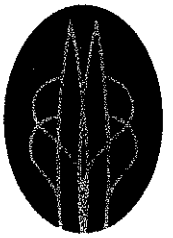


UNIVERSITI
TEKNOLOGI
PETRONAS

Determination of Zinc Uptake by Kenaf (*Hibiscus cannabinus L.*) for Phytoremediation

by

Muhammad Nasrullah Bin Jaafar
10851

Dissertation

submitted in partial fulfillment of the requirements for the

Bachelor of Engineering (Hons)

(Chemical Engineering)

SEPTEMBER 2011

Universiti Teknologi PETRONAS

Bandar Seri Iskandar

31750 Tronoh

Perak Darul Ridzuan

CERTIFICATION OF APPROVAL

Determination of Zinc Uptake by Kenaf (*Hibiscus cannabinus L.*) for Phytoremediation

by

Muhammad Nasrullah Bin Jaafar

A project dissertation submitted to the

Chemical Engineering Programme

UniversitiTeknology PETRONAS

in partial fulfilment of requirement for the

BACHELOR OF ENGINEERING (Hons)

(CHEMICAL ENGINEERING)

Approved by,

(Dr. Nurlidia Binti Mansor)

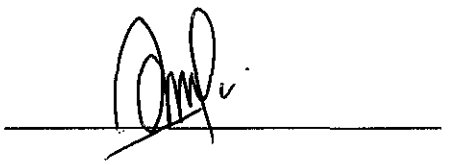
UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

SEPTEMBER 2011

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.



(Muhammad Nasrullah Bin Jaafar)

ABSTRACT

This study investigates the ability of kenaf (*Hibiscus cannabinus* L.) as a potential plant for phytoremediation of ex-mining soil. Ex-mining soil is seemed to have high amount of heavy metals such as zinc, lead and copper. This investigation on the ability of kenaf will be focused on its ability towards zinc. Zinc is one of the heavy metals that discovered in the ex-mining soil in Tronoh which meet its intervention concentration point. The study will be conducted by propagating the plants into contaminated soil spiked with zinc with various concentrations. The concentrations are selected based on normal amount of the zinc in the typical soil and the soil from ex-mining soil in Tronoh. The parts of the plants that will be studied are the root, stem and leaves. Each of the samples will be digested and analyzed in the lab using Atomic Absorption Spectrometer (AAS). The ability of kenaf to accumulate heavy metal will determine its potential for phytoremediation of ex-mining soil.

ACKNOWLEDGEMENT

The author would like to thank his supervisor, Dr Nurlidia B Mansor for his guidance and support throughout FYP I and II despite his many other obligations. Appreciation is also extended to the course coordinator, Dr Lukman B Ismail for his timely arrangement and advices. Special thanks to his family members and fellow friends who gave moral support to motivate him pursue to greater heights in the project. Genuine gratitude is dedicated to examiners and evaluators, both internal and external.

Secondly, endless thanks to the other FYP students for sharing their ideas and information. The thanks extend to the other related lecturers for their endless support in term of welfare and well-being throughout completing this project.

To all individuals that has helped the author in any way, but whose name is not mentioned here, the author would like to thanks and express his gratitude for the wonderful supports.

Thank you very much

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1: INTRODUCTION

1.1 Background of the Project

Mining activities have both local and regional impacts on terrestrial and aquatic ecosystem. In Malaysia, mining sector already started hundred years ago. It involved directly to the history of this country. One of the states that focused on this sector is Perak. Focusing on more specific region, the location of the study will be cover ex-mining area at Tronoh, Perak. This is an ex-tin mining area. The major result from this industry is heavy metals contamination of the land. Phytoremediation seems to be environmental and cheaper technology that can treat this land. A plant known as kenaf is stated to be one of the potential agents of phytoremediation. This study will investigate the facts discovered.

1.2 Problem Statement

Ex-mining area has soil enrich with heavy metals such as lead, iron, nickel, copper and zinc. The high concentration of these heavy metals makes the area unsuitable to be used for agriculture or urbanization due to health concerns. Therefore, the soil has to be treated or remediated before it can be used for that aim. Uptake of heavy metals by hyperaccumulators is one of the best methods to treat contaminated soil. Kenaf has been reported to show potential to become a hyperaccumulator for treating ex-mining soil.

1.3 Objectives

1. To study the potential of kenaf as a hyperaccumulator plant

2. To investigate the uptake of Zn in roots, stems and leaves of kenaf

1.4 Scope of Study

The purpose of this study is to determine the ability of kenaf as a heavy metal accumulator. The heavy metals selected for this study are Zn. It will be mixed with soil as contamination. Then, kenaf will be propagated to the soil. The soil will be spiked with Zn with various concentrations.

In order to analyze the amount of Zn accumulated by kenaf, the analysis will investigate the accumulation in roots, stems and leaves. Other than that, the growth height of the kenaf also will be recorded and analyzed.

CHAPTER 2: LITERATURE REVIEW

2.1 Former Mining Soil – Tin Mining

The tin mining industry is a very essential contributor to Malaysia's economy, producing about one third of total world production. This industry has left large areas of barren land, called tin tailings which were resulted from incessant mining operations which began about 150 years ago. It is estimated that about 250 000 hectares of land fall under this category (Shamshuddin *et* al, 1986).

The definition of tin tailings is tracts of waste land made up of washed waste products of alluvial mining. It is divided into two category; sand tailing and slime tailing. The former is very coarse textured and shows an absence of aggregation and profile development. The slime tailing which has compact structure contains primarily of very fine soils and minerals. The tin tailings are extremely deficient in almost all nutrients and have very low water retention capacity.

Mining sector is one of the biggest sources that contribute to heavy metals contamination. Initially, heavy metals are staying down deep in the earth. Mining activities had brought out all the heavy metals to the surface resulting heavy metals contamination at that area. The soil of ex-mining area is mostly weak, erratic and very complicated. Heavy metals will be left in the ex-mining area because they cannot be degraded or destroyed. However, the effect to the soil from the mining activities will contributed to the heavy metals contamination in soil and will be taken by the plants because they need nutrients to survive and growth. Some heavy metals are necessary for plant growth. However, when taken up in excessive quantities, these elements are transferred into the food chain where they may have adverse effects on the health of humans and animals. Heavy metals can enter the food chain via plant uptake. To a small extent they enter our bodies via food, drinking water and air. As trace elements, some heavy metals like copper, zinc and selenium are essential to maintain the human body metabolism. However, other ones such as cadmium, lead and mercury are toxic at all.

2.2 Soil Quality Standard

In order to setup the experiment, the concentration of the contaminants has been compared to the soil quality standard which is called as the Dutch List. It originates from Netherlands and is widely used in the world. The standard gives us detail values of the target value and intervention values of the specific heavy metals. Other than that, it provides the ABC levels of the heavy metals which Level A implies unpolluted, Level B implies pollution present and further investigation required and Level C implies significant pollution present and cleanup required . The tables below shows the data for zinc based on the Dutch List.

Metal	**Target value (ppm dry matter)**	**Intervention value (ppm dry matter)**
Zinc	140	720

Table 1: Standard Dutch List

	Level A (ppm dry matter)	**Level B (ppm dry matter)**	**Level C (ppm dry matter)**
Zinc	200	500	3000
Significant	Unpolluted	Pollution present Further investigation required	Pollution present Cleanup required

Table 2: ABC Level

2.3 Heavy Metals

There are many definitions of heavy metals. Heavy metals are the elements that have high density and belong largely to the transition group of periodic table. Heavy metals can be determined based upon the density of the elemental form of the metal with the elemental densities more than $5g/cm^3$ (Agarwal, 2009). In general, the term 'heavy metal' always refers to all metals and metalloids other than the alkali and alkaline

earth elements. In other words, the term heavy metals also can be referred to any metallic chemical element that has a relatively high density and is toxic or poisonous at low concentrations.

Heavy metals are natural components of the Earth's crust. It can be hazardous because they cannot be degraded or destroyed but they are bioaccumulate. Heavy metals such as copper, zinc and manganese are essential trace elements for plants and animals. However, at high exposure levels, they can be dangerous and lead to poisoning. The poisoning could occur from drinking-water contamination, high ambient air concentrations near emission sources, or intake via the food chain.

Heavy metals are considered dangerous because they tend to bioaccumulate. Bioaccumulation can be defined as an increase in the concentration of a chemical in a biological organism over time, compared to the chemical's concentration in the environment. Heavy metals that will be analyzed in this study are zinc.

2.4 Zinc (Zn)

Zinc is a bluish-shite soft metal. Its molecular weight is 65.39 g/mole with density of 7.14 g/cm^3. Zinc has boiling point of 907°C. It is always divalent. Zinc will volatile into small zinc oxide particle that rapidly flocculate when heated to temperatures higher than 500°C as they cool, forming fumes. The principle ores of zinc are sphalerite and wurtzite. It is a relatively poor conductor electricity and heat. Zinc constitutes approximately 0.02% of the earth's crust and is distributed widely.

It is estimated that world production of zinc is 7.1 million metric tons. In the industry, zinc is used primarily in the production of noncorrosive alloys, brass and white pigments; in galvanization of iron a steel products; in agriculture as a fungicide and as a protective agent against soil zinc deficiency; and therapeutically in human medicine. Major sources of anthropogenic zinc in the environment include electroplaters, smelting and ore processor, mine drainage domestic and industrial sewage, combustion of solid wastes and fossil fuels, road surface runoff corrosion of zinc alloys and galvanized surfaces, and erosion of agricultural soils.

Zinc is an important trace element for all living organisms. Zinc assures stability of biological molecules such as DNA and of biological structures such as membranes and ribosomes as a constituent of more than 200 metalloenzymes and

other metabolic compounds. Deficiency of zinc has resulted plants in large losses of citrus in California and pecans in Texas and they do not grow well in zinc-depleted soils (Vallee 1959). Other than that, zinc deficiency had been the main cause of the syndrome of nutritional dwarfism in adolescent males from rural areas of Iran and Egypt in 1961 (Casey and Hambidge 1980).

Historical data shows that zinc poisoning has been documented in many animals such as cats, dogs, birds, ferrets, cattle, sheep and horses, usually as a result of ingesting galvanized metal objects, certain paints and fertilizers, zinc-containing coins, and skin and sunblock preparations containing zinc oxide. Some of the symptoms of zinc poisoning are anorexia, depression, enteritis, diarrhea, decreased milk yield, excessive eating and drinking and in severe cases, convulsions and death (Ogden et al. 1988). Aquatic populations are frequently decimated in zinc-polluted waters. Zinc in the aquatic environment is of particular essential because the gills of fish are physically damaged by high concentration of zinc (NAS 1979). Those, some actions must be taken in order to decrease the impacts of the zinc poisoning towards the life especially human.

In the ex-mining land of Tronoh, zinc is one of the heavy metal that has high value content in the soil. The maximum concentration of zinc traced in the soil is 778 ppm (Faizal, 2004). From the Dutch List, the intervention value for zinc is 720ppm. Based on this value, the soil must be treated from the high content of zinc.

2.5 Hibiscus cannabinus L.

Kenaf or its scientific name of *Hibiscus cannabinus L.* is a short-term crop that originated from Africa with a history of more than 4000 years. Kenaf which is from the family of Malvaceae is a close relative to cotton and okra. It is also claimed that kenaf is originated from South Asian region. Kenaf is planted commercially in China, Myanmar, India, Bangladesh and Thailand.

Based on earlier studies by the Malaysian Agricultural Research and Development Institute (MARDI), it can survive in most fertile land in the country and achieve the weight up to 15tonnes of dry stem per hectare. In Malaysia, it is recorded that there are 1692 hectares of kenaf area involving a total of 480 growers until October 2010 (Anim Agro Technology, 2010).The plant is adaptable for uses that range from exceptional paper making characteristics, to forage, to chemical clean-up

process, to non-woven mats, to use as fillers in composite extrusion applications (Integrated Composite Technology, INC, 2001).

Kenaf is a fast growing shrub and can be harvested within 4 months and is convenient to replace the tobacco crops in Malaysia. It is suitable to be planted locally as the appropriate climate for growth requires rainfall between 60-120 mm / month with temperatures between 25 and 28 Celsius, similar to Malaysia. Land of sandy clay soil with good drainage should be selected. Avoid planting kenaf in the area of land available nematode worms. Therefore a test calculation to be made with techniques nematodes Nematode Count. This plant was new in Malaysia and kenaf processing plant is now only available in Pahang while kenaf seed producers in the area of Kedah. Kenaf varieties selected from the hold of the disease contain fiber and are preferred by livestock to be used as animal feed (Anim Agro Technology, 2010). In this research, kenaf will be used as sample to know its ability as hyperaccumulator of heavy metals for ex-mining soil.

Figure 1: Kenaf plants

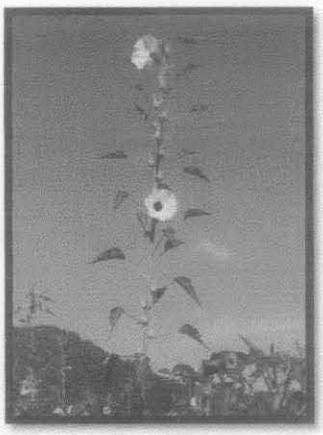


Figure 2: Kenaf flower

Figure 3: One of the kenaf's applications. Kenaf composite ceiling

CHAPTER 3: METHODOLOGY

3.1 Plant Propagation

In order to determine the ability of kenaf to uptake Zn, the plants will be propagated into a container that will be contaminated with Zn. The concentrations that will be used in this study are 300ppm and 700ppm. The 300ppm concentration is used to see the effects under normal concentration while 700ppm is used to know the effects on kenaf under intervention value of Zn. Refer to the Dutch List, the results will show the comparison between these concentrations. Then, there will be another container that will have contaminated soil without the plants. Both of the containers will be compared to determine how much Zn can be uptake by the plants.

3.2 Sampling

Sampling process will be done within 7 days for 5 times. That means the plants will be analyzed for 35 days. The samples that will be taken are the roots, stems, leaves, and soil. All these samples will be processed in the laboratory.

3.3 Plant Sample Preparation

3.3.1 Drying

The samples collected should be air-dried in ambient air circulating cabinet. The drying process should be done as promptly and rapidly as possible to minimize microbial activity (mineralization).

3.3.2 Crushing

After the drying process, the samples should then be crushed using pestle and mortar. This crushing process is done for each of the cores of samples that had been collected from the case study area.

3.3.3 Sieving

Next, the sample has to be sieved by using the 10-mesh screen with a 2mm opening size. This process is important so that all the stones and others extraneous particles could be removed from the samples.

3.3.4 Storage

It is suggested that the samples are stored in an air-dried condition with low humidity level and just above the freezing temperature. The above mentioned condition is the best specification in order to maintain the originality and integrity of the samples (Bates, 1993).

3.4 Sample Digestion Process

After sampling process, all the samples must be digested before running the analysis to evaluate the Zn content. Every type of sample has its own procedure. Below are the procedures of the digestion process for each type of sample.

3.4.1 Pre-treatment for soil sample.

1. Put the sample into petri dish and dry it by using oven at 50°C for one night.
2. Weigh 5.0g of soil sample and put into 100ml digestion tube.
3. Add 10.0ml of nitric acid into the sample. Stand the sample overnight.
4. Evaporate the sample in hot block digestion at 95°C for 1.5 hours. Cover the digestion tube with watch glass cover.
5. Add 5.0ml of hydrogen peroxide into the sample.
6. Continue evaporating the sample in hot block digestion at 95°C for 2.0 hours. Cover the digestion tube with watch glass cover.
7. Add 2.5 ml aqua regia into the sample.
8. Wash watch glass cover with de-ionized water and let the water flow into the digestion tube.
9. Filter the sample into 50ml conical flask with filter paper.
10. Bring up the volume of the solution to 50ml with de-ionized water.
11. Pour the filtered sample into 100ml sample bottle.
12. Sample ready to be analyzed.

3.4.2 Digestion for plant (roots, stems and leaves) sample.

1. Wash, dry and cut sample into small chips.
2. Weigh 1.0g of sample and put into 100ml digestion tube.
3. Add 10.0ml of nitric acid into the sample.
4. Stand the sample overnight.
5. Evaporate the sample in hot block digestion at 95°C for 1.5 hours. Cover the digestion tube with watch glass cover.
6. Add 5.0ml of hydrogen peroxide into the sample.
   Note: Hydrogen peroxide actively reacts with organic. For roots sample, add twice (2.5ml per addition).
7. Continue evaporating the sample in hot block digestion at 95°C for 2.0 hours. Cover the digestion tube with watch glass cover.
8. Add 2.5 ml aqua regia into the sample.
9. Wash watch glass cover with de-ionized water and let the water flow into the digestion tube.
10. Filter the sample into 50ml conical flask with filter paper.
11. Bring up the volume of the solution to 50ml with de-ionized water.
12. Pour the filtered sample into 100ml sample bottle.
13. Sample ready to be analyzed.

3.5 Digestion Process

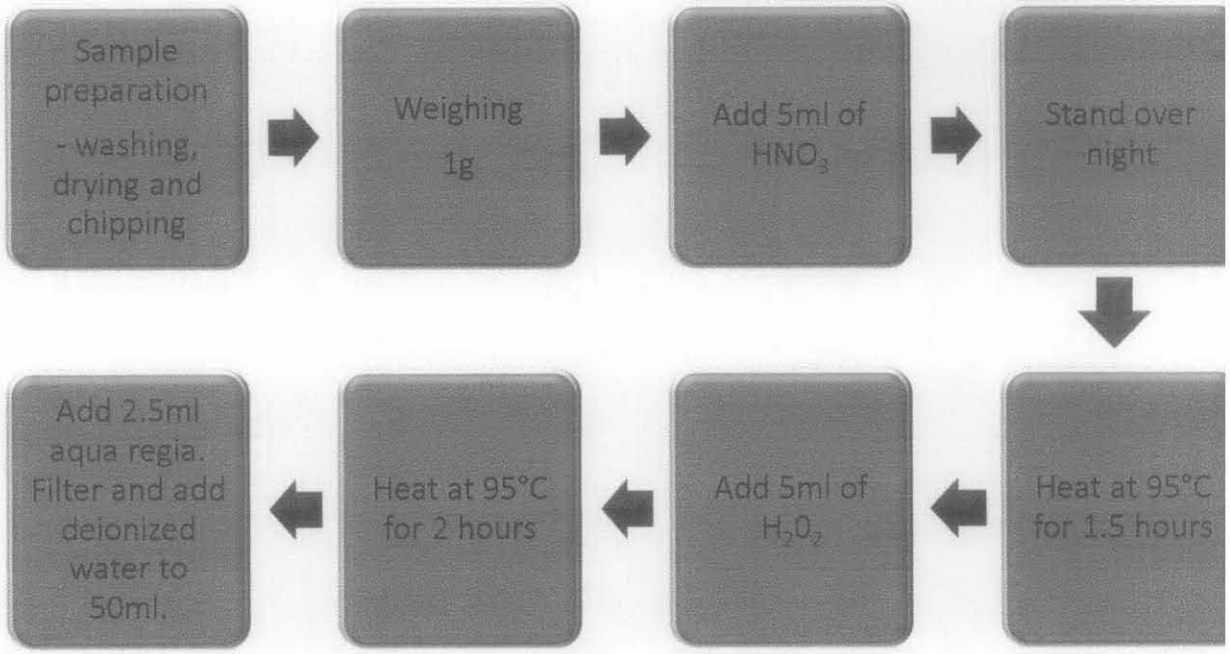


Figure 4: Digestion process for root, stem and leaf sample

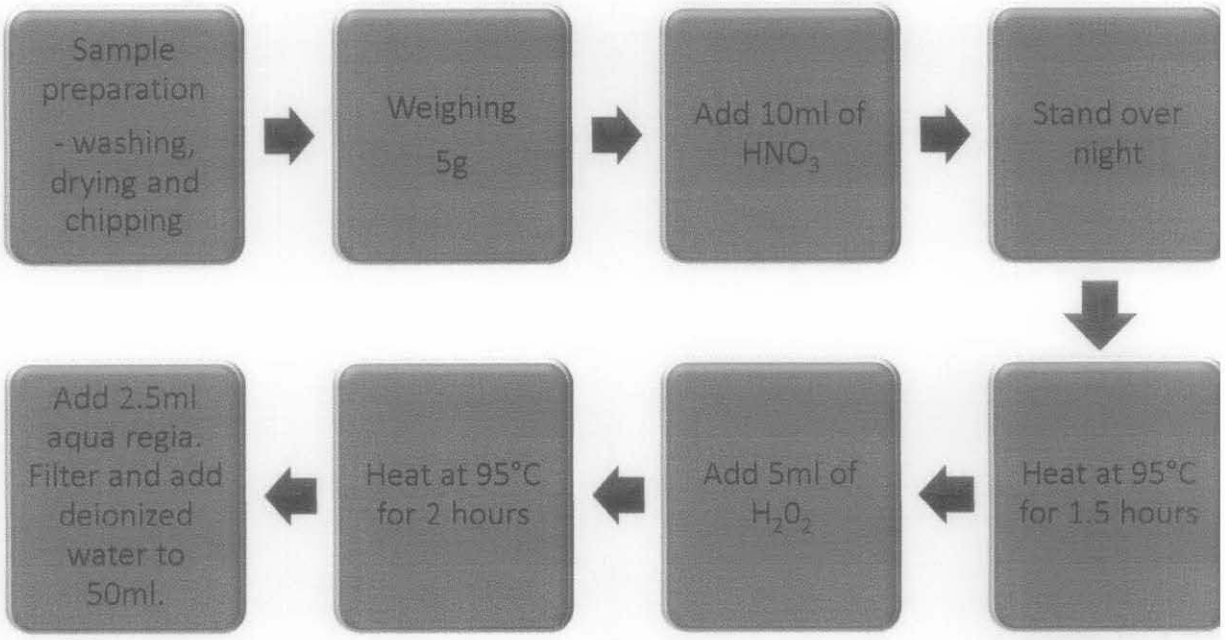


Figure 5: Digestion process for soil samples - Total Digestion.

3.6 Materials and Equipment

3.6.1 Materials

No	Items	Description	Unit/Amount
1	Top soil		110kg
2	Sand		70kg
3	Decompose	cow dung	35kg
4	Kenaf plant		40 plants
5	Nitric acid		5L
6	Hydrochloric acid		5L
7	Zinc sulphate		100g
8	Hydrogen peroxide		1L
9	De-ionized water		-
10	Filter paper	Grade 1	100

Table 3: List of Materials

3.6.2 Equipment

No	Items	Description	Unit/Amount
1	Bucket	15L volume	7
2	Plastic crate	600x400x335 mm	7
3	Measuring cylinder	2L volume	1
4	100ml Digestion tube	Hot block hole size	250
5	Hot block digestion		1
6	Watch glass cover		250
7	Fume cupboard		1
8	Washing/lab bottle		2
9	Conical flask	100 ml	26
10	Filter funnel		3
11	Petri dish		7
12	100ml sample bottle	Plastic	250

13	Digital scale		1
14	Atomic Adsorption Spectrometer (AAS)		1
15	Pipette		2
16	Pipette tips		100
17	Bricks		90
18	Shovel		1

Table 4: List of Equipment

3.7 Atomic Absorption Spectrometer

Atomic absorption spectrometer (AAS) is one of the commonest instrumental methods for analyzing for metals and some metalloids. Metalloids like selenium, arsenic, antimony and tellurium are now routinely analyzed by hydride generation AAS. Inductively coupled plasma (ICP) is also a powerful analytical instrumental method for these elements but at this point it is much higher cost limits widespread use as compared to AAS. The main part of the AAS system is a hollow cathode lamp, nebulizer, air/acetylene flame, and optical system. AAS will be used to analyze the content of Zn in the samples digested.

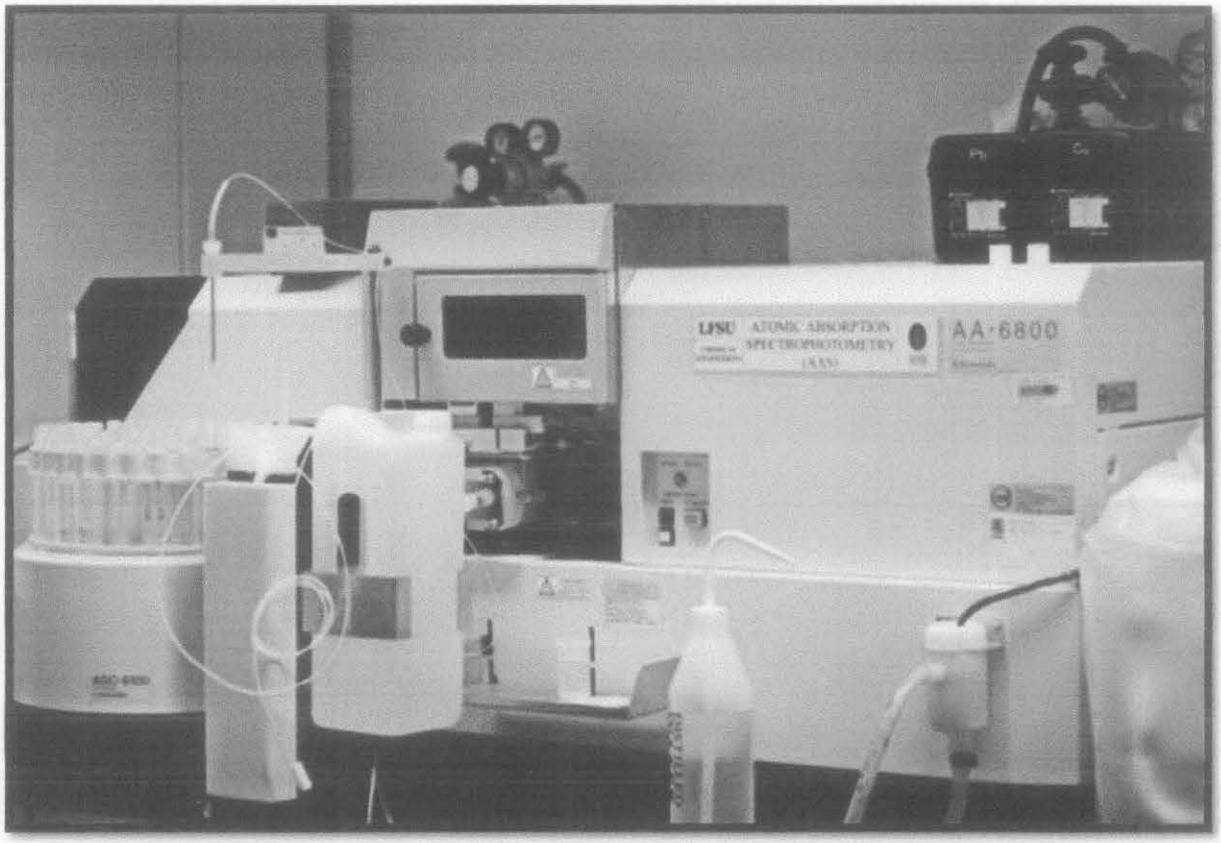


Figure 6: AAS is reading the samples

3.8 Project Planning

Gantt chart 1st Semester

		May Semester																
No	**Detail**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**SW**	**EW1**	**EW2**	**SB**
1	Selection of Project Topic																		
2	Preliminary Research Work																		
3	Submission of Extended Proposal Defense																		
4	Proposal Defense																		
5	Project work continues																		
6	Listing and Finalize Equipment and Methodology																		
7	Purchasing Equipment																		
8	Sample Set Up																		
9	Submission of Interim Draft Report																		
10	Submission of Interim Report																		
11	First Spike																		
12	Taking Sample (every Thursday)																		

Table 5: Gantt chart for May semester

Gantt chart 2nd Semester

		September Semester													
No	**Detail**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
12	Taking Sample (every Thursday)														
13	Lab Analysis														
14	Project Work Continues														
15	Submission of Progress Report														
16	Preparing Analysis and Report														
17	Pre-EDX														
18	Submission of Draft Report														
19	Submission of Dissertation (soft bound)														
20	Submission of Technical Paper														
21	Oral Presentation														
22	Submission of Project Dissertation (Hard Bound)														

Table 6: Gantt chart for September semester

Specific Work
Routine Work (suggested in manual)
Submission and milestone

CHAPTER 4: RESULTS AND DISCUSSION

4.1 Concentration of Zinc in Soils

After taking samples from the propagation area, the soil samples will be dried. After that, they were weighted into 5.0 gram for each sample. Then, they were digested by using HNO_3, H_2O_2 and aqua regia before they were analyzed by using Atomic Absorption Spectrometer (AAS).

The value that AAS gave was in mg/L. In order to get the standard results in ppm, they values got will be calculated through these equations.

Concentration (mg/Kg) = AAS (mg/L) x Volume of Extraction (mL) / Weight of Sample (g)

The value of mg/Kg is the value in ppm (1mg/Kg = 1ppm)

	Sampling Days					
	1	7	14	21	28	35
	Zn (mg/kg)					
PC	25.14	24.95	24.62	22.99	25.63	29.17
R3	30.44	29.04	28.46	27.67	25.40	24.76
R7	32.64	30.77	28.87	27.08	25.87	23.85
CC3	30.35	29.00	26.23	36.48	30.98	26.37
CC7	32.45	30.44	32.74	32.13	28.89	31.70

Table 7: Concentration of Zinc in Soil

4.2 Concentration of Zinc in Leaves, Stems and Roots

Similar to the soil samples, after taking samples from the propagation area, the plants samples will be dried. After that, they were weighted into digestion tube. Then, they were digested by using HNO_3, H_2O_2 and aqua regia before they were analyzed by using Atomic Absorption Spectrometer (AAS).

The value that AAS gave was in mg/L. In order to get the standard results in ppm, they values got will be calculated through these equations.

Concentration (mg/Kg) = AAS (mg/L) x Volume of Extraction (mL) / Weight of Sample (g)

The value of mg/Kg is the value in ppm (1mg/Kg = 1ppm)

	SAMPLING DAYS					
	0	7	14	21	28	35
	Zn (mg/kg) - Leaves					
PC	172.73	207.67	94.26	74.01	44.29	37.68
R3	172.73	256.45	164.44	106.42	140.71	74.93
R7	172.73	663.51	172.95	60.56	45.01	76.37

Table 8: Concentration of Zinc in Leaves

SAMPLING DAYS						
	0	7	14	21	28	35
Zn (mg/kg) - Stems						
PC	105.14	133.33	72.91	57.75	31.80	209.27
R3	105.14	138.75	76.05	76.12	64.88	178.65
R7	105.14	238.10	325.98	74.73	38.05	677.61

Table 9: Concentration of Zinc in Stems

	SAMPLING DAYS					
	0	7	14	21	28	35
	Zn (mg/kg) - Roots					
PC	223.68	230.77	126.18	117.22	13.80	63.64
R3	223.68	242.19	287.50	361.45	102.66	151.42
R7	223.68	377.78	191.98	294.12	28.13	157.11

Table 10: Concentration of Zinc in Roots

4.3 Movement of Zinc in the Soil

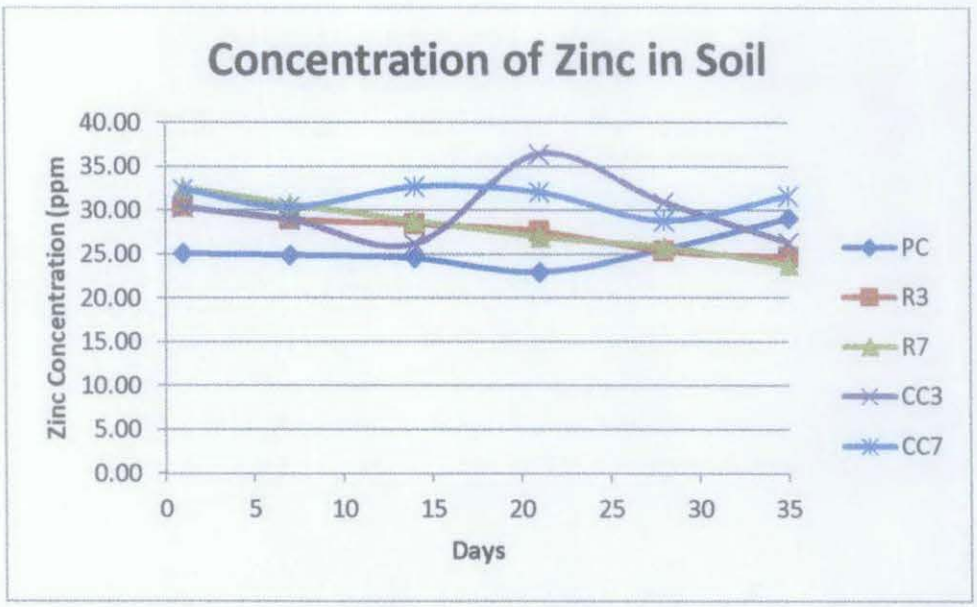


Figure 7: Concentration of Zinc in Soil

The graph shows that the movement of the zinc in the soil for each of the setup. For PC, the concentration of zinc is started with 25.14ppm. Then value decrease until Day 21 but it increases after that until Day 35. For R3, the concentration of the zinc is decrease from Day 1 until Day 35. Same as R3, R7 also shows the same characteristic where the value of the zinc concentration decreases from Day 1 until Day 35. The concentration of zinc in CC3's soil is showing unstable characteristic. It decreases and increases from Day 1 until Day 35. However, the average value for CC3 is 29.90 ppm. CC7 also is showing the same characteristic with the average value is 31.40 ppm.

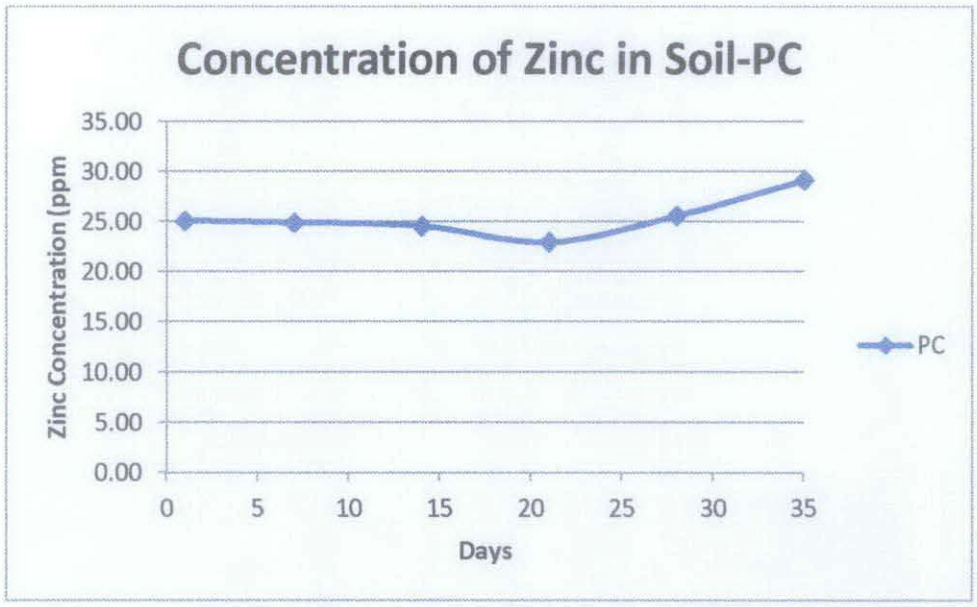


Figure 8: Concentration of Zinc in Soil – PC

The graph above is showing the result for PC. At the beginning, zinc is already in the soil whether the soil was not spiked with zinc. That show that zinc is naturally stay in the normal soil but it is still low value. So, after the propagation of the plants in the soil, the concentration of zinc is showing a decreasing until Day 21. That means zinc in the soil has been moved to the plants that have been propagated. However, After Day 21, the concentration starts to increase until 29.17 ppm. One of the reasons that can describe this is the distribution of the zinc in the soil is not well. The concentration of zinc at this point quite higher than the other points that we take the samples.

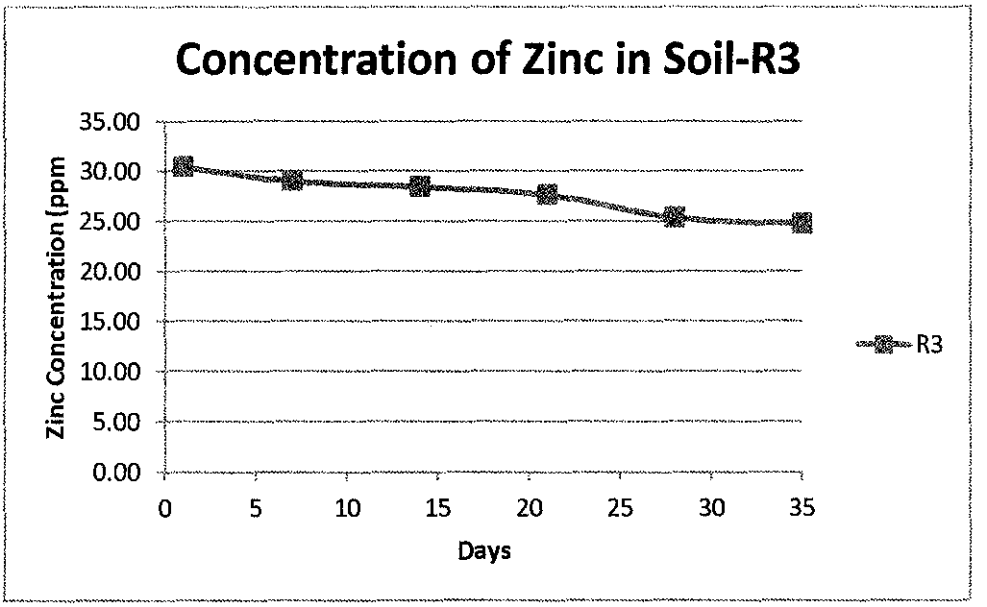


Figure 9: Concentration of Zinc in Soil - R3

In R3, the concentration of zinc decrease from Day 1 until Day 35. This result is same as expected. This result is showing that zinc in the soil has been moved to the kenaf plants that we propagated from Day 1. At the beginning, the concentration of zinc is 30.44 ppm and at the end of the study, the concentration has been decrease to 24.76 ppm.

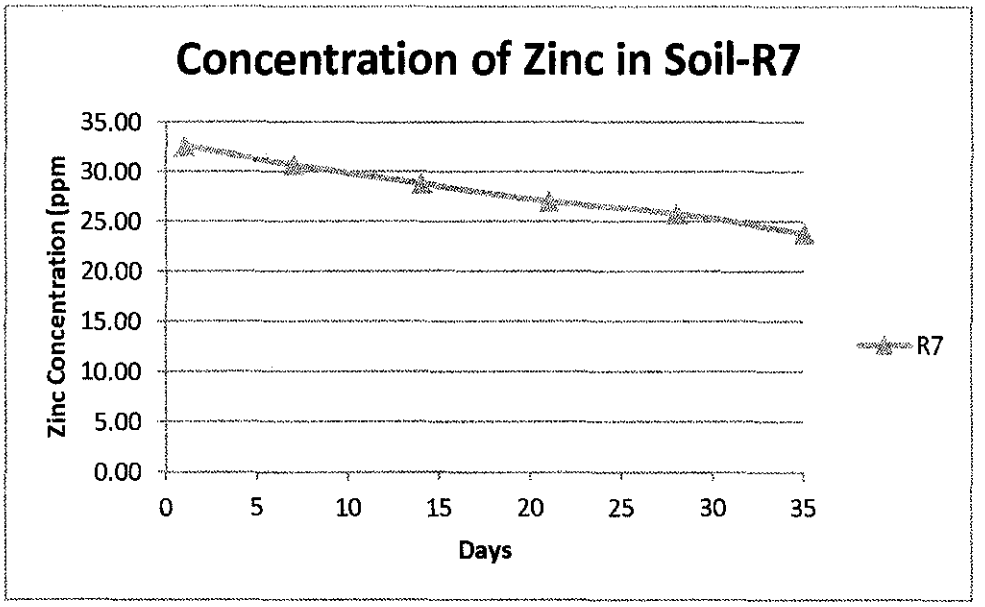


Figure 10: Concentration of Zinc in Soil - R7

Similar to R3, the concentration of zinc in R7 also decrease from Day 1 until Day 35. This result is same as expected. This result is showing that zinc in the soil has been relocated to the kenaf plants that we propagated from Day 1. On Day 1, the concentration of zinc is 32.64 ppm. After 35 days, the concentration of zinc has been decreased to 23.85 ppm. That means, about 8.79 ppm of zinc has been relocated from soil to the plants.

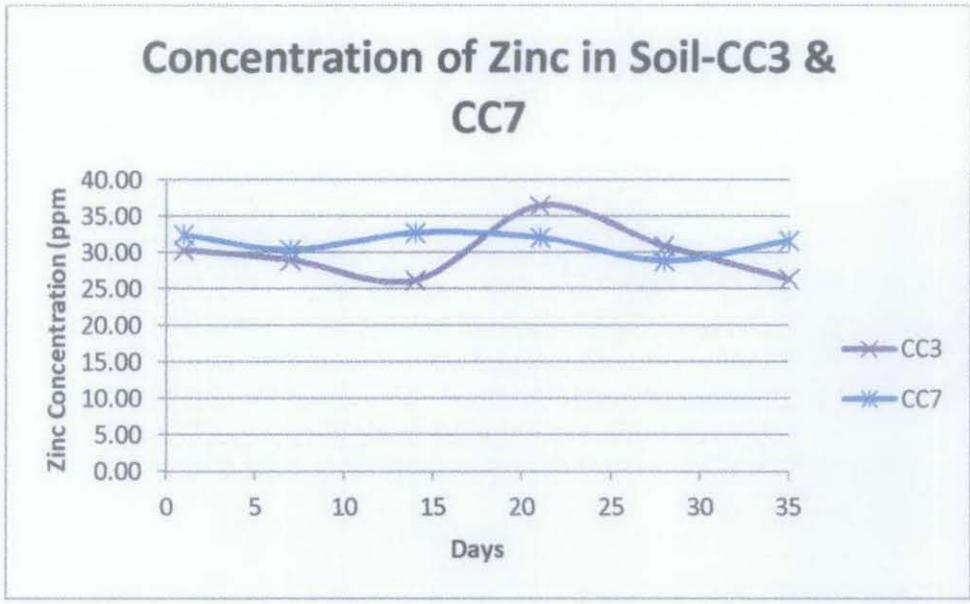


Figure 11: Concentration of Zinc in Soil - CC3 & CC7

This is the value of the zinc in the CC3 and CC7 which have no plants propagated in there. The characteristics of zinc value in both setups are not stable. One of the reasons that can explain this is the distribution of the zinc that has been poured is not well. 1 liter of water that has zinc was poured in each of the setup. So, the water maybe not distributed well in the soil. That is why the concentration of the zinc in the soil not showing any stable characteristics. The value should be about the same from the beginning until the end of the study because no treatment of the soil happen.

4.4 Movement of Zinc in Leaves

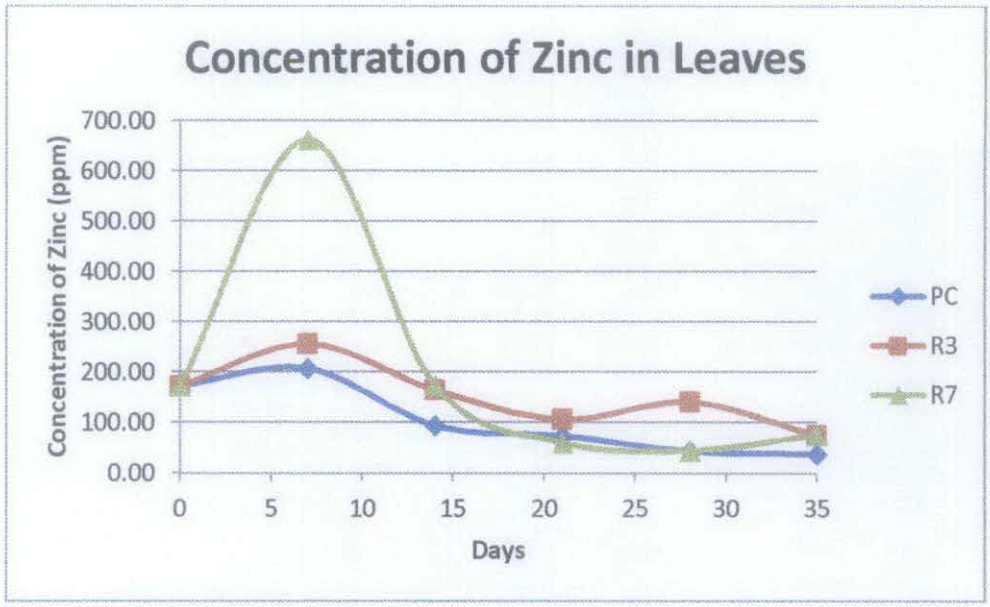


Figure 12: Concentration of Zinc in Leaves

The graph above is showing the value of zinc in leaves of kenaf for PC, R3 and R7. PC is represented with blue colour. At the beginning, the value if zinc is quite high, after Day 7, the value is decreasing. The reason is the concentration of zinc the soil already low resulting that the movement of the zinc from the soil to the plants becomes slower. In R3 and R7, they show same characteristic where the zinc movement becomes slower at the end of the study. However, zinc in R7 at Day 7 is quite high which is 663.51 ppm but after that it goes down to below that 200 ppm. At the end of the study, all the concentrations of zinc in the plants are very low. This shows that zinc already accumulated by the plants in the beginning.

4.5 Movement of Zinc in Stems

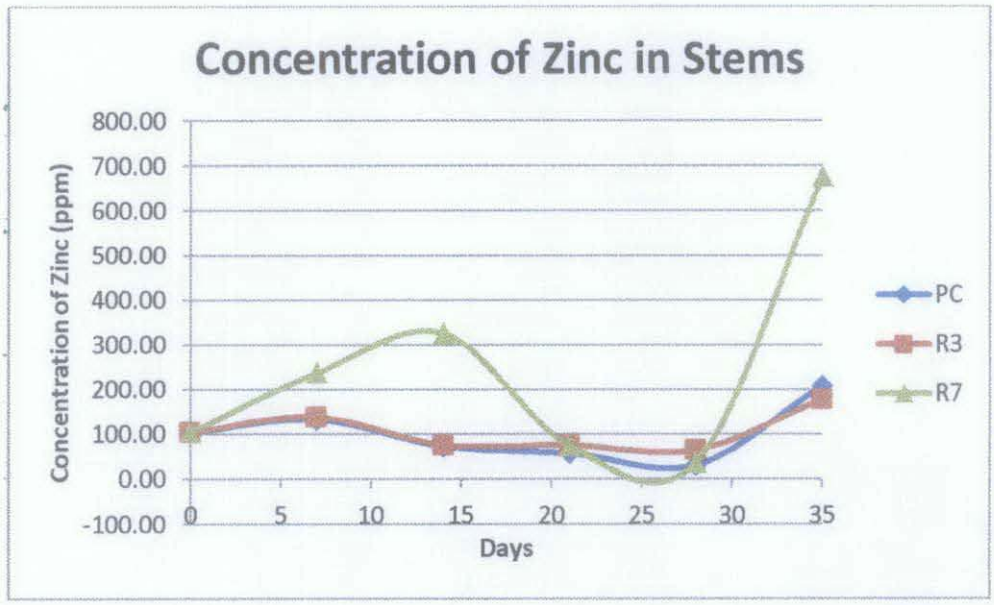


Figure 13: Concentration of Zinc in Stems

The graph above is showing the value of zinc in stems of kenaf for PC, R3 and R7. PC is represented by blue colour; R3 is red in colour while green represents R7. For PC and R3, the characteristic of the graph for both is about the same. The concentration of zinc in stems decrease from Day 1 until Day 28. However, the value suddenly increases on Day 35. It also occurs in R7. It shows that accumulation of zinc by stem starts to increase after Day 28. The stems on that day started to be mature and strong after that day. So, they can accumulate zinc very well. On Day 35, kenaf in R7 shows a very high value of zinc accumulation which is 677.61 ppm. It shows that the plant already accumulate zinc in the soil from the beginning of the study resulting the high value of zinc accumulated into the stem of the plant.

4.6 Movement of Zinc in Roots

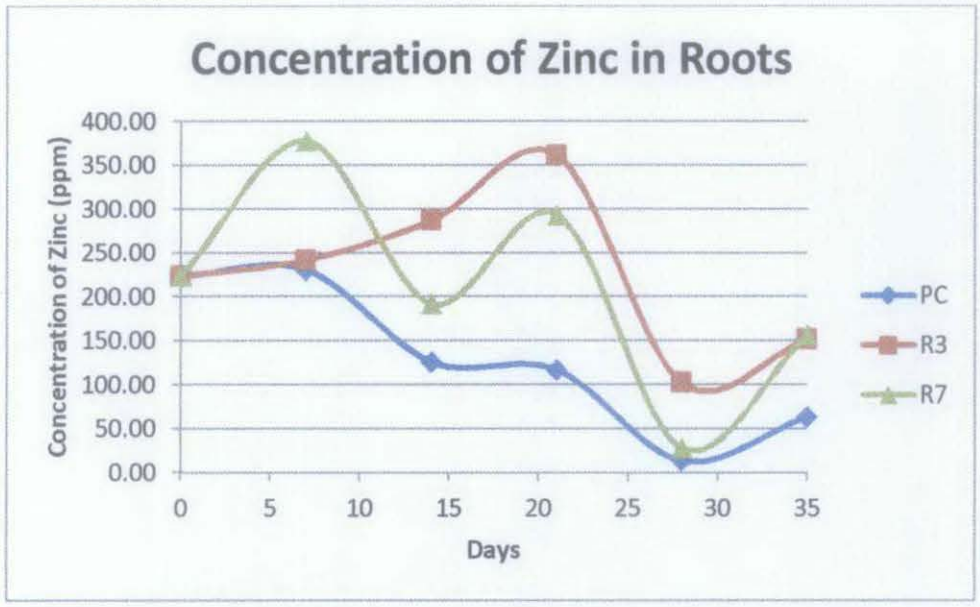


Figure 14: Concentration of Zinc in Roots

The graph above is showing the value of zinc in stems of kenaf for PC, R3 and R7. PC is represented by blue colour; R3 is red in colour while green represents R7. The characteristics of zinc in all the three setup are not stable. They are decreasing and increasing along the days of the experiment. On Day 28, the values of zinc are minimum compared to the previous days but they rise up again on Day 35. This shows that the roots will keep accumulate the zinc if the zinc is still there is the soil.

When compared between leaves, stems and roots, most of the zinc is accumulated in the roots of kenaf. Even some of the value in leaves and stems are very high but the value is not stay at that level. It will go down to the very low value. However, the concentration of zinc that is accumulated by the roots is staying high which is more than 200 ppm until Day 21. Because most of the zinc already accumulated, the values decrease after that time.

CHAPTER 5: CONCLUSION AND RECOMMENDATION

4.7 Conclusion

As the conclusion, the study shows that kenaf has high potential of being a hyperaccumulator plant for phytoremediation. Zinc in the R3 and R7 has been accumulated by kenaf from Day 1 until Day 35 of the study. Zinc also has been traced in the kenaf from Day 1 until day 35. So, this shows that there is movement of zinc from the soil to the plant which is called as accumulation.

From the results of the analysis by AAS, zinc has been found in all the parts of kenaf. At the beginning, leaves show high accumulation of zinc but the value decreases towards the end of the study. Stems show high accumulation of zinc at the end of the study. Roots show average accumulation of zinc from the start until the middle of the study. So, as the overall, roots can be said to be the part of kenaf that mostly accumulate zinc from the soil. From the observation, leaves and stems act as the heavy metal storage while roots as the transporter.

4.8 Recommendation

From the study, there are some recommendations that can be made to improve the result of the study. Firstly is the method to make the contaminated soil. It could be better if the crates if fully with contaminated water rather than to water is every week. Secondly, it could be better to take water sample so that we can know how much zinc is actually mixes with the soil. Thirdly, in order to avoid any disturbance from the insects, it is better to have full covered plant house so that no insects eat the plants.

REFERENCES

Agarwal, S.K. (2009). Heavy Metal Pollution. A P H Publishing Corporation.

Casey, C.E., and Hambidge, K.M. (1980). Epidemiological aspects of human zinc deficiency. Pages 1-27 *in* J. O. Nriagu, editor. Zinc in the environment. Part II: health effects. John Willey, New York.

Chayed, N.F. (2009). Determination of heavy metals uptake by *Acacia mangium* grown in ex-mining area in Kg. Gajah, Perak. *FYP Report* 1: 1-11.

Eisler, R. (1993). Zinc Hazards to Fish, Wildlife, and Invertebrates: A synoptic review. Biological report. U.S. Fish and Wildlife Service.

Mohamed Sulaiman, M.F. (2004). Study of Heavy Metal Content at Ex-Mining Land in Tronoh (Cr, Cu, Ni, Pb, Zn). FYP Report.1: 1-40.

Mun, H.W., Hoe A.L., Koo L.D. (2008). Assessment of Pb uptake, translocation and immobilization in kenaf (*Hibiscus cannabinus L.)* for phytoremediation of sand tailings. Journal of Environmental Sciences, 20: 1341-1347.

Ogden, L., Edwards, W. C., and Nail, N. A. (1988). Zinc intoxication in a dog from the ingestion of copper and clad zinc pennies. Veterinary and Human Toxicology 30:577-578.

Santos, Gláucia Cecília Gabrielli dos, Rodella, Arnaldo A., Abreu, Cleide A. D. and Coscione, Aline R. (2010). Vegetable Species For Phytoextraction Of Boron, Copper, Lead, Manganese And Zinc From Contaminated Soil. *Scientia Agricola,* **67**(6), pp. 713-719.

Shamshuddin, J., Mokhtar, N., & Paramanathan, S. (1986). Morphology, mineralogy and chemistry of ex-mining land in Ipoh, Perak. *Pertanika* 3: 88-91.

Vallee, B. L. (1959). Biochemistry, physiology and pathology of zinc. Physiological Reviews 39:443-490.