep layer of vetiver grass to protect from subterranean termites as an alternative to very expensive chemical treatments that need reapplication every eight years.
Your studies are encouraging, but there is a 2012 study by Lee and Mallette that seems to prove termites will go through vetiver without a problem. There seems to be a few methodological problems with that study (vetiver plants only had 9.5" roots and were perhaps not allowed time to properly establish before termites were introduced, etc), but it was discouraging nonetheless.

I'd really appreciate your comment on that study. Do you agree it was flawed? Has it discouraged you as well?

Mark Meaker
<meaker@gmail.com>
Queensland, Australia
January 19, 2014>

Mark,

We also found that termites can bypass the grass and get to food even when the roots surround the wood. It appears that only when the roots are damaged will they release the repellents/toxicants. Vetiver grass is good if you need a planting for erosion control or toxicant pick-up and you don't want to feed termites. It will not replace a chemical protective border.

Gregg Henderson
<GRHenderson@agcenter.lsu.edu>
January 22, 2014

Gregg,

Thanks, Gregg. I still can't help wondering what the outcome would have been if the experimental wood bait had been surrounded by densely planted, mature vetiver grass clumps, several rows deep. The root masses reach meters deep and are incredibly dense once mature. It's hard to imagine termites going through that without having to chew the roots!

Mark Meaker
<meaker@gmail.com>
January 22, 2014

Mark,

We planted vetiver in trash cans and hammered wooden stakes into the soil filled cans. We did not have a good control but offered large population of termites the ability to move into the trash cans via another trash can. We found that the vetiver root completely filled the cans in 6 mo and that the stakes were attacked. The termites moved around the roots and got to the food. My research on the idea of protection of a home with vetiver planted as a barrier ended at that point.

Gregg Henderson
<GRHenderson@agcenter.lsu.edu>
24 January 2014

Using Vetiver to Remediate Water and Soil Contaminated with Phenol and Other Hazardous Substances from Illegal Dumping*

Communities at Nong Nae Sub-district, Phanom Sarakham District, Chachoengsao Province, Thailand has been suffered from illegal dumping of industrial wastewater containing high concentration of phenol (C_6H_6O) (as high as 500 mg/L) as well as other hazardous organic substances such as petroleum hydrocarbons (TPHs), formaldehyde and metals such as arsenic, chromium, copper, lead and nickel for more than two years. The most widely spreading contaminant is phenol according to its hydrophilic nature. Phenol is a toxic substance causing irritation and kidney inflammation. Phenol migrates from the dumping points causing contamination of shallow-well groundwater and Tat Noi Creek, the main creek of the villagers. All villagers there utilize shallow-well groundwater as their sole drinking water source. Various government agencies monitored the contamination and reported that phenol concentration in shallow-well groundwater exceeds the maximum contamination level (1 μg/L) more than 250 times in household downstream the direction of shallow groundwater and Tat Noi Creek. In order to protect community's health at Nong Nae, decreasing phenol exposure to the villagers is mandatory.

This ongoing research supported by the Office of the Royal Development Projects Board aims at using vetiver system (VS) to protect the Nong Nae community by degrading phenol and other contaminants both in the accessible, remaining illegal dumping source zone and those migrating through surface water (Tat Noi Creek) and shallow groundwater. Our research strategies include: (1) using floating vetiver to treat illegally dumped industrial wastewater at the source, (2) using the root barrier of vetiver fence along Tat Noi Creek to degrade phenol and adsorb TPHs and metals in order to decrease the exposure of the villagers to hazardous substances migrating to shallow groundwater via Tat Noi Creek, and (3) using a barrier of vetiver fence with engineered, extended root zone to intercept plume of phenol and other contaminants in shallow groundwater migrating from an inaccessible illegal dumping source. As a result, this research initiative involves laboratory experiments, field-scaled implementations and strong community involvement.

We examined capability of vetiver to degrade phenol in laboratory scale and found that vetiver can degrade phenol by phyto-fenton reaction followed by rhizomicrobial degradation. Phenol at the concentration of 500 mg/L was used in the experiments. The first 400 to 600 hours of phenol degradation was dominated by phyto-fenton, a newly discovered, self-sustained chemical reaction. Fenton reaction is advanced oxidation reaction by Fe^{2+} and hydrogen peroxide (H_2O_2) to create short-live hydroxyl radical (•OH) which can rapidly degrade hazardous organic contaminants such as phenol and TPHs. Typically, fenton reaction is implemented using engineering design with the addition of Fe^{2+} and H_2O_2. In the case of phyto-fenton reaction discovered in this study, iron (Fe) is available in the illegally dumped wastewater. Due to high organic contaminant loading, Fe is in the reduced form as Fe^{2+}. Then, vetiver releases hydrogen peroxide (H_2O_2) from the root to interact with Fe^{2+} yielding •OH and Fe^{3+} to degrade phenol to CO_2. Fe^{3+} is reduced by TPHs and other contaminants in the contaminated water to yield Fe^{2+} which can undergo a new round of powerful phyto-fenton reaction to degrade phenol until the contaminated water is completely detoxified. Nevertheless,

---

* By T. Phenrat [1/], P. Teeratitayangkul [1/], T. Imthiang [1/], Y. Sawasdee [2/] and J. Naowaopas [2/]
[1/] Faculty of Engineering, Naresuan University, Phitsanulok, Thailand; [2/] Community Researcher, Nong Nae Sub-district, Phanom Sarakham District, Chachoengsao Province, Thailand.
Corresponding E-mail: pomphenrat@gmail.com.

after around 400 to 600 hours, phenol decreases from 500 mg/L (toxic to microbes) to around 100 mg/L; rhizomicrobe grew on the root of vetiver and participated in microbial degradation of phenol at this lower concentration, increasing phenol degradation rate for more than four times. This combination of phyto-fenton and rhizomicrobial degradation completely eliminated 500 mg/L of phenol in wastewater in less than 800 hours.

These days, we are in the process of the field implementation of vetiver systems with strong community involvement. We informed our research results to Nong Nae communities to see the benefit of the vetiver systems for protecting their health. On 28-29 August 2014, we implemented the first vetiver system, the vetiver fence along Tat Noi Creek. More than one hundred volunteers including Nong Nae villagers, government agencies, and news reporters and actors and actress from Channel 3 Thailand were together to cultivate 0.12 million vetiver grass (bare root) to create 1.2-km vetiver fence along the Tat Noi Creek, the major way of transporting residual phenol to shallow wells of the villagers. Similarly, on 5 Devember 2015, we implemented field-scaled treatment of illegally dumped wastewater in a large pound using floating vetiver on bamboo rafts. We are on the process of monitoring its efficacy. In March or April, 2015, we plan to implement the last prototype of vetiver system, a barrier of vetiver fence with engineered, extended root zone to intercept plume in shallow groundwater. To the authors' knowledge, this is the first time that vetiver systems are used for phenol degradation in field scale with strong community involvement, especially for community prevention from hazardous constitutes due to illegal dumping.

Office of the Royal Development Projects Board
2012 Arun Amarin 36, Bang Yi Khan, Bang Phlat
Bangkok 10700, Thailand

To

Vetiverim is an official quarterly newsletter of the Pacific Rim Vetiver Network. It is published by the Office of the Royal Development Projects Board, Bangkok, and distributed free of charge to individuals / institutes working on vetiver of the Network's member countries. Application for membership can be made by writing to the Secretariat, giving name, position, place of work, and mailing address.