การลดบีโอดีในน้ำชะมูลฝอยโดยใช้พื้นที่ชุ่มน้ำที่สร้างขึ้น
แบบไหลผ่านพื้นผิวด้วยหญ้าแฝกลุ่มและบอน

นายอัคินทร์ คูหาภินันทน์

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิศวกรรมศาสตรมหาบัณฑิต
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BOD REMOVAL IN LEACHATE BY FREE WATER SURFACE

FLOW CONSTRUCTED WETLAND WITH VETIVER AND COLOCASIA

Mr. Akharint Khuhapinant

A Thesis Submitted in Partial Fulfillment of the Requirements

For the Degree of Master of Engineering Program in Environmental Engineering

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Thesis Title	BOD REMOVAL IN LEACHATE BY FREE WATER SURFACE FLOW CONSTRUCTED WETLAND WITH VETIVER AND COLOCASIA
By	Mr. Akharint Khuhapinant
Field of Study	Environmental Engineering
Thesis Advisor	Associate Professor Thares Srisatit, Ph. D.

Accepted by the Engineering Faculty, Chulalongkorn University in Partial Fulfillment of the Requirements for the Master's Degree

............................Dean of Faculty of Engineering
(Professor Direk Lavansiri, Ph. D.)

THESIS COMMITEE

................................Chairman
(Associate Professor Sutha Khaodiar, Ph. D.)

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อาจารย์ที่ปรึกษา : รศ. ดร. ธเรศ ศรีสถิตย์. 251 หน้า.

การศึกษาประสิทธิภาพของพื้นที่ชุ่มน้ำที่สร้างขึ้นแบบไหลอิสระเหนือผิวดินในการบำบัดน้ำชะมูลฝอย มลสารในน้ำชะมูลฝอยที่ใช้ประเมินประสิทธิภาพได้แก่ บีโอดี Biochemical Oxygen Demand (BOD), ทีเคเอ็น Total Kjedahl Nitrogen (TKN), ซีโอดี Chemical Oxygen Demand (COD), ทีเอสเอส Total Suspended Solids (TSS) และ ทีดีเอส Total Dissolved Solids (TDS) โดยเปรียบเทียบระดับน้ำในพื้นที่ชุ่มน้ำที่สร้างขึ้น 3 ระดับคือ 0.2 , 0.4 และ 0.6 เมตร คิดเป็นอัตราการไหลของน้ำเท่ากับ 0.075 ,0.150 และ 0.225 ลูกบาศก์เมตรต่อวัน ทำการเปรียบเทียบประสิทธิภาพในการบำบัดของพืชสองชนิดคือ หญ้าแฝกลุ่ม *(Vetiveria zizanioides Nash)* และ บอน *(Colocasia esculenta)* และพื้นที่ชุ่มน้ำที่ไม่มีพืช นอกจากนี้ยังได้ทำการวัดการเจริญเติบโตของทั้งสองชนิดไปพร้อมๆกัน ระยะเวลาการศึกษา 100 วัน บันทึกผลทุก 10 วัน เป็นเวลา 11 ครั้ง

พื้นที่ชุ่มน้ำที่มีหญ้าแฝกสามารถลด BOD ได้ดีที่สุด คือที่ ระดับน้ำที่ 0.2 เมตร โดยสามารถลด BOD ได้เฉลี่ย 66.04 ± 19.02 เปอร์เซ็นต์ โดยส่วนที่รองลงมาก็คือพื้นที่ชุ่มน้ำที่มีหญ้าแฝกที่ 0.4 เมตร โดย สามารถลด BOD ได้เฉลี่ย 63.15 ± 14.37 เปอร์เซ็นต์ และเมื่อได้วิเคราะห์ด้วยโปรแกรม SPSS ปรากฏว่าพื้นที่ชุ่มน้ำที่มีหญ้าแฝกที่ 0.2 และ 0.4 เมตร สามารถลด BOD ได้ดีที่สุดที่แตกต่างอย่างมีนัยสำคัญ ส่วนที่มีบอนสามารถสามารถลด BOD ได้เฉลี่ย 58.96 ± 16.62 และ 58.42 ± 15.45 เปอร์เซ็นต์ ที่ระดับน้ำ 0.2 และ 0.4 เมตร

พื้นที่ชุ่มน้ำที่มีหญ้าแฝกสามารถลด COD ได้ดีที่สุด คือที่ ระดับน้ำที่ 0.2 เมตร โดยสามารถลด COD ได้เฉลี่ย 53.76 ± 30.07 เปอร์เซ็นต์ ส่วนที่รองลงมาก็คือพื้นที่ชุ่มน้ำที่มีหญ้าแฝกที่ 0.4 เมตร โดย สามารถลด COD ได้เฉลี่ย 53.45 ± 30.28 เปอร์เซ็นต์ แต่เมื่อได้วิเคราะห์ด้วยโปรแกรม SPSS ปรากฏว่าพื้นที่ชุ่มน้ำที่มีหญ้าแฝกที่ 0.2 และ 0.4 เมตร สามารถลด COD ได้ดีที่สุดที่แตกต่างอย่างมีนัยสำคัญ ส่วนที่มีบอนสามารถสามารถลด COD ได้เฉลี่ย 42.18±34.02 และ 39.02±32.55 เปอร์เซ็นต์ ที่ระดับน้ำ 0.2 และ 0.4 เมตร

พื้นที่ชุ่มน้ำที่มีหญ้าแฝกสามารถลด TKN ได้ดีที่สุด คือที่ ระดับน้ำที่ 0.2 เมตร สามารถลด TKN ได้เฉลี่ย 79.37±11.46 เปอร์เซ็นต์ TKN และตรงตามผลที่ได้นี้เมื่อวิเคราะห์ด้วยโปรแกรม SPSS เมื่อปรากฏว่ามีความแตกต่างอย่างมีนัยสำคัญที่ 0.2 และ 0.4 เมตร ส่วนที่รองลงมาก็คือพื้นที่ชุ่มน้ำที่มีหญ้าแฝกที่ 0.4 เมตร โดย สามารถลด TKN ได้เฉลี่ย 77.95 ±13.43 เปอร์เซ็นต์ ส่วนที่มีบอนสามารถสามารถลด TKN ได้เฉลี่ย 77.85±15.69 และ 77.73±14.34 เปอร์เซ็นต์ ที่ระดับน้ำ 0.2 และ 0.4 เมตร

พื้นที่ชุ่มน้ำที่มีหญ้าแฝกสามารถลด TSS ได้ดีที่สุด คือที่ ระดับน้ำที่ 0.6 เมตร สามารถลด TSS ได้เฉลี่ย 76.14±28.00 เปอร์เซ็นต์ TSS และผลที่ได้นี้เมื่อวิเคราะห์ด้วยโปรแกรม SPSS ปรากฏว่าตรงตามค่าเฉลี่ย โดยสามารถลด TSS ได้ดีสุด ส่วนที่รองลงมาก็คือพื้นที่ชุ่มน้ำที่มีหญ้าแฝกที่ 0.2 เมตร โดย สามารถลด TSS ได้เฉลี่ย 64.39 ± 38.86เปอร์เซ็นต์ ส่วนที่มีบอนสามารถสามารถลด TSS ได้เฉลี่ย 56.85±41.53 และ 38.42±58.27 เปอร์เซ็นต์ ที่ระดับน้ำ 0.6 และ 0.4 เมตร ส่วนที่ไม่มีพืชสามารถสามารถลด TSS ได้ต่ำสุดที่ -70.08±15.69 เปอร์เซ็นต์ ที่ระดับน้ำ 0.6 เมตร เหตุผลมาจากระยะกักเก็บน้ำและการเกิดสาหร่ายในบ่อ

พื้นที่ชุ่มน้ำที่มีหญ้าแฝกสามารถลด TDS ได้ดีที่สุด คือที่ ระดับน้ำที่ 0.2 เมตร สามารถลด TDS ได้เฉลี่ย 55.71±34.33 เปอร์เซ็นต์ TDS และผลที่ได้นี้เมื่อวิเคราะห์ด้วยโปรแกรม SPSS ปรากฏว่าตรงตามค่าเฉลี่ย พื้นที่ชุ่มน้ำที่มีบอนที่ 0.4 เมตรกลับลดได้ดีที่สุด ส่วนที่รองลงมาก็คือพื้นที่ชุ่มน้ำที่มีหญ้าแฝกที่ 0.4 เมตร โดย สามารถลด TDS ได้เฉลี่ย 49.76 ±26.28 เปอร์เซ็นต์ ส่วนที่มีบอนสามารถสามารถลด TDS ได้เฉลี่ย 35.88±50.72 และ 39.17±30.51 เปอร์เซ็นต์ ที่ระดับน้ำ 0.2 และ 0.4 เมตร ส่วนที่ไม่มีพืชสามารถสามารถลด TSS ได้ต่ำสุดที่ 9.83±46.78 เปอร์เซ็นต์ ที่ระดับน้ำ 0.6 เมตร

จุดประสงค์หลักในการทดลองนี้คือ การลด BOD ซึ่งปรากฏว่าหญ้าแฝกลุ่มและบอนได้ทำหน้าที่ลดมลสาร BOD และมลสารอื่นได้ดีในช่วงน้ำลึกไม่เกิน 0.4 เมตร ดังนั้นหากความลึกเกิน 0.4 เมตร ประสิทธิภาพจะลดลง รวมทั้งการอยู่รอดของพืชทั้งสองชนิด หญ้าแฝกลุ่มลดทุกค่าได้ดีที่สุดแต่แตกต่างตามความลึกที่ต้องการจะใช้ตามจุดประสงค์

ภาควิชา......วิศวกรรมสิ่งแวดล้อม.............. ลายมือชื่อนิสิต..............................

สาขาวิชา......วิศวกรรมสิ่งแวดล้อม.............. ลายมือชื่ออาจารย์ที่ปรึกษา..............................

ปีการศึกษา.........2549..

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KEY WORD: CONSTRUCTED WETLAND/BOD/TKN/COD/FREE WATER SURFACE/ LEACHATE

AKHARINT KHUHAPINANT: BOD REMOVAL IN LEACHATE BY FREE SURFACE FLOW CONSTRUCTED WETLAND WITH VETIVER AND COLOCASIA. THESIS ADVISOR: ASSOC. PROF. THARES SRISATIT, Ph.D., 251 pp.

The study was conducted to determine the efficiency of Free Water Surface (FWS) constructed wetlands in removal of Biochemical Oxygen Demand (BOD), Total Kjedahl Nitrogen (TKN), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), and Total Dissolved Solids (TDS) of leachate from a sanitary landfill. Three water levels were 0.2, 0.4, and 0.6 meters, which yielded flow rates of 0.075, 0.150, and 0.225 cubicmeters per day respectively. Also, the efficiency in removal was compared among two plants (*Vetiveria zizanioides Nash* and *Colocasia esculenta*) and no plant in the system. The growth of the two plants was studied. The studied period was 100 days with 11 sample collection every 10 days from the beginning to the end of the experiment.

The constructed wetland with *Vetiveria zizanioides Nash* at the 0.2 meter water level was the most efficient model in BOD removal. The average efficiency was 66.04 ± 19.02 percent. This result is true to the SPSS analysis of the efficiency of significant difference statistically. The second most efficient model was the wetland with *Vetiveria zizanioides Nash* at 0.4 meter water level. The average efficiency was 63.15 ± 14.37 percent. However, the wetlands with *Colocasia esculenta* do not give the contemptible efficiency in BOD removal. At the water level of 0.2 meter and 0.4 meter, *Colocasia esculenta* gave the BOD removal for 58.96 ± 16.62 percent and 58.42 ± 15.45 percent. The shallower depth, the greater removal quality.

The constructed wetland with *Vetiveria zizanioides Nash* at the 0.2 meter water level was the most efficient model in COD removal too. The average efficiency was 53.76 ± 30.07 percent. The second most efficient model was the wetland with *Vetiveria zizanioides Nash* at 0.4 meter water level. The average efficiency was 53.45 ± 30.28 percent. But by SPSS analysis, the best in COD removal is the constructed wetland with *Vetiveria zizanioides Nash* at 0.2 and 0.4 meter water level of significant difference statistically. However, the wetlands with *Colocasia esculenta* do not give the contemptible efficiency in COD removal. At the water level of 0.2 meter and 0.4 meter, *Colocasia esculenta* give the COD removal for 42.18±34.02 percent and 39.02±32.55 percent. The shallower depth, the greater quality of removal again.

The constructed wetland with *Vetiveria zizanioides Nash* at the 0.2 meter water level was the most efficient model in TKN removal. The average efficiency was 79.37±11.46 percent. By the SPSS analysis of the TKN removal efficiency, the constructed wetland with *Vetiveria zizanioides Nash* at the 0.2 meter water level was the most efficient model in TKN removal of significant difference statistically. The second most efficient model was the wetland with *Vetiveria zizanioides Nash* at 0.4 meter water level. The average efficiency was 77.95 ±13.43 percent. However, the wetlands with *Colocasia esculenta* do not give the contemptible efficiency in TKN removal. At the water level of 0.2 meter and 0.4 meter, *Colocasia esculenta* gave the TKN removal for 77.85±15.69 percent and 77.73±14.34 percent.

The most average efficiency of TSS removal is 76.14 ± 28.00 percent at 0.6 m with *Vetiveria zizanioides Nash*. The second most efficient model was the wetland with *Vetiveria zizanioides Nash* at 0.2 meter water level. The average efficiency was 64.39 ± 38.86 percent. And by the SPSS analysis by One-way ANOVA, the greatest efficient constructed wetland was *Vetiveria zizanioides* at 0.6 meter depth in TSS removal with significant difference statistically. However, the wetlands with *Colocasia esculenta* do not give the contemptible efficiency in TSS removal. At the water level of 0.6 meter and 0.4 meter, *Colocasia esculenta* give the TSS removal for 56.85 ± 41.53 percent and 38.42 ± 58.27 percent. And the lowest average TSS removal is -70.08 ± 201.52 percent at 0.6 m without plants due to the hydraulic loading rate reason and algae bloom in the pond.

Generally, TDS decreases in the same direction as TSS. So the most average efficiency of TDS removal is 55.71 ± 34.33 percent at 0.2 m with *Vetiveria zizanioides Nash*. The second most efficient model was the wetland with *Vetiveria zizanioides Nash* at 0.4 meter water level. The average efficiency was 49.76 ± 26.28 percent. But by the SPSS analysis by One-way ANOVA, the most efficient constructed wetland with *Vetiveria zizanioides* at 0.2 meter depth becomes the best in TDS removal with significant difference statistically. However, the wetlands with *Colocasia esculenta* do not have the contemptible efficiency in TDS removal. At the water level of 0.2 meter and 0.4 meter, *Colocasia esculenta* give the TDS removal for 35.88 ± 50.72 percent and 39.17 ± 30.51 percent. And the lowest average TDS removal is 9.83 ± 46.78 percent at 0.6 m without plants.

Conclusively, the FWS constructed wetland worked well with both plants in BOD and other factors removal but the limitation is the water level in the units. If it is over 0.4 meter, the plants will decrease the removal efficiency and die more than the shallower ones. And the best between both plants is *Vetiveria zizanioides* when the results were analyzed by SPSS program. And the uses are up to the specific purposes.

Department ...Engineering.............
Field of study...Environmental Engineering
Academic year......2006...............

Student's signature...................
Advisor's signature...................

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CONTENTS

CONTENTS (CONT.)

CONTENTS (CONT.)

Page

CONTENTS (CONT.)

LIST OF TABLES

Page

LIST OF TABLES (CONT.)

Page

LIST OF FIGURES

Page

CHAPTER I

INTRODUCTION

Presently, sanitary landfill methods for handling garbage and rubbish are popular with general municipalities for efficiency and low cost reasons. It is especially favorable suitable for municipalities with plenty of available land. So leachate must be accumulated and treated before letting it go to the public watercourses in order to lessen the negative impact to the surrounding environment by the mixing of leachate to surface and subsurface water sources. Otherwise, leachate treatments must be improved to optimum levels and below the standard limit of Wastewater (BOD does not exceed 20 mg/L). The constructed wetland is one of the interesting methods of wastewater treatment from dumping sites, not only because of the low investment and low energy consumption levels but also because this method provides similar qualities of wastewater to other treatments.

1.1 Objectives

1) To study the efficiency of free water surface flow constructed wetland in leachate treatments in the removal of BOD
2) To study the growth of vetiver and colocasia in the constructed wetlands
3) To study the survival of the vetiver and colocasia in the constructed wetlands

1.2 Scopes of Analysis

This research is to study the process of the free water surface flow with *Vetiveria zizaniodies (Linn.) Nash* of Ceylon and *Colocasia esculenta (Linn.) Schott* in actual leachate treatments of the municipal sanitary landfill by comparison of the efficiencies of left substances removal. The flow rates are 0.075, 0.150, and 0.225 m^3/day at the depths of 0.20, 0.40, and 0.60 meters at 10 days for hydraulic retention time (HRT) in each successive session. The experimental site of study is at Saensuk Municipal Solid Waste

Disposal Center, Bangsaen, Chonburi province, Thailand. The studied parameters are BOD, COD, Temperature, pH, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), and Total Kjedahl Nitrogen (TKN).

The selected experiment was free water surface constructed wetland for leachate treatments. The leachate was accumulated from the dump before undergoing treatment at Saensuk Municipal Solid Waste Disposal Center (Figure 1.1)

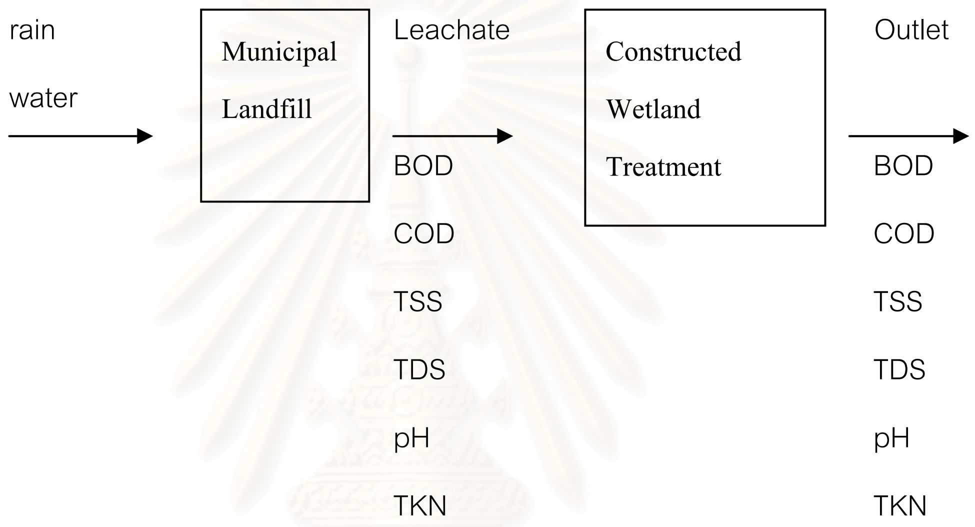


Figure 1.1 Process of Leachate Treatment

The experiment took 100 days. Samples were taken every 10 days at the inlet and the outlet of the constructed wetland and the growth of vetivers and colocasias was measured and recorded by the changes in height and mass. Vetivers were taken from Land Development Department at Kampangsan and Ratchaburi. But colocasias were taken from Saraburi site.

1.3 Beneficial Results

1.3.1 To know the efficiencies of vetiver and colocasia in BOD removal of leachate from landfills by the constructed wetland treatment methods.

1.3.2 To take greater advantage of local water plants in handling the leachate in constructed wetlands

1.3.3 To take the data complied from this experiment and use it to direct the design of constructed wetlands, especially in gauging the depth of water for the most efficient BOD removal from leachate

1.3.4 To better understand and improve more technologies in the construction of wetlands to treat wastewater

CHAPTER II

LITERATURE REVIEW

2.1 Constructed Wetlands

Currently, researchers are very interested in constructed wetlands for wastewater treatment because these areas can treat wastewater quite well with low cost of construction. Even though the idea of constructed wetlands just came about for about 20-30 years ago. Society has actually used natural watercourses such as rivers, canals, bogs, swamps, etc in wastewater treatment in the past.

Constructed wetlands have been made to function like natural swamps in treating wastewater. However, the advantages of constructed vis-à-vis natural wetlands in wastewater treatment are in the control of factors such as location, site, waterways, and detention time. Substances will be removed in the constructed wetlands by a combination of physical, chemical, and biological processes such as sedimentation, crystallization, and adsorption, accumulation by plants and transformation by microorganisms.

The advantages of constructed wetlands to other general wastewater treatments are:

1) Low cost of construction except for the land cost
2) Low energy of operation
3) Low technology in operation for less educated observers
4) Greater flexibility for changes into higher system of treatments than other wastewater treatment method

But constructed wetlands have disadvantages as well:

1) Large space of construction in comparison to other wastewater treatments
2) High risk for less efficiency during winter season

3) Unsuitable for the preliminary treatment of wastewater. In case of condensed wastewater, preliminary treatment is advisable before such water enters the constructed wetlands

2.2 Types of Constructed Wetlands

2.2.1 Free Water Surface Systems with Emergent Plants

This type is old and has been used in Netherlands for almost 30 years (Greiner and De jong, 1984). Generally, such systems are composed of ponds or gullies with clay or absorbers in the wetland soil. There are soils or mediums such as gravel for sticking plants. Also, there is water overflow at the soil surface. Generally, the width of such ponds is 3-5 meters, the length is move than 100 meters, and the depth is not over 45 centimeters. Submerged plants provide a habitat for microorganisms. The flow is plug flow or slow flow with shallow levels. The process of removal for dissolved substances such as nitrogen, phosphorus, and potassium, is adsorption that contributes to the growth of the plants. Non-adsorbed matters are still in the wastewater and soils. Nitrogen will be in nitrifying and denitrifying cycles. Phosphorous and potassium will be adsorbed into the soils. Small molecular carbon will be adsorbed by the plants for originating cells. The harder type of dissolved carbons, such as filaments or rings, will be destroyed or shortened to smaller ones by fungi at the roots or rhizomes afterwards. The dissolved metals that plants are incapable of adsorption such as mercury, aluminum, cadmium, and lead, will be accumulated in the stems, leaves, and roots of plants and left in the soil at the bottom of ponds. The dissolved metals that plants can adsorb to use, such as nickel, copper, iron, selenium, and zinc will be absorbed by plants. The non-adsorbed ones will be in the wastewater and settle at the bottom of the ponds (Kedlec and Knight, 1996.) General features of a free water surface flow constructed Westland is showed below in Figure 2.1

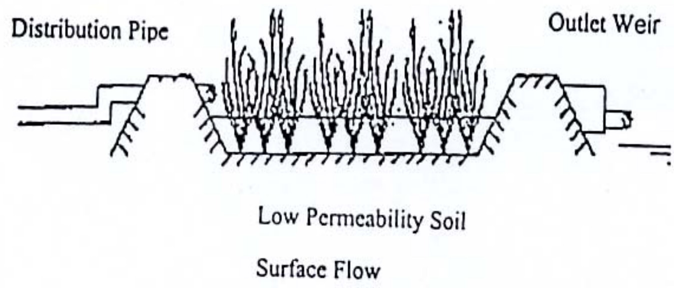


Figure 2.1 Free Water Surface Flow Constructed Wetland

Source: (Kedlec and Knight, 1996)

2.2.2 Subsurface Flow System with Emergent Plants

This type is categorized by the direction of water flow:

1) Horizontal subsurface flow constructed wetlands

The notion of subsurface flow constructed wetland was improved in Germany in 1970 (Brix, 1987 and Kickuth, 1977). Generally, the compositions are medium or substrate for plants such as reed (Common Reed, *Pragmites australis*) and absorption resistant layers. The medium can be soil or gravel. With water flowing around at the roots of plants (Figure 2.2), organic matters are digested by microorganisms. Nitrogen transforms ammonia to nitrogen by nitrification and denitrification processes. Phosphorus and heavy metals will be stuck in the medium. This type of constructed wetland can remove BOD and suspended solids quite well. The concentration of nitrogen and phosphorus present in the water depends on the loads of nitrogen, phosphorus, types of medium such as soil or pebble, and types of wastewater.

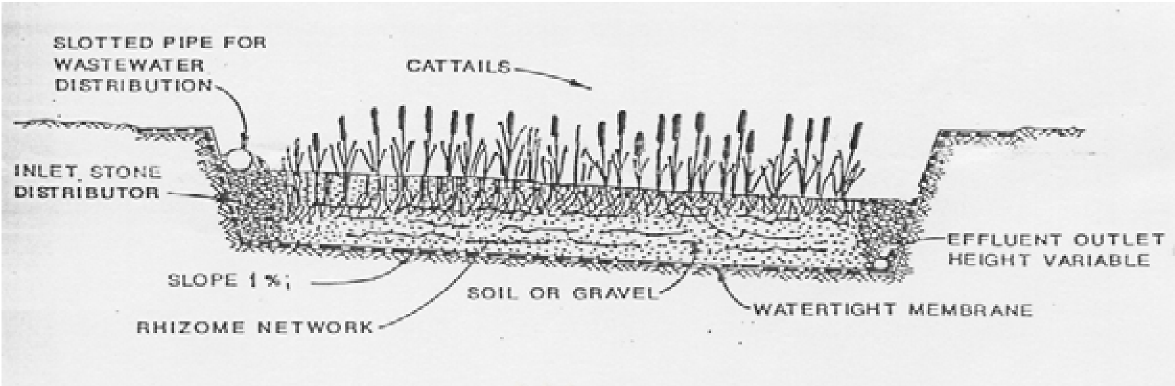


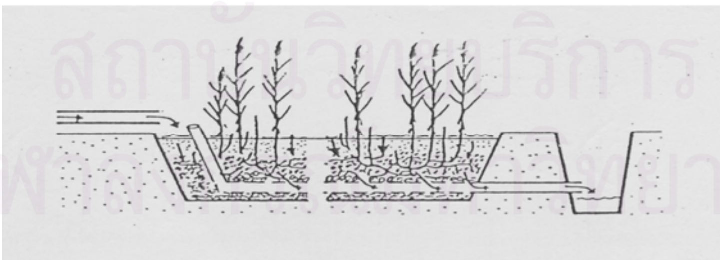
Figure 2.2 Horizontal Subsurface Flow Constructed Wetland

Source: (US. EPA, 1996)

2) Vertical Subsurface Flow Constructed wetlands

This type of constructed wetland is composed of many parallel layers by intermittent vertically loading flow of water that increases more oxygenation in comparison to the horizontal flow. During the inlet flow, oxygen will be pushed out from space between soils again. In this way, the soil is continuously oxygenated. Furthermore, diffusion of oxygen into soil layers will increase when the soil dries. This type of constructed wetland can remove suspended solids BOD, ammonia, and phosphorous quite well as shown Figure 2.3

Inlet



outlet

Figure 2.3 Vertical Subsurface Flow Constructed Wetlands

Source: (Brix, 1993)

2. 3 Compositions of constructed wetlands

Wastewater treatment by constructed wetland depends on 4 parameters: these are plants, microorganisms, water, and mediums with their functions.

1) Plants or Macrophytes

Plants primarily function as a habitat for organisms. Plants, foliages and stems help slow the water flow, making suspended solids settle and allowing microorganisms to grow. Macrophytes in constructed wetlands have leaves, stems, and roots. Fibrous rhizomes will have escaped oxygen making their oxygenation area, which called thin film aerobic region. But for the far and away, the wider area is anaerobic that is close to the thin film aerobic region which is crucial for the transformation of nitrogen and others as shown in Figure 2.4 and Table 2.1

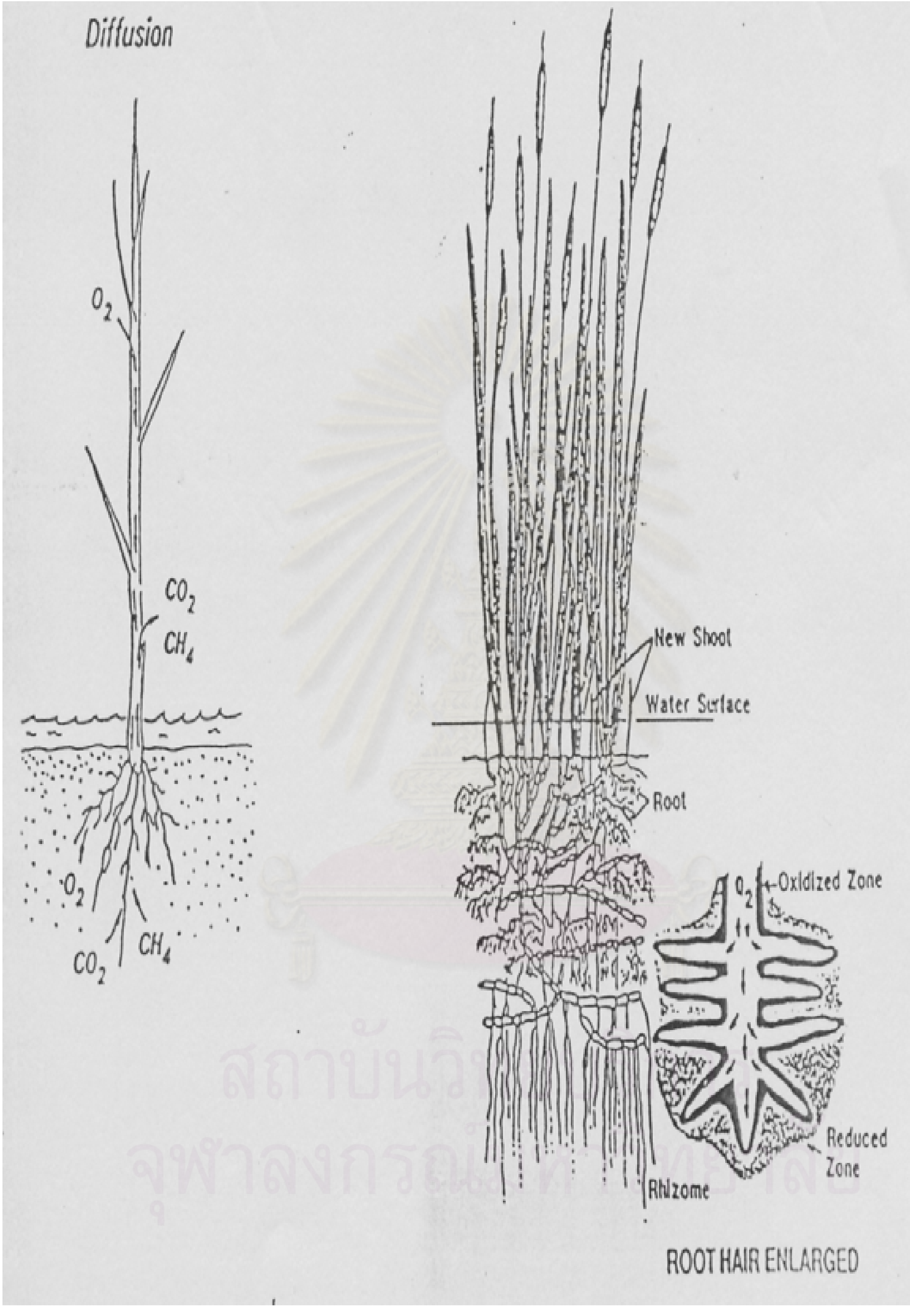


Figure 2.4 the Oxygen Exchange of the Plant

Source: (Hammer and Bastian, 1989)

Table 2.1 Functions of macrophytes in Wetlands (US. EPA, 1996)

Parts	Functions
Submerged roots and stems	1. Habitats of microorganisms 2. Medium for filtration and adsorption of solids
Emerged stems or leaves	1. Shade for sunlight and protect the growth of algae 2. Reduce the influence of wind in water such as interchanging of gases between atmosphere and water 3. Importance of oxygenating in and out for the underwater parts of plants.

Moreover, when the plants grow and die, leaves and stems will top up the bottom soil making a new organic layer. This accumulation of biological mass provides a habitat for microorganisms and a source of carbon for them. Otherwise, plants can use nitrogen and phosphorous as shown in Table 2.2

Table 2.2 Rate of Nitrogen and Phosphorous Use of some Plants and Concentration in the Plant Cells (Reddy and Debusk, 1996)

Plants	Use rate (kg/ha.yr)		Composition in cell (g/kg)		Growth rate (ton/ha.yr)
	Nitrogen	Phosphorous	Nitrogen	Phosphorous	
Cattail	600-2,630	75-403	5-24	0.5-4	8-61
Bulrush	125	10	8-27	1-3	-
Reed	225	35	18-21	2-3	10-60

There are plenty of plants in wetlands as shown:

- **Cattail** (*Typha Augustifolia* and *Typha Latifolia*) are widely seen over the world. The optimum pH is in the range of 4-10. *Typha Augustifolia* can resist salinity in the range of 15-30 ppt (part per thousand). But *Typha Latifolia* can resist no more than 1 ppt. Both types of cattail are fast growing plants. By side Roots can pierce into the gravel layer for around 1 foot through side-spreading. The compositions of cells are solid 30%, carbon 45%, nitrogen 14%, and phosphorous for 2% when analyzing at the dry weight. Seeds and roots are sources of food for animals such as birds and beavers. Cattail can resist flood and drought rather well. In the U.S., they are used in constructed wetlands for free water surface flow and subsurface flow constructed wetlands.

- **Bulrush** are also found worldwide such as hard stem bulrush (*Scirpus acutus*), Wool Grass (*S. Cypernius*), river bulrush (*S. fluviatillis*), alkali bulrush (*S. robustus*), soft-stem bulrush (*S. validus*) and bulrush (*S. lacustris*). The optimum pH is in the range of 4-9. The compositions of cells are solid 30%, carbon 45%, nitrogen 18%, and phosphorous 2% when analyzing by dry weight. Seeds and roots are sources of food for animals such as birds. When flooded, they also provide habitat for fishes. These plants can resist flood rather well, especially the hard stem bulrush. Some can resist drought well. Generally, they can be found in the subsurface flow constructed wetlands in the USA.

- **Reeds** or common reed (*Phragmites australis*) are found all over the world. The optimum pH is in the rage of 2-8. Salinity resistant is not over 45 ppt. The rate of growth is quick, with roots spreading to the sides approximately 1 meter. In 1 year, it can pierce the gravel for about 40 centimeters. Reed has little value nutritionally for most animals, but can be used to make nests. Typically, reeds can withstand the flood for 1 meter and drought too. Reeds are widely used in constructed wetlands in Europe.

- **Rushes** are found globally. Their members are jointed rush (*Juncus articulatus*), Baltic rush (*J. balticus*), and soft rush (*J. effusus*), etc. The optimum pH is 5-7.5. Salinity resistant is up to the types but normally not over 25 ppt. The growth is rather slow. Roots spread to the sides less than 10 centimeters per year. There are solid 50%, carbon 45%, nitrogen 15%, and phosphorous 2% in fibers when analyzing by dry weight. Some birds eat them. Nonetheless, rushes are suitable as supplement in constructed wetlands for animal habitats. However, considering for the main function, we should go for other plants.

- **Sedges** are also found worldwide. Their members are water sedges (*Carex aquatilis*), (*C. lacustris*), tussock sedge (*C. stricata*), etc. The optimum pH is 5-7.5. Salinity resistance is not over 0.5 ppt. The growth rate is moderate to slow. Roots can spread to the sides less than 10 centimeters in 1 year. The compositions in fiber are solid 50%, nitrogen 1%, phosphorous 0.1% when analyzing by the dry weight. They are sources of food for birds and mouse deer. Flood and drought resistance varies according to the type of sedge. As with rushes, sedges should be supplements in constructed wetlands as animals' residents.

- ***Vetiveria zizanioides (Linn.) Nash*** is commonly called vetiver grass. Thais and Laotians call fage. Its origins are believed to be in India. The root words in its name is from the Tanmil refers to Vetiveria is fragrant or aromatic roots and *zizanioides* refers to their growth by the banks of rivers. In India, such plants are called khus-khus, khas-khas, and cos-cus. In Indonesia, they are called Akar Wangi. All of them mean aromatic roots. It is in the family Germinate. Such plants have a long life and bunch with tillers over the soil and leaves. It is reported that vetivers are found for 12 types. (Projects initiated by His Majesty King Bhumibol Adulyadej, 1998) It is reported that vetiver is spreading widely, especially in marshy areas, and in the various types of soils and from the sea level to 800 meter height. The internal structure of vetiver fibrous root looks like that of hygrophyte. So vetiver can resist floods quite well. Vetivers are easily and speedily adaptable to new environments. Rural folk often tie them to the roofing on houses. In the south of Thailand, poor Southern folk use the dry small part over the soil in funeral cremation ceremonies. Indonesians extract its oil for aromatherapy by boiling the plant. In India and Indonesia, plants are also utilized in the making of mats, fans, and hats because of its aroma. (Land Development Department, 1998)

Figure 2.5 *Vetiveria zizanioides (Linn.) Nash*

- ***Colocasia esculenta (Linn.) Schott*** is a small tuberous plant. *Colocasia esculenta* is colloquially called Dasheen, Eddoes, Taro, etc. In Thailand, it is called Tun (Chiangmai), Bon, Bonjeendam, Bonta, Bonnam (South). It in a biennial plant with tuberous stolen. It can grow up to 1.2 meters with single leaves alternately arranged around the stem. The shape of leaf is oval with a triangle or heart shape 10-35 cm in width and 20-50 cm length. The leaf stem is in the middle dividing the leave into 2 halves. The dorsal is green. The ventral is light green or purple. The leave stem is greenish purple or greenish yellow. The inflorescence is single stick with sex distinguishing minor flowers in the same inflorescences. The leaves are juicy. The fruit is green with rare seed. Generally, *Colocasia esculenta* is found in marshy areas. The stem can be cooked by peeling the leave stem and boiling it in hot water as a traditional soup in Thailand (Sripen, 1987).

Figure 2.6 *Colocasia esculenta (Linn.) Schott*: a) habit b) inflorescence c) fruit

Table 2.3 Names of Plants that can use in the Constructed Wetlands (Adapted from Knight, 1997)

Plant Species	Common Name	Growth Form	Shade Tolerance	Water Regime
Carex spp.	Sedges	Emergent Herbaceous	Full shade to full sun	Irregularly to permanently inundated: < 15 cm
Cyperus esculentus	Chufa	Emergent Herbaceous	Full sun	Irregular to regular inundation: < 0.3 m
Eichhornia erassipes	Water Hyacinth	Non-rooted Floating aquatic	Full sun	Permanent inundation
Juncus effusus	Soft rush	Emergent Herbaceous	Full sun	Regular to permanent Inundation; < 30 cm
Phragmites australis	Common reed	Emergent Herbaceous	Full sun	Seasonal to permanent inundation: up to 60 cm
Scripus validus	Soft stem bulrush	Emergent Herbaceous	Full sun	Regular to permanent Inundation; up to 30 cm
Typha latitifolia	Broadleaved cattail	Emergent Herbaceous	Full sun	Irregular to permanent inundation: up to 30 cm

2) Microorganisms

Generally, microorganisms in constructed wetlands are bacteria, fungi, algae, and protozoa. They will transform the waste in wastewater for food and energy in their life cycles. Bacteria and algae can increase the crystallization of iron, manganese and other metals. Processes of bacteria will support oxidation and the reduction of many substances. Bacteria will stick to the plants' roots and perform like a trickling system. The depth of water will define the aerobic or anaerobic digestion. Normally, anaerobic digestion occurs below depths of 3 meters depth in water. And aerobic digestion occurs more in shallower areas. Anaerobic microorganisms will consume sulfate and ferric oxide in organic oxidation in anoxic state (Witthar, 1993.)

3) Water

Free surface and subsurface water will lead substances and gasses such as oxygen to microorganisms. Water will allow unnecessary things not to accumulate in the system. It can also create a favorable environment for the biological processes of microorganisms and plants. Water depth also influences the efficiency of the free water surface flow constructed wetland. The most effective depth should not more than 45 centimeters (Witthar, 1993.) Moreover, the flow rate will limit the detention time of the system, thereby influencing the efficiency of the system.

4) Substrate or medium

The layer of substrate takes a major role in all functions of constructed wetlands and is the major habitat of roots of plants. Substrates can be gravel, sand, soil, etc. Nonetheless, soil should have low enough seepage to maintain constant water levels in the case of free water surface flow constructed wetlands. But if it is a subsurface flow constructed wetland, the substrate should keep enough moisture to allow for microorganisms in the soil. Substrate and sediment layers play major parts in keeping some chemicals and are the habitat where the involved microorganisms play a role in some chemical transformations (Wither, 1993.)

2.4 Removal Mechanisms in Constructed Wetlands

Removal mechanisms in constructed wetlands happen by the cooperation of physical, chemical, and biological processes. These processes may occur independently of one as well as altogether in a chain-effect sequences.

Plants or macrophytes perform major roles in the constructed wetlands. Constructed wetlands combine one or more shallow ponds with one or more species of plants. The inflow can be free water surface or subsurface flow. In all constructed wetlands, waste will be removed by complex physical, chemical, and biological processes. Various processes originate from microorganisms at the roots of the plants. Plants can remove the waste by adsorption to their fibers or let the surface be suited to surroundings of microorganisms which change and lessen waste concentration. Oxygenation of hydrophytes at rhizosphere is necessary for some removal mechanisms of microorganisms to function effectively (Moorhead and Reddy, 1990 and Reddy, Patrick and Lindau, 1989).

Removal Mechanisms are categorized as shown in Table 2.4

Table 2.4 Removal Mechanisms for Wastewater (Brix, 1993)

Wastewater Constituent	Removal Mechanisms
Suspended Solids	Sedimentation/filtration
BOD	Microbial degradation (aerobic and anaerobic)
Nitrogen	Ammonification followed by microbial nitrification and denitrification Plant Uptake. Ammonia Volatilization
Phosphorous	Soil sorption (adsorption - precipitation reactions with aluminum, iron, calcium, and clay minerals in the soil), Plant uptake, (Phosphine production)
Pathogens	Sedimentation/filtration, Natural die-off, UV radiation Excretion of antibiotics from roots of macrophytes

Basic removal mechanisms in constructed wetlands are sedimentation, adsorption, and plant-uptake, transforming adsorption, and recycling of substances in wastewater by microorganisms. All stated mechanisms result in the removal of dissolved organic matters that generally are in the form of Biochemical Oxygen Demand (BOD), Solid organic matters in the form of total suspended solid (TSS), nutrients and heavy metals.

- Organic matters

1) Dissolved organic matters in form of BOD

In constructed wetlands, BOD removal mechanisms change carbon back to the atmosphere in form of methane and carbon dioxide through the functioning of microorganisms. The consumption of oxygen by microorganisms is achieved by advancing the internal space to displace the oxygen from the top to the root of the plants (Kedlec and Knight, 1996.)

2) Solid organic matters in the form of Total Suspended Solids (TSS)

TSS can be removed in FWS constructed wetlands by sedimentation especially when the flow rate is rather slow, as this will improve the sedimentation efficiency of TSS. Also, the optimum detention time will encourage more sedimentation. Besides, hydrophytes are biological filters which bind the solids, allowing them to sink to the bottom. VSB constructed wetlands can be clogged up by this mechanism if TSS is too much. But for FWS constructed wetlands, TSS will settle gradually.

- Nutrients

Primary nutrients for studying of the efficiency of constructed wetlands are nitrogen and phosphorous

1) Nitrogen

In constructed wetlands, nitrogen can enter in forms of particulate and dissolved organic and inorganic matters. Most nitrogen can be removed by biological mechanisms in soil and water, with plant uptake in nitrification and denitrification by microorganisms being the major nitrogen removal mechanism in the constructed wetlands. Ammonia (NH_3) will transform to nitrate (NO_3) by nitrification. The rate of nitrification will relate to the amount of oxygen. The mechanism will function when oxygen dissolves more than 1 milligram per liter by the temperature limit. For instance, the mechanism will take place slower at below 10°C. Nitrate (NO_3) will be removed by spreading to anaerobic soil to make NO_2 and N_2 or ammonium ion (NH^{4+}-N_2). Rates of denitrification are normally limited by nitrate concentration and nitrate spreading from aerobic to anaerobic areas. And ammonium and nitrate nitrogen in the soil will have lots of biological mechanisms for assimilation in the building blocks of fibers, plant uptake to biomass. Nitrogen and ammonia will evaporate to the surface. Nitrogen cycle is shown in Figure 2.7

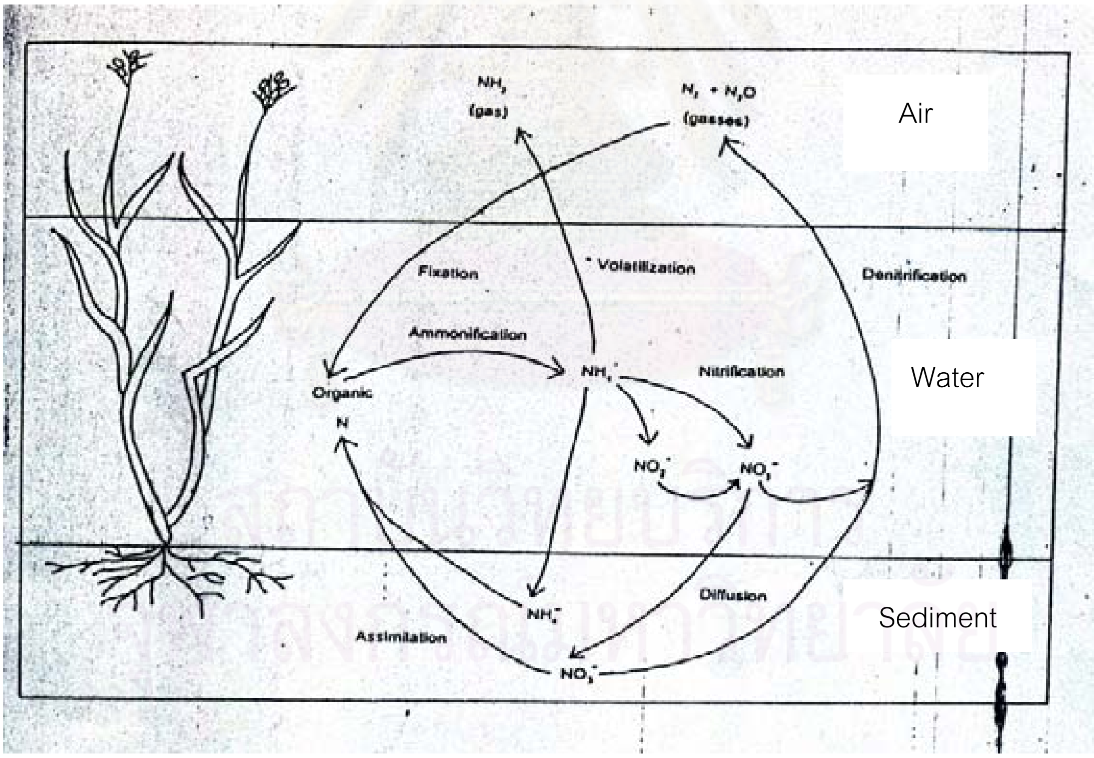


Figure 2.7 Nitrogen Cycle in Constructed Wetlands

Source: (Kedlec and Knight, 1996)

Harvesting does not affect nitrogen removal mechanisms directly but rather affect the oxygen and microorganisms numbers which reside at the roots of plants for nitrification and dentrification

2) Phosphorous

Main phosphorous removal mechanisms are chemical adsorption, precipitation, and plant uptake for growth. The phosphorous removal of FWS constructed wetland is less efficient to VSB constructed wetland due to soil as a major removal factor. Phosphorous will precipitate in soil with metallic salts. Soil with iron and aluminum will increase the removal capability.

- Heavy metals

For treatment of heavy metals in wastewater, the wastewater should pass through preliminary waste treatment in order to lessen the composition of heavy metals in water, so that this does not negatively impact water creatures in the constructed wetlands.

In pH over 7, organic phosphate will be found in form of calcium and magnesium. Hardly dissolved organics make low use of phosphorous. Microorganisms play a role in dissolving inorganic phosphate. By microorganisms' activities making organic and inorganic acids, the acids influence the dissolution of inorganic growth of plants. Adsorption of emerged plants is in the range of 1.8 to 18 gram phosphorous per square meter per year.

Wastewater is composed of dissolved and undissolved metals. Some heavy metals can be consumed by plants and animals for growth. These include barium, boron, chromium, cobalt, copper, iron, manganese, etc. But some heavy metals are toxic to creatures, such as arsenic, cadmium, and lead.

Main heavy metals removal mechanisms combine with 3 processes:

1.) Cation exchange and chelation with particles of soil, sediment binding of other particles to organics.

2.) Precipitation in the form of undissolved salts, sulfides, carbonate, oxyhydroxides.

3.) Uptake of plants, algae, and bacteria.

The final state of particulating heavy metals' reaction at the bottom is an anoxic state and in the form of undissolved sulfides. But if there is transposition or interference of particles into an oxic state in constructed wetlands, heavy metal particles have opportunities to dissolve again.

For plant uptake, heavy metals always enter at the roots. The limits of plant uptake are defined by the species of plant and type of metal. Many analyses reported that heavy metals were found at the roots' internal surface area during precipitation and uptake. Cadmium, copper, lead, nickel, and zinc were accumulated in dead plants for all the growth. The concentration of heavy metals was higher for dead plants. And floating plants such as duckweed were found to accumulate high levels of cadmium, copper, selenium, but only moderate levels of chromium, and least of all nickel and lead (Kedlec and Knight, 1996). Basically, heavy metals enter into the roots and accumulate there. They barely move to the top. Less of them accumulate to the stems and leaves. Or we can say that most heavy metals are always under the soil, never over the soil.

Pathogen removal in constructed wetlands is always by precipitation and filtration when inflow enters as well as natural depth. In the open system, UV influences removal the most.

2.5 Design Criteria of Constructed Wetlands

There are many criteria to choose from.

From the formula:

Q = LWdn/t

Q = Average flow rate (m^3/day)

L = Pond's length (m)

W = Pond's width (m)

d = Depth of the pond (m)

n = Constant of void in the constructed wetland (= 0.75 for FWS)

t = Retention time (day)

Table 2.5 Criteria of Constructed Wetlands

Detail	Unit	Value
Detention time	Day	14
Depth of water	Meter	0.1 – 0.8
Maximum BOD	Kg per hectare-day	60 – 70
Hydraulic loading	Millimeter per day	7 – 60
L:W	-	1:1 to 10:1
Constant of the width	-	0.1-0.75

Source: (Reed, Middlebrooks and Crites 1995)

2.6 Leachate

Leachate is wastewater from biological digestion of garbage water. The compositions are solutions and include suspended solids including microorganisms from sanitary landfills (Metry and Cross, 1976).

Composition and Variation of Leachate

Compositions of leachate are variably inconsistent, due to the age of landfill and the period of sampling of studied leachate. For instance, if sampling the leachate during the organic acid formation of garbage digestion, pH is roughly 4 – 5 but BOD, COD, TOC, nutrients, and heavy metals will be high concentration. But if sampling the leachate during methane release in garbage digestion, pH will be 6.5 – 7.5. BOD, COD, TOC, nutrients, and heavy metals will less than during organic acids forming by garbage digestion. The pH of leachete not only varies due to the organic acids concentration, but also from the influence of carbon dioxide.

In a 1993 study, Tharanit Thapanandana found that the qualities of leachate at On-nuch and Nong Kham municipal solid waste disposal centers had interesting parameters. The leachate from both stations near manholes during May and July, 1993 had high BOD, COD, TS, DS, Hg, Mn, and salinity over the standard of level 4 surface water sources for all parameters. At On-nuch, the parameters were BOD 493 – 268 mg/L, COD 6,380–4,147 mg/L, TS 12,583 – 12,297 mg/L, TDS 12,425 – 12,110 mg/L, Hg 20.71 – 3.73 ppb, Mn 0.68 – 0.83 ppm, and salinity 13.7 – 10 ppt. At Nong kham, the parameters were BOD 216 – 376 mg/L, COD 2,693 – 7,397 mg/L, TS 8,730 – 12,224 mg/L, DS 8,680 – 12,080 mg/L, Hg 2.05 – 2.63 ppb, Mn 0.74 – 0.77 ppm, and salinity 11.5 – 16 ppt.

Moreover, the composer of this thesis went to Saensuk municipal solid waste disposal center, Saensuk, Chonburi .There were facultative ponds from the landfill. The leachate went to the manhole and treatment ponds. The 1^{st}, 2^{nd}, and 3^{rd} ponds were anaerobic sequentially.

2.7 Uses of Constructed Wetlands in Past Researches

Maehlum, T. (1995). This paper is about the constructed wetlands that used the leachate from a landfill in Norway started in July, 1993. The flow rate was 120 m^3/day. At the first stage, low concentration leachate was treated anaerobically at the pond of 400 m^3. At the second stage, it was treated by aeration at the same stage pond with 3 aerators while ammonia-nitrogen and iron reacted here. At the third stage, there were 2 VSB constructed wetlands with 400 m^2 for each one. The substrates were washed gravel and moderately swollen clay size 10 – 20 mm. The studied plants were reeds and typha. At the fourth stage, the water surface was 2,000 m^2 with *Scirpus* and typha plants. The moving equipments there were only aerators. The efficiency of waste removal such as organics, nitrogen, phosphorous, iron, and pathogens were reliable for 70 – 95 %. This paper introduced the idea that a combination of natural treatment with general treatments for leachate would produce a better result.

Buddhawong, S. (1996). This paper is about the FWS constructed wetland treated with *Cyperus corymbosus* and *Eleocharis dulcis* and researches the optimum depth in wastewater treatment by comparison with no plant. The researcher discovered *Eleocharis dulcis* at 0.45 m depth grew more than other depths significantly comparing to reed. However, reeds at different depth make no difference significantly.

Cyperus corymbosus at 0.15 m depth gave the most effective results in the removal of orthophosphate phosphorous, ammonia-nitrogen, TKN, BOD, with more than 60 % similar to *Eleocharis dulcis* at 0.15 and 0.45 m depth. Moreover, all types of plants could reduce TDS by more than 25 % in comparison to the wastewater at the same depth. *Cyperus corymbosus* proved to be more effective than *Eleocharis dulcis*, with the most effective result being at 0.15 m depth.

Mattaraj, S. (1996). The researcher studied the FWS constructed wetlands with cadmium (Cd). There were one pilot scale and 3 bench scale constructed wetlands by typha planting. When Cd in influent was about 0 – 100 mg/L, Cd was removed by 42 –

99%, with plants showing no evidence of negative effects. pH at the beginning affected Cd removal too. The removal efficiency reduced to 42.6% when initial pH was 4 – 5 at Cd concentration of 100 mg/L. When analyzing the balanced mass, Cd was removed by sand adsorption for 73 – 98%, while typha could remove for 1 – 6%. So the main removal here was by sand adsorption.

Maw,T. (1996). The researcher studied the FWS constructed wetlands with diluted phosphorous by one pilot scale and 3 bench scale experiments for public wastewater. The interested factors were Hydraulic Retention Time (HRT), pH of influent, and cut of the stem to phosphorous removal.

The results showed enough particulated phosphorous and chemical particulation of it led P to be removed by 97 % at 9 days HRT. The less HRT, the less phosphorous removal. pH at 4 – 9.5 did not affect the phosphorous removal, though perhaps the buffer in substrate of the wetlands had an influence. Harvesting every 2 weeks did not show the obvious result in phosphorous removal in comparison to no harvest. This might be from the shortness of time of the experiment. The final results showed that the plant up-took the phosphorous up to 90%. The rest was accumulated in the other mediums with 9 days HRT.

Kananidhinant, L. (1997). This paper was about studying 4 emergent plants; *Cyperus corymbosus, Typha angustifolia, Phragmites australis*, and *Eleocharis dulcis'* efficiency in chromium removal of electroplating industry including the survival of them at a depth of 0.3 meters. The results showed that all plants could reduce chromium more than 44 percent. The efficiency ratings were: *Cyperus corymbosus* 98.21%, *Eleocharis dulcis* 95.96%, *Typha angustifolia* 95.90%, and *Phragmites australis* 94.87 %. When studying them in comparison to the control ponds for all experiments, there was no significance at 0.05 levels between the ponds of the control and the plants. Moreover, it was found that chromium had accumulated in soil more than in the plants. On the other hand, it can conclude that more than 90 percent of chromium was in the soil by the plants' mass balance analysis.

Limsuwan, S. (1997). The objective of this paper was to find the optimum stage of a septic tank by VSB constructed wetland. There were 2 pilot scale and 3 bench scale wetlands. The sludge was taken by the septic bus of BKK Metropolitan Department. The plant was Typha. The result showed that at sludge loading 80 – 125 kg. TS/m^2. yr drying for 1 week led the removal of TSS, TCOD, BOD, fecal coliforms, and bacteriophage more than 96%. A week into the experiment, the sludge at bench scale constructed wetlands had TS 33% and the sludge at pilot scale constructed wetlands had TS 65%. It happened because solids had accumulated and packed less than the bench scale constructed wetlands. Therefore the sludge could dry more. And the sludge loading at 40 kg. TS/m^2.yr led plants lacked water. And the sludge loading at 250 kg. TS/m^2.yr led dry sludge to have TS for 14% after having been dry for 1 week. The twice a week sludge loadings allowed for better growth of plants with better qualities of effluent than once a week sludge loading.

Bhurtel, J. (1997). This paper was to study the tropical FWS constructed wetlands in organics removal and evaluate the bacteria film. All kinetics in the removal of organics and COD, and some of the necessary parameters in the model for calculation of COD removal in FWS constructed wetland were taken from the experimental units and researches. The batch experiments were to test the kinetic constants for floating microorganisms and biofilm. With the low bulk liquid stage and lots of surface area, the thin stage is suitable for sticking microorganisms than floating microorganisms. From the spreading of FWS constructed wetlands, the graph at the outlet of the constructed wetlands gave the combined result between well mixed, with the and plug flow and dispersion number being between 0.15 – 0.20.

Pholkerd, S. (1997). The paper was to study the FWS constructed wetlands to find the pathogenic removal parameters especially bacteriophages, fecal coliforms, and fecal streptococci. The results were at organic loading rate (OLR) 50 kg. COD (ha. day) and HRT 0.5 – 5 days giving the viral removal efficiency for 57 – 94%. While fecal coliforms and fecal streptococci removals were in 60 – 97% and total P for 16 – 34%, after the harvest of plants the viral fecal streptococci removals happen before the harvest. This happened because the constructed wetlands pursued more sunlight. By kinetic analysis, k_{20} of virus was 0.13 day^{-1} before and after the harvest. k_{20} of fecal coliforms and fecal streptococci were 0.16 day^{-1} and 0.18 day^{-1} before and after the harvest successively.

Monika et al (1997). This paper was designed to study VSB constructed wetlands in regards to the better qualities of the 3^{rd} stage wastewater treatment by 4 parallel constructed wetlands. The total area was 600 m^2 with reeds in gravel and sand. The HRT was 66 – 266 mm/day. The quality of effluent was tested every 2 weeks continuously for 2 years. The removals of COD, ammonia, phosphate were 50 – 60 %, 40 – 90 %, and 50 – 60 % by the optimum HLR at 200 mm/day.

Bulc, T., Vrhovsek, D. and Kukanja, V. (1997). This study was in Slovenia at Dragonja landfill for Adriatic coast leachate treatment. The system was plugged with 2 subsurface constructed wetland stage 450 m^2 with HLR 3 m^3 /day. The inlet concentrated with COD 1264 mg/L, BOD 60 mg/L, ammonia-nitrogen 88 mg/L, undissolved solids 400 mg/L, and iron 10 mg/L. The experiment began in 1992 and the average results were removals of COD, BOD, ammonia-nitrogen, iron bacteria for 68 %, 46 %, 81 %, 80 %, and 85 % successively. The results show a favorable efficiency. However, the optimum size can hardly be estimated due to varying hydraulic constants and the inlet waste. A future study might clear up some of these uncertainties.

Jittawattanarat, R. (1998). The experiment was designed to find the treatment efficiency and make the sludge in septic tanks dry. The pilot scales of 3 VSB constructed wetlands were planted with narrow-leaved typha. The mixture consisted of solids and wastewater in septic tanks from Bangkok Department and inletted. This test was designed to find solid loading rate (SLR), the frequency of inlet sludge from septic tanks and retention time in the constructed wetlands. Within 6 months, SLR was in the range of 80 –

250 kg. TS/m^2. yr did not show obvious removals for TS, TVS, SS, VSS, NH_3^{-N}, TKN, and TCOD. High SLR affected NH_3-N removal efficiency which might come from the anoxic stage.

Two inlets per week was beneficial for plants but not for TCOD and solid removals. A greater removal of NH_3 and TKN happened when HLR was at 2 days. But the highest TKN removal occurred at HLR 6 days. The volume of sludge in the constructed wetlands decreased for 96 – 99 %. The yet dry sludge left for 38 – 52 % of all TSS. From the results, the optimum parameter was SLR at 250 kg. TS/m^2.yr with once a week sludge inletting and retention time for 6 days.

Summerfelt et al (1999). The study was designed to remove COD, TSS, TKN, and phosphorous from leachate by FWS and subsurface constructed wetlands with vetiver. FWS gave removals of TSS > 96 %, COD > 72 %. Subsurface constructed wetland gave removals of TSS > 98 %, COD > 91 %. Both of them could remove all TKN and phosphorous 80 – 92 %. The interesting thing here was even when COD reached 6,855 mg/L vetiver could grow for 10 months.

Rash, J. K. and Liehr, S. K. (1999). They studied and analyzed 3 types of constructed wetlands; FWS with plants, FWS without plant, and SS with plants. Trace element was lithium chloride. The result was SS always short circuit. But FWS were well mixed without short circuit. Short circuit in SS might come from the objection of vertical mix by physical factors and the density from the mix of rain and the surface inflow also with upward leachate from the bottom of the ponds.

Kozub, D.D. and Liehr, S. K. (1999). The study took place at New Hanover Country, Wilmington city, North Carolina, USA, addition of FWS constructed wetland by measuring the reduction of nitrogen with acetylene and add sodium acetate and sodium phosphate in 1997. The giving rate and consuming rate of nitrogen were 11.1 ± 3.4 $gN/m^3/d$ and 4.5 ± 2.2 $gN/m^3/d$. Conclusively, the increasing rate of nitrogen removal was solely from adding sodium acetate but sodium phosphate had no effect. And the decrease of nitrogen was from the carbon amount in the constructed wetlands.

Sengsai, W. (2001). This study compared the chromium removal efficiency in the tannery post treatment wastewater by FWS constructed wetland both with and without vetivers. The depths were 0.1, 0.15, and 0.2 m. The 0.1 m depth gave the most effective in chromium removal for 89.29%. The least effective occurred in areas without plants at 0.1 meter for 80.72% Chromium was accumulated at the roots more than leaves by analyses. The salinity of the inlet was between 7.3 – 8.9 ppt.

Lin, X., Lan, C. and Shu, W. (2001). This study concerned leachate treatment at Guangzhou, China by SS constructed wetland with vetiver and variety of substrates: coal ash, fly ash, coal, soil, and gravel for 75 days. The influent had COD 1,668 – 1,841 mg/L and NH_4^+-N 851 – 26 mg/L. The constructed wetland planted with coal gave the most effective in NH_4^+-N removal at 74%. The most effective in COD removal was planted with coal ash at 70%.

Kong, X, Lin, W. and Wang, B. (2001). This study concerned the treatment of wastewater from pig farms by planting vetiver in 10 liters pots. Each pot had 5 kg of wastewater. The wastewater had copper 0.0736 mg/pot, 3 inc 0.878 mg/pot, lead 0.0501 mg/pot, mercury 3.02×10^{-4} mg/pot, arsenic 0.0366 mg/pot, nitrogen 33 mg/pot, and phosphorous 13 mg/pot. The removal results were copper > 92%, zinc > 92%, lead 30 – 71%, lead 13 – 58%, arsenic > 60%, nitrogen > 60%, and phosphorous 59 – 85%.

Percy, I and Troung, P. (2001). The study researched the survival of vetiver in leachate. The vetiver could resist arsenic at 100 – 250 mg/kg, cadmium at 20 – 60 mg/kg, copper at 50 – 100 mg/kg, chromium at 200 – 600 mg/kg, lead at more than 1,500 mg/kg, mercury at more than 6 mg/kg, nickel at 100 mg/kg, selenium at more than 74 mg/kg, zinc at more than 750 mg/kg, and salinity at 8 ppt. for the growth. And the plants were dead in half when the salinity reached 20 ppt.

Chayopatham, P. (2003). The study aimed at the efficiency of BOD removal from wastewater originating in swine farms by passing through sunlight. The studied plants were *Cyperus corymbosus* and *Typha Phragmites*. The HRT was 4 – 27 days with 3 depths: 0.5, 0.75, and 0.85 m. The inlet BOD was 205 mg/L. The efficiencies of removal are BOD 64 – 92%, TSS 70 – 97%, TKN 72 – 96%, NO_3-N 47 – 83%, TP 39 – 81%, and total coliforms 52 – 85%.

Siribunjongsak, M. (2004). This study researched the correlation analysis by linear regression between BOD – COD leachate and physical composition of municipal solid waste and environmental condition at Saensuk Municipal Solid Waste Disposal Center, Chonburi during 22/9/2002 – 15/3/2003. The results were shown:

Parameters	Range	Average
BOD (mg/L)	145 – 533	360.6
COD (mg/L)	1,075 – 1,477	1,293.8
Temperature (Celsius)	26.0 – 30.34	28.35
pH	7.23 – 7.63	7.40

Srisatit, T., Rugpao, S., and Pairin, J. (2004). This was a study on the efficiency of FWS constructed wetland in treating wastewater from a stabilizing pond of the latex industry. The depths were 0.15 m, 0.30 m, and 0.45 m. The plants were *Typha anqustifolia* and *Colocasia esculenta*, in comparison with wetlands with no plant. The most BOD removal was from the constructed wetland with colocasia at 0.15 m with 79.95 ± 4.90%. Typha could remove rather low BOD. However, the efficiencies in TKN removal were at 0.15 m by with Typha 65.60 ± 9.77%, without plant 67.26 ± 6.24%, and with colocasia 62.40 ± 9.89%. Generally, they were not very different from each other. Colocasia made a significant difference statistically. And TSS removal would give better results when there were plants. At the 0.15 m depth, colocasia was the most efficient in TSS removal for 85.93 ± 5.56%.

Borin, M. and Tocchetto, D. (2006). The studied land was cultivated with wheat and soy bean for 5 years. The free surface constructed wetlands were planted with *Phragmites australis (Cav.) Trin* and *Typha latifolia (L.)* with 6 ha area. It received more than 2000 kg ha^{-1} of Nitrogen and can reduce nitrogen from 87% to 13%. The efficiency was discontinuous during winter-autumn. The greatest efficiency level achieved was about 90%. The disappearance of nitrogen must have been mainly due to plant uptake, with soil accumulation contributing to denitrification the least.

Sawaittayothin, V. and Polprasert, C. (2007). Experiments were conducted to investigate the feasibility of applying constructed wetlands to treat sanitary landfill leachate containing high nitrogen and bacterial contents under tropical conditions (temperature around 30 C°, with the retention time for 8 days. It yielded removal efficiencies of treatment for BOD, TKN, and fecal coliforms for 91%, 96%, and more than 99 %. The nitrogen uptake by plants was around 88%. However, the bacteria played heterotrophic and autotrophic roles in BOD removal.

Gottschall et al (2007). The South Nation River Watershed, in eastern Ontario, Canada gained excess nutrients loading from cow-dairy operations. The constructed wetlands with *Typha latifolia L. and Typha angustifolia L.* were invented to remove TKN. The nutrients loads were high with 16.2 kg $ha^{-1}d^{-1}$. And the 1st wetland could remove TKN for 0.7 % and the 2nd one could remove for around 30 %. The removal of TKN is noticeably lower than in tropical zone, perhaps due to differences in temperature. The lower the temperature, the lower the removal efficiency.

Conclusively, the previous studies were in vetiver and other water plants but none of them in colocasia in the treatment of wastewater or leachate. So this experiment focused on colocasia in the hopes of gaining greater knowledge in the use of water plants for constructed wetlands.

CHAPTER III

METHODOLOGY

3.1 Location of Study

The location was at Saensuk municipal solid waste disposal center, Muang District, Chonburi Province.

3.2 Experimental Period

The experimental period was 100 days for planting, collecting of treated samples, and sampling plants. The samples were collected every 10 days, totaling for 10 times. The plants were vetivers and colocasias.

3.3 Preparation of Location

1) Construction of Free water surface constructed wetland (Table 3.1)

The calculation is from the formula (Reed, Middlebrooks, and Crites 1995)

By	Q	=	LWdn/t
	Q	=	Average flow rate (m^3/day)
	L	=	Pond's length (m)
	W	=	Pond's width (m)
	d	=	Depth of the pond (m)
	n	=	Constant of void in the constructed wetland (= 0.75 for FWS)
	t	=	Retention time (day)

Table 3.1 Design Criteria for the FWS Constructed Wetland

Details	Model
Length : Width	5 : 1
Flow rate (m^3/day)	0.075, 0.150, 0.225
Depth (m)	0.20, 0.40, 0.60
Retention time (day)	10

FWS constructed wetland would have less space for waters flow because of the plants. The optimum space constant is between 0.65 – 0.75 that the plants will not packed when fully grown. This constant is necessary for calculation too.

The ponds for this experiment are built of concrete. There are 9 ponds with 1.0 meter width, 5.0 meters length, and 1.00 meter depth; and the 3 smaller ponds with 1.0 meter width, 1.6 meter length, and 1.00 meter depth. The 9 big ponds are for the experiment and the small ones are control ponds with normal water (Figure 3.1 and 3.2)

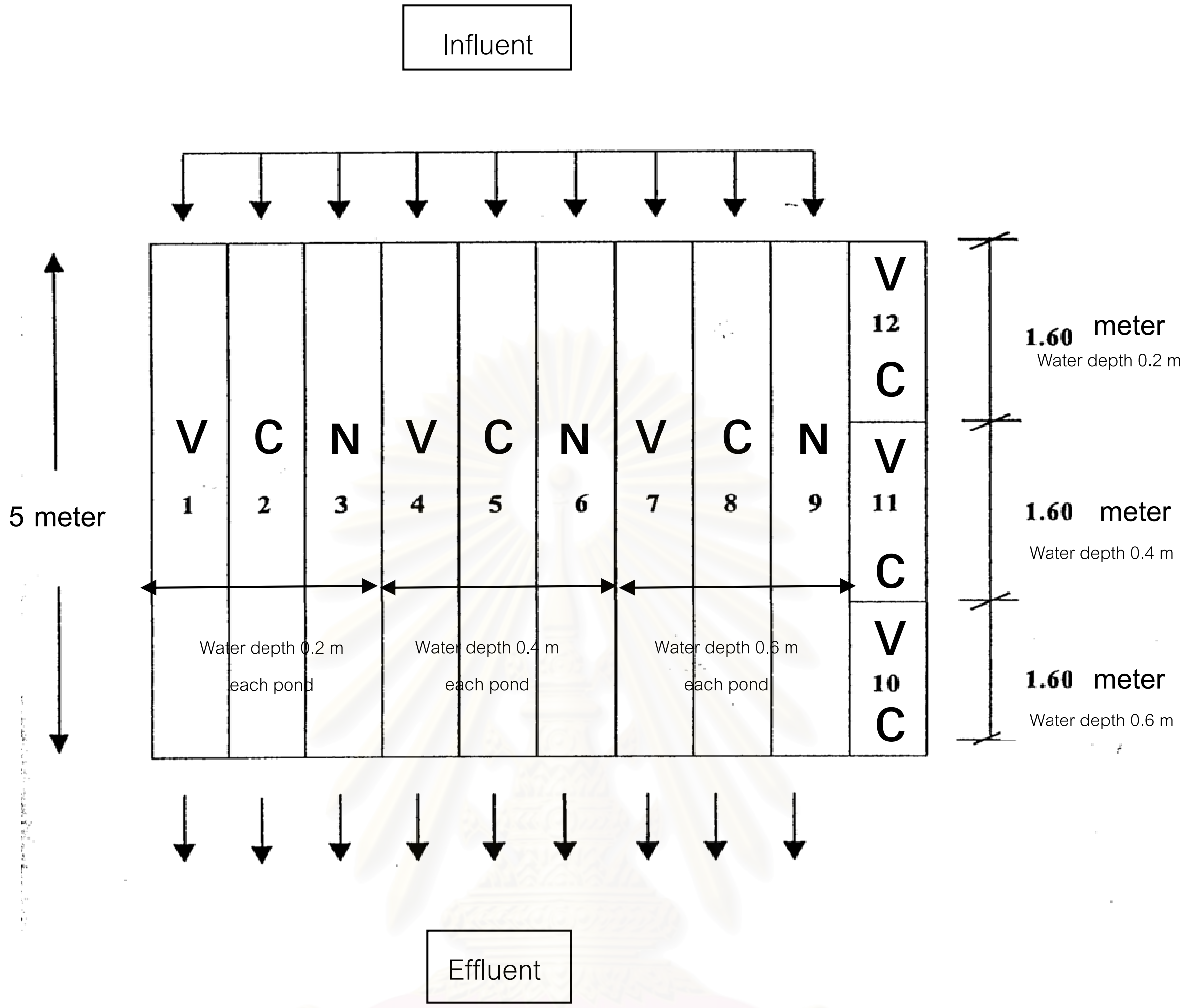


Figure 3.1 Experimental Ponds and Control Ponds at the Upper View

V stands for vetiver

C stands for colocasia

N stands for no plant (Control experiment)

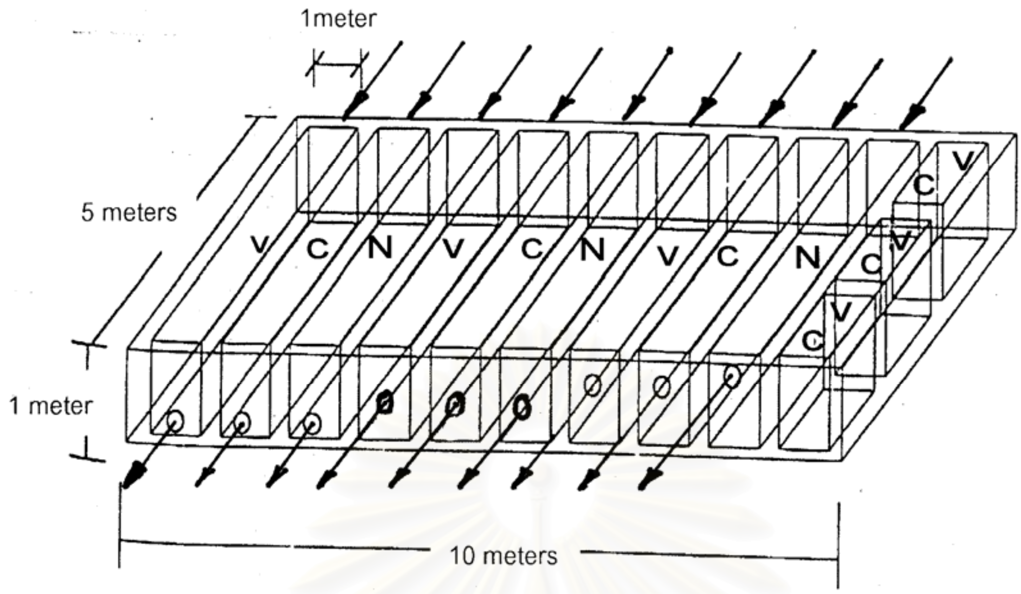


Figure 3.2 Experimental Ponds and Control Ponds at the Angle View:

V stands for vetiver

C stands for colocasia

N stands for no plant (Control experiment)

2) Preparation of soil

The soil was leveled at 0.30 m depth. It was selected and dug from a neighborhood location.

3.4 Preparation of Plants

3.4.1 The plants were *Vetiveria zizanioides (Linn.) Nash* or Ceylon vetiver and *Colocasia esculenta (Linn.) Schott*.

The selected plants numbered about 666 for each species.

3.4.2 The prepared plants were planted at experimental ponds for 6 ponds and 3 small control ponds. The space between each one is 0.15 m and from the rim for 0.05 m. The experimental ponds had 192 plants per pond and the control ponds had 60 plants per unit. The initial heights of plants were 0.40 m. They were left to rest during the experiment for almost a month.

3.5 Procedures of Experiment

3.5.1 The manhole leachate was released every 10 days from the tank by gravity and adapting valves into the 9 experimental ponds, 6 ponds with plants and 3 ponds without plants (Appendix A). The leachate was at different levels for the experimental ponds. The 1st, 2nd, and 3rd ponds had 0.20 m depth. The 4th, 5th, and 6th ponds had 0.4 m depth. The 7th, 8th, and 9th ponds had 0.60 m depth. All of them had HRT for 10 days. By the stated formula, the flow rates were 0.075, 0.15, and 0.225 m^3/day respectively.

3.5.2 Clean water was released into 3 small control ponds with vetiver and colocasia at 0.20, 0.4, and 0.6 m depth successively in order to compare plant the growth with the experimental units.

3.5.3 The experiment was conducted respectively for 100 days.

3.6 Sampling Procedures

1) The samples were collected before and after the treatment from the beginning and every 10 days to the final 100 days. The details are shown in Table 3.2

Table 3.2 Time Table for Sampling Collection

Collection	Date
1st collection of influent	21/3/2006
1st sample collection (influent and effluent)	31/3/2006
2nd sample collection (influent and effluent)	10/4/2006
3rd sample collection (influent and effluent)	20/4/2006
4th sample collection (influent and effluent)	30/4/2006
5th sample collection (influent and effluent)	10/5/2006
6th sample collection (influent and effluent)	20/5/2006
7th sample collection (influent and effluent)	30/5/2006
8th sample collection (influent and effluent)	9/6/2006
9th sample collection (influent and effluent)	19/6/2006
10th sample collection of effluent	29/6/2006

2) 3 samples of each plant and each pond were taken every 10 days by a random selection process that consists of dividing each of the 9 sections and picking one plant 3 times randomly. This process was repeated every 10 days until the end of the experiment.

3.7 Analyses of Data

1) The leachate was from the sump at the outlet of landfill. The leachate was kept into the 1.00 m^3 tank to release to the ponds. The studied parameters were BOD, COD, pH, temperature, TDS, TSS, and TKN. The regular time of collection was at 10.00 am.

2) The liquid samples from the inlet and outlets from the ponds were kept at the ice cooler at a temperature of $4^{\circ}C$ by the grab sampling method.

All parameters would be taken to test at the solid waste laboratory, Chulalongkorn University, except temperature at the site.

Parameters and methods of analyses were summarized in Table 3.3

Table 3.3 Parameters and Methods of Analyses

Parameters	Method of analysis
Temperature	Mercury filled thermometer
pH	Electrometric pH meter
BOD	$20^{\circ}C$ and 5 days BOD test
COD	Closed reflux method
Total Suspended Solids, TSS	Filter and oven dry at $103^{\circ}C$
Total Dissolved Solids, TDS	Evaporate and oven dry at $103^{\circ}C$
Total Kjedahl Nitrogen, TKN	Macro Kjedahl Method

(Based on Standard Methods for the examination of Water and Wastewater of E.I.T. Standard, 2002)

3.8 Studies of the Growth of the Plants

1) The general features of vetiver and colocasia were studying by comparing between the experimental ones and the control ones.

2) The height of the experimental plants and the control plants were measured at every depth every 10 days for 100 days.

3) The fresh plants were weighed before and after oven-drying them at 70°C for 3 days.

3.9 Statistical Method

3.9.1 Data of the growth of vetiver and colocasia

The data of growth for both types of plant were gathered and compared between experimental ponds and control ponds at every level of depth by SPSS statistical program version 10.0 to analyze the variation of the average growth (ANOVA) whether they differ at 0.05 significance. If there were differences, conducted further tests to find the average data of growth and whether they differed to other groups at 0.05 significance by Duncan's new multiple range test (DMRT). It was a comparison of many variables to find the relation at 0.05 significance.

3.9.2 The efficiencies of vetiver and colocasia were tested in BOD and COD removal by analysis of the variation (ANOVA) by (One-Way ANOVA) in statistical analysis

3.9.3 The analysis of the variation (ANOVA) could explain the differences between:

1) Efficiency of constructed wetland with vetiver, colocasia, and no plant

2) Effects of water level to the efficiency of BOD removal

3.9.4 The surrounding geological factors got involved to analyze with the growth of both experimental plants such as precipitation, temperature, humidity, etc.

CHAPTER IV

RESULTS AND DISCUSSION

4.1 Climate

During the experimental period, climate in Chonburi province by the Tapra reservoir climate station during March 2006 to June 2006 was as follows:

1) Rainfall

In the experimental time during March 2006 to June 2006, the total rainfall was 34.4 millimeters in March, 126.6 millimeters in April, 205.6 millimeters in May, and 87.3 millimeters in June. So the maximum total rainfall was in May.

2) Humidity

Daily average humidity of March, April, May, and June were 84, 84, 85, and 83 percent successively.

3) Temperature

Daily average temperature of March, April, May, and June were 28.9, 29.9, 29.6, 29.3 degree Celsius. The minimum monthly temperatures were 14.0, 21.0, 21.2, and 20.8 degree Celsius successively.

4.2 Soil Texture

In geology, soil textures are classified to many types, in proportion to the consistency of the 3 most inorganic matters: silt, sand, and clay. By means of acquiring the proportion of studied soil with Hydrometer (Allen, 1989), soil in all ponds were loam. They were composed of sand with 55.42 to 57.57 percent averaging to 56.50 percent, clay with 23.72 to 26.84 percent averaging to 25.28 percent, and silt at the range of 16.51 to 19.93 percent averaging to 19.93 percent. The method of soil analysis is by the Unified Classification by sieve analysis. The passed no. 200 was analyzed by the hydrometer. Table 4.4 shows the soil properties of the studied location.

Table 4.1 General Data of Soil at the Selected Location

Parameters	
Sand	56.62% by weight
Silt	15.58% by weight
Clay	27.80% by weight
pH	7.4

(Analyzed by the soil laboratory of the Department of Highways, 7/7/2006)

4.3 Leachate

The characteristics of leachate are shown in Table 4.2

Table 4.2 General Data of Leachate Composition from Seansuk Municipal Solid Waste Disposal Center

Leachate	1st Treatment pond	Manhole	Standard industrial effluent
Temperature (ºC)	27	27	<40
pH	8.05	8	5.5-9.0
TSS (mg/L)	55	140	50-150
TDS (mg/L)	2335	7800	<3000-5000
BOD (mg/L)	17.1	279	<20-60
COD (mg/L)	70	2,216	<120-400
TKN (mg/L)	3.83	2,076	<100-200
Salinity (ppt)	0.2	17.4	-
Zn (mg/L)	0.06	0.69	<0.5
Cu (mg/L)	0.10	<0.10	<2.0
As (mg/L)	0.05	1.66	<0.25
P (mg/L)	0.16	1.94	-
Pb (mg/L)	0.02	<0.01	<0.2
Hg (mg/L)	0.004	0.005	<0.005

(Analyzed by Environmental Research Institute Chulalongkorn University Laboratory, 8/2/2006)

4.4 Plant Observations

4.4.1 Characteristics of the Plants.

The growth of vetivers and colocasias were studied by measuring the height in centimeters and weighing the wet and dry plants in grams. Both species of studied plants were dried in the oven at 70°C for 3 days; were randomly selected to 3 of each acquire the average and standard deviation.

4.4.1.1 The Growth of Vetiver

1) Growth of vetiver

The growth of vetivers increased at the gradual rate. At the 0.6 m depth, the vetivers grew at a minimum rate in comparison to the other depths. The average height of vetiver on the 10th day of the experiment at 0.6 m, 0.4 m, and 0.2 m depth were 66.67± 6.67 cm, 78.33± 14.57 cm, and 65.17± 63.17 successively. The average height on the 100th day of the experiment for 0.6 m, 0.4 m, and 0.2 m were 146.67±11.02 cm, 137.33± 1.53cm, and 154.33±33.84cm.

The vetivers gradually increased in average height for the entire period of the experiment at every depth of ponds. The vetivers in the control pond at 0.6 m grew slightly less than vetivers of other depths. The average height ± standard deviation of the 3 randomly picked plants on the 10th day of the experiment at the depth of 0.6 m, 0.4 m, and 0.2 m were 50.67 ± 3.79 cm, 58.67 ± 1.15 cm, and 57.67 ± 2.52 cm successively. And the average height ± standard deviation on the 100th day of the experiment for the depth of 0.6 m, 0.4 m, and 0.2 m were 70.67 ± 3.79 cm, 107.67 ± 3.21 cm, and 119.33 ± 9.02 cm successively. The data are shown in Table 4.3

Table 4.3 Average Height of the Vetivers during the Experiment

Plant and day	Average Height (cm) ± standard deviation		
	Depth (m)		
	0.2	0.4	0.6
Vetiver at the 10th day	65.17± 63.17	78.33± 14.57	66.67± 6.67
Control Vetiver at the 10th day	57.67 ± 2.52	58.67 ± 1.15	50.67 ± 3.79
Vetiver at the 100th day	154.33±33.84	137.33± 1.53	146.67±11.02
Control Vetiver at the 100th day	119.33 ± 9.02	107.67 ± 3.21	70.67 ± 3.79

2) Wet weight of vetiver

The average wet weight of vetiver at a similar rate among ponds at all depths. The wet weight on the 10th day of the experiment at 0.6 m, 0.4 m, and 0.2 m depth were 23.33 ±15.28 g, 31.67±10.41 g, and 43.33±17.56 g successively. And the wet weight on the 100th day of the experiment at the depths of 0.6 m, 0.4 m, and 0.2 m were 58.33±24.66 g, 60.00±10 g, and 88.33±30.14 g successively.

The vetivers increased the average fresh weight at a similar rate among control ponds for all 3 depths. The average fresh weight at the 10th day of the experiment at 0.6 m, 0.4 m, and 0.2 m depths were 15.00 ± 5 g, 16.67 ± 7.64 g, and 30.00 ± 10 g successively. And the average wet weight of them on the 100th day of the experiment at the depths of 0.6 m, 0.4 m, and 0.2 m were 50.00 ± 5 g, 73.75 ± 9.46 g, 65.00 ± 5 g successively. The data are shown in Table 4.4.

Table 4.4 Average Wet Weight of the Vetivers during the Experiment

Plant and day	Average Height (cm) ± standard deviation		
	Depth (m)		
	0.2	0.4	0.6
Vetiver at the 10th day	43.33±17.56	31.67±10.41	23.33 ±15.28
Control Vetiver at the 10th day	30.00 ± 10	16.67 ± 7.64	15.00 ± 5
Vetiver at the 100th day	88.33±30.14	60.00±10	58.33±24.66
Control Vetiver at the 100th day	65.00 ± 5	73.75 ± 9.46	50.00 ± 5

3) Dry weight of vetiver

The average dry weight of vetiver samples increased at the similar rate among ponds at all 3 depths. The average dry weight on the 10th day of the experiment at depths of 0.6 m, 0.4 m, and 0.2 m were 4.00±1.73 g, 9.33 ±9.29 g, 10.67± 8.14 g successively. And the average dry weight on the 100th day of the experiment at depths of 0.6 m, 0.4 m, and 0.2 m were 23.33± 27.54 g, 31.67± 7.64 g, 31.37± 27.54 g successively.

The vetivers of control ponds grew at a similar rate at the depths of 0.4 and 0.2 m. But the vetivers at 0.6 m depth showed a little less increase in dry weight than other ponds. The average dry weight on the 10th day of the experiment at depths of 0.6 m, 0.4 m, and 0.2 m were 5.83 ± 1.44 g, 7.5± 2.5, and 10.00 ± 5g successively. And the average dry weight on the 100th day of the experiment at the depth of 0.6 m, 0.4 m, and 0.2 m were 15.00 ± 5 g, 15.00±5 g, and 25.00± 5 g successively. The data are shown in the table 4.5

Table 4.5 Average Dry Weight of the Vetivers during the Experiment

Plant and day	Average wet weight (g) ± standard deviation		
	Depth (m)		
	0.2	0.4	0.6
Vetiver at the 10th day	10.67± 8.14	9.33 ±9.29	4.00±1.73
Control Vetiver at the 10th day	10.00 ± 5	7.50± 2.5	5.83 ± 1.44
Vetiver at the 100th day	31.37± 27.54	31.67± 7.64	23.33± 27.54
Control Vetiver at the 100th day	25.00± 5	15.00±5	15.00 ± 5

Conclusively, by means of measuring the height of vetivers and weighing the wet and dry states, data indicates that these plants grew at a rather continuous rate of every depth for experimental ponds and control ponds. However, the vetivers at 0.2 and 0.4 m inclined in the same direction and better than those plants at 0.6 m depth. The vetivers in the control ponds are the same. The vetivers in the control ponds at 0.2 and 0.4 m grew better than at 0.6 m.

4.4.1.2 The Growth of Colocasia

1) The height of colocasia

The colocasia in the experimental ponds at depths of 0.2 m and 0.4 m grew at a similar rate. But the colocasia at a 0.6 m depth grew at the slower rate than at other depths. The average height of colocasia in the experimental ponds of the depth at 0.6 m, 0.4 m, and 0.2 m on the 10th day of the experiment were 63± 4 cm, 72±18.33 cm, and 73.33 ± 8.08 cm successively. And on the 100th day of the experiment, they were 115.33±2.88 cm, 98.63±12.58 cm, and 108 ± 21.66 cm successively.

The colocasia in the control ponds at depths of 0.6 m, 0.4 m, and 0.2 m were growing in the similar rate. The average height of the colocasia in the control ponds at depths of 0.6 m, 0.4 m, and 0.2 m on the 10th day of the experiment were 52.33±1.53 cm, 50.67± 3.79 cm, and 52.67± 2.08 cm successively. The average height of the colocasia in the control ponds at depths of 0.6, 0.4, and 0.2 m on the 100th day of the experiment were 78±1 cm, 70.67± 3.79 cm and 79.33± 1.53 cm successively.

The height of the colocasia in the experimental ponds and control ponds at every depth of water declined from the 80th day of the experiment.

In comparing results from the experimental and control ponds, the height of the colocasia increased in the experimental ponds at every depth. And the colocasia in the control ponds increased in height for every depth at the similar way. The data are shown in Table 4.6

Table 4.6 Average Height of the Colocasias during the Experiment

Plant and day	Average Height (cm) ± standard deviation		
	Depth (m)		
	0.2	0.4	0.6
Colocasia at the 10th day	73.33 ± 8.08	72.00±18.33	63.00± 4
Control Colocasia at the 10th day	52.67± 2.08	50.67± 3.79	52.33±1.53
Colocasia at the 100th day	108.00 ± 21.66	98.63±12.58	115.33±2.88
Control Colocasia at the 100th day	79.33± 1.53	70.67± 3.79	78.00±1

2) The wet weight of colocasia

Results showed that the wet weight of colocasia increased at the similar direction in the control ponds at 3 levels. On the 10th day of the experiment, they were 96.67 ± 35.12 g, 221.67 ± 118.99 g, and 211.67 ± 58.38 g at depths of 0.2 m, 0.4 m, and 0.6 m respectively. Also, at the 100th day of the experiment, they were 561.67 ± 81.29 g, 483.33 ± 230.94 g, and 1,100.00 ± 435.89 g respectively.

Wet colocasia increased weight at the similar direction among the control ponds at 3 levels. On the 10th day of the experiment at 0.2 m, 0.4 m, and 0.6 m, they were 115.00 ± 5, 70 ± 22.92, and 70.00 ± 10 respectively. And on the 100th day of the experiment at 0.2 m, 0.4 m, and 0.6 m depths, they were 160.00 ± 10, 193.33 ± 58.59, and 240.00 ± 10 g, respectively. The data are shown in Table 4.7

Table 4.7 Average Wet Weight of the Colocasias during the Experiment

Plant and day	Average wet weight (g) ± standard deviation		
	Depth (m)		
	0.2	0.4	0.6
Colocasia at the 10th day	96.67 ± 35.12	221.67 ± 118.99	211.67 ± 58.38
Control Colocasia at the 10th day	115.00 ± 5	70.00 ± 22.92	70.00 ± 10
Colocasia at the 100th day	561.67 ± 81.29	483.33 ± 230.94	1100.00 ± 435.89
Control Colocasia at the 100th day	160.00 ± 10	193.33 ± 58.59	240.00 ± 10

3) Dry weight of colocasia

Results showed that the dry weight of colocasia increased at the similar rate among the experimental ponds at 3 levels. On the 10th day of the experiment at 0.2, 0.4, and 0.6 m depths, they were 11.67 ± 2.89 g, 31.67 ± 14.43 g, and 23.33 ± 2.89 g respectively. And on the 100th day of the experiment, they were 168.33 ± 170.61 g, 118.33 ± 46.47 g, and 313.33 ± 283.71 g respectively.

The dry weight of colocasia grown in the control ponds at depths of 0.2 m and 0.4 m increased at s similar rate. But at 0.6 m depth, the control colocasia the dry weight increased at the slower rate than at 0.2 m and 0.4 m depths. On the 10th day of the experiment, they were 26.67 ± 7.63 g, 25.00 ± 5 g, and 15.00 ± 5 g at the 0.2 m, 0.4 m, and 0.6 m respectively. On the 100th day of the experiment, they were 100.00 ±10, 65 ± 31.22, and 58.25 ± 15.46 g respectively. The data are shown in the Table 4.8

Table 4.8 Average Dry Weight of the Colocasias during the Experiment

Plant and day	Average wet weight (g) ± standard deviation		
	Depth (m)		
	0.2	0.4	0.6
Colocasia at the 10th day	11.67 ± 2.89	31.67 ± 14.43	23.33 ± 2.89
Control Colocasia at the 10th day	26.67 ± 7.63	25.00 ± 5	15.00 ± 5
Colocasia at the 100th day	168.33 ± 170.61	118.33 ± 46.47	313.33 ± 283.71
Control Colocasia at the 100th day	100.00 ± 10	65.00 ± 31.22	58.25 ± 15.46

Conclusively, the research data shows that colocasia at depth of 0.2 m and 0.4 m grew at a continuous rate through out the experiment for both experimental ponds and control ponds. And a better rate of growth occurred at the 0.2 and 0.4 m than 0.6 m depth. After the 80th day however, colocasia in the ponds started to wither, rot, and die. The life cycles of both plants are normally around 100 days. Also, many plants were torn by the effects of wind; However, new plants were beginning to grow. Some were picked to measure. So they might look like the growth decreased from the 80th day. Colocasia in the experimental ponds were different according to the depth. But there were no big differences of growth among the control ponds.

Table 4.9 Average Height of Plants

Time (days)	Average Height (cm)											
	0.2 m				0.4 m				0.6 m			
	Vetiver	Control Vetiver	Colocasia	Control Colocasia	Vetiver	Control Vetiver	Colocasia	Control Colocasia	Vetiver	Control Vetiver	Colocasia	Control Colocasia
10	65.17	57.67	73.33	52.67	78.33	58.67	72.00	50.67	66.67	58.67	63.00	52.33
20	85.33	61.67	79.00	54.67	91.33	63.67	78.67	51.33	74.00	64.00	81.67	54.33
30	88.00	67.00	82.33	57.33	100.67	65.00	82.00	52.33	89.67	70.00	86.00	55.00
40	106.33	83.33	85.33	62.67	107.00	80.00	84.00	54.00	95.00	90.00	90.67	61.67
50	116.00	92.33	88.33	64.00	121.67	83.33	86.00	58.33	110.00	107.67	92.00	64.67
60	137.33	112.67	93.00	66.67	129.67	92.33	92.67	61.00	116.00	109.67	107.33	65.00
70	147.33	116.67	107.33	67.33	133.00	96.33	97.00	65.00	133.00	111.00	110.33	76.67
80	155.67	145.00	124.67	92.67	156.33	131.67	121.67	88.67	149.67	121.67	118.00	84.33
90	155.33	130.67	108.67	83.67	156.00	127.67	103.67	82.33	147.00	115.00	116.33	80.33
100	154.33	119.33	108.00	79.33	137.33	112.00	98.67	70.67	146.67	107.67	115.33	78.00
Average	121.08	98.63	95.00	68.10	121.13	91.07	91.63	63.43	112.77	95.53	98.07	67.23
Standard Deviation	33.62	30.63	16.38	13.15	26.39	26.07	14.39	13.34	30.89	23.17	18.26	11.78
Maximum	155.67	145.00	124.67	92.67	156.33	131.67	121.67	88.67	149.67	121.67	118.00	84.33
Minimum	65.17	57.67	73.33	52.67	78.33	58.67	72.00	50.67	66.67	58.67	63.00	52.33

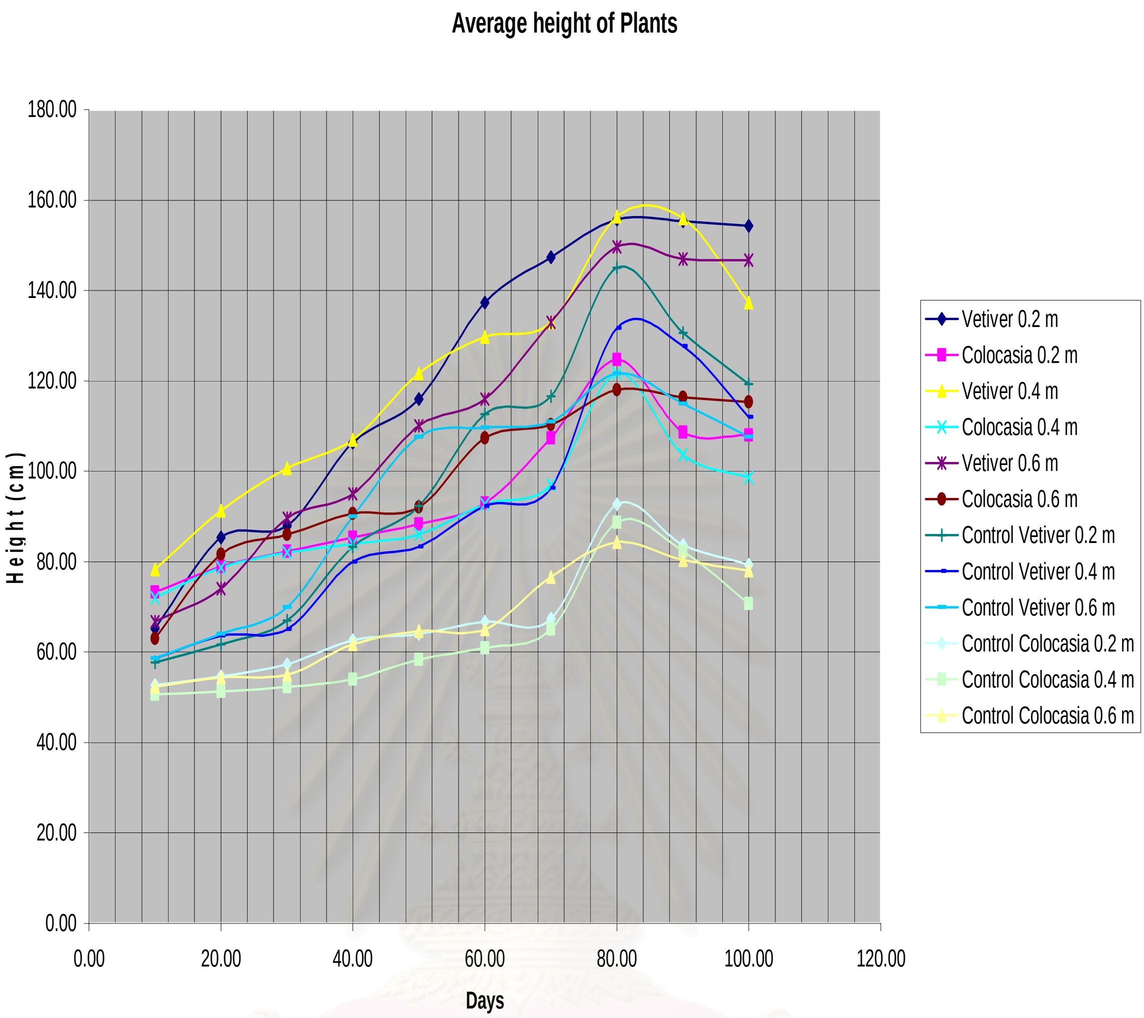


Figure 4.1 Average Height of Plants

Table 4.10 Average Wet Weight of Plants

Time (days)	Average Wet Weight (g)											
	0.2 m				0.4 m				0.6 m			
	Vetiver	Control Vetiver	Colocasia	Control Colocasia	Vetiver	Control Vetiver	Colocasia	Control Colocasia	Vetiver	Control Vetiver	Colocasia	Control Colocasia
10	43.33	30.00	96.67	115.00	31.67	16.67	221.67	70.00	23.33	15.00	211.67	70.00
20	50.00	50.00	130.00	116.67	35.00	26.67	255.00	95.00	25.00	25.00	271.67	76.67
30	61.67	51.67	176.67	130.00	41.67	35.00	283.33	106.67	28.33	40.00	333.33	100.00
40	63.33	51.67	356.67	130.00	50.00	40.00	300.00	141.67	30.00	43.33	370.00	113.33
50	68.33	52.33	376.67	143.33	51.67	43.33	390.00	145.00	43.33	45.00	556.67	148.33
60	76.67	55.00	418.33	151.67	55.00	55.00	393.33	150.00	46.67	46.67	825.00	170.00
70	81.67	56.67	461.67	151.67	58.33	70.00	450.00	190.00	56.67	46.67	860.00	181.67
80	131.67	86.25	753.33	340.00	98.33	89.25	723.33	280.00	88.33	65.00	2,183.33	211.67
90	95.00	79.75	653.33	310.00	68.33	86.25	658.33	233.33	75.00	55.00	1,516.67	220.00
100	88.33	65.00	561.67	160.00	60.00	73.75	483.33	193.33	58.33	50.00	1,100.00	240.00
Average	76.00	57.83	398.50	174.83	55.00	53.59	415.83	160.50	47.50	43.17	822.83	153.17
Standard Deviation	25.41	15.95	220.22	80.84	19.00	25.25	168.26	64.65	22.13	14.24	632.75	61.22
Maximum	131.67	86.25	753.33	340.00	98.33	89.25	723.33	280.00	88.33	65.00	2,183.33	240.00
Minimum	43.33	30.00	96.67	115.00	31.67	16.67	221.67	70.00	23.33	15.00	211.67	70.00

Table 4.11 Average Dry Weight of Plants

Time (days)	Average Dry Weight (g)											
	0.2 m				0.4 m				0.6 m			
	Vetiver	Colocasia	Control Vetiver	Control Colocasia	Vetiver	Colocasia	Control Vetiver	Control Colocasia	Vetiver	Colocasia	Control Vetiver	Control Colocasia
10	10.67	11.67	10.00	26.67	9.33	31.67	7.50	25.00	4.00	23.33	5.83	15.00
20	11.67	18.33	15.00	36.67	10.00	38.33	7.50	30.00	6.67	31.67	10.00	23.33
30	13.00	45.00	15.00	40.00	13.33	43.33	7.50	31.67	8.33	35.00	10.00	25.00
40	13.33	58.33	15.00	45.00	15.00	63.33	10.00	40.00	9.17	75.00	13.33	25.00
50	16.67	71.67	16.67	51.67	21.67	83.33	13.33	40.00	10.00	100.00	15.00	30.00
60	20.00	96.67	20.00	60.00	28.33	100.00	15.00	41.67	14.00	148.33	15.00	38.33
70	21.67	98.33	25.00	81.67	30.00	111.67	15.00	51.67	15.83	186.67	15.00	45.00
80	45.00	168.33	36.67	123.33	35.33	605.00	25.00	92.50	40.00	850.00	20.00	71.25
90	36.67	151.67	25.00	119.50	33.33	480.00	20.00	80.00	31.67	523.33	15.00	65.75
100	31.67	168.33	25.00	100.00	31.67	118.33	15.00	65.00	23.33	313.33	15.00	58.25
Average	22.03	88.83	20.33	68.45	22.80	167.50	13.58	49.75	16.30	228.67	13.42	39.69
Standard Deviation	11.84	58.51	7.73	35.37	10.14	202.11	5.79	22.52	11.79	268.10	3.90	19.59
Maximum	45.00	168.33	36.67	123.33	35.33	605.00	25.00	92.50	40.00	850.00	20.00	71.25
Minimum	10.67	11.67	10.00	26.67	9.33	31.67	7.50	25.00	4.00	23.33	5.83	15.00

By One-way ANOVA Applied to Regression analysis by SPSS for studying the affecting factors for the growth of plants:

-A) Type of water (normal and waste)

-B) The depth (0.2, 0.4, and 0.6 m)

-C) Type of plants (vetiver and colocasia), The results of analyses are shown in the appendix B.

By analyses of all affecting control data concurrently, one can conclude:

1) The level of depth did not affect to the growth of both plants. Even though at the 0.2 and 0.4 m depth they inclined to grow at the similar rate but when controlling other factors together, they found no difference with significance statistically. So the level of depth by itself showed no effect on the growth of plants especially for colocasia. But at the 0.6 m depth, plants showed the slow growth might be from too high substances than the others.

2) Colocasia grew at the faster rate than vetiver even when it grew to the maximum. They inclined to wither and drop down with new stems. So it might use up more nitrogen and carbon than vetiver plants.

3) Both plants gradual grew through the studied period.

4) The plants in the control ponds did not grow as well as in the experimental ponds since there were additional nutrients in the experimental ponds and there were no additional nutrients in normal water.

4.5 The Properties of Wastewater in the Constructed Wetlands

4.5.1 Acid-Base (pH)

The inlet water had pH in the range of 5.4 to 7.41. The average pH was 7.98 with 0.36 standard deviation. The outlet water from the studied ponds at different levels was in the range of 7.34 to 9.9 with 0.38 to 1.37 standard deviation.

Conclusively, constructed wetland in this case did not change the pH of the wastewater much. The pH of the inlet wastewater was suitable for the growth of the plants and the transformation of biochemical substances in the constructed wetland.

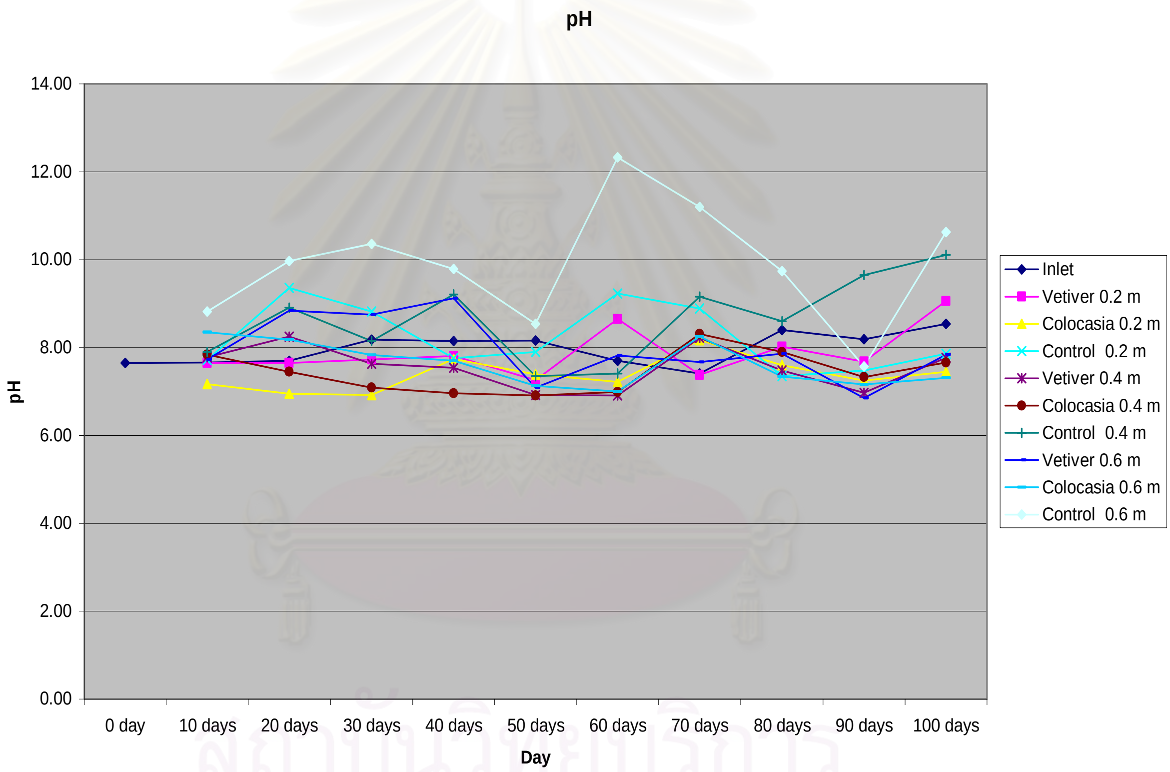


Figure 4.2 pH during the Experiment of the Constructed Wetland

4.5.2 Temperature

The inlet wastewaters were higher than the outlet from wetland for both plants and all level of depth.

At every depth of water, the studied ponds with plants had the lower temperature for outlet wastewater slightly. The range of temperature with plants was between 21 to 29 degrees Celsius. And without plants, the outlet water was in the range of 25 to 29.5 degrees Celsius. The outlet wastewater with colocasia had the lowest temperature maybe from the shade of big leaves shielding sunlight from the water.

Generally, the temperature was suitable for the growth of plants and the ecology of constructed wetlands.

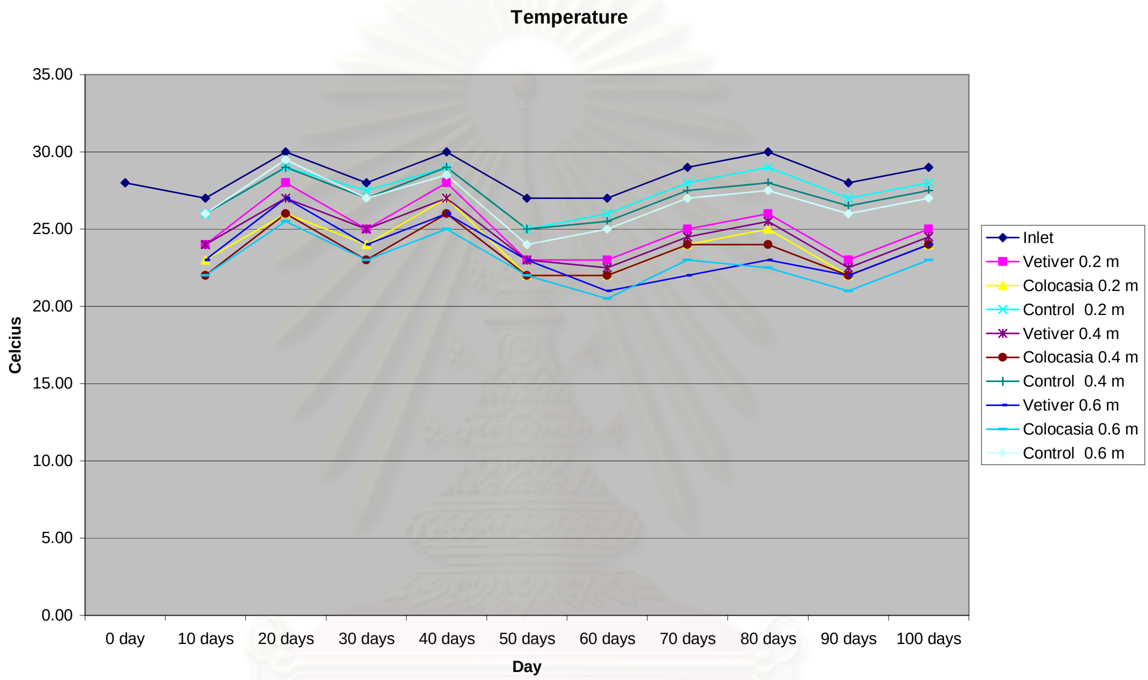


Figure 4.3 Temperature during the Experiment of the Constructed Wetland

4.6 The Efficiencies of the Substances Removal in the Constructed Wetlands

4.6.1 Total Kjhedahl Nitrogen (TKN)

4.6.1.1 Amount of TKN in the Inlet and Outlet wastewaters of the Experiment

The amount of TKN in the inlet wastewater for vetiver, colocasia, and control ponds were 1210.29 mg/L in average with 164.95 standard deviation.

The amount of TKN in the outlets at every level of depth changed due to the type of plants in the experimental ponds with colocasia affected TKN change the test; in vetiver ponds the rate of TKN change was higher; while in ponds with no plants TKN change was the highest.

The minimum TKN at the pond outlet occurred for vetiver at 0.2 m depth for 254.56 ± 157.47 mg/L. The minimum TKN at the pond outlet occurred for colocasia at 0.2 m depth too for 274.76 ± 219.19 mg/L. And the maximum TKN occurred at the control pond at 0.6 m depth for 989.48 ± 160.21 mg/L.

4.6.1.2 Efficiencies for TKN Removal

The efficiencies for TKN removal were shown in the Table 4.4. And it shows that the shallower the pond is with plants, the more removal of TKN occurred. The maximum rate of TKN removal occurred between 70 to 80 days. Also, at 0.2 m depth ponds with plants decreased TKN at a rather constant rate. By One- way ANOVA analyses, the average efficiencies of TKN removal are shown. There are differences with significant figure and type of plants. So the level of depth and type of plants affect the efficiency of TKN removal with significant figures statistically.

One can conclude from the data that the type of plant and the level of depth have no interaction for each other. So the efficiencies of TKN removal for each plant do not rely on the level of depth as shown in the Table 4.12.

Table 4.12 Percent TKN Removal by the FWS Constructed Wetland

Day	Percent removal TKN								
	Water Depth in the Constructed Wetland (m)								
	0.2			0.4			0.6		
	vetiver	colocasia	No plant	vetiver	colocasia	No plant	vetiver	colocasia	No plant
10 days	85.28	86.50	14.72	82.91	87.73	14.72	79.23	84.05	14.72
20 days	84.61	83.58	6.85	88.66	89.67	12.96	89.69	88.66	13.99
30 days	79.55	81.82	27.60	72.73	75.00	27.60	70.45	72.73	27.60
40 days	80.28	74.37	80.28	80.28	76.34	67.89	66.48	38.87	23.52
50 days	81.14	83.53	66.47	78.59	68.11	20.66	52.10	52.10	22.16
60 days	82.24	74.90	59.46	82.24	86.87	14.48	24.71	40.93	20.08
70 days	88.24	87.68	49.02	84.87	84.03	49.30	64.71	56.86	14.29
80 days	85.67	89.10	47.66	84.74	82.55	11.21	50.16	34.58	0.31
90 days	78.79	81.63	57.58	82.77	85.42	44.70	62.88	62.88	16.67
100 days	47.92	35.42	33.04	41.67	41.67	37.50	41.67	31.25	29.17
avg	79.37	77.85	44.27	77.95	77.74	30.10	60.21	56.29	18.25
sd	11.46	15.69	23.35	13.43	14.34	19.12	18.78	20.51	8.32
max	88.24	89.10	80.28	88.66	89.67	67.89	89.69	88.66	29.17
min	47.92	35.42	6.85	41.67	41.67	11.21	24.71	31.25	0.31

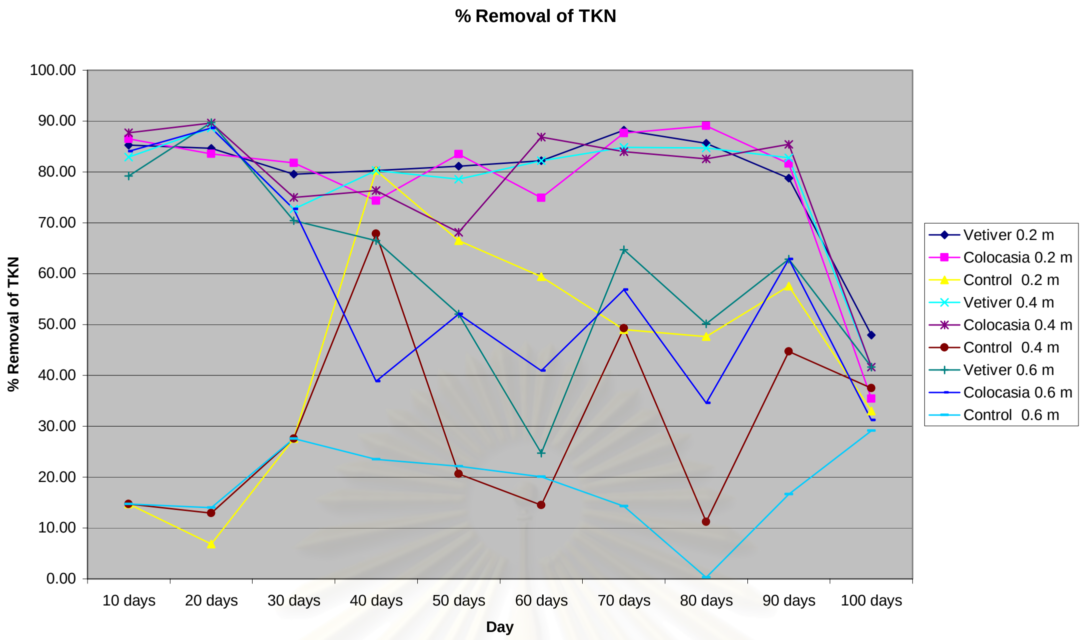


Figure 4.4 Percent Removal of TKN by the FWS Constructed Wetland

Statistical testing efficiency of TKN removal in levels of wastewater and type of plant showed a 0.05 significant difference statistically. By means of Duncan's new multiple ranges test (DMRT), it shows every level of depth differs from one other with significance: as shown in the Table 4.13.

Table 4.13 Efficiency of Average TKN Removal in Percent by SPSS Analysis (%)

Type of Plants	Water Level (m)			F. Probe	The most suitable level
	0.2	0.4	0.6		
Vetiver	$^{c}79.371^{c}$	$^{b}77.95^{b}$	$^{c}60.23^{a}$	26,544.61	0.2
Colocasia	$^{b}77.85^{b}$	$^{b}77.74^{b}$	$^{b}56.30^{a}$	15,025.46	0.2,0.4
No plant	$^{a}44.27^{c}$	$^{a}30.10^{b}$	$^{a}18.25^{a}$	10,444.64	0.2
F. Prob	63,041.02	146,401.4	27,775.41		
The most suitable plant	Vetiver	Vetiver , Colocasia	Vetiver		

*The different left corner letter means the difference among the plants and no plant with 95% confidence

*The different right corner letter means the difference among the level of depth of water with 95% confidence

Applying Duncan's new multiple range test (DMRT) of TKN removal one can conclude that the constructed wetlands without plants significantly differ in terms of statistics from the constructed wetland with colocasia and the constructed wetland with vetiver and no plant.

So the efficiency of TKN removal of constructed wetland with vetiver was similar to the constructed wetland with colocasia. But both of them had better efficiencies than ponds without plant. The shallower the depth, the more TKN removal. So at the depths of 0.2, 0.4, and 0.6 m the average efficiencies of TKN removal were 79.37$\pm$ 11.46, 77.95$\pm$ 13.43, and 60.21$\pm$ 18.78 percent respectively. So the conclusion was the best of TKN removal occurred at the depth of 0.2 m of constructed wetland with vetiver. But for the TKN removal of colocasia, the best efficiencies were similar at 0.2 and 0.4 m. The best of TKN of no plant was at 0.2 m depth.

However, the average TKN in the inlet was 1,210 mg/L. But after the treatment, all the outlet wastewaters were still over the limit of industrial standard wastewater that limit for less than 100 or 200 mg/L.

The main TKN removal in the studied ponds was up-take by plants of ammonia nitrogen. From the study, control ponds without plants had higher average pH for all experimental ponds at every depth of wastewater. At high pH, nitrogen in wastewater is in ammonia nitrogen form (NH, -N). Also, the algae grew there too. This is the source of nitrogen. So the ammonia nitrogen occurs at most of them.

4.6.2 Total Suspended Solids (TSS)

4.6.2.1 Amount of TSS in the Inlet and Outlet of Wastewater

The average TSS in the inlet was 424.91 mg/L with 568.52 standard deviation. The reason why the standard deviation was more than the average because there were interferences of algae bloom at the 50^{th} day and the 70^{th} day of the experiment.

The TSS of outlet wastewaters was lower than the inlet for all. The lowest TSS is 64.2 ± 108.51 mg/L at 0.2 m with vetiver. And the maximum TSS occurred at 0.2 m depth without plant for 162.8 ± 308.56 mg/L. But the lowest TSS for colocasia ponds was 93 ± 183.89 mg/L at 0.4 m depth.

It can be described that the open air with the shallowest depth can cause resuspension by the wind more easily than others. Because of the bigger stems of the colocasia, the sediments attacked and sunk down to the bottom more than the small stems of vetivers. This is true to the theory too.

Also, when there are plants in the ponds, longer detention time occurs. So TSS in the system will decrease. The percent of TSS removal is shown in the table 4.14. Also the percent removal of TSS is analyzed by SPSS and shown in the Table 4.15 too. Vetiver showed the best TSS removal efficiency at 0.6 m depth. Colocasia showed the best TSS removal efficiency at 0.6 m depth. And the no plant unit showed the best TSS removal at 0.4 m depth.

Table 4.14 Percent TSS Removal by the FWS Constructed Wetland

Day	Percent removal TSS									
	Inlet	Vetiver 0.2 m	Colocasia 0.2 m	Control 0.2 m	Vetiver 0.4 m	Colocasia 0.4 m	Control 0.4 m	Vetiver 0.6 m	Colocasia 0.6 m	Control 0.6 m
0 day	692.00									
10 days	28.00	80.35	95.66	86.71	97.11	95.95	91.04	94.80	96.82	81.21
20 days	22.00	71.43	71.43	92.86	71.43	50.00	21.43	92.86	28.57	-307.14
30 days	26.00	63.64	90.91	36.36	36.36	45.45	9.09	81.82	90.91	-309.09
40 days	38.00	7.69	30.77	-38.46	-7.69	-76.92	-15.38	15.38	30.77	61.54
50 days	132.00	89.47	-668.42	-221.05	-142.11	36.84	52.63	73.68	15.79	-426.32
60 days	22.00	86.36	96.97	-16.67	93.94	39.39	84.85	96.97	95.45	80.30
70 days	966.00	-18.18	-245.45	-790.91	63.64	-45.45	-100.00	72.73	0.00	-81.82
80 days	1154.00	94.41	92.13	90.89	90.68	92.75	91.10	94.41	94.00	97.52
90 days	1566.00	69.50	9.01	9.53	49.22	46.97	27.56	39.17	16.29	3.29
100 days		99.23	97.19	94.89	94.25	99.23	95.02	99.62	99.87	99.74
avg		64.39	-32.98	-65.59	44.68	38.42	35.73	76.14	56.85	-70.08
sd		38.86	246.54	272.43	73.44	58.27	61.78	28.00	41.53	201.52
max		99.23	97.19	94.89	97.11	99.23	95.02	99.62	99.87	99.74
min		-18.18	-668.42	-790.91	-142.11	-76.92	-100.00	15.38	0.00	-426.32

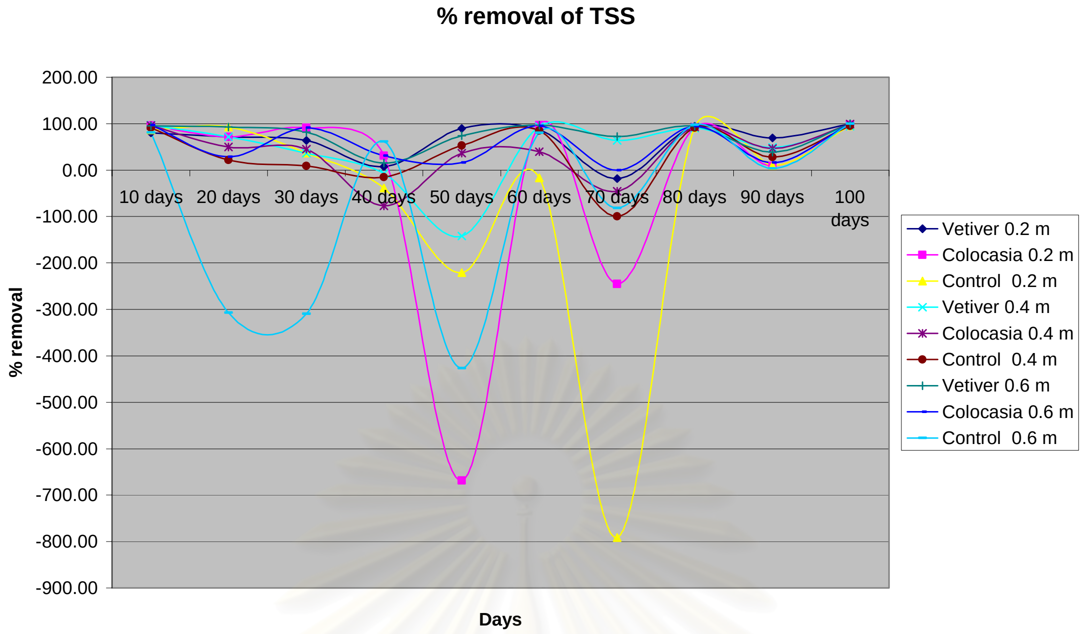


Figure 4.5 Percent Removal of TSS by the FWS Constructed Wetland

*Remark: The TSS was interfered by the algae bloom of leachate of the 50th and 70th day

Table 4.15 Efficiency of Average TSS Removal in Percent by SPSS Analysis (%)

Type of Plants	Water Level (m)			F. Prob	The most suitable level (m)
	0.2	0.4	0.6		
Vetiver	^{c}64.40^{b}	^{a}44.68^{a}	^{b}76.14^{c}	121.70	0.6
Colocasia	^{b}-32.98^{a}	^{a}38.39^{b}	^{b}56.85^{c}	283.46	0.6
No plant	^{a}-65.59^{a}	^{a}35.73^{b}	^{a}-70.08^{a}	66.29	0.4
F. Prob	1,123.27	1.09	155.7		
The most suitable plant	Vetiver	all	Vetiver,Colocasia		

*The different left corner letter means the difference among the plants and no plant with 95% confidence

*The different right corner letter means the difference among the level of depth of water with 95% confidence

4.6.3 BOD

4.6.3.1 Amount of BOD in the Inlet and Outlet Wastewater

The amount of BOD in the inlet was average ± standard deviation for 150.23 ± 30.58 mg/L.

BODs decrease from the declining depth of wastewater. So the lowest BOD outlet wastewater is 49.00 ± 25.41 mg/L at 0.2 m depth in ponds with vetiver. And the most BOD outlet wastewater is 125.00 ± 28.16 mg/L at 0.6 m in ponds without plant. The lowest BOD outlet wastewater is 60.00 ± 20.68 mg/L at 0.2 m depth in ponds with colocasia.

4.6.3.2 Efficiencies of BOD Removal

The 9 types of ponds show the result in the table. The highest efficiency of BOD removal is 95.00 ± 41.67 percent at 0.2 m depth in ponds with vetiver. And the lowest efficiency of BOD removal is 18.64 ± 12.14 percent at 0.6 m in ponds without plant. The highest efficiency of BOD removal in ponds with colocasia is 58.96 ± 16.62 percent at 0.2 m depth.

Table 4.16 Percent BOD Removal in the Constructed Wetland (%)

Day	Percent BOD removal								
	Depth(m)								
	0.2			0.4			0.6		
	vetiver	colocasia	No plant	vetiver	colocasia	No plant	vetiver	colocasia	No plant
10 days	43.86	50.88	29.82	78.95	71.93	43.86	43.86	36.84	22.81
20 days	50.00	33.33	25.00	41.67	50.00	33.33	25.00	16.67	8.33
30 days	70.59	64.71	58.82	70.59	70.59	64.71	58.82	58.82	41.18
40 days	75.00	58.33	41.67	58.33	41.67	16.67	66.67	58.33	33.33
50 days	95.00	90.00	15.00	65.00	65.00	5.00	25.00	25.00	20.00
60 days	86.84	76.32	60.53	78.95	84.21	63.16	26.32	21.05	10.53
70 days	48.48	42.42	39.39	45.45	48.48	27.27	18.18	18.18	15.15
80 days	67.74	54.84	41.94	61.29	41.94	35.48	29.03	22.58	22.58
90 days	41.67	50.00	8.33	50.00	41.67	50.00	16.67	8.33	0.00
100 days	81.25	68.75	6.25	81.25	68.75	31.25	37.50	18.75	12.50
avg	66.04	58.96	32.68	63.15	58.42	37.07	34.70	28.46	18.64
sd	19.03	16.62	19.27	14.37	15.45	19.00	16.95	17.42	12.15
max	95.00	90.00	60.53	81.25	84.21	64.71	66.67	58.82	41.18
min	41.67	33.33	6.25	41.67	41.67	5.00	16.67	8.33	0.00

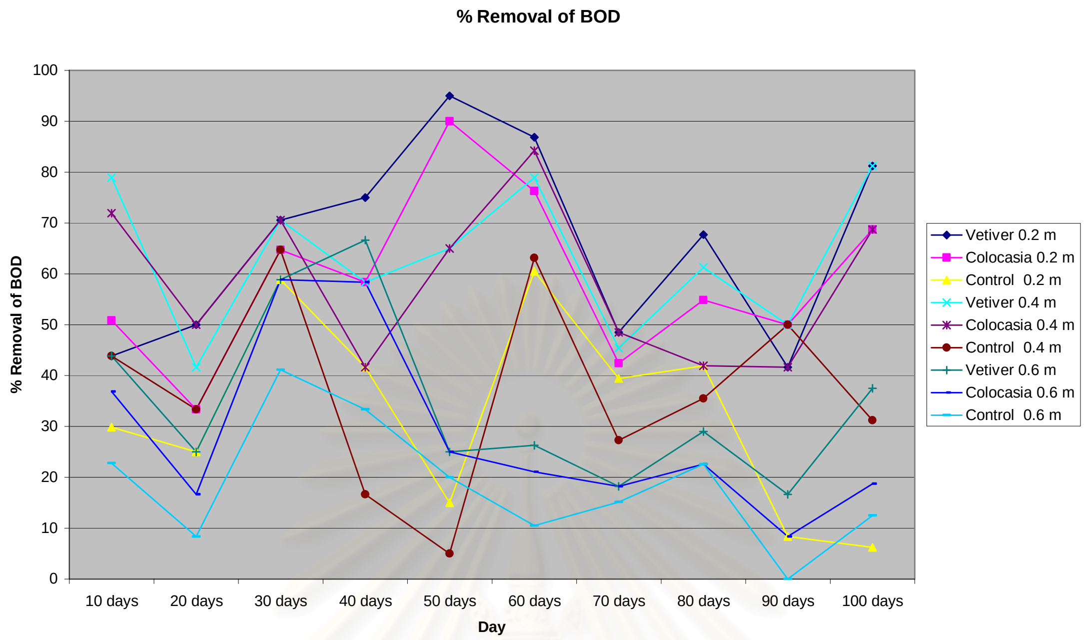


Figure 4.6 Percent Removal of BOD by the FWS Constructed Wetland

By one way ANOVA analysis, the average of BOD removal in the constructed wetlands is different with 0.05 significant figures due to the level of depth and by the type of plant. So the depth of wastewater and type of plant affect the BOD removal efficiency significantly. The Table 4.17 shows the result.

Table 4.17 Efficiency of Average BOD Removal in Percent by SPSS analysis (%)

Type of Plants	Water Level (m)			F. Prob	The most suitable level (m)
	0.2	0.4	0.6		
Vetiver	$^{c}66.04^{b}$	$^{b}63.15^{b}$	$^{b}34.70^{a}$	110.44	0.2,0.4
Colocasia	$^{b}58.65^{b}$	$^{b}58.42^{b}$	$^{b}28.46^{a}$	112.02	0.2,0.4
No plant	$^{a}32.68^{b}$	$^{a}37.07^{b}$	$^{a}18.64^{a}$	32.27	0.2,0.4
F. Prob	294.17	69.72	14.68		
The most suitable	Vetiver	Vetiver,Colocasia	Vetiver, Colocasia		

*The different left corner letter means the difference among the plants and no plant with 95% confidence

*The different right corner letter means the difference among the depth with 95% confidence

Conclusively, the greatest efficiency of BOD removal occurred at the experimental pond with vetivers at 0.2 m depth and 0.4 m depth.

From the analysis, greater BOD removal occurred in the shallower ponds with plants. One reason for this maybe from the hydraulic loading rate. When the hydraulic loading rate is low, the BOD is low too. So a great efficiency of BOD removal occurs.

The reasons why vetiver leads the higher BOD removal maybe because

A) Roots of vetiver can grow up to 1 m for each one in comparison to colocasia's. Microorganisms can host more too. Microorganisms are the main removers of BOD.

B) Leaves of rotten colocasia dropped down to the pond increasing the nutrients for microorganisms or BOD.

C) The shade of colocasia attracts small animals to habitat and die with small algae. So BOD increases by them.

D) Colocasia dies easier than vetiver. The dead stems increase the substances in ponds.

4.6.4 COD

4.6.4.1 Amount of COD in the Inlet and Outlet Wastewater

The amount of COD in the inlet was average ± standard deviation for 1,098.98 ± 257.70 mg/L.

COD decreases with the declining depth of wastewater. The lowest outlet wastewater is 451.84 ± 273.09 mg/L at 0.4 m depth in ponds with colocasia. And the most outlet wastewater is 675.82 ± 279.58 mg/L at 0.2 m depth in ponds without plant.

4.6.4.2 Efficiencies of COD Removal

Out of the 9 types of ponds show the result in the table the most efficiency of COD removal is 53.76 ± 30.07 percent at 0.2 m in ponds with vetiver. The lowest efficiency of COD removal is 34.55 ± 31.23 percent at 0.6 m in ponds without plant. The description of COD removal is the same as BOD removal. The data are in Table 4.18.

Table 4.18 Percent COD Removal in the Constructed Wetland (%)

Day	Percent COD removal								
	Depth of water in the FWS constructed wetland (m)								
	0.2			0.4			0.6		
	vetiver	colocasia	No plant	vetiver	colocasia	No plant	vetiver	colocasia	No plant
10 days	25.85	15.26	18.44	15.26	15.26	25.85	25.85	36.44	36.44
20 days	18.37	2.04	0.87	41.69	2.04	30.03	65.01	41.69	30.03
30 days	81.82	63.64	45.45	87.88	51.52	51.52	45.45	75.76	39.39
40 days	82.83	76.67	45.42	45.42	35.42	14.17	14.17	4.17	3.23
50 days	92.72	92.72	70.87	92.72	92.72	85.44	92.72	85.44	73.30
60 days	84.72	73.67	47.36	12.22	56.11	73.75	82.50	73.67	56.11
70 days	34.07	28.80	20.89	60.44	59.12	20.89	52.53	2.43	1.11
80 days	55.33	55.33	82.13	91.07	73.20	27.67	91.07	68.73	91.07
90 days	47.79	10.90	17.79	27.79	0.90	14.00	27.79	17.79	6.41
100 days	14.14	2.76	2.76	60.00	3.88	2.76	8.53	8.41	8.41
avg	53.76	42.18	35.20	53.45	39.02	34.61	50.56	41.45	34.55
sd	30.07	34.02	27.59	30.28	32.55	27.06	31.44	32.46	31.24
max	92.72	92.72	82.13	92.72	92.72	85.44	92.72	85.44	91.07
min	14.14	2.04	0.87	12.22	0.90	2.76	8.53	2.43	1.11

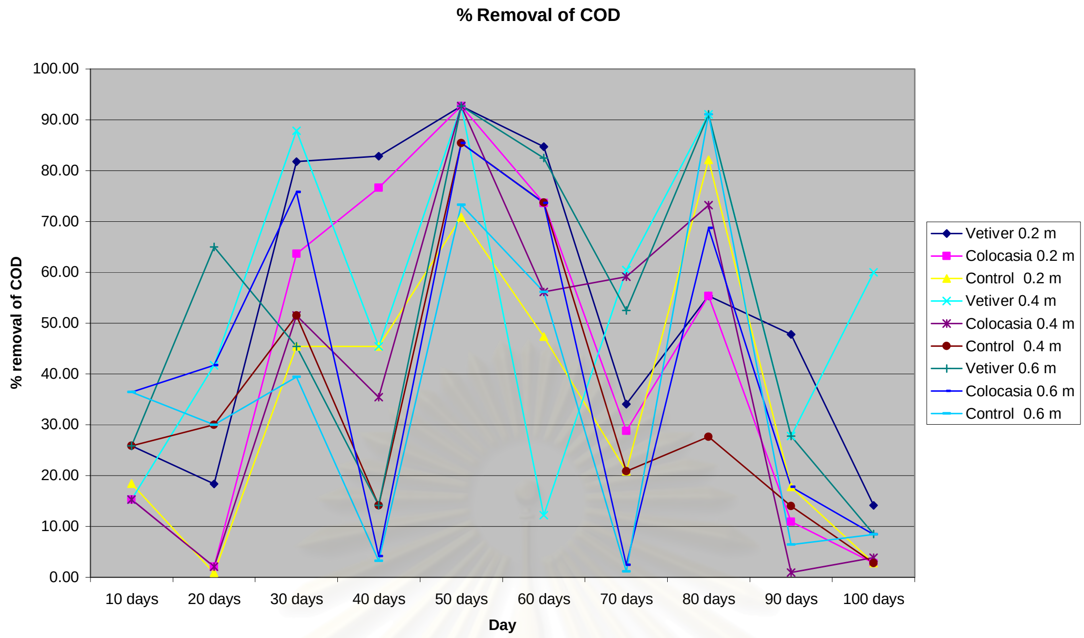


Figure 4.7 Percent COD Removal by the FWS Constructed Wetland

But by one way ANOVA analysis, the average of COD removal in the constructed wetlands is different with 0.05 significant figures due to the level of depth and by the type of plant. So the depth of wastewater and type of plant affects the COD removal efficiency significantly. The table 4.19. It seems the constructed wetland with vetiver at 0.4 meter level of depth get the most efficiency in the COD removal. The One-Way ANOVA is conclusive here because of the fact that the average COD removal is fluctuating and it is close in the removal efficiency.

Table 4.19 Efficiency of Average COD Removal in the Constructed Wetland (%)

Type of Plants	Water Level (m)			F. Prob	The most suitable level (m)
	0.2	0.4	0.6		
Vetiver	$^{c}54.43^{a}$	$^{c}58.84^{b}$	$^{c}50.95^{b}$	44.70	0.2,0.4
Colocasia	$^{b}42.33^{b}$	$^{b}41.70^{a}$	$^{b}39.03^{b}$	62.57	0.2,0.6
No plant	$^{a}35.46^{b}$	$^{a}34.80^{a}$	$^{a}34.64^{a}$	5.48	0.2
F. Prob	1,434.82	2,687.38	1,148.45		
The most suitable	Vetiver	Vetiver	Vetiver		

*The different left corner letter means the difference among the plants with 95% confidence

*The different right corner letter means the difference among the level of depth with 95% confidence

4.6.5 Total Dissolve Solids (TDS)

4.6.5.1 Amount of TDS in the Inlet and Outlet of Wastewater

The average TDS in the inlet in 2,015.82 mg/L with 1,090.48 standard deviation.

The TDSs of outlet wastewater are lower than the inlet for all. The lowest is 698.8 ± 468.63 mg/L at 0.2 m for ponds with vetiver. And the maximum TDS occurs at 0.6 m depth in ponds without plant for 1,436.6 ± 577.90 mg/L. The lowest TDS by colocasia is 914.6 ± 463.21 mg/L at 0.2 m.

It can be concluded that open air ponds with the greatest depth can accumulate more substances than others since it can pursue more substances with more volume.

Also, when there are plants in the ponds, higher hydraulic loading rates occur. So TDS in the system will decrease. The shallower the pond, the less TDS present. The percentages of TDS removal are shown in the table 4.20. And the efficiency of TDS removal analysis by SPSS is shown in Table 4.21. The figure 4.8 shows the percentages of TDS removal in the constructed wetlands.

Table 4.20 Percent TDS Removal in the Constructed Wetland (%)

	Percent TDS removal								
	Depth of water in the FWS constructed wetland (m)								
	0.2			0.4			0.6		
Day	vetiver	colocasia	No plant	vetiver	colocasia	No plant	vetiver	colocasia	No plant
10 days	80.70	79.30	74.00	76.45	70.55	72.20	93.25	48.75	33.75
20 days	86.31	64.49	70.16	57.83	11.84	40.57	35.51	-22.44	-28.11
30 days	69.57	43.71	62.86	53.29	52.43	58.29	58.00	64.43	-9.57
40 days	53.73	30.89	55.05	66.91	31.04	18.01	60.91	-14.20	4.54
50 days	12.50	-65.15	10.23	21.21	-21.21	36.17	17.23	10.98	-61.55
60 days	92.17	93.46	81.12	85.98	77.85	75.97	85.08	85.18	79.39
70 days	66.18	29.88	47.09	42.89	42.98	32.36	68.66	47.69	56.34
80 days	60.87	66.37	52.91	55.27	38.68	26.57	68.83	55.27	53.03
90 days	53.56	-38.52	-37.73	-3.69	19.26	-10.29	7.39	-27.44	-47.23
100 days	-18.52	54.41	-70.75	41.51	68.33	26.18	-5.24	55.04	17.75
avg	55.71	35.88	34.49	49.76	39.17	37.60	48.96	30.33	9.83
sd	34.33	50.72	51.22	26.28	30.51	25.96	33.54	40.17	46.78
max	92.17	93.46	81.12	85.98	77.85	75.97	93.25	85.18	79.39
min	-18.52	-65.15	-70.75	-3.69	-21.21	-10.29	-5.24	-27.44	-61.55

Table 4.21 Efficiency of Average TDS Removal in the Constructed Wetland (%)

Type of Plants	Water Level (m)			F. Prob	The most suitable level (m)
	0.2	0.4	0.6		
Vetiver	$^{c}55.71^{c}$	$^{b}49.76^{b}$	$^{c}48.96^{a}$	894.74	0.2
Colocasia	$^{b}36.54^{b}$	$^{a}39.17^{c}$	$^{b}30.33^{a}$	82.24	0.4
No plant	$^{a}34.63^{b}$	$^{a}37.45^{c}$	$^{a}9.83^{a}$	461.98	0.4
F. Prob	2,402.15	90.02	1,778.05		
The most suitable	Vetiver	Vetiver	Vetiver		

*The different left corner letter means the difference among the plants with 95% confidence

*The different right corner letter means the difference among the level of depth with 95% confidence

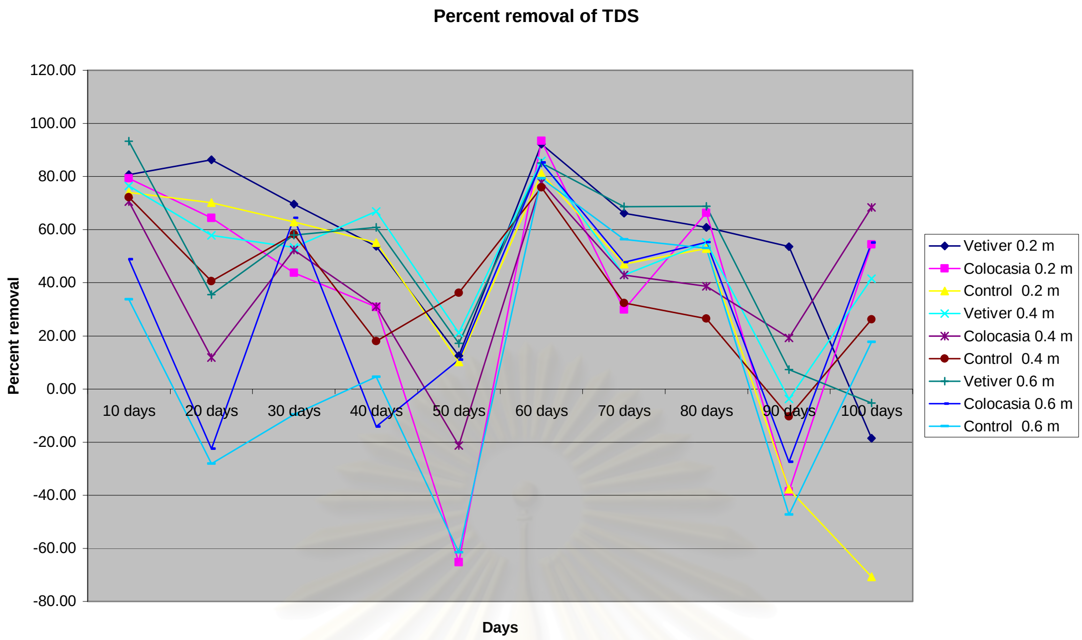


Figure 4.8 Percent TDS Removal by the FWS Constructed Wetlands

4.6.5.2 Efficiencies of TDS Removal

The highest efficiency for average TDS removal was 55.71 ± 34.33 percent at 0.2 m in ponds with vetiver. The lowest efficiency of average TDS removal is 30.33 ± 40.17 percent at 0.6 m in ponds without plant. The best efficiency of average TDS removal is 48.96 ± 33.54 percent at 0.2 m in ponds with colocasia.

And by one way ANOVA analysis, the average of TDS removal in the constructed wetlands is different with 0.05 significant figures due to the level of depth and by the type of plant. So the depth of wastewater and type of plant affect the TDS removal efficiency significantly. From the Table 4.21, it seems the constructed wetland with vetiver at 0.2 meter level of depth get the greatest efficiency in the TDS removal. The One-Way ANOVA is conclusive here because of the fact that the average TDS removal efficiency is fluctuating and it is close in the removal efficiency.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

5.1.1 Growth of Vetiver and Colocasia

Colocasias grew at a faster rate than the vetivers. But these plants also die faster too. Vetiver withstands the high concentration of wastewater better than colocasia due to the texture of its body. The body of vetiver is firmer and stronger. The stem of colocasia is soft and like a sponge. The growths of vetiver and colocasia when the water level is more than 0.4 m declined. The survival of them at 0.6 m depth was less than at the shallower depth. At the end of the experiment, the 0.6 m deep pond had fewer surviving plants than the 0.4 m and 0.2 m ponds.

5.1.2 Efficiency of Constructed Wetland and Suitable Level of Depth for BOD Removal in the Wastewater

A higher efficiency of BOD removal occurs in shallower depths. The highest average efficiency of BOD removal was 66.04 ± 19.02 percent at 0.2 m depth in ponds with vetiver. The second most efficient was the wetlands with vetiver at 0.4 meter water level. The average efficiency was 63.15 ± 14.37 percent. However, the wetlands with colocasia did not have the contemptible efficiency level in BOD removal. At the water level of 0.2 meter and 0.4 meter, colocasias gave the BOD removal for 58.96 ± 16.62 percent and 58.42 ± 15.45 percent. The efficiencies at 0.2 m and 0.4 m with plants are quite similar. The lowest average efficiency of BOD removal was 18.64 ± 12.15 percent at 0.6 m in ponds without plant.

5.1.3 Efficiency of Constructed Wetland and Suitable Level of Depth for TKN Removal in the Wastewater.

Also, the shallower the water, the greater the TKN removal in ponds with plant. The most average TKN removal was 79.37 ± 11.46 percent at 0.2 m depth in ponds with vetiver. The second most efficient model was the wetland with vetiver at 0.4 meter water level. The average efficiency was 77.95 ±13.43 percent. However, the wetlands with colocasia did not give a contemptible efficiency level in TKN removal either. At the water level of 0.2 meter and 0.4 meter, Colocasias gave the TKN removal for 77.85±15.69 percent and 77.73±14.34 percent. So the efficiencies at 0.2 m and 0.4 m with plants were quite similar. And the lowest average TKN removal was 18.25 ± 8.32 percent at 0.6 m without plant. Anyway, the TKN removal percents were similar among 0.2 m and 0.4 m with both plants.

5.1.4 Efficiency of Constructed Wetland and Suitable Level of Depth for COD Removal in the Wastewater

Generally, COD decreases in relation to BOD. So the most average efficiency of COD removal was 53.76 ± 30.06 percent at 0.2 m in ponds with vetiver. The second most efficient model was the wetland with vetivers at 0.4 meter water level. The average efficiency was 53.45 ± 30.28 percent. But by the SPSS analysis by One-way ANOVA, the most efficient constructed wetland with vetiver at 0.4 meter depth becomes the best in COD removal. However, the wetlands with colocasia did not give a contemptible efficiency level in COD removal. At the water level of 0.2 meter and 0.4 meters, colocasias gave the COD removal for 42.18±34.02 percent and 39.02±32.55 percent. And the lowest average of COD removal was 34.55 ± 31.23 percent at 0.6 m without plants due to the hydraulic loading rate.

5.1.5 Efficiency of Constructed Wetland and Suitable Level of Depth for TSS Removal in the Wastewater

The highest efficiency of TSS removal was 76.14 ± 28.00 percent at 0.6 m in ponds with vetiver. The second most efficient model was the wetland with vetivers at 0.2 meter water level. The average efficiency was 64.39 ± 38.86 percent. But by the SPSS analysis by One-way ANOVA, the most efficient constructed wetlands with vetivers in TSS removal were at 0.6 meters depth. However, the wetlands with colocasia did not give a contemptible efficiency level in TSS removal. At the water level of 0.6 meters and

0.4 meters, colocasias gave the TSS removal for 56.85 ± 41.53 percent and 38.42 ± 58.27 percent. And the lowest average of TSS removal was -70.08 ± 201.52 percent at 0.6 m in ponds without plants due to the hydraulic loading rate and algae bloom in the pond.

5.1.6 Efficiency of Constructed Wetland and Suitable Level of Depth for TDS Removal in the Wastewater

Generally, TDS decreases in relation to as TSS. So the most average efficiency of TDS removal was 55.71 ± 34.33 percent at 0.2 m in ponds with vetiver. The second most efficient model was the wetland with vetivers at 0.4 meter water level. The average efficiency was 49.76 ± 26.28 percent. But by the SPSS analysis by One-way ANOVA, the most efficient constructed wetland with colocasia in TDS removal was at 0.4 meter depth. However, the wetlands with colocasia did not give a contemptible efficiency level in TDS removal. At the water level of 0.2 meter and 0.4 meter, Colocasias gave the TDS removal for 35.88 ± 50.72 percent and 39.17 ± 30.51 percent. And the lowest average of TDS removal was 9.83 ± 46.78 percent at 0.6 m in ponds without plants due to the hydraulic loading rate and algae bloom reasons too.

5.2 Recommendations

5.2.1 From the Studied Results

The greatest efficiencies of BOD, COD, and TKN removal of constructed wetland always occur at 0.2 m with vetiver. But at the 0.2 and 0.4 m depth the efficiencies of removal are quite similar. So for limited areas of constructed wetland, a 0.4 m depth would produce similar results as wider areas with 0.2 m depth.

5.2.2 Further Areas of Inquiring

A) It should have more study on retention time of less than 10 days for the removal efficiency may be useful for other factors such as heavy metals, phenol, etc and for energy, low cost of construction, and time savings.

B) It should have more study on other plants to remove selected substances, such as mutualism of floating plants and sinking plants such as water hyacinth, duckweed, water lily, lotus, hydrilla, water clover, water mimosa, etc.

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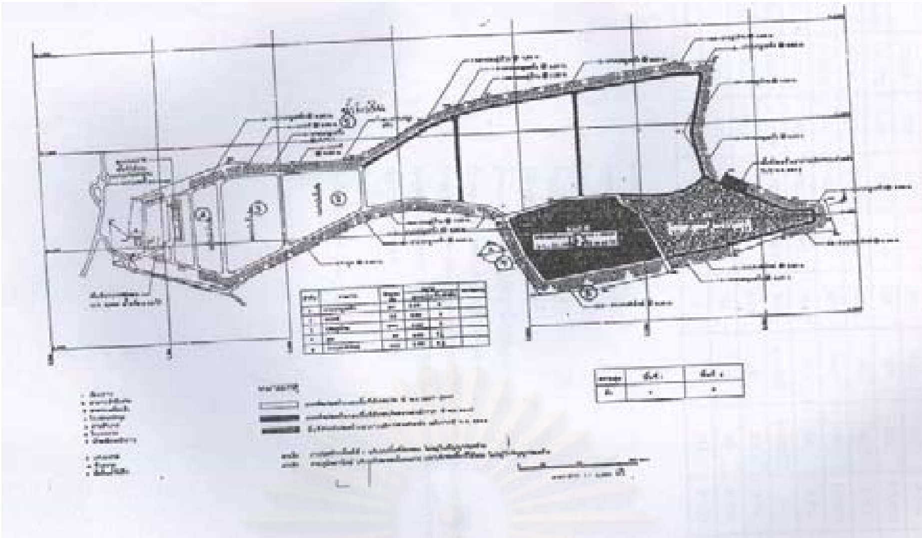
APPENDICE

APPENDIX A

THE PICTURES OF THE SITE, THE PLANTS, INFORMATION OF PLANTS, AND THE TEST



The Map of the Saensuk Municipal Solid Waste Disposal Center

Manhole at the Site of Saensuk Municipal Solid Waste Disposal Center

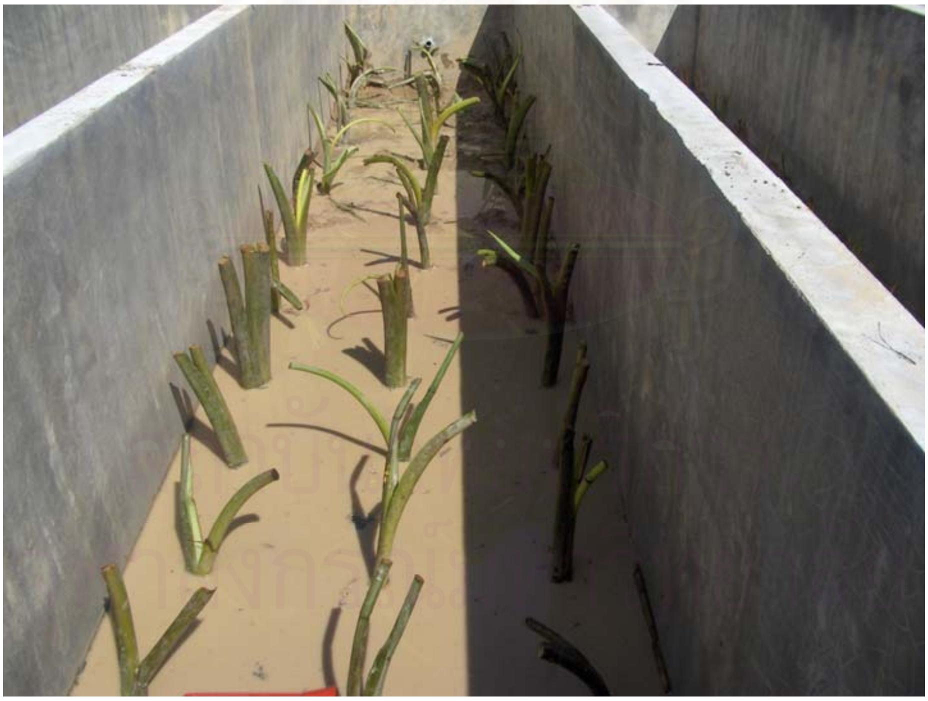
Side View of the FWS Constructed Wetland Outlets

View of the Site

The Constructed Wetland

Stabilization of New Ponds with Normal Water, Water Hyacinth, and Morning Glory

Tanks for Leachate



New Stems of Colocasia

New Stems of Vetiver

New Colocasia

Upper View of Ponds

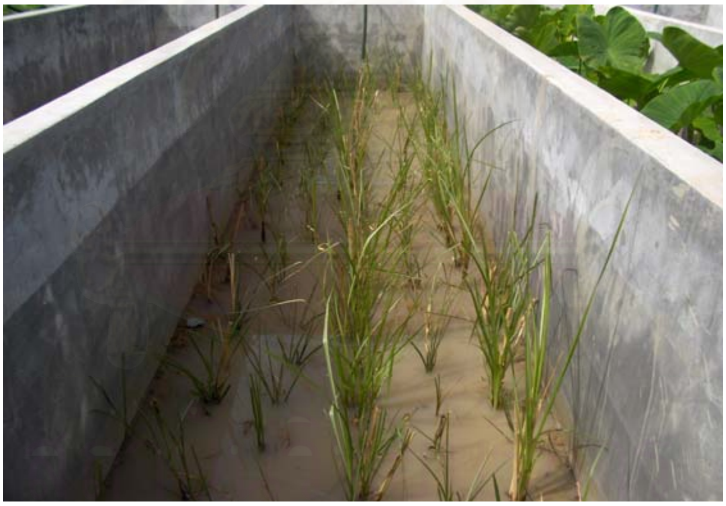
General features of vetiver

All growth of vetivers for 100 days was great for the shallow ponds for the first period of experiment (0 – 20 days). The shallower depth, the better growth.

Firstly, at the depth of 0.4 m, vetivers were growing better than at 0.2 and 0.6 m. Anyway, somehow they got yellowish leaves at the inlet. By the time of 20 – 50 days, at the depth of 0.2 and 0.4 m vetivers grew at the similar rate. The less growth occurred for the depth at 0.6 m with less stems. From 50 – 80 days, vetivers at 0.2 and 0.4 m were growing at the similar rate as 0.6 m and start having more yellowish leaves and dying for some. By the end of the experiment (80 – 100 days), vetivers at 0.2 and 0.4 m were yellowish and dying more. And there were not many alive vetiver at the depth of 0.6 m. For the control ponds, vetivers at 0.2 and 0.4 m were growing at the similar rate at 0.6 m. However, vetivers in the control ponds were smaller and have less leaves.

Conclusively, by the end of the experiment (100^{th} day), the vetivers at the 0.2 m depth grew at the maximum comparing to the other depths by means of measuring the height.

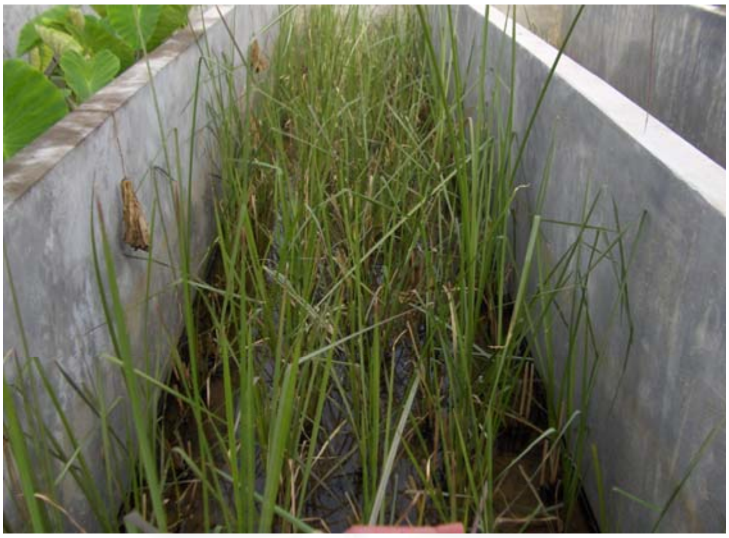
Vetivers at the 0.2 m Pond at the 50^{th} day of the Experiment



Vetivers in the Experimental Ponds at 0.4 m Depth at the 50^{th} day of the Experiment

Vetivers and Colocasias in the Control Ponds at 0.2 m Depth at the 50th day of the Experiment

Vetivers in the Experimental Pond at 0.2 m Depth at the 80th day of the Experiment



Vetivers in the Experimental Pond at 0.4 m Depth at the 80th day of the Experiment

Vetivers and Colocasias in the Control Pond at the 0.2 m depth at the 80th day of the Experiment

General features of colocasia

For the all period of experiment (100 days), colocasias in the experimental ponds were growing less at 0.6 m for the first 20 days. The similar rate of growth occurred at 0.2 and 0.4 m for first 20 days. The greener leaves and bigger stems remained more, the farther of inlet stored. At the depth of 0.2 m and 0.4 m for 20 – 50 days, colocasias were growing at the slower rate than 0.6 m.

By the 50 – 80 days of the experiment period, they were cheerless and dying at the same time and having new stems. The colocasias at 0.2 and 0.4 m had size of stems and leaves similarly. But at the 0.6 m, they were the biggest. From 80 – 100 days of the experiment, all colocasias were dying more with dried leaves. Anyway, they flourished and had new leaves from the old dead ones. For the control ponds, at all level of depth, colocasias were smaller, less green, and more yellowish. Colocasia at the depth of 0.2 and 0.4 m were growing at the fewer rates than 0.6 m. By the end of the experiment, from the 80^{th} day, all colocasias in the control ponds were flourished new leaves as the experimental ponds.

Conclusively, by the end of the experiment (100^{th} day), the colocasias at the 0.6 m depth grew at the maximum comparing to the other depths by means of measuring the height.

Colocasias in the Experimental Pond at the 0.2 m Depth at the 50th day of the Experiment

Colocasias in the Experimental Pond at the 0.4 m depth at the 50th day of the Experiment

Colocasias in the Control Ponds at the 50th day of the Experiment

Colocasias in the Experimental Pond at the 0.2 m Depth at the 80th day of the Experiment

Colocasias in the Experimental Pond at the 0.4 m Depth at the 80^{th} day of the Experiment

Colocasias in the Experimental and Control Ponds at the 80^{th} day of the Experiment

Landfill at Saensuk Municipal Solid Waste Disposal Center

Manhole of Saensuk Municipal Solid Waste Disposal Center

The Pests of Colocasia

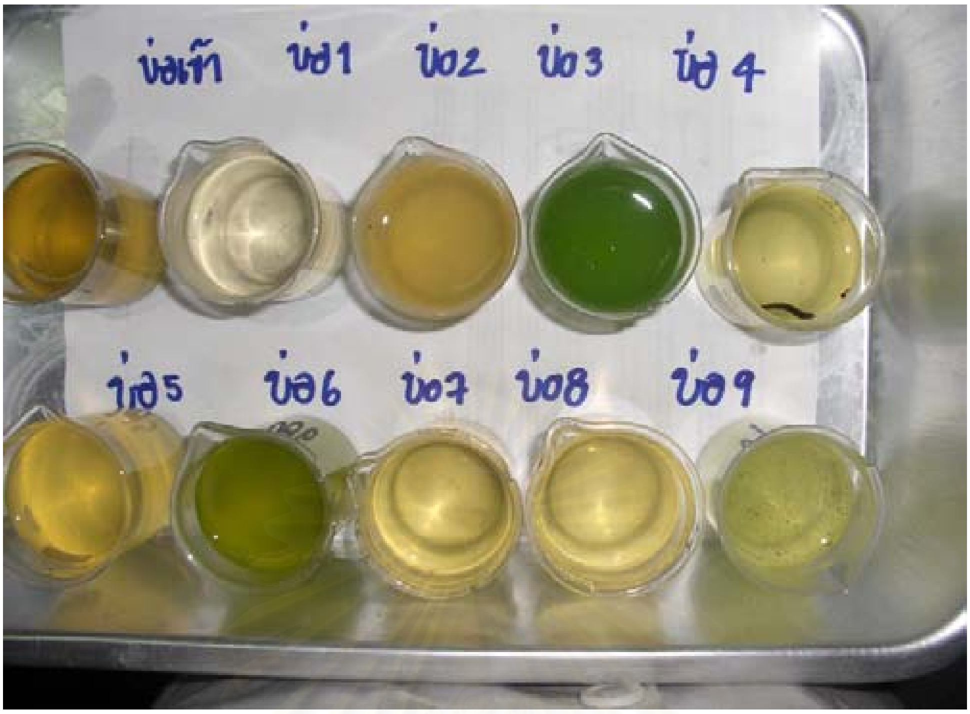
The Damage of Colocasias

The Pest of vetivers

The rotten Colocasias

The Flourished Vetivers at the 110th day

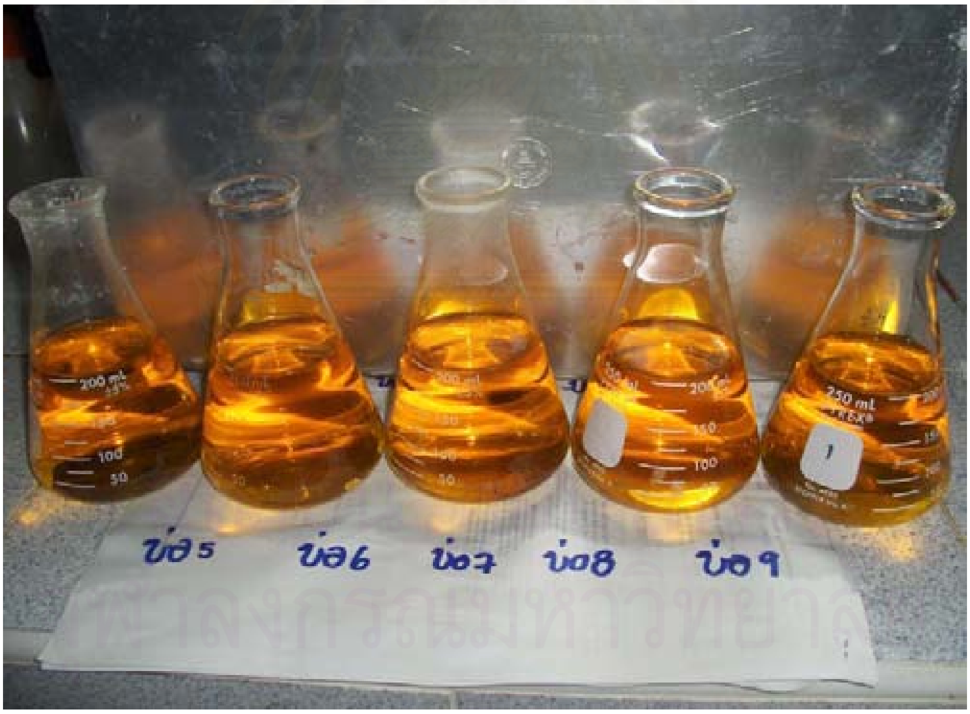
The Bottles of Samples



Samples

The Pond with No Plant

BOD Bottles



BOD Testing

COD Testing

TKN Test

The Sign of Site, Saensuk Municipal Solid Waste Disposal Center

The Direction to the Site, Saensuk Municipal Solid Waste Disposal Center

The site

Saensuk Municipal Solid Waste Disposal Center

APPENDIX B

CONCLUSIONS OF THE ANALYSES BY SPSS OF THE WET WEIGHT, DRY WEIGHT, AND HEIGHT DATA OF THE PLANTS DURING THE EXPERIMENT

Conclusions of the analyses by SPSS of wet weight data

By using of SPSS Version 12.0 analysis at 95% confidence by uses of One-way ANOVA analyses and analyze the difference by DUNCAN

The results are

Wet weight of plants at the 20 centimeter level of depth

At the 10th day, the control ponds with the colocasia were different to the others but the rest were not different to each other

At the 20th day, the control ponds with the colocasia were different to the others but the rest were not different to each other

At the 30th day, the control ponds with the vetiver and the experimental ponds with the vetiver were not different, the control ponds with the colocasia and the experimental ponds with the colocasia were not different either

At the 40th day, the control ponds with the vetiver and the experimental ponds with the vetiver were not different, the control ponds with the colocasia and the experimental ponds with the colocasia were not different either

At the 50th day, the control ponds with the vetiver and the experimental ponds with the vetiver were not different, the control ponds with the colocasia and the experimental ponds with the colocasia were not different either

At the 60th day, the experimental ponds with the vetiver and the colocasia and the control ponds with the colocasia were not different to each other but different to the experimental ponds with the colocasia, the control ponds with the colocasia were not different to the control ponds with the colocasia

At the 70th day, The experimental ponds with the vetiver and the colocasia and the control ponds with the colocasia were not different to each other but different to the experimental ponds with the colocasia, the control ponds with the colocasia were not different to the control ponds with the colocasia

At the 80th day, every pond were not different to each other

At the 90th day, the control ponds with the vetiver and the experimental ponds with the vetiver were not different, the control ponds with the colocasia and the experimental ponds with the colocasia were not different either

At the 100th day, every pond were not different to each other

<u>Oneways</u>

Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
day10	1.424	3	8	.306
day20	1.333	3	8	.330
day30	1.311	3	8	.336
day40	3.851	3	8	.056
day50	4.494	3	8	.040
day60	11.924	3	8	.003
day70	9.002	3	8	.006
day80	12.843	3	8	.002
day90	2.616	3	8	.123
day100	12.489	3	8	.002

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
day10	Between Groups	572.250	3	190.750	4.829	.033
	Within Groups	316.000	8	39.500		
	Total	888.250	11			
day20	Between Groups	1122.917	3	374.306	14.972	.001
	Within Groups	200.000	8	25.000		
	Total	1322.917	11			
day30	Between Groups	2480.250	3	826.750	9.263	.006
	Within Groups	714.000	8	89.250		
	Total	3194.250	11			
day40	Between Groups	4489.583	3	1496.528	6.193	.018
	Within Groups	1933.333	8	241.667		
	Total	6422.917	11			
day50	Between Groups	6675.000	3	2225.000	8.409	.007
	Within Groups	2116.667	8	264.583		
	Total	8791.667	11			
day60	Between Groups	12225.000	3	4075.000	3.390	.074
	Within Groups	9616.667	8	1202.083		
	Total	21841.667	11			
day70	Between Groups	13766.667	3	4588.889	4.102	.049
	Within Groups	8950.000	8	1118.750		
	Total	22716.667	11			
day80	Between Groups	36216.667	3	12072.222	1.620	.260
	Within Groups	59600.000	8	7450.000		
	Total	95816.667	11			
day90	Between Groups	36184.333	3	12061.444	62.603	.000
	Within Groups	1541.333	8	192.667		
	Total	37725.667	11			
day100	Between Groups	40672.917	3	13557.639	1.808	.224
	Within Groups	59983.333	8	7497.917		
	Total	100656.3	11			

Post Hoc Tests

Homogeneous Subsets

day10

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
controlvertiver	3	10.0000	
vertiver	3	10.6667	
colocasia	3	11.6667	
controlcolocasia	3		26.6667
Sig.		.763	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day20

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
vertiver	3	11.6667	
controlvertiver	3	15.0000	
colocasia	3	18.3333	
controlcolocasia	3		36.6667
Sig.		.156	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day30

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
vertiver	3	13.0000	
controlvertiver	3	15.0000	
controlcolocasia	3		40.0000
colocasia	3		45.0000
Sig.		.802	.535

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day40

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
vertiver	3	13.3333	
controlvertiver	3	15.0000	
controlcolocasia	3		45.0000
colocasia	3		58.3333
Sig.		.899	.324

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day50

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
vertiver	3	16.6667	
controlvertiver	3	16.6667	
controlcolocasia	3		51.6667
colocasia	3		71.6667
Sig.		1.000	.171

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day60

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
vertiver	3	20.0000	
controlvertiver	3	20.0000	
controlcolocasia	3	60.0000	60.0000
colocasia	3		96.6667
Sig.		.212	.231

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day70

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
vertiver	3	21.6667	
controlvertiver	3	25.0000	
controlcolocasia	3	81.6667	81.6667
colocasia	3		98.3333
Sig.		.068	.559

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day80

Duncan[a]

treatment	N	Subset for alpha = .05
		1
controlvertiver	3	36.6667
vertiver	3	45.0000
controlcolocasia	3	123.3333
colocasia	3	168.3333
Sig.		.117

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day90

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
controlvertiver	3	25.0000	
vertiver	3	36.6667	
controlcolocasia	3		126.0000
colocasia	3		151.6667
Sig.		.333	.053

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day100

Duncan[a]

treatment	N	Subset for alpha = .05
		1
controlvertiver	3	25.0000
vertiver	3	31.6667
controlcolocasia	3	100.0000
colocasia	3	168.3333
Sig.		.093

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Wet weight of the plants at the 40 centimeter of depth

At the 10th day, the experimental ponds with the vetiver and the control ponds with the vetiver and the colocasia were not different but to the experimental ponds with the colocasia, the control ponds with the colocasia were not different to the experimental ponds with the colocasia

At the 20th day, the control ponds with the vetiver and the experimental ponds with the vetiver were not different, the control ponds with the colocasia and the experimental ponds with the colocasia were not different, the experimental ponds with the vetiver were not different to the control ponds with the colocasia

At the 30th day, the control ponds with the colocasia and the experimental ponds with the colocasia were not different but the control ponds with the colocasia and the experimental ponds with the colocasia were different

At the 40th day, the experimental ponds with the vetiver , the control ponds with the vetiver and the control ponds with the colocasia were not different, the control ponds with the colocasia and the experimental ponds with the colocasia were not different either

At the 50th day, the experimental ponds with the vetiver, the control ponds with the vetiver and the control ponds with the colocasia were not different to each other but the control ponds with the colocasia

At the 60th day, The experimental ponds with the vetiver, the control ponds with the vetiver and the control ponds with the colocasia were not different to each other, the experimental ponds with the vetiver, the control ponds with the colocasia, and the control ponds with the colocasia were not different to each other

At the 70th day, the experimental ponds with the vetiver, the control ponds with the vetiver, and the control ponds with the colocasia were not different to each other

At the 80th day, The experimental ponds with the vetiver , the control ponds with the vetiver, and the control ponds with the colocasia were not different to each other but to the experimental ponds with the colocasia

At the 90th day, The experimental ponds with the vetiver , the control ponds with the vetiver, and the control ponds with the colocasia were not different to each other but to the experimental ponds with the colocasia

At the 100th day, The experimental ponds with the vetiver , the control ponds with the vetiver, and the control ponds with the colocasia were not different to each other but to the experimental ponds with the colocasia and the experimental ponds with the colocasia were not different to the control ponds with the colocasia

Oneway

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
day10	vertiver	3	9.3333	9.29157	5.36449	-13.7482	32.4149	3.00	20.00
	colocasia	3	31.6667	14.43376	8.33333	-4.1888	67.5221	15.00	40.00
	controlvertiver	3	7.5000	2.50000	1.44338	1.2897	13.7103	5.00	10.00
	controlcolocasia	3	25.0000	5.00000	2.88675	12.5793	37.4207	20.00	30.00
	Total	12	18.3750	13.18940	3.80745	9.9949	26.7551	3.00	40.00
day20	vertiver	3	10.0000	8.66025	5.00000	-11.5133	31.5133	5.00	20.00
	colocasia	3	38.3333	18.92969	10.92906	-8.6906	85.3573	25.00	60.00
	controlvertiver	3	7.5000	2.50000	1.44338	1.2897	13.7103	5.00	10.00
	controlcolocasia	3	30.0000	5.00000	2.88675	17.5793	42.4207	25.00	35.00
	Total	12	21.4583	16.46133	4.75198	10.9993	31.9174	5.00	60.00
day30	vertiver	3	13.3333	2.88675	1.66667	6.1622	20.5044	10.00	15.00
	colocasia	3	43.3333	5.77350	3.33333	28.9912	57.6755	40.00	50.00
	controlvertiver	3	7.5000	2.50000	1.44338	1.2897	13.7103	5.00	10.00
	controlcolocasia	3	31.6667	7.63763	4.40959	12.6938	50.6396	25.00	40.00
	Total	12	23.9583	15.57454	4.49598	14.0627	33.8539	5.00	50.00
day40	vertiver	3	15.0000	13.22876	7.63763	-17.8621	47.8621	5.00	30.00
	colocasia	3	63.3333	40.41452	23.33333	-37.0619	163.7286	40.00	110.00
	controlvertiver	3	10.0000	5.00000	2.88675	-2.4207	22.4207	5.00	15.00
	controlcolocasia	3	40.0000	5.00000	2.88675	27.5793	52.4207	35.00	45.00
	Total	12	32.0833	28.87735	8.33617	13.7355	50.4311	5.00	110.00
day50	vertiver	3	21.6667	17.55942	10.13794	-21.9534	65.2867	5.00	40.00
	colocasia	3	83.3333	37.85939	21.85813	-10.7146	177.3813	40.00	110.00
	controlvertiver	3	13.3333	7.63763	4.40959	-5.6396	32.3062	5.00	20.00
	controlcolocasia	3	40.0000	10.00000	5.77350	15.1586	64.8414	30.00	50.00
	Total	12	39.5833	33.80817	9.75958	18.1026	61.0640	5.00	110.00
day60	vertiver	3	28.3333	2.88675	1.66667	21.1622	35.5044	25.00	30.00
	colocasia	3	100.0000	75.00000	43.30127	-86.3103	286.3103	25.00	175.00
	controlvertiver	3	15.0000	5.00000	2.88675	2.5793	27.4207	10.00	20.00
	controlcolocasia	3	41.6667	7.63763	4.40959	22.6938	60.6396	35.00	50.00
	Total	12	46.2500	46.76464	13.49979	16.5372	75.9628	10.00	175.00
day70	vertiver	3	30.0000	10.00000	5.77350	5.1586	54.8414	20.00	40.00
	colocasia	3	111.6667	94.64847	54.64532	-123.4532	346.7865	45.00	220.00
	controlvertiver	3	15.0000	5.00000	2.88675	2.5793	27.4207	10.00	20.00
	controlcolocasia	3	51.6667	7.63763	4.40959	32.6938	70.6396	45.00	60.00
	Total	12	52.0833	56.02184	16.17211	16.4888	87.6779	10.00	220.00
day80	vertiver	3	35.3333	14.18920	8.19214	.0854	70.5813	20.00	48.00
	colocasia	3	605.0000	210.77239	121.68950	81.4124	1128.5876	365.00	760.00
	controlvertiver	3	25.0000	5.00000	2.88675	12.5793	37.4207	20.00	30.00
	controlcolocasia	3	90.0000	5.00000	2.88675	77.5793	102.4207	85.00	95.00
	Total	12	188.8333	267.89612	77.33495	18.6203	359.0464	20.00	760.00
day90	vertiver	3	33.3333	32.14550	18.55921	-46.5205	113.1872	10.00	70.00
	colocasia	3	480.0000	270.73973	156.31165	-192.5548	1152.5548	290.00	790.00
	controlvertiver	3	20.0000	5.00000	2.88675	7.5793	32.4207	15.00	25.00
	controlcolocasia	3	80.0000	10.00000	5.77350	55.1586	104.8414	70.00	90.00
	Total	12	153.3333	229.96377	66.38482	7.2213	299.4453	10.00	790.00
day100	vertiver	3	31.6667	7.63763	4.40959	12.6938	50.6396	25.00	40.00
	colocasia	3	118.3333	46.45787	26.82246	2.9256	233.7411	65.00	150.00
	controlvertiver	3	15.0000	5.00000	2.88675	2.5793	27.4207	10.00	20.00
	controlcolocasia	3	65.0000	31.22499	18.02776	-12.5672	142.5672	40.00	100.00
	Total	12	57.5000	47.79216	13.79641	27.1343	87.8657	10.00	150.00

Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
day10	4.822	3	8	.033
day20	6.022	3	8	.019
day30	2.156	3	8	.171
day40	9.311	3	8	.005
day50	4.476	3	8	.040
day60	3.403	3	8	.074
day70	11.368	3	8	.003
day80	11.767	3	8	.003
day90	12.253	3	8	.002
day100	6.373	3	8	.016

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
day10	Between Groups	1261.729	3	420.576	5.162	.028
	Within Groups	651.833	8	81.479		
	Total	1913.563	11			
day20	Between Groups	2051.563	3	683.854	5.888	.020
	Within Groups	929.167	8	116.146		
	Total	2980.729	11			
day30	Between Groups	2455.729	3	818.576	30.817	.000
	Within Groups	212.500	8	26.563		
	Total	2668.229	11			
day40	Between Groups	5456.250	3	1818.750	3.915	.054
	Within Groups	3716.667	8	464.583		
	Total	9172.917	11			
day50	Between Groups	8772.917	3	2924.306	6.156	.018
	Within Groups	3800.000	8	475.000		
	Total	12572.917	11			
day60	Between Groups	12622.917	3	4207.639	2.944	.099
	Within Groups	11433.333	8	1429.167		
	Total	24056.250	11			
day70	Between Groups	16239.583	3	5413.194	2.369	.147
	Within Groups	18283.333	8	2285.417		
	Total	34522.917	11			
day80	Between Groups	700099.0	3	233366.333	20.894	.000
	Within Groups	89352.667	8	11169.083		
	Total	789451.7	11			
day90	Between Groups	432800.0	3	144266.667	7.750	.009
	Within Groups	148916.7	8	18614.583		
	Total	581716.7	11			
day100	Between Groups	18691.667	3	6230.556	7.748	.009
	Within Groups	6433.333	8	804.167		
	Total	25125.000	11			

Post Hoc Tests

Homogeneous Subsets

day10

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
controlvertiver	3	7.5000	
vertiver	3	9.3333	
controlcolocasia	3	25.0000	25.0000
colocasia	3		31.6667
Sig.		.052	.392

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day20

Duncan[a]

treatment	N	Subset for alpha = .05		
		1	2	3
controlvertiver	3	7.5000		
vertiver	3	10.0000	10.0000	
controlcolocasia	3		30.0000	30.0000
colocasia	3			38.3333
Sig.		.784	.053	.371

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day30

Duncan[a]

treatment	N	Subset for alpha = .05		
		1	2	3
controlvertiver	3	7.5000		
vertiver	3	13.3333		
controlcolocasia	3		31.6667	
colocasia	3			43.3333
Sig.		.203	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day40

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
controlvertiver	3	10.0000	
vertiver	3	15.0000	
controlcolocasia	3	40.0000	40.0000
colocasia	3		63.3333
Sig.		.141	.221

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day50

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
controlvertiver	3	13.3333	
vertiver	3	21.6667	
controlcolocasia	3	40.0000	
colocasia	3		83.3333
Sig.		.189	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day60

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
controlvertiver	3	15.0000	
vertiver	3	28.3333	28.3333
controlcolocasia	3	41.6667	41.6667
colocasia	3		100.0000
Sig.		.431	.056

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day70

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
controlvertiver	3	15.0000	
vertiver	3	30.0000	30.0000
controlcolocasia	3	51.6667	51.6667
colocasia	3		111.6667
Sig.		.394	.080

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day80

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
controlvertiver	3	25.0000	
vertiver	3	35.3333	
controlcolocasia	3	90.0000	
colocasia	3		605.0000
Sig.		.490	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day90

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
controlvertiver	3	20.0000	
vertiver	3	33.3333	
controlcolocasia	3	80.0000	
colocasia	3		480.0000
Sig.		.619	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day100

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
controlvertiver	3	15.0000	
vertiver	3	31.6667	
controlcolocasia	3	65.0000	65.0000
colocasia	3		118.3333
Sig.		.072	.050

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Wet weight of the plants at the 60 centimeter of depth

At the 10th day, the experimental ponds with the vetiver and the control ponds with the vetiver were not different but to the experimental ponds with the colocasia and the control ponds with the colocasia

At the 20th day, the control ponds with the vetiver and the experimental ponds with the vetiver were not different, the control ponds with the colocasia and the experimental ponds with the colocasia were not different

At the 30th day, the control ponds with the vetiver and the experimental ponds with the vetiver were not different, the control ponds with the colocasia and the experimental ponds with the colocasia were not different

At the 40th day, the experimental ponds with the vetiver , the control ponds with the vetiver and the control ponds with the colocasia were not different but the experimental ponds with the colocasia

At the 50th day, the experimental ponds with the vetiver , the control ponds with the vetiver and the control ponds with the colocasia were not different but the experimental ponds with the colocasia

At the 60th day, the experimental ponds with the vetiver , the control ponds with the vetiver and the control ponds with the colocasia were not different but the experimental ponds with the colocasia

At the 70th day, the experimental ponds with the vetiver , the control ponds with the vetiver and the control ponds with the colocasia were not different but the experimental ponds with the colocasia

At the 80th day, the experimental ponds with the vetiver , the control ponds with the vetiver and the control ponds with the colocasia were not different but the experimental ponds with the colocasia

At the 90th day, the experimental ponds with the vetiver , the control ponds with the vetiver and the control ponds with the colocasia were not different but the experimental ponds with the colocasia

At the 100th day, The experimental ponds with the vetiver , the control ponds with the vetiver, and the control ponds with the colocasia were not different to the experimental ponds with the colocasia and the control ponds with the colocasia

Oneway

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
day10	vertiver	3	4.0000	1.73205	1.00000	-.3027	8.3027	2.00	5.00
	colocasia	3	23.3333	2.88675	1.66667	16.1622	30.5044	20.00	25.00
	controlvertiver	3	5.8333	1.44338	.83333	2.2478	9.4189	5.00	7.50
	controlcolocasia	3	15.0000	5.00000	2.88675	2.5793	27.4207	10.00	20.00
	Total	12	12.0417	8.50256	2.45448	6.6394	17.4439	2.00	25.00
day20	vertiver	3	6.6667	2.88675	1.66667	-.5044	13.8378	5.00	10.00
	colocasia	3	31.6667	7.63763	4.40959	12.6938	50.6396	25.00	40.00
	controlvertiver	3	10.0000	5.00000	2.88675	-2.4207	22.4207	5.00	15.00
	controlcolocasia	3	23.3333	5.77350	3.33333	8.9912	37.6755	20.00	30.00
	Total	12	17.9167	11.57158	3.34043	10.5644	25.2689	5.00	40.00
day30	vertiver	3	8.3333	5.77350	3.33333	-6.0088	22.6755	5.00	15.00
	colocasia	3	35.0000	8.66025	5.00000	13.4867	56.5133	25.00	40.00
	controlvertiver	3	10.0000	5.00000	2.88675	-2.4207	22.4207	5.00	15.00
	controlcolocasia	3	25.0000	5.00000	2.88675	12.5793	37.4207	20.00	30.00
	Total	12	19.5833	12.69544	3.66486	11.5170	27.6496	5.00	40.00
day40	vertiver	3	9.1667	1.44338	.83333	5.5811	12.7522	7.50	10.00
	colocasia	3	75.0000	22.91288	13.22876	18.0813	131.9187	50.00	95.00
	controlvertiver	3	13.3333	7.63763	4.40959	-5.6396	32.3062	5.00	20.00
	controlcolocasia	3	25.0000	5.00000	2.88675	12.5793	37.4207	20.00	30.00
	Total	12	30.6250	29.39011	8.48419	11.9514	49.2986	5.00	95.00
day50	vertiver	3	10.0000	8.66025	5.00000	-11.5133	31.5133	5.00	20.00
	colocasia	3	100.0000	70.00000	40.41452	-73.8896	273.8896	30.00	170.00
	controlvertiver	3	15.0000	5.00000	2.88675	2.5793	27.4207	10.00	20.00
	controlcolocasia	3	30.0000	5.00000	2.88675	17.5793	42.4207	25.00	35.00
	Total	12	38.7500	48.34182	13.95508	8.0351	69.4649	5.00	170.00
day60	vertiver	3	14.0000	3.60555	2.08167	5.0433	22.9567	10.00	17.00
	colocasia	3	148.3333	95.69918	55.25195	-89.3966	386.0633	70.00	255.00
	controlvertiver	3	15.0000	5.00000	2.88675	2.5793	27.4207	10.00	20.00
	controlcolocasia	3	38.3333	7.63763	4.40959	19.3604	57.3062	30.00	45.00
	Total	12	53.9167	70.90642	20.46892	8.8649	98.9685	10.00	255.00
day70	vertiver	3	15.8333	5.20416	3.00463	2.9055	28.7612	10.00	20.00
	colocasia	3	186.6667	100.16653	57.83117	-62.1608	435.4941	90.00	290.00
	controlvertiver	3	15.0000	5.00000	2.88675	2.5793	27.4207	10.00	20.00
	controlcolocasia	3	45.0000	5.00000	2.88675	32.5793	57.4207	40.00	50.00
	Total	12	65.6250	85.58704	24.70685	11.2456	120.0044	10.00	290.00
day80	vertiver	3	40.0000	17.32051	10.00000	-3.0265	83.0265	20.00	50.00
	colocasia	3	850.0000	51.96152	30.00000	720.9204	979.0796	790.00	880.00
	controlvertiver	3	20.0000	5.00000	2.88675	7.5793	32.4207	15.00	25.00
	controlcolocasia	3	61.6667	2.88675	1.66667	54.4956	68.8378	60.00	65.00
	Total	12	242.9167	367.16022	05.99003	9.6342	476.1991	15.00	880.00
day90	vertiver	3	31.6667	41.93249	24.20973	-72.4994	135.8327	5.00	80.00
	colocasia	3	523.3333	236.71361	36.66667	-64.6959	1111.3625	250.00	660.00
	controlvertiver	3	15.0000	5.00000	2.88675	2.5793	27.4207	10.00	20.00
	controlcolocasia	3	57.6667	2.51661	1.45297	51.4151	63.9183	55.00	60.00
	Total	12	156.9167	244.10596	70.46732	1.8191	312.0142	5.00	660.00
day100	vertiver	3	23.3333	27.53785	15.89899	-45.0745	91.7412	5.00	55.00
	colocasia	3	313.3333	285.71548	64.95791	-396.4233	1023.0899	40.00	610.00
	controlvertiver	3	15.0000	5.00000	2.88675	2.5793	27.4207	10.00	20.00
	controlcolocasia	3	51.0000	6.55744	3.78594	34.7104	67.2896	45.00	58.00
	Total	12	100.6667	177.85558	51.34248	-12.3374	213.6707	5.00	610.00

Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
day10	1.247	3	8	.355
day20	.988	3	8	.446
day30	1.032	3	8	.429
day40	4.443	3	8	.041
day50	3.243	3	8	.081
day60	8.516	3	8	.007
day70	4.367	3	8	.042
day80	10.822	3	8	.003
day90	13.800	3	8	.002
day100	4.634	3	8	.037

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
day10	Between Groups	718.396	3	239.465	24.933	.000
	Within Groups	76.833	8	9.604		
	Total	795.229	11			
day20	Between Groups	1222.917	3	407.639	13.044	.002
	Within Groups	250.000	8	31.250		
	Total	1472.917	11			
day30	Between Groups	1456.250	3	485.417	12.263	.002
	Within Groups	316.667	8	39.583		
	Total	1772.917	11			
day40	Between Groups	8280.729	3	2760.243	18.088	.001
	Within Groups	1220.833	8	152.604		
	Total	9501.563	11			
day50	Between Groups	15656.250	3	5218.750	4.154	.048
	Within Groups	10050.000	8	1256.250		
	Total	25706.250	11			
day60	Between Groups	36795.583	3	12265.194	5.301	.026
	Within Groups	18509.333	8	2313.667		
	Total	55304.917	11			
day70	Between Groups	60355.729	3	20118.576	7.960	.009
	Within Groups	20220.833	8	2527.604		
	Total	80576.563	11			
day80	Between Groups	1476806	3	492268.750	649.146	.000
	Within Groups	6066.667	8	758.333		
	Total	1482873	11			
day90	Between Groups	539818.9	3	179939.639	12.448	.002
	Within Groups	115646.0	8	14455.750		
	Total	655464.9	11			
day100	Between Groups	183039.3	3	61013.111	2.960	.098
	Within Groups	164919.3	8	20614.917		
	Total	347958.7	11			

Post Hoc Tests

Homogeneous Subsets

day10

Duncan[a]

treatment	N	Subset for alpha = .05		
		1	2	3
vertiver	3	4.0000		
controlvertiver	3	5.8333		
controlcolocasia	3		15.0000	
colocasia	3			23.3333
Sig.		.489	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day20

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
vertiver	3	6.6667	
controlvertiver	3	10.0000	
controlcolocasia	3		23.3333
colocasia	3		31.6667
Sig.		.486	.105

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day30

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
vertiver	3	8.3333	
controlvertiver	3	10.0000	
controlcolocasia	3		25.0000
colocasia	3		35.0000
Sig.		.754	.087

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day40

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
vertiver	3	9.1667	
controlvertiver	3	13.3333	
controlcolocasia	3	25.0000	
colocasia	3		75.0000
Sig.		.171	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day50

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
vertiver	3	10.0000	
controlvertiver	3	15.0000	
controlcolocasia	3	30.0000	
colocasia	3		100.0000
Sig.		.526	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day60

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
vertiver	3	14.0000	
controlvertiver	3	15.0000	
controlcolocasia	3	38.3333	
colocasia	3		148.3333
Sig.		.568	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day70

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
controlvertiver	3	15.0000	
vertiver	3	15.8333	
controlcolocasia	3	45.0000	
colocasia	3		186.6667
Sig.		.503	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day80

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
controlvertiver	3	20.0000	
vertiver	3	40.0000	
controlcolocasia	3	61.6667	
colocasia	3		850.0000
Sig.		.113	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day90

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
controlvertiver	3	15.0000	
vertiver	3	31.6667	
controlcolocasia	3	57.6667	
colocasia	3		523.3333
Sig.		.687	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day100

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
controlvertiver	3	15.0000	
vertiver	3	23.3333	
controlcolocasia	3	51.0000	51.0000
colocasia	3		313.3333
Sig.		.776	.056

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Conclusions of the analyses by SPSS of dry weight data

By using of SPSS Version 12.0 analysis at 95% confidence by uses of One-way ANOVA analyses and analyze the difference by DUNCAN

The results are

Dry weight of plants at the 20 centimeter level of depth

At the 10th day, the control ponds with the colocasia were different to the others but the rest were not different to each other

At the 20th day, the control ponds with the colocasia were different to the others but the rest were not different to each other

At the 30th day, the control ponds with the vetiver and the experimental ponds with the vetiver were not different, the control ponds with the colocasia and the experimental ponds with the colocasia were not different either

At the 40th day, the control ponds with the vetiver and the experimental ponds with the vetiver were not different, the control ponds with the colocasia and the experimental ponds with the colocasia were not different either

At the 50th day, the control ponds with the vetiver and the experimental ponds with the vetiver were not different, the control ponds with the colocasia and the experimental ponds with the colocasia were not different either

At the 60th day, The experimental ponds with the vetiver and the colocasia and the control ponds with the colocasia were not different to each other but different to the experimental ponds with the colocasia, the control ponds with the colocasia were not different to the control ponds with the colocasia

At the 70th day, The experimental ponds with the vetiver and the colosia and the control ponds with the colocasia were not different to each other but different to the experimental ponds with the colocasia, the experimental ponds with the colocasia were not different to the control ponds with the colocasia

At the 80th day, every pond were not different to each other

At the 90^{th} day, the control ponds with the vetiver and the experimental ponds with the vetiver were not different, the control ponds with the colocasia and the experimental ponds with the colocasia were not different either

At the 100^{th} day, every pond were not different to each other

Oneway

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
day10	vertiver	3	10.6667	8.14453	4.70225	-9.5655	30.8988	5.00	20.00
	colocasia	3	11.6667	2.88675	1.66667	4.4956	18.8378	10.00	15.00
	controlvertiver	3	10.0000	5.00000	2.88675	-2.4207	22.4207	5.00	15.00
	controlcolocasia	3	26.6667	7.63763	4.40959	7.6938	45.6396	20.00	35.00
	Total	12	14.7500	8.98610	2.59406	9.0405	20.4595	5.00	35.00
day20	vertiver	3	11.6667	2.88675	1.66667	4.4956	18.8378	10.00	15.00
	colocasia	3	18.3333	2.88675	1.66667	11.1622	25.5044	15.00	20.00
	controlvertiver	3	15.0000	5.00000	2.88675	2.5793	27.4207	10.00	20.00
	controlcolocasia	3	36.6667	7.63763	4.40959	17.6938	55.6396	30.00	45.00
	Total	12	20.4167	10.96655	3.16577	13.4489	27.3845	10.00	45.00
day30	vertiver	3	13.0000	2.64575	1.52753	6.4276	19.5724	10.00	15.00
	colocasia	3	45.0000	15.00000	8.66025	7.7379	82.2621	30.00	60.00
	controlvertiver	3	15.0000	5.00000	2.88675	2.5793	27.4207	10.00	20.00
	controlcolocasia	3	40.0000	10.00000	5.77350	15.1586	64.8414	30.00	50.00
	Total	12	28.2500	17.04073	4.91923	17.4228	39.0772	10.00	60.00
day40	vertiver	3	13.3333	2.88675	1.66667	6.1622	20.5044	10.00	15.00
	colocasia	3	58.3333	30.13857	17.40051	-16.5350	133.2017	30.00	90.00
	controlvertiver	3	15.0000	5.00000	2.88675	2.5793	27.4207	10.00	20.00
	controlcolocasia	3	45.0000	5.00000	2.88675	32.5793	57.4207	40.00	50.00
	Total	12	32.9167	24.16405	6.97556	17.5636	48.2698	10.00	90.00
day50	vertiver	3	16.6667	7.63763	4.40959	-2.3062	35.6396	10.00	25.00
	colocasia	3	71.6667	30.55050	17.63834	-4.2250	147.5583	45.00	105.00
	controlvertiver	3	16.6667	2.88675	1.66667	9.4956	23.8378	15.00	20.00
	controlcolocasia	3	51.6667	7.63763	4.40959	32.6938	70.6396	45.00	60.00
	Total	12	39.1667	28.27088	8.16110	21.2042	57.1291	10.00	105.00
day60	vertiver	3	20.0000	.00000	.00000	20.0000	20.0000	20.00	20.00
	colocasia	3	96.6667	67.88471	39.19325	-71.9683	265.3016	55.00	175.00
	controlvertiver	3	20.0000	10.00000	5.77350	-4.8414	44.8414	10.00	30.00
	controlcolocasia	3	60.0000	10.00000	5.77350	35.1586	84.8414	50.00	70.00
	Total	12	49.1667	44.56014	12.86340	20.8545	77.4788	10.00	175.00
day70	vertiver	3	21.6667	16.07275	9.27961	-18.2603	61.5936	10.00	40.00
	colocasia	3	98.3333	64.29101	37.11843	-61.3744	258.0410	25.00	145.00
	controlvertiver	3	25.0000	5.00000	2.88675	12.5793	37.4207	20.00	30.00
	controlcolocasia	3	81.6667	7.63763	4.40959	62.6938	100.6396	75.00	90.00
	Total	12	56.6667	45.44394	13.11853	27.7930	85.5404	10.00	145.00
day80	vertiver	3	45.0000	5.00000	2.88675	32.5793	57.4207	40.00	50.00
	colocasia	3	168.3333	170.61164	98.50268	-255.4895	592.1562	60.00	365.00
	controlvertiver	3	36.6667	15.27525	8.81917	-1.2792	74.6125	20.00	50.00
	controlcolocasia	3	123.3333	20.81666	12.01850	71.6219	175.0448	100.00	140.00
	Total	12	93.3333	93.33063	26.94223	34.0339	152.6328	20.00	365.00
day90	vertiver	3	36.6667	15.27525	8.81917	-1.2792	74.6125	20.00	50.00
	colocasia	3	151.6667	22.54625	13.01708	95.6587	207.6747	130.00	175.00
	controlvertiver	3	25.0000	5.00000	2.88675	12.5793	37.4207	20.00	30.00
	controlcolocasia	3	126.0000	2.00000	1.15470	121.0317	130.9683	124.00	128.00
	Total	12	84.8333	58.56284	16.90564	47.6243	122.0424	20.00	175.00
day100	vertiver	3	31.6667	27.53785	15.89899	-36.7412	100.0745	5.00	60.00
	colocasia	3	168.3333	170.61164	98.50268	-255.4895	592.1562	60.00	365.00
	controlvertiver	3	25.0000	5.00000	2.88675	12.5793	37.4207	20.00	30.00
	controlcolocasia	3	100.0000	10.00000	5.77350	75.1586	124.8414	90.00	110.00
	Total	12	81.2500	95.65860	27.61426	20.4714	142.0286	5.00	365.00

Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
day10	1.424	3	8	.306
day20	1.333	3	8	.330
day30	1.311	3	8	.336
day40	3.851	3	8	.056
day50	4.494	3	8	.040
day60	11.924	3	8	.003
day70	9.002	3	8	.006
day80	12.843	3	8	.002
day90	2.616	3	8	.123
day100	12.489	3	8	.002

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
day10	Between Groups	572.250	3	190.750	4.829	.033
	Within Groups	316.000	8	39.500		
	Total	888.250	11			
day20	Between Groups	1122.917	3	374.306	14.972	.001
	Within Groups	200.000	8	25.000		
	Total	1322.917	11			
day30	Between Groups	2480.250	3	826.750	9.263	.006
	Within Groups	714.000	8	89.250		
	Total	3194.250	11			
day40	Between Groups	4489.583	3	1496.528	6.193	.018
	Within Groups	1933.333	8	241.667		
	Total	6422.917	11			
day50	Between Groups	6675.000	3	2225.000	8.409	.007
	Within Groups	2116.667	8	264.583		
	Total	8791.667	11			
day60	Between Groups	12225.000	3	4075.000	3.390	.074
	Within Groups	9616.667	8	1202.083		
	Total	21841.667	11			
day70	Between Groups	13766.667	3	4588.889	4.102	.049
	Within Groups	8950.000	8	1118.750		
	Total	22716.667	11			
day80	Between Groups	36216.667	3	12072.222	1.620	.260
	Within Groups	59600.000	8	7450.000		
	Total	95816.667	11			
day90	Between Groups	36184.333	3	12061.444	62.603	.000
	Within Groups	1541.333	8	192.667		
	Total	37725.667	11			
day100	Between Groups	40672.917	3	13557.639	1.808	.224
	Within Groups	59983.333	8	7497.917		
	Total	100656.3	11			

Post Hoc Tests

Homogeneous Subsets

day10

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
controlvertiver	3	10.0000	
vertiver	3	10.6667	
colocasia	3	11.6667	
controlcolocasia	3		26.6667
Sig.		.763	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day20

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
vertiver	3	11.6667	
controlvertiver	3	15.0000	
colocasia	3	18.3333	
controlcolocasia	3		36.6667
Sig.		.156	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day30

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
vertiver	3	13.0000	
controlvertiver	3	15.0000	
controlcolocasia	3		40.0000
colocasia	3		45.0000
Sig.		.802	.535

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day40

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
vertiver	3	13.3333	
controlvertiver	3	15.0000	
controlcolocasia	3		45.0000
colocasia	3		58.3333
Sig.		.899	.324

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day50

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
vertiver	3	16.6667	
controlvertiver	3	16.6667	
controlcolocasia	3		51.6667
colocasia	3		71.6667
Sig.		1.000	.171

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day60

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
vertiver	3	20.0000	
controlvertiver	3	20.0000	
controlcolocasia	3	60.0000	60.0000
colocasia	3		96.6667
Sig.		.212	.231

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day70

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
vertiver	3	21.6667	
controlvertiver	3	25.0000	
controlcolocasia	3	81.6667	81.6667
colocasia	3		98.3333
Sig.		.068	.559

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day80

Duncan[a]

treatment	N	Subset for alpha = .05
		1
controlvertiver	3	36.6667
vertiver	3	45.0000
controlcolocasia	3	123.3333
colocasia	3	168.3333
Sig.		.117

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day90

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
controlvertiver	3	25.0000	
vertiver	3	36.6667	
controlcolocasia	3		126.0000
colocasia	3		151.6667
Sig.		.333	.053

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day100

Duncan[a]

treatment	N	Subset for alpha = .05
		1
controlvertiver	3	25.0000
vertiver	3	31.6667
controlcolocasia	3	100.0000
colocasia	3	168.3333
Sig.		.093

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Dry weight of the plants at the 40 centimeter of depth

At the 10th day, the experimental ponds with the vetiver and the control ponds with the vetiver and the colocasia were not different but to the experimental ponds with the colocasia, the control ponds with the colocasia were not different to the experimental ponds with the colocasia

At the 20th day, the control ponds with the vetiver and the experimental ponds with the vetiver were not different, the control ponds with the colocasia and the experimental ponds with the colocasia were not different, the experimental ponds with the vetiver were not different to the control ponds with the colocasia

At the 30th day, the control ponds with the colocasia and the experimental ponds with the colocasia were not different but the control ponds with the colocasia and the experimental ponds with the colocasia were different

At the 40th day, the experimental ponds with the vetiver , the control ponds with the vetiver and the control ponds with the colocasia were not different, the control ponds with the colocasia and the experimental ponds with the colocasia were not different either

At the 50th day, the experimental ponds with the vetiver , the control ponds with the vetiver and the control ponds with the colocasia were not different to each other but the experimental ponds with the colocasia

At the 60th day, The experimental ponds with the vetiver , the control ponds with the vetiver and the control ponds with the colocasia were not different to each other , the experimental ponds with the vetiver, the experimental ponds with the colocasia, and the control ponds with the colocasia were not different to each other

At the 70th day, the experimental ponds with the vetiver, the control ponds with the vetiver, and the control ponds with the colocasia were not different to each other

At the 80th day, the experimental ponds with the vetiver, the control ponds with the vetiver, and the control ponds with the colocasia were not different to each other but to the experimental ponds with the colocasia

At the 90th day, the experimental ponds with the vetiver, the control ponds with the vetiver, and the control ponds with the colocasia were not different to each other but to the experimental ponds with the colocasia

At the 100th day, The experimental ponds with the vetiver , the control ponds with the vetiver, and the control ponds with the colocasia were not different to each other but to the experimental ponds with the colocasia and the experimental ponds with the colocasia were not different to the control ponds with the colocasia

Oneway

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
day10	vertiver	3	9.3333	9.29157	5.36449	-13.7482	32.4149	3.00	20.00
	colocasia	3	31.6667	14.43376	8.33333	-4.1888	67.5221	15.00	40.00
	controlvertiver	3	7.5000	2.50000	1.44338	1.2897	13.7103	5.00	10.00
	controlcolocas	3	25.0000	5.00000	2.88675	12.5793	37.4207	20.00	30.00
	Total	12	18.3750	13.18940	3.80745	9.9949	26.7551	3.00	40.00
day20	vertiver	3	10.0000	8.66025	5.00000	-11.5133	31.5133	5.00	20.00
	colocasia	3	38.3333	18.92969	10.92906	-8.6906	85.3573	25.00	60.00
	controlvertiver	3	7.5000	2.50000	1.44338	1.2897	13.7103	5.00	10.00
	controlcolocas	3	30.0000	5.00000	2.88675	17.5793	42.4207	25.00	35.00
	Total	12	21.4583	16.46133	4.75198	10.9993	31.9174	5.00	60.00
day30	vertiver	3	13.3333	2.88675	1.66667	6.1622	20.5044	10.00	15.00
	colocasia	3	43.3333	5.77350	3.33333	28.9912	57.6755	40.00	50.00
	controlvertiver	3	7.5000	2.50000	1.44338	1.2897	13.7103	5.00	10.00
	controlcolocas	3	31.6667	7.63763	4.40959	12.6938	50.6396	25.00	40.00
	Total	12	23.9583	15.57454	4.49598	14.0627	33.8539	5.00	50.00
day40	vertiver	3	15.0000	13.22876	7.63763	-17.8621	47.8621	5.00	30.00
	colocasia	3	63.3333	40.41452	23.33333	-37.0619	163.7286	40.00	110.00
	controlvertiver	3	10.0000	5.00000	2.88675	-2.4207	22.4207	5.00	15.00
	controlcolocas	3	40.0000	5.00000	2.88675	27.5793	52.4207	35.00	45.00
	Total	12	32.0833	28.87735	8.33617	13.7355	50.4311	5.00	110.00
day50	vertiver	3	21.6667	17.55942	10.13794	-21.9534	65.2867	5.00	40.00
	colocasia	3	83.3333	37.85939	21.85813	-10.7146	177.3813	40.00	110.00
	controlvertiver	3	13.3333	7.63763	4.40959	-5.6396	32.3062	5.00	20.00
	controlcolocas	3	40.0000	10.00000	5.77350	15.1586	64.8414	30.00	50.00
	Total	12	39.5833	33.80817	9.75958	18.1026	61.0640	5.00	110.00
day60	vertiver	3	28.3333	2.88675	1.66667	21.1622	35.5044	25.00	30.00
	colocasia	3	100.0000	75.00000	43.30127	-86.3103	286.3103	25.00	175.00
	controlvertiver	3	15.0000	5.00000	2.88675	2.5793	27.4207	10.00	20.00
	controlcolocas	3	41.6667	7.63763	4.40959	22.6938	60.6396	35.00	50.00
	Total	12	46.2500	46.76464	13.49979	16.5372	75.9628	10.00	175.00
day70	vertiver	3	30.0000	10.00000	5.77350	5.1586	54.8414	20.00	40.00
	colocasia	3	111.6667	94.64847	54.64532	-123.4532	346.7865	45.00	220.00
	controlvertiver	3	15.0000	5.00000	2.88675	2.5793	27.4207	10.00	20.00
	controlcolocas	3	51.6667	7.63763	4.40959	32.6938	70.6396	45.00	60.00
	Total	12	52.0833	56.02184	16.17211	16.4888	87.6779	10.00	220.00
day80	vertiver	3	35.3333	14.18920	8.19214	.0854	70.5813	20.00	48.00
	colocasia	3	605.0000	210.77239	121.68950	81.4124	1128.5876	365.00	760.00
	controlvertiver	3	25.0000	5.00000	2.88675	12.5793	37.4207	20.00	30.00
	controlcolocas	3	90.0000	5.00000	2.88675	77.5793	102.4207	85.00	95.00
	Total	12	188.8333	267.89612	77.33495	18.6203	359.0464	20.00	760.00
day90	vertiver	3	33.3333	32.14550	18.55921	-46.5205	113.1872	10.00	70.00
	colocasia	3	480.0000	270.73973	156.31165	-192.5548	1152.5548	290.00	790.00
	controlvertiver	3	20.0000	5.00000	2.88675	7.5793	32.4207	15.00	25.00
	controlcolocas	3	80.0000	10.00000	5.77350	55.1586	104.8414	70.00	90.00
	Total	12	153.3333	229.96377	66.38482	7.2213	299.4453	10.00	790.00
day100	vertiver	3	31.6667	7.63763	4.40959	12.6938	50.6396	25.00	40.00
	colocasia	3	118.3333	46.45787	26.82246	2.9256	233.7411	65.00	150.00
	controlvertiver	3	15.0000	5.00000	2.88675	2.5793	27.4207	10.00	20.00
	controlcolocas	3	65.0000	31.22499	18.02776	-12.5672	142.5672	40.00	100.00
	Total	12	57.5000	47.79216	13.79641	27.1343	87.8657	10.00	150.00

Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
day10	4.822	3	8	.033
day20	6.022	3	8	.019
day30	2.156	3	8	.171
day40	9.311	3	8	.005
day50	4.476	3	8	.040
day60	3.403	3	8	.074
day70	11.368	3	8	.003
day80	11.767	3	8	.003
day90	12.253	3	8	.002
day100	6.373	3	8	.016

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
day10	Between Groups	1261.729	3	420.576	5.162	.028
	Within Groups	651.833	8	81.479		
	Total	1913.563	11			
day20	Between Groups	2051.563	3	683.854	5.888	.020
	Within Groups	929.167	8	116.146		
	Total	2980.729	11			
day30	Between Groups	2455.729	3	818.576	30.817	.000
	Within Groups	212.500	8	26.563		
	Total	2668.229	11			
day40	Between Groups	5456.250	3	1818.750	3.915	.054
	Within Groups	3716.667	8	464.583		
	Total	9172.917	11			
day50	Between Groups	8772.917	3	2924.306	6.156	.018
	Within Groups	3800.000	8	475.000		
	Total	12572.917	11			
day60	Between Groups	12622.917	3	4207.639	2.944	.099
	Within Groups	11433.333	8	1429.167		
	Total	24056.250	11			
day70	Between Groups	16239.583	3	5413.194	2.369	.147
	Within Groups	18283.333	8	2285.417		
	Total	34522.917	11			
day80	Between Groups	700099.0	3	233366.333	20.894	.000
	Within Groups	89352.667	8	11169.083		
	Total	789451.7	11			
day90	Between Groups	432800.0	3	144266.667	7.750	.009
	Within Groups	148916.7	8	18614.583		
	Total	581716.7	11			
day100	Between Groups	18691.667	3	6230.556	7.748	.009
	Within Groups	6433.333	8	804.167		
	Total	25125.000	11			

Post Hoc Tests

Homogeneous Subsets

day10

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
controlvertiver	3	7.5000	
vertiver	3	9.3333	
controlcolocasia	3	25.0000	25.0000
colocasia	3		31.6667
Sig.		.052	.392

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day20

Duncan[a]

treatment	N	Subset for alpha = .05		
		1	2	3
controlvertiver	3	7.5000		
vertiver	3	10.0000	10.0000	
controlcolocasia	3		30.0000	30.0000
colocasia	3			38.3333
Sig.		.784	.053	.371

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day30

Duncan[a]

treatment	N	Subset for alpha = .05		
		1	2	3
controlvertiver	3	7.5000		
vertiver	3	13.3333		
controlcolocasia	3		31.6667	
colocasia	3			43.3333
Sig.		.203	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day40

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
controlvertiver	3	10.0000	
vertiver	3	15.0000	
controlcolocasia	3	40.0000	40.0000
colocasia	3		63.3333
Sig.		.141	.221

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day50

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
controlvertiver	3	13.3333	
vertiver	3	21.6667	
controlcolocasia	3	40.0000	
colocasia	3		83.3333
Sig.		.189	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day60

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
controlvertiver	3	15.0000	
vertiver	3	28.3333	28.3333
controlcolocasia	3	41.6667	41.6667
colocasia	3		100.0000
Sig.		.431	.056

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day70

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
controlvertiver	3	15.0000	
vertiver	3	30.0000	30.0000
controlcolocasia	3	51.6667	51.6667
colocasia	3		111.6667
Sig.		.394	.080

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day80

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
controlvertiver	3	25.0000	
vertiver	3	35.3333	
controlcolocasia	3	90.0000	
colocasia	3		605.0000
Sig.		.490	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day90

Duncan[a]

treatment	N	Subset for alpha = .05 1	2
controlvertiver	3	20.0000	
vertiver	3	33.3333	
controlcolocasia	3	80.0000	
colocasia	3		480.0000
Sig.		.619	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day100

Duncan[a]

treatment	N	Subset for alpha = .05 1	2
controlvertiver	3	15.0000	
vertiver	3	31.6667	
controlcolocasia	3	65.0000	65.0000
colocasia	3		118.3333
Sig.		.072	.050

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Dry weight of the plants at the 60 centimeter of depth

At the 10th day, the experimental ponds with the vetiver and the control ponds with the vetiver were not different but to the experimental ponds with the colocasia and the control ponds with the colocasia

At the 20th day, the control ponds with the vetiver and the experimental ponds with the vetiver were not different, the control ponds with the colocasia and the experimental ponds with the colocasia were not different

At the 30th day, the control ponds with the vetiver and the experimental ponds with the vetiver were not different, the control ponds with the colocasia and the experimental ponds with the colocasia were not different

At the 40th day, the experimental ponds with the vetiver , the control ponds with the vetiver and the control ponds with the colocasia were not different but the experimental ponds with the colocasia

At the 50th day, the experimental ponds with the vetiver , the control ponds with the vetiver and the control ponds with the colocasia were not different but the experimental ponds with the colocasia

At the 60th day, the experimental ponds with the vetiver , the control ponds with the vetiver and the control ponds with the colocasia were not different but the experimental ponds with the colocasia

At the 70th day, the experimental ponds with the vetiver , the control ponds with the vetiver and the control ponds with the colocasia were not different but the experimental ponds with the colocasia

At the 80th day, the experimental ponds with the vetiver , the control ponds with the vetiver and the control ponds with the colocasia were not different but the experimental ponds with the colocasia

At the 90th day, the experimental ponds with the vetiver , the control ponds with the vetiver and the control ponds with the colocasia were not different but the experimental ponds with the colocasia

At the 100th day, The experimental ponds with the vetiver , the control ponds with the vetiver, and the control ponds with the colocasia were not different, the experimental ponds with the colocasia and the control ponds with the colocasia were not different

Oneway

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
day10	vertiver	3	4.0000	1.73205	1.00000	-.3027	8.3027	2.00	5.00
	colocasia	3	23.3333	2.88675	1.66667	16.1622	30.5044	20.00	25.00
	controlvertiver	3	5.8333	1.44338	.83333	2.2478	9.4189	5.00	7.50
	controlcolocasi	3	15.0000	5.00000	2.88675	2.5793	27.4207	10.00	20.00
	Total	12	12.0417	8.50256	2.45448	6.6394	17.4439	2.00	25.00
day20	vertiver	3	6.6667	2.88675	1.66667	-.5044	13.8378	5.00	10.00
	colocasia	3	31.6667	7.63763	4.40959	12.6938	50.6396	25.00	40.00
	controlvertiver	3	10.0000	5.00000	2.88675	-2.4207	22.4207	5.00	15.00
	controlcolocasi	3	23.3333	5.77350	3.33333	8.9912	37.6755	20.00	30.00
	Total	12	17.9167	11.57158	3.34043	10.5644	25.2689	5.00	40.00
day30	vertiver	3	8.3333	5.77350	3.33333	-6.0088	22.6755	5.00	15.00
	colocasia	3	35.0000	8.66025	5.00000	13.4867	56.5133	25.00	40.00
	controlvertiver	3	10.0000	5.00000	2.88675	-2.4207	22.4207	5.00	15.00
	controlcolocasi	3	25.0000	5.00000	2.88675	12.5793	37.4207	20.00	30.00
	Total	12	19.5833	12.69544	3.66486	11.5170	27.6496	5.00	40.00
day40	vertiver	3	9.1667	1.44338	.83333	5.5811	12.7522	7.50	10.00
	colocasia	3	75.0000	22.91288	13.22876	18.0813	131.9187	50.00	95.00
	controlvertiver	3	13.3333	7.63763	4.40959	-5.6396	32.3062	5.00	20.00
	controlcolocasi	3	25.0000	5.00000	2.88675	12.5793	37.4207	20.00	30.00
	Total	12	30.6250	29.39011	8.48419	11.9514	49.2986	5.00	95.00
day50	vertiver	3	10.0000	8.66025	5.00000	-11.5133	31.5133	5.00	20.00
	colocasia	3	100.0000	70.00000	40.41452	-73.8896	273.8896	30.00	170.00
	controlvertiver	3	15.0000	5.00000	2.88675	2.5793	27.4207	10.00	20.00
	controlcolocasi	3	30.0000	5.00000	2.88675	17.5793	42.4207	25.00	35.00
	Total	12	38.7500	48.34182	13.95508	8.0351	69.4649	5.00	170.00
day60	vertiver	3	14.0000	3.60555	2.08167	5.0433	22.9567	10.00	17.00
	colocasia	3	148.3333	95.69918	55.25195	-89.3966	386.0633	70.00	255.00
	controlvertiver	3	15.0000	5.00000	2.88675	2.5793	27.4207	10.00	20.00
	controlcolocasi	3	38.3333	7.63763	4.40959	19.3604	57.3062	30.00	45.00
	Total	12	53.9167	70.90642	20.46892	8.8649	98.9685	10.00	255.00
day70	vertiver	3	15.8333	5.20416	3.00463	2.9055	28.7612	10.00	20.00
	colocasia	3	186.6667	100.16653	57.83117	-62.1608	435.4941	90.00	290.00
	controlvertiver	3	15.0000	5.00000	2.88675	2.5793	27.4207	10.00	20.00
	controlcolocasi	3	45.0000	5.00000	2.88675	32.5793	57.4207	40.00	50.00
	Total	12	65.6250	85.58704	24.70685	11.2456	120.0044	10.00	290.00
day80	vertiver	3	40.0000	17.32051	10.00000	-3.0265	83.0265	20.00	50.00
	colocasia	3	850.0000	51.96152	30.00000	720.9204	979.0796	790.00	880.00
	controlvertiver	3	20.0000	5.00000	2.88675	7.5793	32.4207	15.00	25.00
	controlcolocasi	3	61.6667	2.88675	1.66667	54.4956	68.8378	60.00	65.00
	Total	12	242.9167	367.16022	05.99003	9.6342	476.1991	15.00	880.00
day90	vertiver	3	31.6667	41.93249	24.20973	-72.4994	135.8327	5.00	80.00
	colocasia	3	523.3333	236.71361	36.66667	-64.6959	1111.3625	250.00	660.00
	controlvertiver	3	15.0000	5.00000	2.88675	2.5793	27.4207	10.00	20.00
	controlcolocasi	3	57.6667	2.51661	1.45297	51.4151	63.9183	55.00	60.00
	Total	12	156.9167	244.10596	70.46732	1.8191	312.0142	5.00	660.00
day100	vertiver	3	23.3333	27.53785	15.89899	-45.0745	91.7412	5.00	55.00
	colocasia	3	313.3333	285.71548	64.95791	-396.4233	1023.0899	40.00	610.00
	controlvertiver	3	15.0000	5.00000	2.88675	2.5793	27.4207	10.00	20.00
	controlcolocasi	3	51.0000	6.55744	3.78594	34.7104	67.2896	45.00	58.00
	Total	12	100.6667	177.85558	51.34248	-12.3374	213.6707	5.00	610.00

Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
day10	1.247	3	8	.355
day20	.988	3	8	.446
day30	1.032	3	8	.429
day40	4.443	3	8	.041
day50	3.243	3	8	.081
day60	8.516	3	8	.007
day70	4.367	3	8	.042
day80	10.822	3	8	.003
day90	13.800	3	8	.002
day100	4.634	3	8	.037

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
day10	Between Groups	718.396	3	239.465	24.933	.000
	Within Groups	76.833	8	9.604		
	Total	795.229	11			
day20	Between Groups	1222.917	3	407.639	13.044	.002
	Within Groups	250.000	8	31.250		
	Total	1472.917	11			
day30	Between Groups	1456.250	3	485.417	12.263	.002
	Within Groups	316.667	8	39.583		
	Total	1772.917	11			
day40	Between Groups	8280.729	3	2760.243	18.088	.001
	Within Groups	1220.833	8	152.604		
	Total	9501.563	11			
day50	Between Groups	15656.250	3	5218.750	4.154	.048
	Within Groups	10050.000	8	1256.250		
	Total	25706.250	11			
day60	Between Groups	36795.583	3	12265.194	5.301	.026
	Within Groups	18509.333	8	2313.667		
	Total	55304.917	11			
day70	Between Groups	60355.729	3	20118.576	7.960	.009
	Within Groups	20220.833	8	2527.604		
	Total	80576.563	11			
day80	Between Groups	1476806	3	492268.750	649.146	.000
	Within Groups	6066.667	8	758.333		
	Total	1482873	11			
day90	Between Groups	539818.9	3	179939.639	12.448	.002
	Within Groups	115646.0	8	14455.750		
	Total	655464.9	11			
day100	Between Groups	183039.3	3	61013.111	2.960	.098
	Within Groups	164919.3	8	20614.917		
	Total	347958.7	11			

Post Hoc Tests

Homogeneous Subsets

day10

Duncan[a]

treatment	N	Subset for alpha = .05		
		1	2	3
vertiver	3	4.0000		
controlvertiver	3	5.8333		
controlcolocasia	3		15.0000	
colocasia	3			23.3333
Sig.		.489	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day20

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
vertiver	3	6.6667	
controlvertiver	3	10.0000	
controlcolocasia	3		23.3333
colocasia	3		31.6667
Sig.		.486	.105

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day30

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
vertiver	3	8.3333	
controlvertiver	3	10.0000	
controlcolocasia	3		25.0000
colocasia	3		35.0000
Sig.		.754	.087

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day40

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
vertiver	3	9.1667	
controlvertiver	3	13.3333	
controlcolocasia	3	25.0000	
colocasia	3		75.0000
Sig.		.171	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day50

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
vertiver	3	10.0000	
controlvertiver	3	15.0000	
controlcolocasia	3	30.0000	
colocasia	3		100.0000
Sig.		.526	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day60

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
vertiver	3	14.0000	
controlvertiver	3	15.0000	
controlcolocasia	3	38.3333	
colocasia	3		148.3333
Sig.		.568	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day70

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
controlvertiver	3	15.0000	
vertiver	3	15.8333	
controlcolocasia	3	45.0000	
colocasia	3		186.6667
Sig.		.503	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day80

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
controlvertiver	3	20.0000	
vertiver	3	40.0000	
controlcolocasia	3	61.6667	
colocasia	3		850.0000
Sig.		.113	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day90

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
controlvertiver	3	15.0000	
vertiver	3	31.6667	
controlcolocasia	3	57.6667	
colocasia	3		523.3333
Sig.		.687	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day100

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
controlvertiver	3	15.0000	
vertiver	3	23.3333	
controlcolocasia	3	51.0000	51.0000
colocasia	3		313.3333
Sig.		.776	.056

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Conclusions of the analyses by SPSS of the height data

By using of SPSS Version 12.0 analysis at 95% confidence by uses of One-way ANOVA analyses and analyze the difference by DUNCAN

The results are

Height at the 20 centimeter level of depth

At the 10th day, the control ponds with the vetiver and the control ponds with the colocasia were not different, the control ponds with the vetiver and the experimental ponds with the vetiver were not different, the experimental ponds with the vetiver and the colocasia were not different, and the rest ponds were different

At the 20th day, the control ponds with the vetiver and the control ponds with the colocasia were not different, the experimental ponds with the vetiver and the experimental ponds with the colocasia were not different, and the rest ponds were different

At the 30th day, the control ponds with the vetiver and the control ponds with the colocasia were not different, the experimental ponds with the vetiver and the experimental ponds with the colocasia were not different, the rest ponds were different

At the 40th day, every pond was not different except the control ponds with the colocasia and the experimental ponds with the vetiver that were different

At the 50th day, every pond was different except the control ponds with the vetiver and the experimental ponds with the colocasia that were not different

At the 60th day, every pond was different

At the 70th day, every pond was different

At the 80th day, the experimental ponds with the colocasia and the control ponds with the colocasia were not different, the control ponds with the colocasia and the control ponds with the vetiver and the experimental ponds with the vetiver were not different to each other but the experimental ponds with the colocasia

At the 90th day, every pond was different

At the 100th day, the control ponds with the colocasia, the experimental ponds with the colocasia and the control ponds with the vetiver were not different, the control ponds with the vetiver and the experimental ponds with the vetiver were not different

Oneway

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
day10	vertiver	3	65.167	6.1712	3.5629	49.837	80.497	60.0	72.0
	colocasia	3	73.333	8.0829	4.6667	53.254	93.412	66.0	82.0
	controlvertiver	3	57.667	2.5166	1.4530	51.415	63.918	55.0	60.0
	controlcolocasi	3	52.667	2.0817	1.2019	47.496	57.838	51.0	55.0
	Total	12	62.208	9.3455	2.6978	56.270	68.146	51.0	82.0
day20	vertiver	3	85.333	13.4288	7.7531	51.974	118.692	70.0	95.0
	colocasia	3	79.000	5.5678	3.2146	65.169	92.831	73.0	84.0
	controlvertiver	3	61.667	1.5275	.8819	57.872	65.461	60.0	63.0
	controlcolocasi	3	54.667	.5774	.3333	53.232	56.101	54.0	55.0
	Total	12	70.167	14.4275	4.1648	61.000	79.333	54.0	95.0
day30	vertiver	3	88.000	8.8882	5.1316	65.921	110.079	81.0	98.0
	colocasia	3	82.333	11.6762	6.7412	53.328	111.339	72.0	95.0
	controlvertiver	3	67.000	6.0828	3.5119	51.890	82.110	60.0	71.0
	controlcolocasi	3	57.333	1.1547	.6667	54.465	60.202	56.0	58.0
	Total	12	73.667	14.4054	4.1585	64.514	82.819	56.0	98.0
day40	vertiver	3	106.333	25.8908	14.9481	42.017	170.650	77.0	126.0
	colocasia	3	85.333	10.0167	5.7831	60.451	110.216	75.0	95.0
	controlvertiver	3	83.333	20.8167	12.0185	31.622	135.045	60.0	100.0
	controlcolocasi	3	62.667	2.0817	1.2019	57.496	67.838	61.0	65.0
	Total	12	84.417	21.9150	6.3263	70.493	98.341	60.0	126.0
day50	vertiver	3	116.000	14.4222	8.3267	80.173	151.827	100.0	128.0
	colocasia	3	88.333	14.1539	8.1718	53.173	123.494	72.0	97.0
	controlvertiver	3	92.333	13.6504	7.8811	58.424	126.243	80.0	107.0
	controlcolocasi	3	64.000	4.3589	2.5166	53.172	74.828	59.0	67.0
	Total	12	90.167	21.9662	6.3411	76.210	104.123	59.0	128.0
day60	vertiver	3	137.333	1.5275	.8819	133.539	141.128	136.0	139.0
	colocasia	3	93.000	6.0828	3.5119	77.890	108.110	89.0	100.0
	controlvertiver	3	112.667	6.4291	3.7118	96.696	128.637	108.0	120.0
	controlcolocasi	3	66.667	4.9329	2.8480	54.413	78.921	61.0	70.0
	Total	12	102.417	27.4407	7.9214	84.982	119.852	61.0	139.0
day70	vertiver	3	147.333	3.2146	1.8559	139.348	155.319	145.0	151.0
	colocasia	3	107.333	4.6188	2.6667	95.860	118.807	102.0	110.0
	controlvertiver	3	116.667	3.2146	1.8559	108.681	124.652	113.0	119.0
	controlcolocasi	3	67.333	2.0817	1.2019	62.162	72.504	65.0	69.0
	Total	12	109.667	29.9828	8.6553	90.616	128.717	65.0	151.0
day80	vertiver	3	155.667	36.1156	20.8513	65.951	245.383	114.0	178.0
	colocasia	3	124.667	14.5029	8.3732	88.640	160.694	110.0	139.0
	controlvertiver	3	145.000	5.5678	3.2146	131.169	158.831	140.0	151.0
	controlcolocasi	3	92.667	4.7258	2.7285	80.927	104.406	89.0	98.0
	Total	12	129.500	30.2279	8.7260	110.294	148.706	89.0	178.0
day90	vertiver	3	155.333	10.0664	5.8119	130.327	180.340	146.0	166.0
	colocasia	3	108.667	8.5049	4.9103	87.539	129.794	99.0	115.0
	controlvertiver	3	130.667	3.7859	2.1858	121.262	140.071	128.0	135.0
	controlcolocasi	3	83.667	1.5275	.8819	79.872	87.461	82.0	85.0
	Total	12	119.583	28.3018	8.1700	101.601	137.565	82.0	166.0
day100	vertiver	3	154.333	33.8428	19.5391	70.263	238.403	117.0	183.0
	colocasia	3	108.000	21.6564	12.5033	54.203	161.797	83.0	121.0
	controlvertiver	3	119.333	9.0185	5.2068	96.930	141.737	110.0	128.0
	controlcolocasi	3	79.333	1.5275	.8819	75.539	83.128	78.0	81.0
	Total	12	115.250	33.1062	9.5569	94.215	136.285	78.0	183.0

Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
day10	2.125	3	8	.175
day20	7.675	3	8	.010
day30	2.732	3	8	.114
day40	4.062	3	8	.050
day50	1.470	3	8	.294
day60	2.730	3	8	.114
day70	1.384	3	8	.316
day80	6.906	3	8	.013
day90	2.605	3	8	.124
day100	4.649	3	8	.037

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
day10	Between Groups	732.563	3	244.188	8.562	.007
	Within Groups	228.167	8	28.521		
	Total	960.729	11			
day20	Between Groups	1861.667	3	620.556	11.599	.003
	Within Groups	428.000	8	53.500		
	Total	2289.667	11			
day30	Between Groups	1775.333	3	591.778	9.332	.005
	Within Groups	507.333	8	63.417		
	Total	2282.667	11			
day40	Between Groups	2866.250	3	955.417	3.163	.086
	Within Groups	2416.667	8	302.083		
	Total	5282.917	11			
day50	Between Groups	4080.333	3	1360.111	8.865	.006
	Within Groups	1227.333	8	153.417		
	Total	5307.667	11			
day60	Between Groups	8072.917	3	2690.972	102.513	.000
	Within Groups	210.000	8	26.250		
	Total	8282.917	11			
day70	Between Groups	9796.000	3	3265.333	281.899	.000
	Within Groups	92.667	8	11.583		
	Total	9888.667	11			
day80	Between Groups	6915.000	3	2305.000	5.880	.020
	Within Groups	3136.000	8	392.000		
	Total	10051.000	11			
day90	Between Groups	8430.250	3	2810.083	59.056	.000
	Within Groups	380.667	8	47.583		
	Total	8810.917	11			
day100	Between Groups	8660.250	3	2886.750	6.800	.014
	Within Groups	3396.000	8	424.500		
	Total	12056.250	11			

Post Hoc Tests

Homogeneous Subsets

day10

Duncan[a]

treatment	N	Subset for alpha = .05		
		1	2	3
controlcolocasia	3	52.667		
controlvertiver	3	57.667	57.667	
vertiver	3		65.167	65.167
colocasia	3			73.333
Sig.		.285	.124	.098

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day20

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
controlcolocasia	3	54.667	
controlvertiver	3	61.667	
colocasia	3		79.000
vertiver	3		85.333
Sig.		.275	.320

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day30

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
controlcolocasia	3	57.333	
controlvertiver	3	67.000	
colocasia	3		82.333
vertiver	3		88.000
Sig.		.175	.409

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day40

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
controlcolocasia	3	62.667	
controlvertiver	3	83.333	83.333
colocasia	3	85.333	85.333
vertiver	3		106.333
Sig.		.164	.159

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day50

Duncan[a]

treatment	N	Subset for alpha = .05		
		1	2	3
controlcolocasia	3	64.000		
colocasia	3		88.333	
controlvertiver	3		92.333	
vertiver	3			116.000
Sig.		1.000	.703	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day60

Duncan[a]

treatment	N	Subset for alpha = .05			
		1	2	3	4
controlcolocasia	3	66.667			
colocasia	3		93.000		
controlvertiver	3			112.667	
vertiver	3				137.333
Sig.		1.000	1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day70

Duncan[a]

treatment	N	Subset for alpha = .05			
		1	2	3	4
controlcolocasia	3	67.333			
colocasia	3		107.333		
controlvertiver	3			116.667	
vertiver	3				147.333
Sig.		1.000	1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day80

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
controlcolocasia	3	92.667	
colocasia	3	124.667	124.667
controlvertiver	3		145.000
vertiver	3		155.667
Sig.		.083	.103

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day90

Duncan[a]

treatment	N	Subset for alpha = .05			
		1	2	3	4
controlcolocasia	3	83.667			
colocasia	3		108.667		
controlvertiver	3			130.667	
vertiver	3				155.333
Sig.		1.000	1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day100

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
controlcolocasia	3	79.333	
colocasia	3	108.000	
controlvertiver	3	119.333	119.333
vertiver	3		154.333
Sig.		.052	.071

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Height at the 40 centimeter level of depth

At the 10th day, the control ponds with the vetiver ,the control ponds with the colocasia , and the experimental ponds with the colocasia were not different to each other, the control ponds with the vetiver ,the experimental ponds with the vetiver, and the experimental ponds with the colocasia were not different to each other

At the 20th day, the control ponds with the vetiver and the control ponds with the colocasia were not different, the control ponds with the vetiver and the experimental ponds with the colocasia were not different, the experimental ponds with the vetiver and the experimental ponds with the colocasia were not different

At the 30th day, the control ponds with the vetiver and the control ponds with the colocasia were not different, the control ponds with the vetiver and the experimental ponds with the colocasia were not different, the experimental ponds with the vetiver and the experimental ponds with the colocasia were not different

At the 40th day, every pond was different except the control ponds with the vetiver and the experimental ponds with the colocasia that were not different

At the 50th day, the control ponds with the colocasia , the control ponds with the vetiver and the experimental ponds with the colocasia were not different to each other, the control ponds with the vetiver, the experimental ponds with the colocasia and the experimental ponds with the vetiver were not different to each other

At the 60th day, the control ponds with the colocasia , the control ponds with the vetiver and the experimental ponds with the colocasia were not different to each other but to the experimental ponds with the vetiver

At the 70th day, every pond was different except the control ponds with the experimental ponds with the colocasia that were not different

At the 80th day, the experimental ponds with the colocasia, and the control ponds with the colocasia, and the control ponds with the vetiver were not different, the experimental ponds with the colocasia, the control ponds with the vetiver, and the experimental ponds with the vetiver were not different to each other

At the 90th day, every pond was different

At the 100th day, every pond was different except the experimental ponds with the colocasia and the control ponds with the vetiver were not different

Oneway

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
day10	vertiver	3	78.333	14.5717	8.4130	42.135	114.531	63.0	92.0
	colocasia	3	72.000	18.3303	10.5830	26.465	117.535	52.0	88.0
	controlvertiver	3	58.667	3.5119	2.0276	49.943	67.391	55.0	62.0
	controlcolocasia	3	50.667	3.7859	2.1858	41.262	60.071	48.0	55.0
	Total	12	64.917	15.2760	4.4098	55.211	74.623	48.0	92.0
day20	vertiver	3	91.333	10.0664	5.8119	66.327	116.340	82.0	102.0
	colocasia	3	78.667	25.1661	14.5297	16.151	141.183	52.0	102.0
	controlvertiver	3	63.667	3.5119	2.0276	54.943	72.391	60.0	67.0
	controlcolocasia	3	51.333	.5774	.3333	49.899	52.768	51.0	52.0
	Total	12	71.250	19.6150	5.6624	58.787	83.713	51.0	102.0
day30	vertiver	3	100.667	22.4796	12.9786	44.824	156.509	76.0	120.0
	colocasia	3	82.000	8.1854	4.7258	61.666	102.334	75.0	91.0
	controlvertiver	3	65.000	6.0828	3.5119	49.890	80.110	61.0	72.0
	controlcolocasia	3	52.333	.5774	.3333	50.899	53.768	52.0	53.0
	Total	12	75.000	21.7088	6.2668	61.207	88.793	52.0	120.0
day40	vertiver	3	107.000	8.1854	4.7258	86.666	127.334	100.0	116.0
	colocasia	3	84.000	12.2882	7.0946	53.474	114.526	75.0	98.0
	controlvertiver	3	80.000	10.0000	5.7735	55.159	104.841	70.0	90.0
	controlcolocasia	3	54.000	1.0000	.5774	51.516	56.484	53.0	55.0
	Total	12	81.250	21.0675	6.0817	67.864	94.636	53.0	116.0
day50	vertiver	3	121.667	47.0142	27.1437	4.877	238.456	83.0	174.0
	colocasia	3	86.000	10.4403	6.0277	60.065	111.935	74.0	93.0
	controlvertiver	3	83.333	15.2753	8.8192	45.388	121.279	70.0	100.0
	controlcolocasia	3	58.333	.5774	.3333	56.899	59.768	58.0	59.0
	Total	12	87.333	31.9355	9.2190	67.042	107.624	58.0	174.0
day60	vertiver	3	129.667	34.2394	19.7681	44.611	214.722	98.0	166.0
	colocasia	3	92.667	3.0551	1.7638	85.078	100.256	90.0	96.0
	controlvertiver	3	92.333	5.8595	3.3830	77.778	106.889	88.0	99.0
	controlcolocasia	3	61.000	1.0000	.5774	58.516	63.484	60.0	62.0
	Total	12	93.917	29.4355	8.4973	75.214	112.619	60.0	166.0
day70	vertiver	3	133.000	24.6374	14.2244	71.797	194.203	110.0	159.0
	colocasia	3	97.000	7.5498	4.3589	78.245	115.755	90.0	105.0
	controlvertiver	3	96.333	16.4418	9.4927	55.490	137.177	84.0	115.0
	controlcolocasia	3	65.000	3.0000	1.7321	57.548	72.452	62.0	68.0
	Total	12	97.833	28.3479	8.1833	79.822	115.845	62.0	159.0
day80	vertiver	3	156.333	52.9182	30.5523	24.877	287.789	100.0	205.0
	colocasia	3	121.667	2.0817	1.2019	116.496	126.838	120.0	124.0
	controlvertiver	3	131.667	25.3246	14.6211	68.757	194.576	103.0	151.0
	controlcolocasia	3	88.667	.5774	.3333	87.232	90.101	88.0	89.0
	Total	12	124.583	35.6280	10.2849	101.946	147.220	88.0	205.0
day90	vertiver	3	156.000	7.8102	4.5092	136.598	175.402	151.0	165.0
	colocasia	3	103.667	15.8219	9.1348	64.363	142.971	90.0	121.0
	controlvertiver	3	127.667	10.0167	5.7831	102.784	152.549	118.0	138.0
	controlcolocasia	3	82.333	1.5275	.8819	78.539	86.128	81.0	84.0
	Total	12	117.417	29.9529	8.6466	98.386	136.448	81.0	165.0
day100	vertiver	3	137.333	1.5275	.8819	133.539	141.128	136.0	139.0
	colocasia	3	98.667	12.5831	7.2648	67.409	129.925	87.0	112.0
	controlvertiver	3	112.000	8.8882	5.1316	89.921	134.079	102.0	119.0
	controlcolocasia	3	70.667	3.7859	2.1858	61.262	80.071	68.0	75.0
	Total	12	104.667	26.0186	7.5109	88.135	121.198	68.0	139.0

Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
day10	2.704	3	8	.116
day20	3.824	3	8	.057
day30	4.734	3	8	.035
day40	2.362	3	8	.147
day50	5.958	3	8	.019
day60	4.851	3	8	.033
day70	2.710	3	8	.115
day80	4.713	3	8	.035
day90	2.536	3	8	.130
day100	2.750	3	8	.112

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
day10	Between Groups	1416.917	3	472.306	3.286	.079
	Within Groups	1150.000	8	143.750		
	Total	2566.917	11			
day20	Between Groups	2737.583	3	912.528	4.884	.032
	Within Groups	1494.667	8	186.833		
	Total	4232.250	11			
day30	Between Groups	3964.667	3	1321.556	8.671	.007
	Within Groups	1219.333	8	152.417		
	Total	5184.000	11			
day40	Between Groups	4244.250	3	1414.750	17.740	.001
	Within Groups	638.000	8	79.750		
	Total	4882.250	11			
day50	Between Groups	6112.667	3	2037.556	3.192	.084
	Within Groups	5106.000	8	638.250		
	Total	11218.667	11			
day60	Between Groups	7096.917	3	2365.639	7.775	.009
	Within Groups	2434.000	8	304.250		
	Total	9530.917	11			
day70	Between Groups	6953.000	3	2317.667	9.828	.005
	Within Groups	1886.667	8	235.833		
	Total	8839.667	11			
day80	Between Groups	7070.250	3	2356.750	2.735	.113
	Within Groups	6892.667	8	861.583		
	Total	13962.917	11			
day90	Between Groups	9040.917	3	3013.639	29.117	.000
	Within Groups	828.000	8	103.500		
	Total	9868.917	11			
day100	Between Groups	6938.667	3	2312.889	36.423	.000
	Within Groups	508.000	8	63.500		
	Total	7446.667	11			

Post Hoc Tests

Homogeneous Subsets

day10

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
controlcolocasia	3	50.667	
controlvertiver	3	58.667	58.667
colocasia	3	72.000	72.000
vertiver	3		78.333
Sig.		.070	.090

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day20

Duncan[a]

treatment	N	Subset for alpha = .05		
		1	2	3
controlcolocasia	3	51.333		
controlvertiver	3	63.667	63.667	
colocasia	3		78.667	78.667
vertiver	3			91.333
Sig.		.301	.216	.289

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day30

Duncan[a]

treatment	N	Subset for alpha = .05		
		1	2	3
controlcolocasia	3	52.333		
controlvertiver	3	65.000	65.000	
colocasia	3		82.000	82.000
vertiver	3			100.667
Sig.		.244	.130	.101

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day40

Duncan[a]

treatment	N	Subset for alpha = .05		
		1	2	3
controlcolocasia	3	54.000		
controlvertiver	3		80.000	
colocasia	3		84.000	
vertiver	3			107.000
Sig.		1.000	.598	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day50

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
controlcolocasia	3	58.333	
controlvertiver	3	83.333	83.333
colocasia	3	86.000	86.000
vertiver	3		121.667
Sig.		.234	.112

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day60

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
controlcolocasia	3	61.000	
controlvertiver	3	92.333	
colocasia	3	92.667	
vertiver	3		129.667
Sig.		.065	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day70

Duncan[a]

treatment	N	Subset for alpha = .05		
		1	2	3
controlcolocasia	3	65.000		
controlvertiver	3		96.333	
colocasia	3		97.000	
vertiver	3			133.000
Sig.		1.000	.959	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day80

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
controlcolocasia	3	88.667	
colocasia	3	121.667	121.667
controlvertiver	3	131.667	131.667
vertiver	3		156.333
Sig.		.124	.203

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day90

Duncan[a]

treatment	N	Subset for alpha = .05			
		1	2	3	4
controlcolocasia	3	82.333			
colocasia	3		103.667		
controlvertiver	3			127.667	
vertiver	3				156.000
Sig.		1.000	1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day100

Duncan[a]

treatment	N	Subset for alpha = .05		
		1	2	3
controlcolocasia	3	70.667		
colocasia	3		98.667	
controlvertiver	3		112.000	
vertiver	3			137.333
Sig.		1.000	.075	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Height at the 60 centimeter level of depth

At the 10th day, the control ponds with the vetiver and the control ponds with the colocasia were not different, the control ponds with the vetiver and the experimental ponds with the colocasia were not different, the experimental ponds with the vetiver and the experimental ponds with the colocasia were not different

At the 20th day, the control ponds with the vetiver and the control ponds with the colocasia were not different, the control ponds with the vetiver and the experimental ponds with the vetiver were not different, the experimental ponds with the vetiver and the experimental ponds with the colocasia were not different

At the 30th day, the control ponds with the vetiver and the control ponds with the colocasia were not different, the control ponds with the vetiver and the experimental ponds with the colocasia , and the experimental ponds with the vetiver were not different

At the 40th day, every pond was not different

At the 50th day, the control ponds with the colocasia and the experimental ponds with the colocasia were not different, the control ponds with the vetiver, the experimental ponds with the colocasia and the experimental ponds with the vetiver were not different to each other

At the 60th day, the experimental ponds with the colocasia , the control ponds with the vetiver and the experimental ponds with the vetiver were not different to each other but to the control ponds with the colocasia

At the 70th day, every pond was different except the control ponds with the vetiver and the experimental ponds with the colocasia that were not different

At the 80th day, every pond was different except the control ponds with the vetiver and the experimental ponds with the colocasia that were not different

At the 90th day, every pond was different except the control ponds with the vetiver and the experimental ponds with the colocasia that were not different

At the 100th day, every pond was different except the experimental ponds with the colocasia and the control ponds with the vetiver that were not different to each other

Oneway

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	Upper Bound	Minimum	Maximum
day10	vertiver	3	66.667	6.6583	3.8442	50.126	83.207	61.0	74.0
	colocasia	3	63.000	4.0000	2.3094	53.063	72.937	59.0	67.0
	controlvertiver	3	58.667	1.1547	.6667	55.798	61.535	58.0	60.0
	controlcolocas	3	52.333	1.5275	.8819	48.539	56.128	51.0	54.0
	Total	12	60.167	6.5343	1.8863	56.015	64.318	51.0	74.0
day20	vertiver	3	74.000	4.5826	2.6458	62.616	85.384	70.0	79.0
	colocasia	3	81.667	15.5671	8.9876	42.996	120.337	67.0	98.0
	controlvertiver	3	64.000	3.6056	2.0817	55.043	72.957	60.0	67.0
	controlcolocas	3	54.333	.5774	.3333	52.899	55.768	54.0	55.0
	Total	12	68.500	12.8876	3.7203	60.312	76.688	54.0	98.0
day30	vertiver	3	89.667	22.5019	12.9915	33.769	145.564	67.0	112.0
	colocasia	3	86.000	7.9373	4.5826	66.283	105.717	77.0	92.0
	controlvertiver	3	70.000	6.2450	3.6056	54.487	85.513	63.0	75.0
	controlcolocas	3	55.000	1.7321	1.0000	50.697	59.303	54.0	57.0
	Total	12	75.167	17.8521	5.1535	63.824	86.509	54.0	112.0
day40	vertiver	3	95.000	39.1280	22.5906	-2.199	192.199	69.0	140.0
	colocasia	3	90.667	1.1547	.6667	87.798	93.535	90.0	92.0
	controlvertiver	3	90.000	10.0000	5.7735	65.159	114.841	80.0	100.0
	controlcolocas	3	61.667	.5774	.3333	60.232	63.101	61.0	62.0
	Total	12	84.333	22.0839	6.3751	70.302	98.365	61.0	140.0
day50	vertiver	3	110.000	30.0000	17.3205	35.476	184.524	80.0	140.0
	colocasia	3	92.000	7.2111	4.1633	74.087	109.913	86.0	100.0
	controlvertiver	3	107.667	3.2146	1.8559	99.681	115.652	104.0	110.0
	controlcolocas	3	64.667	1.1547	.6667	61.798	67.535	64.0	66.0
	Total	12	93.583	23.0551	6.6554	78.935	108.232	64.0	140.0
day60	vertiver	3	116.000	5.0000	2.8868	103.579	128.421	111.0	121.0
	colocasia	3	107.333	10.0167	5.7831	82.451	132.216	97.0	117.0
	controlvertiver	3	109.667	9.5044	5.4874	86.056	133.277	100.0	119.0
	controlcolocas	3	65.000	1.0000	.5774	62.516	67.484	64.0	66.0
	Total	12	99.500	21.9814	6.3455	85.534	113.466	64.0	121.0
day70	vertiver	3	133.000	3.0000	1.7321	125.548	140.452	130.0	136.0
	colocasia	3	110.333	7.0238	4.0552	92.885	127.781	103.0	117.0
	controlvertiver	3	111.000	7.2111	4.1633	93.087	128.913	105.0	119.0
	controlcolocas	3	76.667	3.2146	1.8559	68.681	84.652	73.0	79.0
	Total	12	107.750	21.5412	6.2184	94.063	121.437	73.0	136.0
day80	vertiver	3	149.667	12.0554	6.9602	119.719	179.614	137.0	161.0
	colocasia	3	118.000	1.7321	1.0000	113.697	122.303	117.0	120.0
	controlvertiver	3	121.667	6.0277	3.4801	106.693	136.640	116.0	128.0
	controlcolocas	3	84.333	5.5076	3.1798	70.652	98.015	78.0	88.0
	Total	12	118.417	25.0035	7.2179	102.530	134.303	78.0	161.0
day90	vertiver	3	147.000	8.5440	4.9329	125.776	168.224	138.0	155.0
	colocasia	3	116.333	4.5092	2.6034	105.132	127.535	112.0	121.0
	controlvertiver	3	115.000	6.0828	3.5119	99.890	130.110	108.0	119.0
	controlcolocas	3	80.333	.5774	.3333	78.899	81.768	80.0	81.0
	Total	12	114.667	25.1227	7.2523	98.704	130.629	80.0	155.0
day100	vertiver	3	146.667	11.0151	6.3596	119.304	174.030	134.0	154.0
	colocasia	3	115.333	2.0817	1.2019	110.162	120.504	113.0	117.0
	controlvertiver	3	107.667	3.2146	1.8559	99.681	115.652	104.0	110.0
	controlcolocas	3	78.000	1.0000	.5774	75.516	80.484	77.0	79.0
	Total	12	111.917	26.0016	7.5060	95.396	128.437	77.0	154.0

Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
day10	2.827	3	8	.107
day20	3.477	3	8	.070
day30	2.321	3	8	.152
day40	10.898	3	8	.003
day50	2.957	3	8	.098
day60	1.545	3	8	.276
day70	1.257	3	8	.352
day80	1.983	3	8	.195
day90	2.342	3	8	.149
day100	8.862	3	8	.006

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
day10	Between Groups	341.667	3	113.889	7.118	.012
	Within Groups	128.000	8	16.000		
	Total	469.667	11			
day20	Between Groups	1273.667	3	424.556	6.138	.018
	Within Groups	553.333	8	69.167		
	Total	1827.000	11			
day30	Between Groups	2283.000	3	761.000	4.979	.031
	Within Groups	1222.667	8	152.833		
	Total	3505.667	11			
day40	Between Groups	2099.333	3	699.778	1.714	.241
	Within Groups	3265.333	8	408.167		
	Total	5364.667	11			
day50	Between Groups	3919.583	3	1306.528	5.423	.025
	Within Groups	1927.333	8	240.917		
	Total	5846.917	11			
day60	Between Groups	4881.667	3	1627.222	30.041	.000
	Within Groups	433.333	8	54.167		
	Total	5315.000	11			
day70	Between Groups	4862.917	3	1620.972	53.734	.000
	Within Groups	241.333	8	30.167		
	Total	5104.250	11			
day80	Between Groups	6446.917	3	2148.972	39.981	.000
	Within Groups	430.000	8	53.750		
	Total	6876.917	11			
day90	Between Groups	6681.333	3	2227.111	68.177	.000
	Within Groups	261.333	8	32.667		
	Total	6942.667	11			
day100	Between Groups	7162.917	3	2387.639	69.712	.000
	Within Groups	274.000	8	34.250		
	Total	7436.917	11			

Post Hoc Tests

Homogeneous Subsets

day10

Duncan[a]

treatment	N	Subset for alpha = .05		
		1	2	3
controlcolocasia	3	52.333		
controlvertiver	3	58.667	58.667	
colocasia	3		63.000	63.000
vertiver	3			66.667
Sig.		.088	.221	.294

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day20

Duncan[a]

treatment	N	Subset for alpha = .05		
		1	2	3
controlcolocasia	3	54.333		
controlvertiver	3	64.000	64.000	
vertiver	3		74.000	74.000
colocasia	3			81.667
Sig.		.192	.179	.292

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day30

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
controlcolocasia	3	55.000	
controlvertiver	3	70.000	70.000
colocasia	3		86.000
vertiver	3		89.667
Sig.		.176	.099

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day40

Duncan[a]

treatment	N	Subset for alpha = .05
		1
controlcolocasia	3	61.667
controlvertiver	3	90.000
colocasia	3	90.667
vertiver	3	95.000
Sig.		.094

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day50

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
controlcolocasia	3	64.667	
colocasia	3	92.000	92.000
controlvertiver	3		107.667
vertiver	3		110.000
Sig.		.063	.210

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day60

Duncan[a]

treatment	N	Subset for alpha = .05	
		1	2
controlcolocasia	3	65.000	
colocasia	3		107.333
controlvertiver	3		109.667
vertiver	3		116.000
Sig.		1.000	.204

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day70

Duncan[a]

treatment	N	Subset for alpha = .05		
		1	2	3
controlcolocasia	3	76.667		
colocasia	3		110.333	
controlvertiver	3		111.000	
vertiver	3			133.000
Sig.		1.000	.886	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day80

Duncan[a]

treatment	N	Subset for alpha = .05		
		1	2	3
controlcolocasia	3	84.333		
colocasia	3		118.000	
controlvertiver	3		121.667	
vertiver	3			149.667
Sig.		1.000	.557	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day90

Duncan[a]

treatment	N	Subset for alpha = .05		
		1	2	3
controlcolocasia	3	80.333		
controlvertiver	3		115.000	
colocasia	3		116.333	
vertiver	3			147.000
Sig.		1.000	.782	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

day100

Duncan[a]

treatment	N	Subset for alpha = .05		
		1	2	3
controlcolocasia	3	78.000		
controlvertiver	3		107.667	
colocasia	3		115.333	
vertiver	3			146.667
Sig.		1.000	.147	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Average TKN Removal of 100 days (0.2 meter)

Oneway

Descriptives

DAY100

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	M
					Lower Bound	Upper Bound		
vertiver0.2	3	79.3700	9.000E-02	5.196E-02	79.1464	79.5936	79.28	
colocasia0.2	3	77.8500	.1600	9.238E-02	77.4525	78.2475	77.69	
control0.2	3	44.2700	.1500	8.660E-02	43.8974	44.6426	44.12	
Total	9	67.1633	17.1830	5.7277	53.9553	80.3714	44.12	

ANOVA

DAY100

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2361.937	2	1180.968	63041.02	.000
Within Groups	.112	6	1.873E-02		
Total	2362.049	8			

Post Hoc Tests

Homogeneous Subsets

DAY100

Duncan[a]

TREATMEN	N	Subset for alpha = .05		
		1	2	3
control0.2	3	44.2700		
colocasia0.2	3		77.8500	
vertiver0.2	3			79.3700
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Average TKN Removal of 100 days (0.4 meter)

Oneway

Descriptives

DAY100

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
vertiver0.4	3	77.9467	.1650	9.528E-02	77.5367	78.3566	77.78	78.11
colocasia0.4	3	77.7367	.1350	7.796E-02	77.4012	78.0721	77.60	77.87
control0.4	3	30.1033	3.512E-02	2.028E-02	30.0161	30.1906	30.07	30.14
Total	9	61.9289	23.8696	7.9565	43.5811	80.2767	30.07	78.11

ANOVA

DAY100

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4557.963	2	2278.982	146401.4	.000
Within Groups	9.340E-02	6	1.557E-02		
Total	4558.056	8			

Post Hoc Tests

Homogeneous Subsets

DAY100

Duncan[a]

TREATMEN	N	Subset for alpha = .05: 1	2
control0.4	3	30.1033	
colocasia0.4	3		77.7367
vertiver0.4	3		77.9467
Sig.		1.000	.085

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Average TKN Removal of 100 days (0.6 meter)

Oneway

Descriptives

DAY100

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
vertiver0.6	3	60.2267	5.686E-02	3.283E-02	60.0854	60.3679	60.18	60.29
colocasia0.6	3	56.2967	.2201	.1271	55.7500	56.8434	56.08	56.52
control0.6	3	18.2500	.3500	.2021	17.3806	19.1194	17.90	18.60
Total	9	44.9244	20.0792	6.6931	29.4902	60.3587	17.90	60.29

ANOVA

DAY100

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3225.034	2	1612.517	27775.41	.000
Within Groups	.348	6	5.806E-02		
Total	3225.383	8			

Post Hoc Tests

Homogeneous Subsets

DAY100

Duncan[a]

TREATMEN	N	Subset for alpha = .05		
		1	2	3
control0.6	3	18.2500		
colocasia0.6	3		56.2967	
vertiver0.6	3			60.2267
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Average TSS Removal of 100 days (0.2 meter)

Oneway

Descriptives

DAY100

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
vertiver0.2	3	64.3967	2.9500	1.7032	57.0684	71.7249	61.45	67.35
colocasia0.2	3	-32.9800	4.0600	2.3440	-43.0656	-22.8944	-37.04	-28.92
control0.2	3	-65.5867	3.3850	1.9543	-73.9955	-57.1779	-68.97	-62.20
Total	9	-11.3900	58.6455	19.5485	-56.4689	33.6889	-68.97	67.35

ANOVA

DAY100

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	27441.08	2	13720.538	1123.273	.000
Within Groups	73.289	6	12.215		
Total	27514.37	8			

Post Hoc Tests

Homogeneous Subsets

DAY100

Duncan[a]

TREATMEN	N	Subset for alpha = .05 1	2	3
control0.2	3	-65.5867		
colocasia0.2	3		-32.9800	
vertiver0.2	3			64.3967
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Average TSS Removal of 100 days (0.4 meter)

Oneway

Descriptives

DAY100

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
vertiver0.4	3	44.6833	2.3750	1.3712	38.7835	50.5832	42.31	47.06
colocasia0.4	3	38.3933	5.9900	3.4584	23.5132	53.2734	32.39	44.37
control0.4	3	35.7333	11.5450	6.6655	7.0540	64.4127	24.19	47.28
Total	9	39.6033	7.7165	2.5722	33.6719	45.5348	24.19	47.28

ANOVA

DAY100

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	126.742	2	63.371	1.088	.395
Within Groups	349.617	6	58.269		
Total	476.359	8			

Post Hoc Tests

Homogeneous Subsets

DAY100

Duncan[a]

TREATMEN	N	Subset for alpha = .05 1
control0.4	3	35.7333
colocasia0.4	3	38.3933
vertiver0.4	3	44.6833
Sig.		.214

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Average TSS Removal of 100 days (0.6 meter)

Oneway

Descriptives

DAY100

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
vertiver0.6	3	76.1433	2.0850	1.2038	70.9639	81.3228	74.06	78.23
colocasia0.6	3	56.8500	4.3700	2.5230	45.9943	67.7057	52.48	61.22
control0.6	3	-70.0767	18.4750	10.6665	-115.9711	-24.1822	-88.55	-51.60
Total	9	20.9722	69.4554	23.1518	-32.4159	74.3604	-88.55	78.23

ANOVA

DAY100

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	37862.90	2	18931.450	155.699	.000
Within Groups	729.540	6	121.590		
Total	38592.44	8			

Post Hoc Tests

Homogeneous Subsets

DAY100

Duncan[a]

TREATMEN	N	Subset for alpha = .05 1	Subset for alpha = .05 2
control0.6	3	-70.0767	
colocasia0.6	3		56.8500
vertiver0.6	3		76.1433
Sig.		1.000	.076

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Average BOD Removal of 100 days (0.2 meter)

Oneway

Descriptives

DAY100

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
vertiver0.2	3	66.0400	1.4200	.8198	62.5125	69.5675	64.62	67.46
colocasia0.2	3	58.6467	2.5644	1.4806	52.2764	65.0170	55.94	61.04
control0.2	3	32.6767	.8950	.5167	30.4534	34.9000	31.78	33.57
Total	9	52.4544	15.2521	5.0840	40.7307	64.1782	31.78	67.46

ANOVA

DAY100

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1842.214	2	921.107	294.172	.000
Within Groups	18.787	6	3.131		
Total	1861.001	8			

Post Hoc Tests

Homogeneous Subsets

DAY100

Duncan[a]

TREATMEN	N	Subset for alpha = .05		
		1	2	3
control0.2	3	32.6767		
colocasia0.2	3		58.6467	
vertiver0.2	3			66.0400
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Average BOD Removal of 100 days (0.4 meter)

Oneway

Descriptives

DAY100

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
vertiver0.4	3	63.1467	3.8150	2.2026	53.6697	72.6237	59.33	66.96
colocasia0.4	3	58.4200	1.0000	.5774	55.9359	60.9041	57.42	59.42
control0.4	3	37.0700	3.0600	1.7667	29.4685	44.6715	34.01	40.13
Total	9	52.8789	12.2882	4.0961	43.4334	62.3244	34.01	66.96

ANOVA

DAY100

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1158.156	2	579.078	69.719	.000
Within Groups	49.836	6	8.306		
Total	1207.992	8			

Post Hoc Tests

Homogeneous Subsets

DAY100

Duncan[a]

TREATMEN	N	Subset for alpha = .05 1	Subset for alpha = .05 2
control0.4	3	37.0700	
colocasia0.4	3		58.4200
vertiver0.4	3		63.1467
Sig.		1.000	.091

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Average BOD Removal of 100 days (0.6 meter)

Oneway

Descriptives

DAY100

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
vertiver0.6	3	34.7033	2.8050	1.6195	27.7353	41.6713	31.90	37.51
colocasia0.6	3	28.4600	4.0800	2.3556	18.3247	38.5953	24.38	32.54
control0.6	3	18.6400	3.9600	2.2863	8.8028	28.4772	14.68	22.60
Total	9	27.2678	7.6961	2.5654	21.3521	33.1835	14.68	37.51

ANOVA

DAY100

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	393.442	2	196.721	14.682	.005
Within Groups	80.392	6	13.399		
Total	473.834	8			

Post Hoc Tests

Homogeneous Subsets

DAY100

Duncan[a]

TREATMEN	N	Subset for alpha = .05 1	Subset for alpha = .05 2
control0.6	3	18.6400	
colocasia0.6	3		28.4600
vertiver0.6	3		34.7033
Sig.		1.000	.082

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Average COD Removal of 100 days (0.2 meter)

Oneway

Descriptives

DAY100

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
vertiver0.2	3	54.4300	.6300	.3637	52.8650	55.9950	53.80	55.06
colocasia0.2	3	42.3267	.2650	.1530	41.6683	42.9850	42.06	42.59
control0.2	3	35.4467	.3350	.1934	34.6144	36.2789	35.11	35.78
Total	9	44.0678	8.3318	2.7773	37.6634	50.4722	35.11	55.06

ANOVA

DAY100

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	554.192	2	277.096	1434.822	.000
Within Groups	1.159	6	.193		
Total	555.351	8			

Post Hoc Tests

Homogeneous Subsets

DAY100

Duncan[a]

TREATMEN	N	Subset for alpha = .05		
		1	2	3
control0.2	3	35.4467		
colocasia0.2	3		42.3267	
vertiver0.2	3			54.4300
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Average COD Removal of 100 days (0.4 meter)

Oneway

Descriptives

DAY100

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
vertiver0.4	3	53.8367	.4050	.2338	52.8306	54.8428	53.43	54.24
colocasia0.4	3	39.0300	.4100	.2367	38.0115	40.0485	38.62	39.44
control0.4	3	34.8000	5.000E-02	2.887E-02	34.6758	34.9242	34.75	34.85
Total	9	42.5556	8.6617	2.8872	35.8976	49.2135	34.75	54.24

ANOVA

DAY100

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	599.525	2	299.762	2687.382	.000
Within Groups	.669	6	.112		
Total	600.194	8			

Post Hoc Tests

Homogeneous Subsets

DAY100

Duncan[a]

TREATMEN	N	Subset for alpha = .05		
		1	2	3
control0.4	3	34.8000		
colocasia0.4	3		39.0300	
vertiver0.4	3			53.8367
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Average COD Removal of 100 days (0.6 meter)

Oneway

Descriptives

DAY100

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
vertiver0.6	3	50.9500	.3700	.2136	50.0309	51.8691	50.58	51.32
colocasia0.6	3	41.7000	.4500	.2598	40.5821	42.8179	41.25	42.15
control0.6	3	34.6400	.4300	.2483	33.5718	35.7082	34.21	35.07
Total	9	42.4300	7.0929	2.3643	36.9779	47.8821	34.21	51.32

ANOVA

DAY100

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	401.422	2	200.711	1148.452	.000
Within Groups	1.049	6	.175		
Total	402.471	8			

Post Hoc Tests

Homogeneous Subsets

DAY100

Duncan[a]

TREATMEN	N	Subset for alpha = .05		
		1	2	3
control0.6	3	34.6400		
colocasia0.6	3		41.7000	
vertiver0.6	3			50.9500
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Average TDS Removal of 100 days (0.2 meter)

Oneway

Descriptives

DAY100

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
vertiver0.2	3	55.7100	8.000E-02	4.619E-02	55.5113	55.9087	55.63	55.79
colocasia0.2	3	36.5433	.5755	.3323	35.1136	37.9730	35.88	36.91
control0.2	3	34.6333	.4140	.2390	33.6048	35.6619	34.31	35.10
Total	9	42.2956	10.1011	3.3670	34.5312	50.0599	34.31	55.79

ANOVA

DAY100

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	815.235	2	407.618	2402.146	.000
Within Groups	1.018	6	.170		
Total	816.253	8			

Post Hoc Tests

Homogeneous Subsets

DAY100

Duncan[a]

TREATMEN	N	Subset for alpha = .05		
		1	2	3
control0.2	3	34.6333		
colocasia0.2	3		36.5433	
vertiver0.2	3			55.7100
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Average TDS Removal of 100 days (0.4 meter)

Oneway

Descriptives

DAY100

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
vertiver0.4	3	49.7633	.3550	.2050	48.8814	50.6452	49.41	50.12
colocasia0.4	3	39.1733	.7850	.4532	37.2233	41.1234	38.39	39.96
control0.4	3	37.4467	1.9246	1.1112	32.6657	42.2276	35.45	39.29
Total	9	42.1278	5.8707	1.9569	37.6151	46.6404	35.45	50.12

ANOVA

DAY100

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	266.830	2	133.415	90.017	.000
Within Groups	8.893	6	1.482		
Total	275.722	8			

Post Hoc Tests

Homogeneous Subsets

DAY100

Duncan[a]

TREATMEN	N	Subset for alpha = .05	
		1	2
control0.4	3	37.4467	
colocasia0.4	3	39.1733	
vertiver0.4	3		49.7633
Sig.		.133	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Average TDS Removal of 100 days (0.6 meter)

Oneway

Descriptives

DAY100

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
vertiver0.6	3	48.9633	6.506E-02	3.756E-02	48.8017	49.1250	48.90	49.03
colocasia0.6	3	30.3267	1.1450	.6611	27.4823	33.1710	29.18	31.47
control0.6	3	9.8300	.7900	.4561	7.8675	11.7925	9.04	10.62
Total	9	29.7067	16.9659	5.6553	16.6655	42.7478	9.04	49.03

ANOVA

DAY100

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2298.856	2	1149.428	1778.047	.000
Within Groups	3.879	6	.646		
Total	2302.735	8			

Post Hoc Tests

Homogeneous Subsets

DAY100

Duncan[a]

TREATMEN	N	Subset for alpha = .05 1	2	3
control0.6	3	9.8300		
colocasia0.6	3		30.3267	
vertiver0.6	3			48.9633
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Average TKN Removal of 100 days (Vetiver)

Oneway

Descriptives

DAY100

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	Upper Bound	Minimum	Maximum
vertiver0.2	3	79.3700	9.000E-02	5.196E-02	79.1464	79.5936	79.28	79.46
vertiver0.4	3	77.9467	.1650	9.528E-02	77.5367	78.3566	77.78	78.11
vertiver0.6	3	60.2267	5.686E-02	3.283E-02	60.0854	60.3679	60.18	60.29
Total	9	72.5144	9.2369	3.0790	65.4143	79.6146	60.18	79.46

ANOVA

DAY100

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	682.491	2	341.246	26544.61	.000
Within Groups	7.713E-02	6	1.286E-02		
Total	682.569	8			

Post Hoc Tests

Homogeneous Subsets

DAY100

Duncan[a]

TREATMEN	N	Subset for alpha = .05 1	2	3
vertiver0.6	3	60.2267		
vertiver0.4	3		77.9467	
vertiver0.2	3			79.3700
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Average TKN Removal of 100 days (Colocasia)

Oneway

Descriptives

DAY100

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
colocasia0.2	3	77.8500	.1600	9.238E-02	77.4525	78.2475	77.69	78.01
colocasia0.4	3	77.7367	.1350	7.796E-02	77.4012	78.0721	77.60	77.87
colocasia0.6	3	56.2967	.2201	.1271	55.7500	56.8434	56.08	56.52
Total	9	70.6278	10.7495	3.5832	62.3650	78.8906	56.08	78.01

ANOVA

DAY100

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	924.233	2	462.116	15025.46	.000
Within Groups	.185	6	3.076E-02		
Total	924.417	8			

Post Hoc Tests

Homogeneous Subsets

DAY100

Duncan[a]

TREATMEN	N	Subset for alpha = .05 1	Subset for alpha = .05 2
colocasia0.6	3	56.2967	
colocasia0.4	3		77.7367
colocasia0.2	3		77.8500
Sig.		1.000	.459

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Average TKN Removal of 100 days (Control)

Oneway

Descriptives

DAY100

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
control0.2	3	44.2700	.1500	8.660E-02	43.8974	44.6426	44.12	44.42
control0.4	3	30.1033	3.512E-02	2.028E-02	30.0161	30.1906	30.07	30.14
control0.6	3	18.2500	.3500	.2021	17.3806	19.1194	17.90	18.60
Total	9	30.8744	11.2834	3.7611	22.2012	39.5477	17.90	44.42

ANOVA

DAY100

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1018.236	2	509.118	10444.64	.000
Within Groups	.292	6	4.874E-02		
Total	1018.529	8			

Post Hoc Tests

Homogeneous Subsets

DAY100

Duncan[a]

TREATMEN	N	Subset for alpha = .05: 1	2	3
control0.6	3	18.2500		
control0.4	3		30.1033	
control0.2	3			44.2700
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Average TSS Removal of 100 days (Vetiver)

Oneway

Descriptives

DAY100

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
vertiver0.2	3	64.3967	2.9500	1.7032	57.0684	71.7249	61.45	67.35
vertiver0.4	3	44.6833	2.3750	1.3712	38.7835	50.5832	42.31	47.06
vertiver0.6	3	76.1433	2.0850	1.2038	70.9639	81.3228	74.06	78.23
Total	9	61.7411	13.9361	4.6454	51.0289	72.4533	42.31	78.23

ANOVA

DAY100

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1516.331	2	758.166	121.693	.000
Within Groups	37.381	6	6.230		
Total	1553.712	8			

Post Hoc Tests

Homogeneous Subsets

DAY100

Duncan[a]

TREATMEN	N	Subset for alpha = .05		
		1	2	3
vertiver0.4	3	44.6833		
vertiver0.2	3		64.3967	
vertiver0.6	3			76.1433
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Average TSS Removal of 100 days (Colocasia)

Oneway

Descriptives

DAY100

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
colocasia0.2	3	-32.9800	4.0600	2.3440	-43.0656	-22.8944	-37.04	-28.92
colocasia0.4	3	38.3933	5.9900	3.4584	23.5132	53.2734	32.39	44.37
colocasia0.6	3	56.8500	4.3700	2.5230	45.9943	67.7057	52.48	61.22
Total	9	20.7544	41.3025	13.7675	-10.9934	52.5023	-37.04	61.22

ANOVA

DAY100

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	13504.23	2	6752.115	283.460	.000
Within Groups	142.922	6	23.820		
Total	13647.15	8			

Post Hoc Tests

Homogeneous Subsets

DAY100

Duncan[a]

TREATMEN	N	Subset for alpha = .05		
		1	2	3
colocasia0.2	3	-32.9800		
colocasia0.4	3		38.3933	
colocasia0.6	3			56.8500
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Average TSS Removal of 100 days (Control)

Oneway

Descriptives

DAY100

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
control0.2	3	-65.5867	3.3850	1.9543	-73.9955	-57.1779	-68.97	-62.20
control0.4	3	35.7333	11.5450	6.6655	7.0540	64.4127	24.19	47.28
control0.6	3	-70.0767	18.4750	10.6665	-115.9711	-24.1822	-88.55	-51.60
Total	9	-33.3100	52.9785	17.6595	-74.0329	7.4129	-88.55	47.28

ANOVA

DAY100

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	21481.66	2	10740.829	66.292	.000
Within Groups	972.142	6	162.024		
Total	22453.80	8			

Post Hoc Tests

Homogeneous Subsets

DAY100

Duncan[a]

TREATMEN	N	Subset for alpha = .05 1	2
control0.6	3	-70.0767	
control0.2	3	-65.5867	
control0.4	3		35.7333
Sig.		.681	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Average BOD Removal of 100 days (Vetiver)

Oneway

Descriptives

DAY100

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
vertiver0.2	3	66.0400	1.4200	.8198	62.5125	69.5675	64.62	67.46
vertiver0.4	3	63.1467	3.8150	2.2026	53.6697	72.6237	59.33	66.96
vertiver0.6	3	34.7033	2.8050	1.6195	27.7353	41.6713	31.90	37.51
Total	9	54.6300	15.1997	5.0666	42.9464	66.3136	31.90	67.46

ANOVA

DAY100

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1799.381	2	899.691	110.443	.000
Within Groups	48.877	6	8.146		
Total	1848.259	8			

Post Hoc Tests

Homogeneous Subsets

DAY100

Duncan[a]

TREATMEN	N	Subset for alpha = .05	
		1	2
vertiver0.6	3	34.7033	
vertiver0.4	3		63.1467
vertiver0.2	3		66.0400
Sig.		1.000	.261

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Average BOD Removal of 100 days (Colocasia)

Oneway

Descriptives

DAY100

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
colocasia0.2	3	58.6467	2.5644	1.4806	52.2764	65.0170	55.94	61.04
colocasia0.4	3	58.4200	1.0000	.5774	55.9359	60.9041	57.42	59.42
colocasia0.6	3	28.4600	4.0800	2.3556	18.3247	38.5953	24.38	32.54
Total	9	48.5089	15.2370	5.0790	36.7967	60.2211	24.38	61.04

ANOVA

DAY100

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1808.888	2	904.444	112.017	.000
Within Groups	48.445	6	8.074		
Total	1857.333	8			

Post Hoc Tests

Homogeneous Subsets

DAY100

Duncan[a]

TREATMEN	N	Subset for alpha = .05	
		1	2
colocasia0.6	3	28.4600	
colocasia0.4	3		58.4200
colocasia0.2	3		58.6467
Sig.		1.000	.925

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Average BOD Removal of 100 days (Control)

Oneway

Descriptives

DAY100

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	Upper Bound	Minimum	Maximum
control0.2	3	32.6767	.8950	.5167	30.4534	34.9000	31.78	33.57
control0.4	3	37.0700	3.0600	1.7667	29.4685	44.6715	34.01	40.13
control0.6	3	18.6400	3.9600	2.2863	8.8028	28.4772	14.68	22.60
Total	9	29.4622	8.7156	2.9052	22.7629	36.1616	14.68	40.13

ANOVA

DAY100

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	555.994	2	277.997	32.267	.001
Within Groups	51.692	6	8.615		
Total	607.687	8			

Post Hoc Tests

Homogeneous Subsets

DAY100

Duncan[a]

TREATMEN	N	Subset for alpha = .05 1	2
control0.6	3	18.6400	
control0.2	3		32.6767
control0.4	3		37.0700
Sig.		1.000	.116

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Average COD Removal of 100 days (Vetiver)

Oneway

Descriptives

DAY100

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
vertiver0.2	3	54.4300	.6300	.3637	52.8650	55.9950	53.80	55.06
vertiver0.4	3	53.8367	.4050	.2338	52.8306	54.8428	53.43	54.24
vertiver0.6	3	50.9500	.3700	.2136	50.0309	51.8691	50.58	51.32
Total	9	53.0722	1.6655	.5552	51.7920	54.3524	50.58	55.06

ANOVA

DAY100

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	20.795	2	10.398	44.700	.000
Within Groups	1.396	6	.233		
Total	22.191	8			

Post Hoc Tests

Homogeneous Subsets

DAY100

Duncan[a]

TREATMEN	N	Subset for alpha = .05	
		1	2
vertiver0.6	3	50.9500	
vertiver0.4	3		53.8367
vertiver0.2	3		54.4300
Sig.		1.000	.183

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Average COD Removal of 100 days (Colocasia)

Oneway

Descriptives

DAY100

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
colocasia0.2	3	42.3267	.2650	.1530	41.6683	42.9850	42.06	42.59
colocasia0.4	3	39.0300	.4100	.2367	38.0115	40.0485	38.62	39.44
colocasia0.6	3	41.7000	.4500	.2598	40.5821	42.8179	41.25	42.15
Total	9	41.0189	1.5521	.5174	39.8259	42.2119	38.62	42.59

ANOVA

DAY100

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	18.390	2	9.195	62.573	.000
Within Groups	.882	6	.147		
Total	19.271	8			

Post Hoc Tests

Homogeneous Subsets

DAY100

Duncan[a]

TREATMEN	N	Subset for alpha = .05	
		1	2
colocasia0.4	3	39.0300	
colocasia0.6	3		41.7000
colocasia0.2	3		42.3267
Sig.		1.000	.092

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Average COD Removal of 100 days (Control)

Oneway

Descriptives

DAY100

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
control0.2	3	35.4467	.3350	.1934	34.6144	36.2789	35.11	35.78
control0.4	3	34.8000	5.000E-02	2.887E-02	34.6758	34.9242	34.75	34.85
control0.6	3	34.6400	.4300	.2483	33.5718	35.7082	34.21	35.07
Total	9	34.9622	.4601	.1534	34.6085	35.3159	34.21	35.78

ANOVA

DAY100

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.094	2	.547	5.479	.044
Within Groups	.599	6	9.988E-02		
Total	1.694	8			

Post Hoc Tests

Homogeneous Subsets

DAY100

Duncan[a]

TREATMEN	N	Subset for alpha = .05: 1	2
control0.6	3	34.6400	
control0.4	3	34.8000	
control0.2	3		35.4467
Sig.		.558	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Average TDS Removal of 100 days (Vetiver)

Oneway

Descriptives

DAY100

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
vertiver0.2	3	55.7100	8.000E-02	4.619E-02	55.5113	55.9087	55.63	55.79
vertiver0.4	3	49.7633	.3550	.2050	48.8814	50.6452	49.41	50.12
vertiver0.6	3	48.9633	6.506E-02	3.756E-02	48.8017	49.1250	48.90	49.03
Total	9	51.4789	3.1975	1.0658	49.0210	53.9367	48.90	55.79

ANOVA

DAY100

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	81.520	2	40.760	894.736	.000
Within Groups	.273	6	4.556E-02		
Total	81.794	8			

Post Hoc Tests

Homogeneous Subsets

DAY100

Duncan[a]

TREATMEN	N	Subset for alpha = .05 1	2	3
vertiver0.6	3	48.9633		
vertiver0.4	3		49.7633	
vertiver0.2	3			55.7100
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Average TDS Removal of 100 days (Colocasia)

Oneway

Descriptives

DAY100

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
colocasia0.2	3	36.5433	.5755	.3323	35.1136	37.9730	35.88	36.91
colocasia0.4	3	39.1733	.7850	.4532	37.2233	41.1234	38.39	39.96
colocasia0.6	3	30.3267	1.1450	.6611	27.4823	33.1710	29.18	31.47
Total	9	35.3478	4.0054	1.3351	32.2690	38.4266	29.18	39.96

ANOVA

DAY100

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	123.827	2	61.914	82.241	.000
Within Groups	4.517	6	.753		
Total	128.344	8			

Post Hoc Tests

Homogeneous Subsets

DAY100

Duncan[a]

TREATMEN	N	Subset for alpha = .05		
		1	2	3
colocasia0.6	3	30.3267		
colocasia0.2	3		36.5433	
colocasia0.4	3			39.1733
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Average TDS Removal of 100 days (Control)

Oneway

Descriptives

DAY100

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
control0.2	3	34.6333	.4140	.2390	33.6048	35.6619	34.31	35.10
control0.4	3	37.4467	1.9246	1.1112	32.6657	42.2276	35.45	39.29
control0.6	3	9.8300	.7900	.4561	7.8675	11.7925	9.04	10.62
Total	9	27.3033	13.2042	4.4014	17.1537	37.4530	9.04	39.29

ANOVA

DAY100

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1385.800	2	692.900	461.978	.000
Within Groups	8.999	6	1.500		
Total	1394.800	8			

Post Hoc Tests

Homogeneous Subsets

DAY100

Duncan[a]

TREATMEN	N	Subset for alpha = .05 1	2	3
control0.6	3	9.8300		
control0.2	3		34.6333	
control0.4	3			37.4467
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

APPENDIX C

GENERAL DATA OF THE EXPERIMENT

Daily Mean Dry Temperature (Celsius)

STATION : 459201 Chon Buri* YEAR : 2006

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	29.0	29.2	28.9	28.7	30.9	28.4	28.5	26.4	28.8	29.0	-	-
2	29.6	28.7	28.4	29.3	30.8	29.3	27.5	27.8	29.2	26.8	-	-
3	29.6	28.5	27.8	28.9	31.0	28.2	28.3	28.7	29.5	27.4	-	-
4	28.8	29.4	28.1	30.2	31.3	29.3	29.0	27.9	30.3	28.7	-	-
5	28.2	29.1	29.4	30.0	29.9	29.8	29.8	28.7	30.1	27.8	-	-
6	28.1	29.1	29.2	31.0	30.4	29.8	30.0	29.9	29.4	27.7	-	-
7	27.8	29.5	29.9	30.8	29.8	30.4	30.4	29.9	28.4	28.6	-	-
8	26.5	29.9	29.6	29.4	29.3	30.3	30.7	29.7	29.7	28.6	-	-
9	26.0	29.5	28.7	30.2	28.3	30.1	30.9	29.0	29.6	27.2	-	-
10	26.0	29.4	29.2	30.2	27.3	30.6	30.6	28.3	28.2	27.5	-	-
11	26.3	29.9	29.7	31.1	28.0	29.8	29.9	29.6	28.3	26.9	-	-
12	26.5	28.5	30.3	30.9	29.4	31.2	30.6	30.0	28.2	27.9	-	-
13	26.8	24.9	30.5	31.3	30.1	31.5	30.2	30.5	26.3	28.0	-	-
14	27.1	27.0	28.8	29.8	28.2	31.2	30.2	28.8	27.6	28.2	-	-
15	27.5	28.4	28.8	28.4	29.2	30.7	30.1	28.4	28.2	28.4	-	-
16	27.3	28.9	29.7	27.4	30.6	30.9	30.1	29.1	28.3	28.8	-	-
17	28.4	29.1	30.1	28.8	28.4	30.4	29.2	29.8	29.0	28.9	-	-
18	28.0	26.8	30.9	30.0	26.7	29.4	28.6	29.5	28.8	27.0	-	-
19	27.8	28.4	29.5	30.1	28.3	28.5	29.1	29.6	27.6	28.6	-	-
20	27.5	28.1	29.4	28.1	28.0	29.1	29.2	29.5	26.7	29.8	-	-
21	25.9	28.0	29.0	28.3	28.6	27.8	29.1	29.7	27.7	30.1	-	-
22	26.5	28.8	29.5	30.0	28.4	29.1	28.8	29.8	28.2	30.0	-	-
23	27.1	30.2	29.4	30.2	29.3	28.8	29.9	29.0	27.2	29.5	-	-
24	27.0	30.3	29.8	30.5	29.9	27.7	30.4	30.2	28.6	30.1	-	-
25	26.3	29.3	29.9	31.0	30.2	27.7	29.6	30.4	27.4	30.1	-	-
26	25.2	29.9	30.4	30.3	28.9	28.0	29.5	29.3	27.4	30.1	-	-
27	27.0	29.6	30.2	30.9	29.8	29.0	29.0	28.5	28.1	30.0	-	-
28	27.3	29.5	30.5	31.3	29.7	29.9	30.0	29.2	28.3	30.2	-	-
29	27.7		29.1	30.7	30.2	29.6	30.7	29.9	29.4	29.4	-	-
30	27.1		30.5	30.3	29.2	27.7	30.5	26.5	28.9	29.1	-	-
31	28.0		28.0		28.8		28.7	27.3		29.1		-
MEAN	27.4	28.9	29.5	29.9	29.3	29.5	29.6	29.1	28.4	28.7	-	-

ANNUAL MEAN TEMPERATURE = 29.0* CELSIUS.

"-" IS MISSING VALUE OR NO DATA REPORTED

"#" MEANS INCOMPLETE DATA IN THE SPECIFIED MONTH AND ANNUAL VALUES

Data Processing Sub-division
Climatology Division
Meteological Department
15-Jan-2007

DAILY RAINFALL IN MILLIMETRE

STATION : 459201 Chon Buri* YEAR : 2006
PROVINCE : Chon Buri

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	.0	.0	T	.0	.0	.5	46.4	5.1	.0	36.2	-	-
2	.0	.0	.0	9.3	.0	5.8	1.5	T	3.5	5.6	-	-
3	.0	.0	.0	.9	.0	2.6	1.2	.4	.0	12.7	-	-
4	.0	.0	.0	.0	.0	3.5	.1	15.2	10.1	.0	-	-
5	.0	.0	.0	T	.0	6.0	.0	.0	.0	44.2	-	-
6	.0	.0	.0	.0	.0	.0	.0	.0	20.3	.0	-	-
7	.0	.0	.0	.0	1.0	.0	.0	.0	2.2	.0	-	-
8	.0	.0	.0	.0	13.1	1.4	.0	.0	.0	62.1	-	-
9	.0	.0	13.6	T	31.6	.0	.0	.1	1.6	5.3	-	-
10	.0	.0	.0	.0	5.3	1.7	.2	23.6	1.1	40.1	-	-
11	.0	.0	.0	T	12.7	.0	.0	.0	4.7	6.2	-	-
12	.0	.8	.0	.0	.0	1.2	.0	.0	17.6	55.2	-	-
13	.0	.4	.0	.0	.0	.0	.0	T	7.7	2.3	-	-
14	.0	.0	1.2	20.7	25.2	.0	.0	14.4	5.7	2.5	-	-
15	.0	.0	.0	1.8	.0	.0	.0	.0	.0	.3	-	-
16	.0	.0	.0	48.0	30.0	2.2	.0	.0	.8	10.3	-	-
17	.0	26.6	.0	.0	30.0	.0	.0	.0	11.0	4.4	-	-
18	.0	53.7	.0	.0	23.0	.2	7.5	.0	17.3	12.7	-	-
19	.0	.0	4.7	.1	15.8	.1	2.3	.0	11.3	.0	-	-
20	.0	.0	.8	14.9	4.0	3.1	.0	.0	8.9	.0	-	-
21	.0	.0	.0	24.8	.8	14.2	.7	.0	12.5	.0	-	-
22	.0	.0	.0	.0	1.9	.1	.0	T	37.4	.0	-	-
23	.0	.0	.0	.0	.0	1.7	.0	.2	.5	1.5	-	-
24	.0	.0	.0	.0	.0	2.9	.0	.0	.0	.0	-	-
25	.0	.0	.0	.0	.0	25.5	3.1	.0	31.9	.0	-	-
26	.0	.0	.0	1.2	2.1	.7	T	.1	9.7	.0	-	-
27	.0	.0	.0	.0	T	.0	.0	3.7	.9	.0	-	-
28	.0	.0	T	.0	T	.0	.0	T	.1	.0	-	-
29	.0		T	4.9	3.1	.0	.0	27.7	.0	.0	-	-
30	.0		13.6	.0	1.0	13.9	.0	45.3	.4	.0	-	-
31	.0		.5		5.0		43.3	.7		.0		-
N	31	28	31	30	31	30	31	31	30	31	-	-
TOTAL	.0	81.5	34.4	126.6	205.6	87.3	106.3	136.5	217.2	301.6	-	-
R-DAY	0	4	6	10	17	19	10	12	23	16	-	-
MAX.	.0	53.7	13.6	48.0	31.6	25.5	46.4	45.3	37.4	62.1	-	-

ANNUAL RAINFALL = 1297.0* MM. TOTAL NO. OF DAYS WITH RAINFALL = 117*
DAILY MAXIMUM RAINFALL = 62.1* MM. ON 8 OCT

REMARKS : DAILY VALUES ARE ACCUMULATED RAINFALL BETWEEN 07.00-07.00 HOURS
R-DAY IS NO. OF DAYS WITH RAINFALL GREATER THAN OR EQUAL TO 0.1 MM.
"T" IS TRACE RAINFALL, RAINFALL AMOUNT LESS THAN 0.1 MM.
"-" IS MISSING VALUE OR NO DATA REPORTED
"*" MEANS INCOMPLETE DATA IN SPECIFIED MONTH AND/OR ANNUAL VALUES

Data Processing Sub-division
Climatology Division
Meteorological Department
15-Jan-2007

Daily Mean Relative Humidity (%)

STATION : 459201 CHON BURI YEAR : 2006

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	64	70	76	74	71	79	81	86	75	79	-	-
2	63	76	65	73	70	73	86	79	73	88	-	-
3	58	77	69	76	68	78	83	72	74	85	-	-
4	67	62	77	70	70	76	79	81	68	81	-	-
5	77	55	72	72	74	71	75	75	73	85	-	-
6	79	54	73	70	74	73	72	68	79	83	-	-
7	59	53	70	66	72	71	72	69	84	76	-	-
8	55	52	71	67	76	70	70	68	75	78	-	-
9	57	48	76	72	84	71	69	69	76	86	-	-
10	53	56	78	72	87	67	70	77	84	84	-	-
11	55	59	73	71	86	72	75	70	81	85	-	-
12	64	72	67	70	77	67	68	68	80	82	-	-
13	67	80	71	70	74	66	69	68	89	80	-	-
14	74	72	71	80	78	68	68	76	81	81	-	-
15	73	74	66	79	70	68	67	80	81	81	-	-
16	76	76	74	79	60	69	71	74	80	80	-	-
17	72	72	72	77	79	73	73	71	76	79	-	-
18	71	85	66	71	91	77	80	76	75	84	-	-
19	71	77	76	73	80	79	78	75	82	75	-	-
20	67	79	75	80	81	80	78	75	86	71	-	-
21	69	77	76	81	77	87	72	72	82	70	-	-
22	72	74	74	73	80	82	76	72	79	67	-	-
23	71	62	74	74	74	80	70	74	82	71	-	-
24	60	60	72	72	73	85	66	70	78	70	-	-
25	49	72	71	70	72	87	70	69	84	68	-	-
26	51	72	69	72	80	82	71	74	84	66	-	-
27	51	72	73	70	76	77	71	75	82	66	-	-
28	52	72	72	66	76	71	67	75	79	66	-	-
29	59		74	71	75	70	67	72	73	62	-	-
30	64		68	72	81	81	68	86	78	63	-	-
31	72		77		78		72	83		62		-
MEAN	64	68	72	73	76	75	73	74	79	76	-*	-=

"-" IS MISSING VALUE OR NO DATA REPORTED

"*" MEANS INCOMPLETE DATA IN THE SPECIFIED MONTH

Daily Maximum Temperature (Celsius)

STATION : 459201 Chon Buri* YEAR : 2006

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	33.6	35.8	33.2	33.8	34.9	33.2	32.6	28.6	32.1	32.9	-	-
2	34.6	32.3	33.3	33.3	35.0	34.6	31.0	33.0	32.6	29.9	-	-
3	35.4	33.0	33.0	34.0	35.9	33.5	32.5	31.9	33.4	31.3	-	-
4	33.2	35.5	31.1	34.7	36.3	34.0	32.5	31.6	34.0	32.6	-	-
5	31.1	35.8	33.7	35.1	34.7	33.6	33.7	31.6	34.6	32.0	-	-
6	33.1	35.7	33.8	36.2	35.0	33.5	33.7	32.7	31.8	31.6	-	-
7	32.8	36.0	34.4	35.9	34.1	34.6	33.7	33.4	32.5	33.0	-	-
8	32.6	35.0	34.7	33.4	34.9	34.5	34.0	33.0	33.6	32.5	-	-
9	31.6	35.2	34.3	35.0	33.6	34.5	34.7	33.1	34.0	31.0	-	-
10	32.5	35.6	33.8	35.3	33.8	34.3	34.4	32.6	32.3	31.2	-	-
11	32.5	36.0	34.0	35.5	32.3	34.4	33.0	33.2	33.0	30.6	-	-
12	32.2	33.7	34.9	35.9	33.9	35.2	33.8	33.2	33.3	34.4	-	-
13	31.8	26.7	35.0	35.9	35.0	35.5	33.7	33.0	29.6	33.5	-	-
14	32.3	32.1	34.5	34.3	32.5	35.3	33.8	32.7	32.0	32.1	-	-
15	31.9	31.5	35.5	34.1	34.0	35.1	33.4	31.3	32.3	33.5	-	-
16	31.0	33.6	34.1	34.2	35.3	35.8	33.3	32.7	32.0	33.1	-	-
17	33.4	33.1	34.2	32.4	32.7	35.3	33.0	34.0	33.1	35.2	-	-
18	33.3	30.7	35.5	33.7	29.8	32.6	33.0	33.0	33.0	31.5	-	-
19	32.1	32.4	34.3	34.2	32.0	31.2	33.2	33.0	30.5	34.7	-	-
20	32.7	33.8	33.8	33.3	32.0	33.5	32.8	33.0	29.6	35.0	-	-
21	33.8	32.2	33.0	33.2	32.5	32.6	32.9	33.6	33.3	34.7	-	-
22	32.6	32.8	33.7	33.9	31.7	33.8	34.0	33.4	33.0	34.5	-	-
23	32.0	36.3	34.5	34.5	33.5	32.8	33.3	32.2	31.0	35.0	-	-
24	32.2	36.7	34.5	35.0	33.9	33.0	34.3	34.9	32.3	35.1	-	-
25	32.5	33.6	35.4	35.0	34.7	32.5	33.5	33.9	29.6	34.9	-	-
26	30.7	34.2	33.3	35.1	33.1	31.5	32.4	33.4	32.4	35.0	-	-
27	33.1	33.5	34.0	34.8	34.4	32.1	32.0	32.1	33.2	35.0	-	-
28	34.3	33.0	35.2	35.0	33.4	33.8	34.0	33.2	32.5	34.7	-	-
29	34.5		33.7	33.7	34.1	32.1	34.3	33.8	33.1	34.3	-	-
30	32.5		35.3	34.5	34.0	30.7	34.1	31.3	33.4	34.6	-	-
31	32.2		33.0		34.4		33.9	31.5		34.3	-	-
MEAN	32.7	33.8	34.1	34.5	33.8	33.6	33.4	32.7	32.4	33.3	-	-
MAX.	35.4	36.7	35.5	36.2	36.3	35.8	34.7	34.9	34.6	35.2	-	-
DAY	3	24	15.18	6	4	16	9	24	5	17	-	-

Extreme maximum temperature = 36.7* celsius

remark : in line day, if the number of days with maximum temperature greater than 2 days the number of days is shown in parenthesis other number(s) showing the day with maximum temperature in that month.
"-" IS MISSING VALUE OR NO DATA REPORTED
"#" MEANS INCOMPLETE DATA IN THE SPECIFIED MONTH AND ANNUAL VALUES

Data Processing Sub-division
Climatology Division
Meteological Department
15-Jan-2007

Daily Minimum Temperature (Celsius)

STATION : 459201 Chon Buri* YEAR : 2006

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	25.7	24.7	25.2	24.7	27.7	25.6	25.8	24.3	25.6	25.6	-	-
2	25.3	25.6	25.4	26.9	27.2	25.2	25.0	25.0	26.3	24.1	-	-
3	25.5	24.5	25.8	25.5	27.0	25.1	26.1	26.7	25.6	24.5	-	-
4	25.0	24.5	24.2	25.7	27.1	25.1	26.6	24.1	27.5	26.0	-	-
5	25.5	24.1	26.3	27.2	28.0	25.0	27.2	24.1	25.7	26.8	-	-
6	25.3	23.5	25.8	27.3	27.3	25.5	27.5	27.5	27.3	24.0	-	-
7	24.7	23.2	25.7	26.4	27.3	27.0	27.3	27.0	25.9	26.2	-	-
8	21.0	25.3	25.7	25.5	25.5	27.6	27.6	27.8	25.6	26.7	-	-
9	21.5	24.2	24.0	26.5	24.9	27.1	27.9	27.3	26.9	24.5	-	-
10	20.4	24.0	24.1	26.7	25.8	27.5	28.2	25.0	26.1	24.8	-	-
11	21.3	26.0	26.5	27.7	25.7	24.9	28.0	27.0	24.8	24.1	-	-
12	21.5	25.3	26.3	28.1	25.4	28.6	28.3	27.0	24.6	24.8	-	-
13	21.7	23.9	27.7	28.1	26.8	28.0	28.3	28.0	24.2	24.4	-	-
14	22.4	23.0	25.7	28.4	25.4	28.1	28.0	24.4	25.1	24.6	-	-
15	22.8	25.3	24.1	25.6	24.9	27.3	28.0	26.5	25.2	24.4	-	-
16	23.1	26.0	26.0	23.3	26.1	27.0	28.2	27.1	25.5	25.1	-	-
17	25.0	26.5	27.1	25.0	23.5	26.2	27.0	26.9	25.4	25.5	-	-
18	23.0	23.1	27.5	27.1	24.6	28.0	26.0	27.2	23.5	25.3	-	-
19	23.7	25.3	26.9	27.0	24.8	26.3	26.5	27.4	24.2	23.8	-	-
20	24.0	26.0	25.7	25.0	24.5	27.0	26.6	27.0	23.5	25.3	-	-
21	20.4	24.1	27.0	24.4	25.9	26.0	26.7	27.0	24.5	26.0	-	-
22	20.7	24.5	26.1	26.5	26.9	25.7	26.0	27.0	25.3	26.0	-	-
23	21.8	25.1	26.4	26.3	26.2	26.5	27.3	27.5	24.1	25.5	-	-
24	22.8	25.1	27.2	27.6	27.3	25.5	27.0	27.2	25.6	25.6	-	-
25	21.1	26.0	26.2	26.5	27.0	25.6	25.8	27.8	23.4	25.9	-	-
26	20.3	26.7	27.6	27.1	27.2	25.1	25.2	27.5	23.0	25.3	-	-
27	23.1	26.6	27.3	26.5	26.4	26.5	26.8	25.1	25.0	26.8	-	-
28	22.2	26.5	26.4	27.5	26.6	27.5	27.5	26.0	26.1	26.0	-	-
29	21.8		24.4	28.2	27.3	27.8	28.2	27.3	26.7	25.3	-	-
30	22.5		26.8	26.1	26.1	25.0	28.6	24.1	26.2	24.8	-	-
31	24.4		23.5		26.2		24.4	21.6		24.7		-
MEAN	22.9	24.9	26.0	26.5	26.2	26.4	27.0	26.3	25.3	25.2	-	-
MIN.	20.3	23.0	23.5	23.3	23.5	24.9	24.4	21.6	23.0	23.8	-	-
DAY	26	14	31	16	17	11	31	31	26	19	-	-

Extreme minimum temperature = 20.3* celsius

remark : in line day, if the number of days with minimum temperature greater than 2 days the number of days is shown in parenthesis other number(s) showing the day with minimum temperature in that month.
"-" IS MISSING VALUE OR NO DATA REPORTED
"#" MEANS INCOMPLETE DATA IN THE SPECIFIED MONTH AND ANNUAL VALUES

Data Processing Sub-division
Climatology Division
Meteological Department
15-Jan-2007

DAILY AND MONTHLY DATA

MARCH 2006
CHON BURI

Local Index 459201
WMO Index 48459
Latitude 3 22 N
Longitude 59 E

Elevation of station above MSL 1
Height of barometer above MSL 2
Height of thermometer above ground 1.60
Height of wind vane above ground 13.45
Height of raingauge above ground 1.00

Date	MSL. Pres-sure (hPa)	Air Temperature (C) Mean	Max.	Min.	Mean Dew Point Temp. (C)	Mean Vapour Pres-sure (hPa)	Relative Humidity (%) Mean	Max.	Min.	Surface Wind (knots) Mean Speed	Dir.	Maximum Speed	Dir.	Mean Cloud Amount (0-10)	Sun-shine hours	Total Evapo-ration (mm)	Pr… pit…
1	1010.1	28.9	33.2	25.2	23.9	29.7	76	88	51	1.0	SW,NW	5	WNW	5.9	-	4.8	
2	1011.8	28.4	33.3	25.4	21.0	25.0	65	81	49	1.3	vary	6	ENE	5.3	-	4.1	
3	1011.8	27.8	33.0	25.8	21.2	25.6	69	84	43	2.3	E	7	SSW	5.8	-	5.0	
4	1011.7	28.1	31.1	24.2	23.5	29.0	77	90	64	1.0	vary	4	W	3.8	-	3.7	
5	1012.1	29.4	33.7	26.3	23.6	29.1	72	84	56	1.1	vary	5	S	1.5	-	4.7	
6	1011.8	29.2	33.8	25.8	23.5	29.0	73	85	56	2.0	S	7	SSW	1.5	-	4.5	
7	1011.0	29.9	34.4	25.7	23.4	28.8	70	84	53	1.8	S,SW	6	WSW	.9	-	7.6	
8	1011.3	29.6	34.7	25.7	23.7	29.2	71	84	60	1.4	SE	6	SSW	.6	-	5.8	
9	1011.9	28.7	34.3	24.0	23.7	29.4	75	91	60	1.0	SW	6	S	3.4	-	8.7	13
10	1010.8	29.2	33.8	24.1	24.6	31.0	78	90	60	1.9	S	6	SSW	3.8	-	2.8	
11	1009.3	29.7	34.0	26.5	24.2	30.2	73	87	59	.8	S	4	SSW	.8	-	5.7	
12	1006.9	30.3	34.9	26.3	23.1	28.3	67	84	46	1.0	W	6	SE	.5	-	5.8	
13	1007.9	30.5	35.0	27.7	24.6	30.9	71	81	60	2.4	S	6	W	1.1	-	5.3	
14	1010.6	28.8	34.5	25.7	22.8	27.8	71	88	54	2.9	NE	6	NE	2.4	-	6.7	1
15	1011.4	28.8	35.5	24.1	21.4	25.5	66	83	42	1.5	NE	7	ENE	5.6	-	4.9	
16	1008.4	29.7	34.1	26.0	24.5	30.7	74	87	63	1.1	NW	5	NNW	1.5	-	4.8	
17	1007.3	30.1	34.2	27.1	24.3	30.5	72	83	60	1.9	S	5	SW	2.8	-	4.3	
18	1007.7	30.9	35.5	27.5	23.3	28.6	66	82	44	.5	SE,W	4	W	2.3	-	8.6	
19	1007.9	29.5	34.3	26.9	24.6	30.9	76	83	61	.9	SW,NW	7	WNW	3.8	-	4.1	4
20	1008.4	29.4	33.8	25.7	24.3	30.4	75	91	63	.5	S,W	4	S	2.4	-	4.8	
21	1007.8	29.0	33.0	27.0	24.1	30.1	76	84	59	1.5	S	6	SSE	5.3	-	3.4	
22	1006.5	29.5	33.7	26.1	24.1	30.1	74	90	60	1.8	vary	6	SSW	1.5	-	4.9	
23	1006.1	29.4	34.5	26.4	23.8	29.6	74	90	51	.8	E,NW	4	NW	3.0	-	5.2	
24	1006.3	29.8	34.5	27.2	24.1	30.0	72	85	59	1.5	S,SW	6	NW	3.9	-	4.2	
25	1007.5	29.9	35.4	26.2	23.8	29.6	71	88	60	.5	SW	7	SSW	2.5	-	5.5	
26	1008.7	30.4	33.3	27.6	23.3	28.7	69	78	55	2.0	S	6	W	2.3	-	5.5	
27	1008.0	30.2	34.0	27.3	24.7	31.2	73	86	59	1.6	SW	6	WNW	3.6	-	4.4	
28	1008.5	30.5	35.2	28.4	24.7	31.1	72	85	56	2.0	SW	6	WSW	2.8	-	4.5	
29	1009.9	29.1	33.7	24.4	23.9	29.7	74	88	63	1.0	vary	6	NNE	5.9	-	4.0	
30	1010.4	30.5	36.3	26.8	23.6	29.2	68	81	50	1.0	vary	6	SW	3.0	-	7.3	13.
31	1010.5	28.0	33.0	23.5	23.5	28.9	77	91	51	2.1	SW,W	7	SSE	5.5	-	3.9	
Total															-	150.9	34
Mean	1009.4	29.5	34.1	26.0	23.7	29.3	72	86	56	1.4		6		3.0	-	5.2	
Normal	1009.9	29.7	-	-	22.4		70	86	54	4.6					-	-	31.

Note: Daily mean values are computed from 8 three-hourly observations.

DAILY AND MONTHLY DATA

APRIL 2006
CHON BURI

Local Index 459201
WMO Index 48459
Latitude 22 N
Longitude 59 E

Elevation of station above MSL 1
Height of barometer above MSL 2
Height of thermometer above ground 1.50
Height of wind vane above ground 13.45
Height of raingauge above ground 1.00

Date	MSL. Pressure (hPa)	Air Temperature (C) Mean	Max.	Min.	Mean Dew Point Temp. (C)	Mean Vapour Pressure (hPa)	Relative Humidity (%) Mean	Max.	Min.	Surface Wind (Knots) Mean Speed	Dir.	Maximum Speed	Dir.	Mean Cloud Amount (0-10)	Sunshine hours	Total Evaporation (mm)	Pr pi [
1	1009.7	28.7	33.8	24.7	23.4	28.7	74	91	56	.0	calm	4	W	5.1	-	5.3	
2	1009.2	29.3	33.3	26.4	23.9	29.6	73	86	58	.5	SE,S	5	S	3.6	-	4.9	9
3	1008.9	28.9	34.0	25.5	24.0	29.8	76	89	58	.3	SE	5	SE	4.4	-	2.7	
4	1009.0	30.2	34.7	25.7	24.1	29.9	70	86	58	1.3	SW	7	SW	2.3	-	6.5	
5	1008.2	30.0	36.1	27.2	24.4	30.6	72	82	61	[illegible]	SSE,SW	5	SW	4.0	-	5.3	
6	1007.8	31.0	35.2	27.3	24.7	31.1	70	86	53	.9	SW,W	5	SW	.5	-	7.1	
7	1007.8	30.8	36.9	26.4	23.5	29.2	66	82	50	1.8	SW	16	NE	1.4	-	5.4	
8	1008.0	29.4	33.4	25.5	22.6	27.4	67	77	56	1.1	NW	4	NW	4.1	-	4.2	
9	1008.2	30.2	35.0	25.5	24.4	30.6	72	84	62	1.0	SE,W	8	W	4.0	-	3.9	
10	1008.7	30.2	35.3	26.7	24.5	30.7	72	88	59	.9	SW	4	SW	4.9	-	5.5	
11	1007.4	31.1	35.5	27.7	24.9	31.4	71	84	56	2.4	SW	7	SSW	2.9	-	6.5	
12	1005.9	30.8	35.9	28.1	24.7	31.2	70	81	57	1.1	vary	7	WSW	4.6	-	5.2	
13	1007.0	31.3	35.8	28.1	24.9	31.5	70	83	54	.9	SW,W	5	W	3.1	-	6.2	
14	1008.7	29.8	34.3	28.4	26.0	33.5	80	88	66	.6	W	5	W	5.9	-	4.1	23
15	1009.8	28.4	34.1	25.6	24.3	30.4	79	98	57	.9	E,SW	7	E	7.5	-	3.4	8
16	1010.0	27.4	34.2	23.3	23.2	28.4	79	92	59	1.0	E	6	SSE	8.2	-	9.5	45
17	1008.9	28.8	32.4	25.0	24.0	29.8	77	94	57	.3	W	4	W	6.3	-	3.6	
18	1009.6	30.0	33.7	27.1	23.9	29.7	71	83	55	.8	W	6	WNW	3.8	-	3.3	
19	1010.3	30.1	34.2	27.0	24.5	30.7	73	86	57	1.9	vary	6	ENE	3.8	-	6.2	
20	1010.2	28.1	33.3	25.0	24.1	30.0	80	92	60	1.1	W	4	WNW	8.9	-	7.0	14
21	1009.0	28.3	33.2	24.4	24.6	31.0	81	92	66	1.1	vary	7	WNW	5.5	-	-	24
22	1008.0	30.0	33.9	26.5	24.2	30.1	72	89	54	.6	SW	4	W	1.9	-	6.7	
23	1006.9	30.2	34.5	26.3	24.7	31.2	74	86	61	.8	vary	5	SW	4.3	-	6.1	
24	1007.7	30.5	35.0	27.6	24.6	30.9	72	81	54	.6	SE,S	5	SSE	3.9	-	3.0	
25	1007.7	31.0	35.0	26.5	24.7	31.2	70	85	57	.9	S	4	S	3.3	-	7.0	
26	1008.2	30.3	35.1	27.1	24.5	30.7	72	83	58	.6	S,SW	6	SSE	3.5	-	4.2	1
27	1008.1	30.9	34.8	26.6	24.4	30.6	70	82	55	.9	SW	5	WSW	2.5	-	4.8	
28	1007.3	31.3	35.0	27.5	23.8	29.5	66	80	48	1.0	S	6	S	2.8	-	5.9	
29	1008.8	30.7	33.7	28.2	24.7	31.1	71	81	59	1.3	SE	6	SSE	5.0	-	5.6	4
30	1008.2	30.3	34.5	26.1	24.3	30.4	72	90	53	.0	calm	4	ESE	6.1	-	5.0	
Total															-	153.8*	126
Mean	1008.4	29.9	34.6	26.6	24.3	30.4	73	86	57	.9		6		4.3	-	5.3	
Normal	1008.4	29.7	-	-	23.5		71	87	55	4.1					-	-	78

* indicates incomplete data.
Note: Daily mean values are computed from 8 three-hourly observations.

DAILY AND MONTHLY DATA

MAY 2006
CHON BURI

Local Index 459201
WMO Index 48459
Latitude 22 N
Longitude 59 E

Elevation of station above MSL 1 Mete
Height of barometer above MSL 2 Mete
Height of thermometer above ground 1.50 Mete
Height of wind vane above ground 13.45 Mete
Height of raingauge above ground 1.00 Mete

Date	MSL. Pressure (hPa)	Air Temperature (C) Mean	Max.	Min.	Mean Dew Point Temp. (C)	Mean Vapour Pressure (hPa)	Relative Humidity (%) Mean	Max.	Min.	Surface Wind (Knots) Mean Speed	Dir.	Maximum Speed	Dir.	Mean Cloud Amount (0-10)	Sunshine hours	Total Evaporation (mm)	Precipitation (mm)
1	1008.9	30.9	34.9	27.7	24.7	31.2	71	84	53	.6	S,SW	4	S	2.0	-	5.7	.0
2	1008.5	30.8	35.0	27.2	24.4	30.5	70	85	56	.8	S,NW	5	S	3.8	-	5.3	.0
3	1008.5	31.0	35.9	27.0	24.3	30.4	68	80	54	.5	SW	4	SSW	3.5	-	4.1	.0
4	1009.2	31.3	36.3	27.1	24.9	31.5	70	88	52	.5	SW	4	SSW	3.6	-	6.3	.0
5	1010.1	29.9	34.7	28.0	24.5	30.8	74	84	56	.9	S	5	SSE	5.8	-	3.9	.0
6	1008.7	30.4	35.0	27.3	25.1	31.8	74	85	60	1.0	S,SW	5	WSW	7.6	-	3.9	.0
7	1008.4	29.9	34.1	27.3	24.0	29.9	72	79	60	1.3	SW	6	SSW	6.6	-	4.0	1.0
8	1008.7	29.3	34.9	25.5	24.4	30.7	76	86	58	.3	W	6	W	4.5	-	2.9	13.1
9	1008.9	28.3	33.6	24.9	25.4	32.4	84	91	75	.0	calm	3	SSW	5.4	-	2.9	31.6
10	1008.1	27.3	33.8	25.8	24.9	31.5	87	92	71	.3	SW	4	SW	6.3	-	2.5	5.3
11	1009.4	28.0	32.3	25.7	25.4	32.3	86	94	70	.4	W	7	W	9.0	-	3.4	12.7
12	1009.9	29.4	33.9	25.4	24.7	31.2	77	93	62	.0	calm	3	SSE	6.3	-	3.5	.0
13	1009.3	30.1	35.0	26.8	24.7	31.2	74	92	53	.9	S,W	5	W	4.9	-	4.5	.0
14	1008.8	28.2	32.5	26.4	23.9	29.7	78	92	65	1.0	vary	7	WNW	7.5	-	4.3	25.2
15	1008.0	29.2	34.0	24.9	22.7	27.6	70	88	52	1.6	NE	5	NNE	4.0	-	6.8	.0
16	1007.9	30.6	35.3	26.1	21.5	25.8	60	81	40	.8	vary	4	W	6.3	-	4.2	30.0
17	1007.9	28.4	32.7	23.5	24.1	30.1	79	94	64	1.0	W	6	W	7.0	-	-	30.0
18	1008.8	26.7	29.8	24.6	25.0	31.6	91	96	80	.0	calm	4	WSW	9.4	-	5.7	23.0
19	1005.9	28.3	32.0	24.8	24.3	30.4	80	94	60	1.0	vary	5	SW	8.1	-	5.9	15.8
20	1006.0	28.0	32.0	24.5	24.2	30.1	81	94	67	1.0	S	4	SSW	9.1	-	3.9	4.0
21	1005.6	28.6	32.5	25.9	24.0	29.8	77	89	67	2.6	SE,S	9	SSE	9.4	-	3.3	.8
22	1005.9	28.4	31.7	26.9	24.4	30.6	80	88	65	2.3	S	6	SSE	9.5	-	3.2	1.9
23	1006.0	29.3	33.5	26.2	23.9	29.7	74	89	58	1.3	S,SW	6	SSW	8.4	-	5.3	.0
24	1006.8	29.9	33.9	27.3	24.4	30.5	73	82	55	1.6	S	5	S	6.4	-	3.2	.0
25	1007.9	30.2	34.7	27.0	24.3	30.4	72	84	51	1.3	vary	6	S	8.1	-	6.0	.0
26	1009.4	28.9	33.1	27.2	25.1	31.7	80	86	72	.9	S,W	7	SSW	7.4	-	3.0	2.1
27	1009.6	29.8	34.4	26.4	24.9	31.4	76	92	63	.3	NW	4	W	4.8	-	3.1	T
28	1008.5	29.7	33.4	26.6	25.0	31.6	76	86	58	1.0	vary	5	S	5.1	-	3.1	T
29	1006.7	30.2	34.1	27.3	25.0	31.8	75	86	63	.6	S,SW	6	SSW	6.5	-	3.9	3.1
30	1007.4	29.2	34.0	26.1	25.3	32.3	81	90	65	.6	S,SW	4	SSW	7.0	-	2.8	1.0
31	1009.4	28.8	34.4	26.2	24.4	30.5	78	85	60	.9	E,SW	5	SW	9.4	-	3.4	5.0
Total															-	123.0*	206.6
Mean	1008.1	29.3	33.8	26.2	24.4	30.7	76	88	61	.9		5		6.4	-	4.1	
Normal	1006.9	29.3	-	-	24.1		75	88	60	3.6					-	-	166.6

* indicates incomplete data.
Note: Daily mean values are computed from 8 three-hourly observations.

DAILY AND MONTHLY DATA

JUNE 2006
CHON BURI

Local Index 459201
WMO Index 48459
Latitude 2 N
Longitude 9 E

Elevation of station above MSL 1 Me
Height of barometer above MSL 2 Me
Height of thermometer above ground 1.50 Me
Height of wind vane above ground 13.45 Me
Height of raingauge above ground 1.00 Me

Date	MSL. Pres-sure (hPa)	Air Temperature (C) Mean	Max.	Min.	Mean Dew Point Temp. (C)	Mean Vapour Pres-sure (hPa)	Relative Humidity (%) Mean	Max.	Min.	Surface Wind (Knots) Mean Speed	Mean Dir.	Maximum Speed	Maximum Dir.	Mean Cloud Amount (0-10)	Sun-shine hours	Total Evapo-ration (mm)	Prec pita (mm
1	1009.2	28.4	33.2	25.5	24.3	30.4	79	93	63	.5	SW	5	SW	8.8	-	3.8	.5
2	1008.4	29.3	34.0	25.2	23.8	29.4	73	92	53	1.3	S	10	SSW	6.5	-	6.6	5.8
3	1008.3	28.2	33.5	25.1	23.9	29.4	78	89	60	1.4	vary	8	SW	4.9	-	5.5	2.6
4	1008.6	29.3	34.0	25.1	24.3	30.4	76	91	57	1.0	vary	6	W	7.3	-	5.7	3.5
5	1009.0	29.8	33.6	25.0	23.7	29.3	71	88	55	.9	W	6	SW	3.9	-	6.2	6.0
6	1009.1	29.8	33.5	25.5	24.3	30.3	73	91	59	.4	W	4	W	4.6	-	4.4	.0
7	1008.1	30.4	34.6	27.0	24.2	30.3	71	91	49	.8	SW	5	SW	3.9	-	7.6	.0
8	1007.6	30.3	34.5	27.6	24.2	30.2	70	82	59	.6	S,W	5	S	2.8	-	5.5	1.4
9	1007.5	30.1	34.5	27.1	24.1	30.1	71	82	59	1.0	SW	6	W	6.0	-	6.4	.0
10	1008.3	30.6	34.3	27.5	23.5	29.0	67	82	53	.6	SW	5	SSW	5.4	-	4.9	1.7
11	1008.3	29.8	34.4	24.9	23.8	29.5	72	92	54	.6	SW	5	SW	5.6	-	7.1	.0
12	1006.9	31.2	35.2	28.6	24.2	30.2	67	81	53	.0	calm	3	S	6.9	-	6.2	1.2
13	1006.3	31.5	35.5	28.0	24.1	30.1	66	82	50	.8	vary	5	SSW	3.0	-	5.5	.0
14	1006.5	31.2	35.3	28.1	24.4	30.5	68	81	52	1.1	S,SW	5	S	3.3	-	5.7	.0
15	1006.6	30.7	35.1	27.3	24.0	29.8	68	82	54	.5	SW	4	WSW	6.0	-	5.9	.0
16	1006.3	30.9	35.8	27.0	24.1	30.1	69	86	51	.9	SW	7	SSE	3.9	-	4.9	2.2
17	1005.4	30.4	35.3	26.2	24.6	31.0	73	89	56	1.0	W	6	WNW	6.1	-	6.7	.0
18	1004.3	29.4	32.6	28.0	25.0	31.6	77	85	66	.0	calm	4	S	8.0	-	2.3	.2
19	1004.9	28.5	31.2	26.3	24.4	30.6	79	86	71	.6	S,SW	5	WSW	7.4	-	2.2	.1
20	1006.3	29.1	33.5	27.0	25.1	31.8	80	88	61	.9	SE,NW	6	WNW	6.5	-	2.6	3.1
21	1007.0	27.8	32.6	26.0	25.3	32.2	87	92	73	.8	W	6	W	9.1	-	2.6	14.2
22	1006.9	29.1	33.8	25.7	25.5	32.6	82	95	65	.4	W	4	W	8.1	-	3.3	.1
23	1006.2	28.8	32.8	26.5	25.0	31.6	80	88	70	.3	SE	4	SSW	7.5	-	2.8	1.7
24	1007.1	27.7	33.0	25.5	24.8	31.4	85	92	70	.0	calm	3	SSW	6.1	-	1.8	2.9
25	1006.8	27.7	32.5	25.6	25.2	32.1	87	93	70	.3	NE	5	SSW	7.0	-	4.0	25.5
26	1007.4	28.0	31.5	25.1	24.6	30.9	82	95	69	.0	calm	4	SSW	7.3	-	3.0	.7
27	1007.2	29.0	32.1	25.5	24.4	30.6	77	87	67	.9	SW	5	SW	7.3	-	3.9	.0
28	1007.5	29.9	33.8	27.5	23.8	29.6	71	82	62	1.8	vary	8	S	8.5	-	5.4	.0
29	1007.1	29.6	32.1	27.8	23.4	28.7	70	75	63	1.3	SW	6	SW	7.9	-	4.8	.0
30	1007.7	27.7	30.7	25.0	24.1	30.1	81	94	69	.0	calm	8	W	10.0	-	1.2	13.9
Total															-	137.3	97.3
Mean	1007.2	29.5	33.6	26.4	24.3	30.5	75	88	60	.7		5		6.3	-	4.6	
Normal	1006.5	29.1	-	-	23.8		74	87	60	4.3					-	-	133.2

Note: Daily mean values are computed from 8 three-hourly observations.

DAILY AND MONTHLY DATA

JULY 2006
CHON BURI

Local Index	469201		Elevation of station above MSL	1	M.
WMO Index	48459		Height of barometer above MSL	2	M.
Latitude	N		Height of thermometer above ground	1.60	M.
Longitude	E		Height of wind vane above ground	13.45	M.
			Height of raingauge above ground	1.00	M.

Date	MSL. Pressure (hPa)	Air Temperature (C) Mean	Max.	Min.	Mean Dew Point Temp. (C)	Mean Vapour Pressure (hPa)	Relative Humidity (%) Mean	Max.	Min.	Surface Wind (Knots) Mean Speed	Dir.	Maximum Speed	Dir.	Mean Cloud Amount (0-10)	Sunshine hours	Total Evaporation (mm)	Precipitation (m
1	1005.8	28.5	32.6	25.8	24.7	31.1	81	93	61	.9	vary	6	SSW	9.4	-	-	48.
2	1005.6	27.5	31.0	25.0	25.0	31.6	86	95	74	.9	SW	5	SSW	10.0	-	1.1	1.
3	1006.2	28.3	32.5	25.1	25.1	31.9	83	92	69	.3	S	6	SSW	9.9	-	2.8	1.
4	1005.1	29.0	32.5	26.6	24.9	31.4	79	89	67	1.5	S	6	S	8.9	-	3.4	.
5	1006.4	29.8	33.7	27.2	24.8	31.3	75	87	69	1.1	SW	7	SSW	6.3	-	5.4	.
6	1006.7	30.0	33.7	27.5	24.3	30.5	72	81	61	.9	S	5	S	8.6	-	4.8	.
7	1005.8	30.4	33.7	27.9	24.7	31.0	72	85	59	2.1	S	7	SSW	3.9	-	6.1	.
8	1005.7	30.7	34.0	27.6	24.4	30.5	70	82	58	1.6	SW	5	SW	4.3	-	6.6	.
9	1005.8	30.9	34.7	27.9	24.4	30.5	69	81	55	2.0	SE,SW	7	SSW	1.6	-	6.3	.
10	1005.8	30.8	34.4	28.2	24.4	30.5	70	81	56	1.3	vary	5	SSE	6.0	-	5.8	.
11	1005.5	29.9	33.0	28.0	25.1	31.8	75	82	66	.9	S	6	SW	9.6	-	3.7	.
12	1005.4	30.6	33.8	28.3	24.0	29.7	68	79	56	2.0	SW	7	SW	9.5	-	2.7	.
13	1005.4	30.2	33.7	28.3	23.7	29.3	69	75	57	1.3	SW	5	SSW	8.6	-	5.8	.
14	1006.1	30.2	33.8	28.0	23.4	28.8	68	79	58	3.0	SW	6	S	8.4	-	4.5	.
15	1005.8	30.1	33.4	28.0	23.1	28.3	67	82	55	1.3	vary	6	WSW	8.5	-	6.1	.
16	1005.7	30.1	33.3	28.2	24.0	29.9	71	78	59	3.4	SE,SW	7	SSW	5.6	-	5.6	.
17	1006.6	29.2	32.0	27.0	23.7	29.3	73	80	53	2.0	SW	7	SSW	9.4	-	5.4	.
18	1007.2	28.6	33.0	26.0	24.7	31.0	80	92	62	1.8	S	6	SSW	10.0	-	3.3	7.
19	1008.7	29.1	33.2	26.5	24.7	31.0	78	89	67	1.4	W	7	W	8.8	-	3.4	2.
20	1008.5	29.2	32.6	26.0	24.9	31.4	78	92	62	1.4	NW	6	WNW	7.5	-	4.3	.
21	1007.9	29.1	32.9	26.7	23.4	28.7	72	82	59	.9	SW	6	SSW	7.8	-	3.9	.
22	1008.1	28.8	34.0	26.3	23.8	29.5	76	93	58	1.5	S,SW	4	S	8.4	-	4.9	.
23	1007.3	29.8	33.3	27.3	23.6	29.2	70	81	56	1.9	SW	8	WSW	6.8	-	5.2	.
24	1006.8	30.4	34.3	27.0	23.3	28.6	66	81	54	1.9	SW,W	5	SW	4.3	-	7.7	.
25	1007.2	29.6	33.5	25.8	23.3	28.6	70	88	53	2.3	S	8	SSE	3.3	-	5.2	3.
26	1009.5	29.5	32.4	26.2	23.5	29.0	71	84	62	1.0	SW	7	W	8.3	-	3.7	
27	1009.7	29.0	32.0	26.8	23.2	28.5	71	81	61	.8	W	6	W	9.4	-	4.4	.
28	1006.2	30.0	34.0	27.5	23.2	28.4	67	77	50	1.0	vary	6	W	8.4	-	6.2	.
29	1006.0	30.7	34.3	28.2	23.8	29.4	67	77	52	1.3	SW	6	SSW	6.4	-	5.8	.
30	1006.6	30.5	34.1	28.6	23.8	29.4	68	75	53	1.8	vary	7	SSW	7.9	-	5.7	.
31	1007.0	28.7	33.9	24.4	22.9	28.0	72	94	53	.8	SW,W	7	WSW	8.4	-	-	43.
Total															-	142.9*	108.
Mean	1006.6	29.6	33.4	27.0	24.1	29.9	73	84	59	1.5		5		7.7	-	4.9	
Normal	1006.6	28.6	-	-	23.4		74	88	60	4.1					-	-	133.

* indicates incomplete data.
Note: Daily mean values are computed from 8 three-hourly observations.

Climate table for Chonburi - eastern Thailand. Information provided by Thailand Meterological Department.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
Mean temperature ($^{\circ}$C)													
Daily	26.3	27.6	28.9	29.9	29.6	29.3	28.8	28.6	27.9	27.6	26.9	25.9	28.1
Morning Minimum	21.2	23.3	25.0	26.1	26.0	25.9	25.6	25.4	24.7	24.1	22.7	20.9	24.2
Extreme Min	12.4	16.6	14.0	21.0	21.2	20.8	20.5	21.3	21.0	17.9	14.2	12.0	12.0
Afternoon Maximum	32.5	33.0	34.2	34.9	34.1	33.3	32.9	32.6	32.3	32.5	32.4	32.3	33.1
Extreme Max	37.5	37.6	38.4	39.9	38.5	36.8	37.2	36.2	35.8	36.1	36.7	36.9	39.9
Mean relative humidity (%)													
at 0700 am.	80	84	84	84	85	83	84	85	89	90	83	77	84
at 0100 pm.	51	57	57	59	63	62	62	63	67	65	55	47	59
Surface wind													
Mean Speed (km./hr.)	5.6	6.3	6.7	5.7	5.0	5.9	5.7	5.6	4.1	4.1	6.3	6.7	5.6
Direction	east	south	south	south	south	southwest	southwest	southwest	west	east	east	east	east
Mean rainfall													
Amount (mm./month)	10.9	16.7	34.5	78.5	165.3	143.3	132.1	162.9	281.7	210.0	58.2	4.7	1298.8
Rainy Day (day/month)	1.2	2.5	3.9	7.2	13.8	14.3	15.2	16.8	19.6	16.4	5.8	0.9	117.6
Heavy Rainy Day (day/month) Greater Than 35 mm./day	0.0	0.0	0.4	0.7	1.6	1.0	1.0	1.0	2.7	1.7	0.3	0.0	10.1
Visibility (km.)													
Time 07.00	5.5	5.7	6.6	8.2	10.2	11.1	10.6	10.3	9.6	8.6	7.9	7.0	8.4
Daily	6.6	6.9	7.5	9.1	11.1	11.7	11.5	11.1	10.4	9.6	8.9	8.0	9.4
Mean sunshine duration													
Daily	-	-	-	-	-	-	-	-	-	-	-	-	-

Salinity in the FWS constructed wetland (ppt)

Time (days)	Inlet	Outlet								
		0.2 m			0.4 m			0.6 m		
		Vetiver	Colocasia	Control	Vetiver	Colocasia	Control	Vetiver	Colocasia	Control
0	3.3									
10	1.5	0.7	0.7	0.8	0.9	1.1	0.9	1	2.6	2.5
20	0.4	0.6	0.8	0.7	0.8	1.1	0.8	0.8	2.1	1.6
30	0.7	0.5	0.8	0.5	0.6	0.9	0.6	0.7	1.4	1.4
40	2	0.7	1.4	0.5	0.5	0.9	0.5	0.6	1.3	1.4
50	4.6	0.6	1.8	0.9	0.7	1.3	0.6	0.7	1.8	1.3
60	3.9	0.3	1	0.6	0.5	1.7	0.6	0.6	0.8	1.1
70	1.2	0.5	1.8	1	0.8	1.9	0.6	0.7	1.2	0.8
80	1	0.4	1.1	0.6	0.6	1.3	0.4	0.6	1	0.7
90	3.3	0.4	1.2	0.7	0.6	1.2	0.5	0.7	1.1	0.8
100	3.2	0.3	0.8	0.5	0.5	1	0.4	0.5	0.8	0.6
Average	2.28	0.5	1.14	0.68	0.65	1.24	0.59	0.69	1.41	1.22
Standard Deviation	1.43	0.15	0.41	0.18	0.15	0.34	0.16	0.14	0.59	0.57
Maximum	4.6	0.7	1.8	1	0.9	1.9	0.9	1	2.6	2.5
Minimum	0.4	0.3	0.7	0.5	0.5	0.9	0.4	0.5	0.8	0.6

PH in the FWS constructed wetland

Time (days)	Inlet	Outlet								
		0.2 m			0.4 m			0.6 m		
		Vetiver	Colocasia	Control	Vetiver	Colocasia	Control	Vetiver	Colocasia	Control
0	7.65									
10	7.66	7.65	7.17	7.72	7.78	7.84	7.9	7.73	8.35	8.82
20	7.7	7.65	6.95	9.36	8.25	7.45	8.91	8.84	8.18	9.97
30	8.18	7.73	6.92	8.82	7.63	7.09	8.15	8.75	7.83	10.36
40	8.15	7.81	7.74	7.76	7.54	6.96	9.21	9.12	7.7	9.79
50	8.16	7.26	7.39	7.9	6.92	6.91	7.35	7.09	7.13	8.54
60	7.7	8.65	7.22	9.23	6.91	6.99	7.41	7.82	7	12.33
70	7.41	7.38	8.17	8.89	8.22	8.31	9.16	7.67	8.25	11.2
80	8.4	8.02	7.6	7.35	7.48	7.9	8.6	7.86	7.34	9.74
90	8.19	7.68	7.25	7.48	6.97	7.33	9.65	6.85	7.16	7.57
100	8.54	9.06	7.45	7.86	7.77	7.66	10.11	7.84	7.31	10.63
Average	7.98	7.89	7.39	8.24	7.55	7.44	8.65	7.96	7.63	9.90
Standard Deviation	0.36	0.56	0.38	0.75	0.49	0.47	0.93	0.74	0.51	1.37
Maximum	8.54	9.06	8.17	9.36	8.25	8.31	10.11	9.12	8.35	12.33
Minimum	7.41	7.26	6.92	7.35	6.91	6.91	7.35	6.85	7	7.57

COD in the FWS constructed wetland (mg/L)

Time (days)	Inlet	Outlet								
		0.2 m			0.4 m			0.6 m		
		Vetiver	Colocasia	Control	Vetiver	Colocasia	Control	Vetiver	Colocasia	Control
0	1080									
10	1029	800.8	915.2	880.8	915.2	915.2	800.8	800.8	686.4	686.4
20	1320	840	1008	1020	600	1008	720	360	600	720
30	960	240	480	720	160	640	640	720	320	800
40	1648	164.8	224	524	524	620	824	824	920	929
50	720	120	120	480	120	120	240	120	240	440
60	758.4	110	189.6	379	632	316	189	126	189.6	316
70	1200	500	540	600	300	310	600	360	740	750
80	1018.4	536	536	214.4	107.2	321.6	868	107.2	375.2	107.2
90	1160	464	892	812	696	1008	856	696	812	944
100	1195	996	1128	1128	464	1115	1128	1061	1062.4	1062.4
Average	1098.98	477.16	603.28	675.82	451.84	637.38	686.58	517.50	594.56	675.50
Standard Deviation	257.70	320.75	363.94	289.37	273.09	358.73	287.94	345.08	300.90	301.27
Maximum	1648	996	1128	1128	915.2	1115	1128	1061	1062.4	1062.4
Minimum	720	110	120	214.4	107.2	120	189	107.2	189.6	107.2

BOD in the FWS constructed wetland (mg/L)

Time (days)	Inlet	Outlet								
		0.2 m			0.4 m			0.6 m		
		Vetiver	Colocasia	Control	Vetiver	Colocasia	Control	Vetiver	Colocasia	Control
0	142.5									
10	120	80	70	100	30	40	80	80	90	110
20	170	60	80	90	70	60	80	90	100	110
30	120	50	60	70	50	50	60	70	70	100
40	200	30	50	70	50	70	100	40	50	80
50	190	10	20	170	70	70	190	150	150	160
60	165	25	45	75	40	30	70	140	150	170
70	155	85	95	100	90	85	120	135	135	140
80	120	50	70	90	60	90	100	110	120	120
90	160	70	60	110	60	70	60	100	110	120
100	110	30	50	150	30	50	110	100	130	140
Average	150.23	49.00	60.00	102.50	55.00	61.50	97.00	101.50	110.50	125.00
Standard Deviation	30.34	25.03	20.68	33.44	19.00	19.16	38.60	34.00	33.37	27.59
Maximum	200	85	95	170	90	90	190	150	150	170
Minimum	110	10	20	70	30	30	60	40	50	80

TKN in the FWS constructed wetland (mg/L)

Time (days)	Inlet	Outlet								
		0.2 m			0.4 m			0.6 m		
		Vetiver	Colocasia	Control	Vetiver	Colocasia	Control	Vetiver	Colocasia	Control
0	912.8									
10	1086.4	134.4	123.2	778.4	156	112	778.4	189.6	145.6	778.4
20	1232	167.2	178.4	1012	123.2	112.2	945.6	112	123.2	934.4
30	1420	252	224	892	336	308	892	364	336	892
40	1336	280	364	280	280	336	456	476	868	1086
50	1036	252	220	448	286	426	1060	640	640	1040
60	1428	184	260	420	184	136	886	780	612	828
70	1284	168	176	728	216	228	724	504	616	1224
80	1056	184	140	672	196	224	1140	640	840	1280
90	1344	224	194	448	182	154	584	392	392	880
100	1176	700	868	900	784	784	840	784	924	952
Average	1210.11	254.56	274.76	657.84	274.32	282.02	830.60	488.16	549.68	989.48
Standard Deviation	170.34	163.14	219.19	246.30	190.55	204.95	206.49	229.61	290.18	165.94
Maximum	1428	700	868	1012	784	784	1140	784	924	1280
Minimum	912.8	134.4	123.2	280	123.2	112	456	112	123.2	778.4

TSS in the FWS constructed wetland (mg/L)

Time (days)	Inlet	Outlet								
		0.2 m			0.4 m			0.6 m		
		Vetiver	Colocasia	Control	Vetiver	Colocasia	Control	Vetiver	Colocasia	Control
0	692									
10	28	136	30	92	20	28	62	36	22	130
20	22	8	8	2	8	14	22	2	20	114
30	26	8	2	14	14	12	20	4	2	90
40	38	24	18	36	28	46	30	22	18	10
50	132	4	292	122	92	24	18	10	32	200
60	22	18	4	154	8	80	20	4	6	26
70	966	26	76	196	8	32	44	6	22	40
80	1154	54	76	88	90	70	86	54	58	24
90	1566	352	1050	1044	586	612	836	702	966	1116
100	28	12	44	80	90	12	78	6	2	4
Average	424.91	64.20	160.00	182.80	94.40	93.00	121.60	84.60	114.80	175.40
Standard Deviation	568.52	108.51	324.30	308.56	176.55	183.89	252.28	217.60	299.53	336.45
Maximum	1566	352	1050	1044	586	612	836	702	966	1116
Minimum	22	4	2	2	8	12	18	2	2	4

TDS in the FWS constructed wetland (mg/L)

Time (days)	Inlet	Outlet								
		0.2 m			0.4 m			0.6 m		
		Vetiver	Colocasia	Control	Vetiver	Colocasia	Control	Vetiver	Colocasia	Control
0	4000									
10	1622	772	828	1040	942	1178	1112	270	2050	2650
20	1400	222	576	484	684	1430	964	1046	1986	2078
30	1366	426	788	520	654	666	584	588	498	1534
40	1056	632	944	614	452	942	1120	534	1560	1304
50	4036	924	1744	948	832	1280	674	874	940	1706
60	2336	316	264	762	566	894	970	602	598	832
70	1784	790	1638	1236	1334	1332	1580	732	1222	1020
80	758	698	600	840	798	1094	1310	556	798	838
90	1566	352	1050	1044	786	612	836	702	966	1116
100	2250	1856	714	2674	916	496	1156	1648	704	1288
Average	2015.82	698.80	914.60	1016.20	796.40	992.40	1030.60	755.20	1132.20	1436.60
Standard Deviation	1090.48	468.63	463.21	631.53	242.79	323.90	294.93	376.33	558.73	577.90
Maximum	4036	1856	1744	2674	1334	1430	1580	1648	2050	2650
Minimum	758	222	264	484	452	496	584	270	498	832

Temperature in the FWS constructed wetland (Celsius)

Time (days)	Inlet	Outlet								
		0.2 m			0.4 m			0.6 m		
		Vetiver	Colocasia	Control	Vetiver	Colocasia	Control	Vetiver	Colocasia	Control
0	28									
10	27	24	23	26	24	22	26	23	22	26
20	30	28	26	29	27	26	29	27	25.5	29.5
30	28	25	24	27.5	25	23	27	24	23	27
40	30	28	27	29	27	26	29	26	25	28.5
50	27	23	22	25	23	22	25	23	22	24
60	27	23	22	26	22.5	22	25.5	21	20.5	25
70	29	25	24	28	24.5	24	27.5	22	23	27
80	30	26	25	29	25.5	24	28	23	22.5	27.5
90	28	23	22	27	22.5	22	26.5	22	21	26
100	29	25	24	28	24.5	24	27.5	24	23	27
Average	28.45	25.00	23.90	27.45	24.55	23.50	27.10	23.50	22.75	26.75
Standard Deviation	1.21	1.89	1.73	1.42	1.64	1.58	1.37	1.84	1.57	1.60
Maximum	30	28	27	29	27	26	29	27	25.5	29.5
Minimum	27	23	22	25	22.5	22	25	21	20.5	24

Data of COD in the FWS constructed wetland (mg/L)

COD	Inlet	Vetiver at 0.2 m	Colocasia at 0.2 m	Control at 0.2 m	Vetiver at 0.4 m	Colocasia at 0.4 m	Control at 0.4 m	Vetiver at 0.6 m	Colocasia at 0.6 m	Control at 0.6 m
0 day	1080.00									
	1070.00									
	1090.00									
10^{th} day	1029.00	800.80	915.20	880.80	915.20	915.20	800.80	800.80	686.40	686.40
	1030.00	820.80	910.20	870.80	910.20	915.20	798.80	800.00	690.40	680.40
	1028.00	780.80	920.20	890.80	920.20	915.20	802.80	801.60	682.40	692.40
20^{th} day	1320.00	840.00	1008.00	1020.00	600.00	1008.00	720.00	360.00	600.00	720.00
	1310.00	820.00	1000.00	1010.00	640.00	1000.00	710.00	360.00	591.00	710.00
	1330.00	860.00	1016.00	1030.00	560.00	10016.00	730.00	360.00	609.00	730.00
30^{th} day	960.00	240.00	480.00	720.00	160.00	640.00	640.00	720.00	320.00	800.00
	970.00	200.00	470.00	730.00	150.00	650.00	650.00	710.00	310.00	850.00
	950.00	280.00	490.00	710.00	170.00	630.00	630.00	730.00	330.00	750.00
40^{th} day	1648.00	164.80	224.00	524.00	524.00	620.00	824.00	824.00	920.00	929.00
	1650.00	160.80	220.00	520.00	520.00	620.00	820.00	825.00	900.00	928.00
	1646.00	168.80	228.00	528.00	528.00	620.00	828.00	823.00	940.00	930.00
50^{th} day	720.00	120.00	120.00	480.00	120.00	120.00	240.00	120.00	240.00	440.00
	730.00	110.00	110.00	470.00	110.00	110.00	230.00	110.00	200.00	445.00
	740.00	130.00	130.00	490.00	130.00	130.00	250.00	130.00	280.00	435.00
60^{th} day	758.40	110.00	189.60	379.00	632.00	316.00	189.00	126.00	189.60	316.00
	758.00	100.00	189.00	380.00	630.00	310.00	190.00	126.00	190.60	315.00
	758.80	120.00	190.20	378.00	634.00	322.00	188.00	126.00	188.60	317.00
70^{th} day	1200.00	500.00	540.00	600.00	300.00	310.00	600.00	360.00	740.00	750.00
	1250.00	490.00	550.00	650.00	320.00	300.00	610.00	340.00	750.00	700.00
	1300.00	510.00	530.00	550.00	280.00	320.00	590.00	380.00	730.00	800.00
80^{th} day	1018.40	536.00	536.00	214.40	107.20	321.60	868.00	107.20	375.20	107.20

	1020.40	536.00	530.00	210.40	107.00	320.60	870.00	107.00	375.00	107.50
	1016.40	536.00	542.00	218.40	107.40	322.60	866.00	107.40	375.40	106.90
90^{th} day	1160.00	464.00	892.00	812.00	696.00	1008.00	856.00	696.00	812.00	944.00
	1150.00	466.00	890.00	810.00	700.00	1000.00	856.00	700.00	810.00	940.00
	1170.00	462.00	894.00	814.00	692.00	1016.00	856.00	692.00	814.00	948.00
100^{th} day	1195.00	996.00	1128.00	1128.00	464.00	1115.00	1128.00	1061.00	1062.40	1062.40
	1190.00	1000.00	1126.00	1120.00	460.00	1110.00	1120.00	1060.00	1062.40	1066.40
	1200.00	992.00	1130.00	1136.00	468.00	1120.00	1136.00	1062.00	1062.40	1058.40
avg	1104.44	477.16	603.28	675.82	451.84	637.38	686.58	517.50	594.56	675.50
sd	250.80	309.80	351.21	279.58	263.80	346.19	277.90	333.03	290.62	291.31
max	1650.00	1000.00	1130.00	1136.00	920.20	1120.00 c	1136.00	1062.00	1062.40	1066.40
min	720.00	100.00	110.00	210.40	107.00	110.00	188.00	107.00	188.60	106.90

Data of TDS in the FWS constructed wetland (mg/L)

TDS	Inlet	Vetiver at 0.2 m	Colocasia at 0.2 m	Control at 0.2 m	Vetiver at 0.4 m	Colocasia at 0.4 m	Control at 0.4 m	Vetiver at 0.6 m	Colocasia at 0.6 m	Control at 0.6 m
0 day	4000.00									
	3880									
	4120									
10th day	1622.00	772.00	828.00	1040.00	942.00	1178.00	1112.00	270.00	2050.00	2650.00
	1630	770	820	1000	940	1180	1100	300	2000	2600
	1614	774	836	1080	944	1176	1124	240	2100	2700
20th day	1400.00	222.00	576.00	484.00	684.00	1430.00	964.00	1046.00	1986.00	2078.00
	1410	220	570	480	680	1400	960	1050	1980	2070
	1390.00	224.00	582.00	488.00	688.00	1460.00	968.00	1042.00	1992.00	2086.00
30th day	1366.00	426.00	788.00	520.00	654.00	666.00	584.00	588.00	498.00	1534.00
	1380	420	780	500	650	660	580	600	500	1500
	1352.00	432.00	796.00	480.00	658.00	672.00	588.00	576.00	496.00	1568.00
40th day	1056.00	632.00	944.00	614.00	452.00	942.00	1120.00	534.00	1560.00	1304.00
	1050.00	630.00	940.00	610.00	450.00	950.00	1000.00	500.00	1500.00	1300.00
	1062.00	634.00	948.00	618.00	454.00	934.00	1240.00	568.00	1620.00	1308.00
50th day	4036.00	924.00	1744.00	948.00	832.00	1280.00	674.00	874.00	940.00	1706.00
	4030.00	920.00	1740.00	950.00	830.00	1300.00	670.00	880.00	900.00	1700.00
	4042.00	928.00	1748.00	946.00	834.00	1260.00	678.00	868.00	980.00	1712.00
60th day	2336.00	316.00	264.00	762.00	566.00	894.00	970.00	602.00	598.00	832.00
	2330.00	310.00	260.00	760.00	560.00	890.00	978.00	600.00	600.00	800.00
	2342.00	322.00	268.00	764.00	572.00	898.00	962.00	604.00	596.00	864.00
70th day	1784.00	790.00	1638.00	1236.00	1334.00	1332.00	1580.00	732.00	1222.00	1020.00
	1780.00	800.00	1630.00	1230.00	1300.00	1300.00	1500.00	730.00	1200.00	1000.00
	1788.00	780.00	1646.00	1242.00	1368.00	1364.00	1660.00	734.00	1244.00	1040.00
80th day	758.00	698.00	600.00	840.00	798.00	1094.00	1310.00	556.00	798.00	838.00
	760.00	710.00	580.00	800.00	800.00	1000.00	1300.00	550.00	800.00	840.00

	756.00	686.00	620.00	880.00	796.00	1188.00	1290.00	562.00	796.00	836.00
90th day	1566.00	352.00	1050.00	1044.00	786.00	612.00	836.00	702.00	966.00	1116.00
	1560.00	350.00	1000.00	1040.00	780.00	600.00	840.00	700.00	960.00	1110.00
	1572.00	354.00	950.00	1048.00	792.00	624.00	832.00	704.00	972.00	1122.00
100th day	2250.00	1856.00	714.00	2674.00	916.00	496.00	1156.00	1648.00	704.00	1288.00
	2280.00	1850.00	710.00	2670.00	910.00	500.00	1100.00	1650.00	700.00	1280.00
	2220.00	1862.00	718.00	2678.00	922.00	492.00	1312.00	1646.00	708.00	1296.00
avg	2015.82	698.8	909.6	1014.2	796.4	992.4	1032.93	755.2	1132.2	1436.6
sd	1056.32	452.21	445.89	611.29	234.46	313.79	289.28	363.34	539.65	557.94
max	4120	1862	1748	2678	1368	1460	1660	1650	2100	2700
min	756	220	260	480	450	492	580	240	496	800

Data of BOD in the FWS constructed wetland

BOD	Inlet	Vetiver at 0.2 m	Colocasia at 0.2 m	Control at 0.2 m	Vetiver at 0.4 m	Colocasia at 0.4 m	Control at 0.4 m	Vetiver at 0.6 m	Colocasia at 0.6 m	Control at 0.6 m
0 day	142.50									
	140.00									
	145.00									
10^{th} day	120.00	80.00	70.00	100.00	30.00	40.00	80.00	80.00	90.00	110.00
	110.00	85.00	50.00	90.00	25.00	41.00	85.00	85.00	99.00	100.00
	130.00	75.00	90.00	110.00	35.00	39.00	75.00	75.00	81.00	120.00
20^{th} day	170.00	60.00	80.00	90.00	70.00	60.00	80.00	90.00	100.00	110.00
	150.00	50.00	70.00	100.00	50.00	65.00	82.00	80.00	101.00	100.00
	190.00	70.00	90.00	80.00	90.00	55.00	78.00	100.00	99.00	120.00
30^{th} day	120.00	50.00	60.00	70.00	50.00	50.00	60.00	70.00	70.00	100.00
	110.00	40.00	50.00	75.00	40.00	58.00	50.00	80.00	78.00	100.00
	130.00	60.00	70.00	65.00	60.00	42.00	70.00	60.00	62.00	100.00
40^{th} day	200.00	30.00	50.00	70.00	50.00	70.00	100.00	40.00	50.00	80.00
	190.00	20.00	50.00	80.00	50.00	60.00	90.00	45.00	40.00	90.00
	210.00	40.00	50.00	60.00	50.00	80.00	110.00	35.00	60.00	70.00
50^{th} day	190.00	10.00	20.00	170.00	70.00	70.00	190.00	150.00	150.00	160.00
	200.00	5.00	15.00	150.00	75.00	65.00	180.00	130.00	120.00	160.00
	180.00	15.00	25.00	190.00	65.00	75.00	200.00	170.00	180.00	160.00
60^{th} day	165.00	25.00	45.00	75.00	40.00	30.00	70.00	140.00	150.00	170.00
	170.00	30.00	40.00	80.00	30.00	35.00	90.00	130.00	140.00	170.00
	160.00	20.00	50.00	70.00	50.00	25.00	50.00	150.00	160.00	170.00
70^{th} day	155.00	85.00	95.00	100.00	90.00	85.00	120.00	135.00	135.00	140.00
	150.00	100.00	100.00	90.00	100.00	80.00	110.00	140.00	130.00	145.00
	160.00	70.00	90.00	110.00	80.00	90.00	130.00	130.00	140.00	135.00
80^{th} day	120.00	50.00	70.00	90.00	60.00	90.00	100.00	110.00	120.00	120.00

	110.00	40.00	80.00	100.00	50.00	100.00	90.00	100.00	110.00	110.00
	130.00	60.00	60.00	80.00	70.00	80.00	110.00	120.00	130.00	130.00
90th day	160.00	70.00	60.00	110.00	60.00	70.00	60.00	100.00	110.00	120.00
	150.00	80.00	60.00	100.00	50.00	80.00	50.00	90.00	100.00	100.00
	170.00	60.00	60.00	120.00	70.00	60.00	70.00	110.00	120.00	140.00
100th day	110.00	30.00	50.00	150.00	30.00	50.00	110.00	100.00	130.00	140.00
	100.00	20.00	55.00	140.00	29.00	45.00	100.00	90.00	120.00	120.00
	120.00	40.00	60.00	160.00	31.00	55.00	120.00	110.00	140.00	160.00
avg	150.23	49.00	60.50	102.50	55.00	61.50	97.00	101.50	110.50	125.00
sd	30.58	25.41	21.11	33.47	20.04	19.38	38.28	33.92	33.84	28.16
max	210.00	100.00	100.00	190.00	100.00	100.00	200.00	170.00	180.00	170.00
min	100.00	5.00	15.00	60.00	25.00	25.00	50.00	35.00	40.00	70.00

Data of TKN in the FWS constructed wetland (mg/L)

TKN	Inlet	Vetiver at 0.2 m	Colocasia at 0.2 m	Control at 0.2 m	Vetiver at 0.4 m	Colocasia at 0.4 m	Control at 0.4 m	Vetiver at 0.6 m	Colocasia at 0.6 m	Control at 0.6 m
0 day	912.80									
	910.80									
	914.80									
10th day	1086.40	134.40	123.20	778.40	156.00	112.00	778.40	189.60	145.60	778.40
	1083.40	134.20	123.00	776.40	156.00	110.00	778.00	186.60	140.60	770.40
	1089.40	134.60	123.40	780.40	156.00	114.00	778.80	192.60	150.60	786.40
20th day	1232.00	167.20	178.40	1012.00	123.20	112.20	945.60	112.00	123.20	934.40
	1230.00	167.00	178.00	1018.00	123.40	112.40	945.00	110.00	120.20	930.40
	1234.00	167.40	178.80	1006.00	123.00	112.00	946.20	114.00	126.20	938.40
30th day	1420.00	252.00	224.00	892.00	336.00	308.00	892.00	364.00	336.00	892.00
	1425.00	250.00	220.00	890.00	334.00	310.00	890.00	360.00	330.00	890.00
	1415.00	254.00	228.00	894.00	338.00	306.00	894.00	368.00	339.00	894.00
40th day	1336.00	280.00	364.00	280.00	280.00	336.00	456.00	476.00	868.00	1086.00
	1340.00	285.00	360.00	280.00	282.00	335.00	455.00	470.00	869.00	1080.00
	1332.00	275.00	368.00	280.00	278.00	337.00	457.00	482.00	867.00	1092.00
50th day	1036.00	252.00	220.00	448.00	286.00	426.00	1060.00	640.00	640.00	1040.00
	1030.00	250.00	221.00	444.00	288.00	428.00	1070.00	650.00	630.00	1030.00
	1042.00	254.00	219.00	452.00	284.00	424.00	1050.00	630.00	650.00	1050.00
60th day	1428.00	184.00	260.00	420.00	184.00	136.00	886.00	780.00	612.00	828.00
	1420.00	180.00	265.00	410.00	180.00	134.00	885.00	788.00	610.00	825.00
	1436.00	188.00	255.00	430.00	188.00	138.00	887.00	772.00	614.00	831.00
70th day	1284.00	168.00	176.00	728.00	216.00	228.00	724.00	504.00	616.00	1224.00
	1280.00	160.00	173.00	726.00	210.00	225.00	725.00	500.00	610.00	1220.00
	1288.00	176.00	179.00	730.00	222.00	231.00	723.00	508.00	622.00	1228.00
80th day	1056.00	184.00	140.00	672.00	196.00	224.00	1140.00	640.00	840.00	1280.00

	1056.00	180.00	130.00	670.00	190.00	220.00	1145.00	650.00	850.00	1290.00
	1056.00	188.00	150.00	674.00	202.00	228.00	1135.00	630.00	830.00	1270.00
90^{th} day	1344.00	224.00	194.00	448.00	182.00	154.00	584.00	392.00	392.00	880.00
	1340.00	220.00	190.00	446.00	180.00	150.00	580.00	390.00	390.00	870.00
	1348.00	228.00	198.00	450.00	184.00	158.00	588.00	388.00	394.00	890.00
100^{th} day	1176.00	700.00	868.00	900.00	784.00	784.00	840.00	784.00	924.00	952.00
	1170.00	710.00	866.00	901.00	780.00	780.00	830.00	780.00	920.00	950.00
	1188.00	690.00	870.00	899.00	788.00	788.00	850.00	788.00	928.00	954.00
avg	1210.29	254.56	274.76	657.84	274.32	282.02	830.60	487.96	549.58	989.48
sd	164.95	157.47	211.52	237.68	183.89	197.77	199.28	221.70	280.12	160.21
max	1436.00	710.00	870.00	1018.00	788.00	788.00	1145.00	788.00	928.00	1290.00
min	910.80	134.20	123.00	280.00	123.00	110.00	455.00	110.00	120.20	770.40

Data of TSS in the FWS constructed wetland (mg/L)

TSS	Inlet	Vetiver at 0.2 m	Colocasia at 0.2 m	Control at 0.2 m	Vetiver at 0.4 m	Colocasia at 0.4 m	Control at 0.4 m	Vetiver at 0.6 m	Colocasia at 0.6 m	Control at 0.6 m
0 day	692.00									
	690									
	694.00									
10^{th} day	28.00	136.00	30.00	92.00	20.00	28.00	62.00	36.00	22.00	130.00
	20	130	20	90	10	29	60	30	20	120
	36	142	40	94	30	27	64	42	24	140
20^{th} day	22.00	8.00	8.00	2.00	8.00	14.00	22.00	2.00	20.00	114.00
	20.00	7.00	8.00	2.50	7.00	10.00	20.00	2.00	10.00	110.00
	24.00	9.00	8.00	1.50	9.00	18.00	24.00	2.00	30.00	118.00
30^{th} day	26.00	8.00	2.00	14.00	14.00	12.00	20.00	4.00	2.00	90.00
	20	8	1	10	10	10	10	4.5	2	80
	32.00	8.00	3.00	18.00	18.00	14.00	30.00	3.50	2.00	100.00
40^{th} day	38.00	24.00	18.00	36.00	28.00	46.00	30.00	22.00	18.00	10.00
	30.00	20.00	19.00	30.00	30.00	40.00	20.00	20.00	20.00	5.00
	46.00	28.00	17.00	42.00	26.00	52.00	40.00	24.00	16.00	15.00
50^{th} day	132.00	4.00	292.00	122.00	92.00	24.00	18.00	10.00	32.00	200.00
	130.00	4.00	290.00	120.00	90.00	20.00	16.00	5.00	30.00	180.00
	134.00	4.00	294.00	124.00	94.00	28.00	20.00	15.00	34.00	220.00
60^{th} day	22.00	18.00	4.00	154.00	8.00	80.00	20.00	4.00	6.00	26.00
	20.00	18.00	3.00	150.00	7.00	90.00	20.50	3.00	5.00	20.00
	24.00	18.00	5.00	158.00	9.00	70.00	19.50	5.00	7.00	32.00
70^{th} day	966.00	26.00	76.00	196.00	8.00	32.00	44.00	6.00	22.00	40.00
	960.00	24.00	70.00	200.00	8.00	30.00	40.00	6.00	20.00	30.00
	972.00	28.00	82.00	192.00	8.00	34.00	48.00	6.00	24.00	50.00
80^{th} day	1154.00	54.00	76.00	88.00	90.00	70.00	86.00	54.00	58.00	24.00

	1150.00	50.00	70.00	80.00	80.00	60.00	80.00	50.00	60.00	20.00
	1158.00	56.00	82.00	96.00	100.00	80.00	92.00	58.00	56.00	28.00
90th day	1566.00	352.00	1050.00	1044.00	586.00	612.00	836.00	702.00	966.00	1116.00
	1560.00	350.00	1000.00	1000.00	580.00	610.00	830.00	700.00	960.00	1100.00
	1572.00	354.00	1100.00	1088.00	592.00	624.00	842.00	704.00	972.00	1132.00
100th day	28.00	12.00	44.00	80.00	90.00	12.00	78.00	6.00	2.00	4.00
	20.00	10.00	40.00	90.00	80.00	14.00	80.00	5.00	2.50	5.00
	36.00	14.00	48.00	70.00	100.00	10.00	76.00	7.00	1.50	3.00
avg	424.91	64.13	160	182.8	94.4	93.33	121.6	84.6	114.8	175.4
sd	550.49	104.73	313.22	297.99	170.43	178.51	243.47	209.98	289.04	324.75
max	1572	354	1100	1088	592	624	842	704	972	1132
min	20	4	1	1.5	7	10	10	2	1.5	3

Dry Weight in the FWS constructed wetland (g)

Vetiver 0.2 m										
Days	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
1.00	7.00	10.00	15.00	15.00	25.00	20.00	40.00	40.00	40.00	30.00
2.00	5.00	15.00	14.00	15.00	10.00	20.00	15.00	45.00	20.00	5.00
3.00	20.00	10.00	10.00	10.00	15.00	20.00	10.00	50.00	50.00	60.00
average	10.67	11.67	13.00	13.33	16.67	20.00	21.67	45.00	36.67	31.67
sd	8.14	2.89	2.65	2.89	7.64	0.00	16.07	5.00	15.28	27.54
Colocasia 0.2 m										
Days	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
1.00	15.00	20.00	45.00	30.00	45.00	55.00	25.00	60.00	130.00	60.00
2.00	10.00	20.00	30.00	55.00	105.00	60.00	145.00	365.00	150.00	365.00
3.00	10.00	15.00	60.00	90.00	65.00	175.00	125.00	80.00	175.00	80.00
average	11.67	18.33	45.00	58.33	71.67	96.67	98.33	168.33	151.67	168.33
sd	2.89	2.89	15.00	30.14	30.55	67.88	64.29	170.61	22.55	170.61
Vetiver 0.4 m										
Days	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
1.00	5.00	5.00	15.00	30.00	40.00	30.00	40.00	20.00	70.00	25.00
2.00	3.00	20.00	15.00	5.00	5.00	30.00	20.00	38.00	10.00	30.00
3.00	20.00	5.00	10.00	10.00	20.00	25.00	30.00	48.00	20.00	40.00
average	9.33	10.00	13.33	15.00	21.67	28.33	30.00	35.33	33.33	31.67
Sd	9.29	8.66	2.89	13.23	17.56	2.89	10.00	14.19	32.15	7.64
Colocasia 0.4 m										
Days	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
1.00	40.00	25.00	50.00	40.00	40.00	175.00	220.00	760.00	290.00	65.00
2.00	40.00	60.00	40.00	40.00	100.00	25.00	45.00	365.00	360.00	150.00
3.00	15.00	30.00	40.00	110.00	110.00	100.00	70.00	690.00	790.00	140.00
average	31.67	38.33	43.33	63.33	83.33	100.00	111.67	605.00	480.00	118.33
Sd	14.43	18.93	5.77	40.41	37.86	75.00	94.65	210.77	270.74	46.46
Vetiver										

Days	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
1.00	5.00	10.00	5.00	10.00	20.00	17.00	20.00	50.00	80.00	10.00
2.00	2.00	5.00	5.00	7.50	5.00	15.00	10.00	50.00	5.00	55.00
3.00	5.00	5.00	15.00	10.00	5.00	10.00	17.50	20.00	10.00	5.00
average	4.00	6.67	8.33	9.17	10.00	14.00	15.83	40.00	31.67	23.33
sd	1.73	2.89	5.77	1.44	8.66	3.61	5.20	17.32	41.93	27.54
Colocasia 0.6 m										
Days	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
1.00	20.00	25.00	40.00	50.00	100.00	255.00	90.00	880.00	660.00	40.00
2.00	25.00	30.00	25.00	95.00	170.00	70.00	290.00	790.00	250.00	610.00
3.00	25.00	40.00	40.00	80.00	30.00	120.00	180.00	880.00	660.00	290.00
average	23.33	31.67	35.00	75.00	100.00	148.33	186.67	850.00	523.33	313.33
sd	2.89	7.64	8.66	22.91	70.00	95.70	100.17	51.96	236.71	285.72
Control Vetiver 0.2 m										
Days	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
1.00	10.00	15.00	15.00	15.00	15.00	20.00	25.00	40.00	20.00	25.00
2.00	5.00	10.00	20.00	10.00	20.00	10.00	20.00	50.00	25.00	20.00
3.00	15.00	20.00	10.00	20.00	15.00	30.00	30.00	20.00	30.00	30.00
average	10.00	15.00	15.00	15.00	16.67	20.00	25.00	36.67	25.00	25.00
sd	5.00	5.00	5.00	5.00	2.89	10.00	5.00	15.28	5.00	5.00
Control Colocasia 0.2 m										
Days	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
1.00	20.00	30.00	40.00	40.00	45.00	70.00	80.00	100.00	124.00	90.00
2.00	25.00	35.00	30.00	45.00	50.00	60.00	90.00	130.00	128.00	100.00
3.00	35.00	45.00	50.00	50.00	60.00	50.00	75.00	140.00	126.00	110.00
average	26.67	36.67	40.00	45.00	51.67	60.00	81.67	123.33	119.50	100.00
sd	7.64	7.64	10.00	5.00	7.64	10.00	7.64	20.82	13.10	10.00
Control Vetiver										

0.4 m										
Days	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
1.00	7.50	7.50	7.50	10.00	15.00	15.00	15.00	30.00	20.00	15.00
2.00	5.00	5.00	5.00	5.00	5.00	10.00	10.00	20.00	15.00	10.00
3.00	10.00	10.00	10.00	15.00	20.00	20.00	20.00	25.00	25.00	20.00
average	7.50	7.50	7.50	10.00	13.33	15.00	15.00	25.00	20.00	15.00
sd	2.50	2.50	2.50	5.00	7.64	5.00	5.00	5.00	5.00	5.00
Control Colocasia 0.4 m										
Days	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
1.00	25.00	30.00	25.00	40.00	30.00	35.00	45.00	90.00	80.00	55.00
2.00	20.00	25.00	30.00	35.00	40.00	40.00	50.00	85.00	70.00	40.00
3.00	30.00	35.00	40.00	45.00	50.00	50.00	60.00	95.00	90.00	100.00
average	25.00	30.00	31.67	40.00	40.00	41.67	51.67	92.50	80.00	65.00
sd	5.00	5.00	7.64	5.00	10.00	7.64	7.64	6.46	10.00	31.22
Control Vetiver 0.6 m										
Days	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
1.00	5.00	10.00	10.00	15.00	10.00	10.00	15.00	20.00	15.00	15.00
2.00	5.00	5.00	5.00	5.00	15.00	15.00	10.00	15.00	10.00	10.00
3.00	7.50	15.00	15.00	20.00	20.00	20.00	20.00	25.00	20.00	20.00
average	5.83	10.00	10.00	13.33	15.00	15.00	15.00	20.00	15.00	15.00
sd	1.44	5.00	5.00	7.64	5.00	5.00	5.00	5.00	5.00	5.00
Control Colocasia 0.6 m										
Days	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
1.00	15.00	20.00	25.00	20.00	25.00	30.00	40.00	60.00	55.00	50.00
2.00	10.00	20.00	20.00	25.00	30.00	40.00	45.00	65.00	58.00	45.00
3.00	20.00	30.00	30.00	30.00	35.00	45.00	50.00	60.00	60.00	58.00
average	15.00	23.33	25.00	25.00	30.00	38.33	45.00	71.25	65.75	58.25
sd	5.00	5.77	5.00	5.00	5.00	7.64	5.00	19.31	16.30	15.46

Wet Weight of plants in the constructed wetland (g)

Vetiver 0.2 m										
Days	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
1.00	7.00	10.00	15.00	15.00	25.00	20.00	40.00	40.00	40.00	30.00
2.00	5.00	15.00	14.00	15.00	10.00	20.00	15.00	45.00	20.00	5.00
3.00	20.00	10.00	10.00	10.00	15.00	20.00	10.00	50.00	50.00	60.00
average	10.67	11.67	13.00	13.33	16.67	20.00	21.67	45.00	36.67	31.67
sd	8.14	2.89	2.65	2.89	7.64	0.00	16.07	5.00	15.28	27.54
Colocasia 0.2 m										
Days	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
1.00	15.00	20.00	45.00	30.00	45.00	55.00	25.00	60.00	130.00	60.00
2.00	10.00	20.00	30.00	55.00	105.00	60.00	145.00	365.00	150.00	365.00
3.00	10.00	15.00	60.00	90.00	65.00	175.00	125.00	80.00	175.00	80.00
average	11.67	18.33	45.00	58.33	71.67	96.67	98.33	168.33	151.67	168.33
sd	2.89	2.89	15.00	30.14	30.55	67.88	64.29	170.61	22.55	170.61
Vetiver 0.4 m										
Days	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
1.00	5.00	5.00	15.00	30.00	40.00	30.00	40.00	20.00	70.00	25.00
2.00	3.00	20.00	15.00	5.00	5.00	30.00	20.00	38.00	10.00	30.00
3.00	20.00	5.00	10.00	10.00	20.00	25.00	30.00	48.00	20.00	40.00
average	9.33	10.00	13.33	15.00	21.67	28.33	30.00	35.33	33.33	31.67
sd	9.29	8.66	2.89	13.23	17.56	2.89	10.00	14.19	32.15	7.64
Colocasia 0.4 m										
Days	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
1.00	40.00	25.00	50.00	40.00	40.00	175.00	220.00	760.00	290.00	65.00
2.00	40.00	60.00	40.00	40.00	100.00	25.00	45.00	365.00	360.00	150.00

3.00	15.00	30.00	40.00	110.00	110.00	100.00	70.00	690.00	790.00	140.00
average	31.67	38.33	43.33	63.33	83.33	100.00	111.67	605.00	480.00	118.33
sd	14.43	18.93	5.77	40.41	37.86	75.00	94.65	210.77	270.74	46.46
Vetiver 0.6 m										
Days	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
1.00	5.00	10.00	5.00	10.00	20.00	17.00	20.00	50.00	80.00	10.00
2.00	2.00	5.00	5.00	7.50	5.00	15.00	10.00	50.00	5.00	55.00
3.00	5.00	5.00	15.00	10.00	5.00	10.00	17.50	20.00	10.00	5.00
average	4.00	6.67	8.33	9.17	10.00	14.00	15.83	40.00	31.67	23.33
sd	1.73	2.89	5.77	1.44	8.66	3.61	5.20	17.32	41.93	27.54
Colocasia 0.6 m										
Days	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
1.00	20.00	25.00	40.00	50.00	100.00	255.00	90.00	880.00	660.00	40.00
2.00	25.00	30.00	25.00	95.00	170.00	70.00	290.00	790.00	250.00	610.00
3.00	25.00	40.00	40.00	80.00	30.00	120.00	180.00	880.00	660.00	290.00
average	23.33	31.67	35.00	75.00	100.00	148.33	186.67	850.00	523.33	313.33
sd	2.89	7.64	8.66	22.91	70.00	95.70	100.17	51.96	236.71	285.72
Control Vetiver 0.2 m										
Days	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
1.00	10.00	15.00	15.00	15.00	15.00	20.00	25.00	40.00	20.00	25.00
2.00	5.00	10.00	20.00	10.00	20.00	10.00	20.00	50.00	25.00	20.00
3.00	15.00	20.00	10.00	20.00	15.00	30.00	30.00	20.00	30.00	30.00
average	10.00	15.00	15.00	15.00	16.67	20.00	25.00	36.67	25.00	25.00
sd	5.00	5.00	5.00	5.00	2.89	10.00	5.00	15.28	5.00	5.00
Control Colocasia 0.2 m										
Days	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

1.00	20.00	30.00	40.00	40.00	45.00	70.00	80.00	100.00	124.00	90.00
2.00	25.00	35.00	30.00	45.00	50.00	60.00	90.00	130.00	128.00	100.00
3.00	35.00	45.00	50.00	50.00	60.00	50.00	75.00	140.00	126.00	110.00
average	26.67	36.67	40.00	45.00	51.67	60.00	81.67	123.33	119.50	100.00
sd	7.64	7.64	10.00	5.00	7.64	10.00	7.64	20.82	13.10	10.00
Control Vetiver 0.4 m										
Days	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
1.00	7.50	7.50	7.50	10.00	15.00	15.00	15.00	30.00	20.00	15.00
2.00	5.00	5.00	5.00	5.00	5.00	10.00	10.00	20.00	15.00	10.00
3.00	10.00	10.00	10.00	15.00	20.00	20.00	20.00	25.00	25.00	20.00
average	7.50	7.50	7.50	10.00	13.33	15.00	15.00	25.00	20.00	15.00
sd	2.50	2.50	2.50	5.00	7.64	5.00	5.00	5.00	5.00	5.00
Control Colocasia 0.4 m										
Days	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
1.00	25.00	30.00	25.00	40.00	30.00	35.00	45.00	90.00	80.00	55.00
2.00	20.00	25.00	30.00	35.00	40.00	40.00	50.00	85.00	70.00	40.00
3.00	30.00	35.00	40.00	45.00	50.00	50.00	60.00	95.00	90.00	100.00
average	25.00	30.00	31.67	40.00	40.00	41.67	51.67	92.50	80.00	65.00
sd	5.00	5.00	7.64	5.00	10.00	7.64	7.64	6.46	10.00	31.22
Control Vetiver 0.6 m										
Days	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
1.00	5.00	10.00	10.00	15.00	10.00	10.00	15.00	20.00	15.00	15.00
2.00	5.00	5.00	5.00	5.00	15.00	15.00	10.00	15.00	10.00	10.00
3.00	7.50	15.00	15.00	20.00	20.00	20.00	20.00	25.00	20.00	20.00
average	5.83	10.00	10.00	13.33	15.00	15.00	15.00	20.00	15.00	15.00
sd	1.44	5.00	5.00	7.64	5.00	5.00	5.00	5.00	5.00	5.00

Control Colocasia 0.6 m										
Days	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
1.00	15.00	20.00	25.00	20.00	25.00	30.00	40.00	60.00	55.00	50.00
2.00	10.00	20.00	20.00	25.00	30.00	40.00	45.00	65.00	58.00	45.00
3.00	20.00	30.00	30.00	30.00	35.00	45.00	50.00	60.00	60.00	58.00
average	15.00	23.33	25.00	25.00	30.00	38.33	45.00	71.25	65.75	58.25
sd	5.00	5.77	5.00	5.00	5.00	7.64	5.00	19.31	16.30	15.46

Height of plants in the constructed wetland (cm)

Vetiver 0.2 m										
Days	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
1.00	60.00	95.00	81.00	77.00	100.00	139.00	145.00	114.00	166.00	163.00
2.00	63.50	91.00	98.00	116.00	120.00	136.00	151.00	178.00	154.00	183.00
3.00	72.00	70.00	85.00	126.00	128.00	137.00	146.00	175.00	146.00	117.00
average	65.17	85.33	88.00	106.33	116.00	137.33	147.33	155.67	155.33	154.33
sd	6.17	13.43	8.89	25.89	14.42	1.53	3.21	36.12	10.07	33.84
Colocasia 0.2 m										
Days	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
1.00	82.00	80.00	72.00	86.00	96.00	100.00	102.00	139.00	99.00	120.00
2.00	72.00	84.00	95.00	75.00	97.00	89.00	110.00	110.00	115.00	121.00
3.00	66.00	73.00	80.00	95.00	72.00	90.00	110.00	125.00	112.00	83.00
average	73.33	79.00	82.33	85.33	88.33	93.00	107.33	124.67	108.67	108.00
sd	8.08	5.57	11.68	10.02	14.15	6.08	4.62	14.50	8.50	21.66
Vetiver 0.4 m										
Days	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
1.00	80.00	82.00	106.00	116.00	174.00	166.00	110.00	205.00	151.00	139.00
2.00	92.00	102.00	120.00	105.00	108.00	125.00	159.00	164.00	152.00	136.00
3.00	63.00	90.00	76.00	100.00	83.00	98.00	130.00	100.00	165.00	137.00
average	78.33	91.33	100.67	107.00	121.67	129.67	133.00	156.33	156.00	137.33
sd	14.57	10.07	22.48	8.19	47.01	34.24	24.64	52.92	7.81	1.53
Colocasia 0.4 m										
Days	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
1.00	88.00	52.00	75.00	75.00	93.00	90.00	105.00	120.00	90.00	97.00
2.00	52.00	102.00	91.00	79.00	74.00	96.00	96.00	124.00	100.00	112.00
3.00	76.00	82.00	80.00	98.00	91.00	92.00	90.00	121.00	121.00	87.00

average	72.00	78.67	82.00	84.00	86.00	92.67	97.00	121.67	103.67	98.67
sd	18.33	25.17	8.19	12.29	10.44	3.06	7.55	2.08	15.82	12.58
Vetiver 0.6 m										
Days	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
1.00	74.00	73.00	112.00	140.00	110.00	121.00	136.00	161.00	155.00	152.00
2.00	61.00	79.00	90.00	76.00	140.00	116.00	130.00	151.00	138.00	154.00
3.00	65.00	70.00	67.00	69.00	80.00	111.00	133.00	137.00	148.00	134.00
average	66.67	74.00	89.67	95.00	110.00	116.00	133.00	149.67	147.00	146.67
sd	6.66	4.58	22.50	39.13	30.00	5.00	3.00	12.06	8.54	11.02
Colocasia 0.6 m										
Days	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
1.00	59.00	67.00	89.00	90.00	86.00	117.00	117.00	117.00	116.00	113.00
2.00	63.00	98.00	92.00	92.00	100.00	108.00	111.00	117.00	112.00	117.00
3.00	67.00	80.00	77.00	90.00	90.00	97.00	103.00	120.00	121.00	116.00
average	63.00	81.67	86.00	90.67	92.00	107.33	110.33	118.00	116.33	115.33
sd	4.00	15.57	7.94	1.15	7.21	10.02	7.02	1.73	4.51	2.08
Control Vetiver 0.2 m										
Days	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
1.00	55.00	63.00	60.00	90.00	107.00	108.00	113.00	140.00	135.00	120.00
2.00	58.00	62.00	70.00	100.00	90.00	120.00	118.00	144.00	129.00	128.00
3.00	60.00	60.00	71.00	60.00	80.00	110.00	119.00	151.00	128.00	110.00
average	57.67	61.67	67.00	83.33	92.33	112.67	116.67	145.00	130.67	119.33
sd	2.52	1.53	6.08	20.82	13.65	6.43	3.21	5.57	3.79	9.02
Control Colocasia 0.2 m										
Days	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
1.00	55.00	64.00	61.00	90.00	100.00	99.00	115.00	103.00	118.00	102.00

2.00	59.00	67.00	62.00	80.00	70.00	88.00	90.00	141.00	127.00	115.00
3.00	62.00	60.00	72.00	70.00	80.00	90.00	84.00	151.00	138.00	119.00
average	58.67	63.67	65.00	80.00	83.33	92.33	96.33	131.67	127.67	112.00
sd	3.51	3.51	6.08	10.00	15.28	5.86	16.44	25.32	10.02	8.89
Control Vetiver 0.4 m										
Days	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
1.00	58.00	65.00	63.00	100.00	104.00	100.00	105.00	116.00	108.00	104.00
2.00	58.00	67.00	72.00	90.00	109.00	110.00	109.00	128.00	119.00	109.00
3.00	60.00	60.00	75.00	80.00	110.00	119.00	119.00	121.00	118.00	110.00
average	58.67	64.00	70.00	90.00	107.67	109.67	111.00	121.67	115.00	107.67
sd	1.15	3.61	6.24	10.00	3.21	9.50	7.21	6.03	6.08	3.21
Control Colocasia 0.4 m										
Days	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
1.00	51.00	55.00	58.00	65.00	67.00	70.00	69.00	98.00	85.00	81.00
2.00	55.00	55.00	58.00	62.00	66.00	69.00	68.00	91.00	84.00	79.00
3.00	52.00	54.00	56.00	61.00	59.00	61.00	65.00	89.00	82.00	78.00
average	52.67	54.67	57.33	62.67	64.00	66.67	67.33	92.67	83.67	79.33
sd	2.08	0.58	1.15	2.08	4.36	4.93	2.08	4.73	1.53	1.53
Control Vetiver 0.6 m										
Days	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
1.00	48.00	51.00	52.00	55.00	58.00	60.00	62.00	89.00	84.00	68.00
2.00	49.00	52.00	52.00	54.00	59.00	61.00	68.00	89.00	81.00	69.00
3.00	55.00	51.00	53.00	53.00	58.00	62.00	65.00	88.00	82.00	75.00
average	50.67	51.33	52.33	54.00	58.33	61.00	65.00	88.67	82.33	70.67
sd	3.79	0.58	0.58	1.00	0.58	1.00	3.00	0.58	1.53	3.79
Control										

Colocasia 0.6 m										
Days	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
1.00	51.00	54.00	54.00	62.00	64.00	66.00	73.00	88.00	80.00	77.00
2.00	52.00	54.00	54.00	61.00	64.00	65.00	78.00	87.00	80.00	78.00
3.00	54.00	55.00	57.00	62.00	66.00	64.00	79.00	78.00	81.00	79.00
average	52.33	54.33	55.00	61.67	64.67	65.00	76.67	84.33	80.33	78.00
sd	1.53	0.58	1.73	0.58	1.15	1.00	3.21	5.51	0.58	1.00

APPENDIX D

LAWS/STANDARDS/NOTIFICATION/REGULATION

Industrial Effluent Standards

Items	Units	Standard Values	Remarks
BOD (5 day, at 20C)	mg/l	20	Depends on physical geography or under office's consideration but not more than 60 mg/l except 1) Fishery canning Max. 100 2) Starch industry -Centrifugal Max. 60 -Sedimentation Max. 100 3) Noodle industry Max. 100 4) Tanning industry Max. 100 5) Pulp industry Max. 100 6) Frozen Food industry Max. 100 7) Industrial Estate Authorits of Thailand Standard Value :Max 1000 mg/l per day.
Chemical Oxygen Demand	mg/l	Max. 120	Notification of the Ministry of Industry NO.2, B. E.2539(1996). Depend on offfice's consideration but not more than 400 mg/l.
Chloride As Chlorine	mg/l	Max. 2000	Notitcation of Industrial Estate Authorits of Thailand.
Colour and odour	-	None	
Cyanide as HCN	mg/l	Max. 0.2	
Dissolved solids (DS)	mg/l	see remarks	1) Standard value: Max. 2,O00 or under office's consideration but not more than 5,000 2) Notification Of The Ministry Of Industry No2,B.E.2539(1996). Standard value:Max3,000 or under office's condideration but not more than 5,000. 3) If salinity of receiving water is higher than 2,000 mg/l, DS in the effluent should not be higher than 5,000 mg/l of the Ds in the receiving water.
Formaldchyde	mg/l	Max. 1.0	Notification Of Industrial Estate Authorits of Thailand. Standard value: Max. 2 mg/l.
Free Chlorine	mg/l	Max. 1.0	Notification of Industrial Estate Authorits of Thailand. Standard value: Max. 5 mg/l.
Free ammonia	mg/l	Max. 5	Only Of Industrial Estate Authorits of Thailand.
Heavy Metals/Copper (Cu)	mg/l	Max. 1.0	Notification of The Ministry of Industry No 2,B.E.2539(1996). Standard Value: Max 2.0 mg/l.
Heavy metals/Arsenic (As)	mg/l	Max. 0.25	Notification of Industrial Estate Authorits of Thailand. Standard value: Max. 1 mg/l.

Heavy metals/Barium (Ba)	mg/l	Max. 1.0	
Heavy metals/Cadmium (Cd)	mg/l	Max. 0.03	1) Zinc industry max. 0.1 2) Notification Of Industrial Estate Authorits of Thailand. Standard value: Max. 1 mg/l.
Heavy metals/Chromium (Cr)	mg/l	Max. 0.5	1) Zinc industry max. 0.22 2) Notification of The Ministry of Industry No 2,B.E.2539(1996). Standard Value: Hexavlent Chromium: Max 0.25 mg/l Trivalent Chromium: Max 0.75 mgA
Heavy metals/Lead (Pb)	mg/l	Max. 0.2	Notification Of Industrial Estate Authorits of Thailand. Standard value Max. 1 mg/l.
Heavy metals/Manganese (Mn)	mg/l	Max. 5.0	1) Zinc industry Max. 0.02 2)Notification of Industrial Estate Authorits of Thailand. Standard value: Max 10 mgA.
Heavy metals/Mercury (Hg)	mg/l	Max. 0.005	Zinc Industry Max. 0.002
Heavy metals/Nickel (Nl)	mg/l	Max. 0.2	1) Zinc industry Max. 0.2 2) Notification Of Industrial Estate Authorits of Thailand. Standard value: Max. 1 mg/l.
Heavy metals/Selenium (Se)	mg/l	Max. 0.2	Notification Of Industrial Estate Authorits of Thailand. Standard value: Max. 1 mg/l.
Heavy metals/Silver (Ag)	mg/l	-	Notification of Industrial Estate Authorits of Thailand. Standard value: Max. 1.0 mg/l
Heavy metals/Soluble iron	mg/l	Max. 10	Only Of Industrial Estate Authorits of Thailand.
Heavy metals/Zinc(Zn)	mg/l	Max. 5.0	Zinc industry Max. 3.0
Insecticides	mg/l	none	
Oil & Grease	mg/l	Max. 5.0	1) Refinery & Lubricant oil industry Max 15.0 2) Notification Of Industrial Estate Authorits of Thailand. Standard value: Max. 10 mg/l.
Permanganate Value	-	Max. 60	
Phenol & cresols	mg/l	Max. 1.0	
Radioactivity	Becqure/l	none	
Sulphide as H2S	-	Max. 1.0	Notification Of Industrial Estate Authorits of Thailand. Standard value: Max. 5 mg/l.
Suspended solids (SS)	mg/l	see remark	1) Standard value: depents on dilution ratio of wastewater and receiving water 2) Ratio of wastewater and receiving water 1) 1/8 to 1/150 Max. 30 2) 1/151 to 1/300 Max. 60 3) 1/301 to 1/500 Max. 150

			3) Notification of The Ministry Of Industry No 2,B.E.2539(1996). Standard value: Max 50 mg/l or under office's consideration but not more than 150 mg/l. 4)Notification of Industrial Estate Authorits of Thailand Standard value: Max 200 mg/l.
Synthetic detergent	mg/l	Max. 30	Only Of Industrial Estate Authorits of Thailand.
Tar	mg/l	none	Notification of Industrial Estate Authorits of Thailand. Standard value: Max. 10 mg/l.
Temperature	C	Max. 40	Notification of Industrial Estate Authorits of Thailand. Standard value: Max. 45
Total Kjeldahl Nitrogen	mg/l	Max. 100	Notification of The Ministry of Industry No 2,B.E.2539(1996). Depend on office's consideration but not more than 200 mg/l.
Total ammonical Nitrogen as N	mg/l	Max. 50	Only Of Industrial Estate Authorits of Thailand.
pH	-	5-9	1) NotiEcation of The Ministry Of Industry No 2,B.E.2539(1996). Standard value: Max. 5.5-9 2) Notification of Industrial Estate Authorits of Thailand Standard value: Max. 6-9

DOCUMENTATION

(1)Notification of the Ministry of Industry No.12, B.E. 2525 (1982) issued under the Factory Act B.E.2521 (1978),
published in the Royal Government Gazette. Vol.95 Part 33, dated March 5, B.E. 2525(1982).

(2) Notification of the Ministry of Industry No. 10,B.E.2521 (1978) issued under the Factory ACT B.E. 2521 (1978),
published in the Royal Government Gazette, vol. 95, Part 132, dated November 28, B.E.2521 (1978).

(3) Notification of the Harbour Department No.214/2525(1982)

(4) Notification of the Ministry of Industry No.2 B.E. 2539(1996) issue under the Factory Act B.E. 2535(1992).

(5) Notification of Industry Estate Authorits of Thailand B.E.2530(1987)

LAND EFFLUENT STANDARDS

ITEMS	UNITS	STANDARD VALUES
BOD	mg/l	30*,20**
Fat Oil and Grease	mg/l	20
Nitrogen in form TKN	mg/l	35
Settleable Solids	mg/l	0.5
Sulfide	mg/l	1.0
Suspended Solids	mg/l	40*,30**
Total Dissolved Solids (TDS)	mg/l	500
pH	-	5.5-9.0

DOCUMENTATION

(1) Notification of the Ministry of Science Technology and Environment issued under the Enhancement and Conservation of National Environmental Quality Act B.E. 2535 (1992)

REMARK

mg/l = miligram per liter
*fortypeA
**for type B

Water Characteristics Discharged into Deep Wells

PARAMETER	UNITS	STANDARD VALUES (MAXIMUM ALLOWANCE)
Color	Patinum Cobalt	50
Turbidity	JTU	50
pH	-	5.0-9.2
Total solids	mg/l	2
BOD	mg/l	40
Oil and Grease	mg/l	5.0
Free Chlorine	mg/l	5.0
Copper (Cu)	mg/l	1.5
Zine (Zn)	mg/l	15
Chromium (Cr)	mg/1	2.0
Arsenic (As)	mg/l	0.05
Cyanide (Cn)	mg/l	0.2
Mercuny (Hg)	mg/l	0.002
Lead (Pb)	mg/l	0.1
Cadmium (Cd)	mg/l	0.1
Barium (Ba)	mg/l	1.0

DOCUMENTATION
Notification of the Ministry of industry No 5, B E 2521 (1978), issued under the Ground Water Act B E 2520 (1977) published n the Royal Government Gazene,Vol. 95 Part 66 datedJune27,BE2521(1978)

VITA

NAME:	Akharint Khuhapinant, Mr.
PLACE OF BIRTH:	Bangkok, Thailand.
EDUCATION:	AAS degree option II
	Edmonds Community College, Lynnwood,
	Washington State, USA. (2000)
	Bachelor Degree of Science in Civil Engineering
	(Specialization in Environmental Engineering),
	Seattle, Washington State, USA. (2003)