Characterization on Organic Fertilizer of *Eichhornia crassipes* (Mart.) Solms (Beda)

Moe Tin Khaing*

Abstract

Eichhornia crassipes (Mart.) Solms is a invasive weed known to out-complete native plants and one of the principle means of control currently is harvesting water hyacinth to make fertilizer. In this research work, experiments were conducted to study the effect of water hyacinth on the cultivated soil by applying determinations of NPK values. Some physicochemical parameters of water hyacinth were also detected to evaluate the nutrient contents which are released to the cultivated soil. Then characterizations on the ash of water hyacinth were laid out as quantitative and qualitative analysis such as EDXRF, XRD, SEM and FT-IR measurements. To carry out the necessary treatment, cultivated soil was combined with water hyacinth in the proportion of (1:1), (7:3) and (9:1) respectively. Specific durations for the determination of NPK values on combined soil took 45 and 90 days. After the determinations, it was found that combined applications of soil and water hyacinth could produce significantly higher potassium values than the soil or water hyacinth only. The amended soil can be widely used in the agriculture as potassium rich organic fertilizer. In addition, this research information can be attributed to the agricultural production about water hyacinth fertilizer.

Keywords: Nitrogen, phosphorus and potassium (NPK), Energy dispersive X-ray fluorescence (EDXRF), X-ray diffraction (XRD), Scanning electron microscopy (SEM) and Fourier-Transform Infrared (FT-IR)

*Lecturer, Dr., Department of Chemistry, Yadanarbon University

Introduction

Eichhornia crassies (Mart.) Solms, (water hyacinth) originated in the rich and diverse rain forests of the Amazon River Basin. On account of its great natural beauty, even in the 1 9 century it was taken around the world as a botanical specialty, and decorated ornamental ponds. From the beginning of the 20th century it began to find its way into fresh water rivers and lakes throughout the tropics and subtropics, where almost every country is affected. Water hyacinth, sometimes called water orchid, is an exotic plant.This member of the Pontederiaceae family rapidly regenerates via runners, cuttings, or seeds, and has become one of the most serious pest weeds in the southeastern states. The seeds may lie dormant in the substrate and survive even extreme drought periods.

Water hyacinth is considered to be a serious environmental problem for wetlands in the gulf states, since the plants may double in growth in less than 20 days and quickly take over waterways. Expansive mats of growth may cut out light to submergent aquatic life forms, hinder navigation and water flow, and reduce oxygen levels, as these aggressive plants dominate aquatic ecosystems. A single acre of water hyacinths produces as much as 500 tons of decaying plant material per year. The decomposing detritus introduces excessive nutrient loads and depletes available oxygen, thus inhibiting survival of native plants and animals. The fresh water areas of the tropics are now generating, in the form of water hyacinth, vast quantities of biomass which, very urgently, must be removed. Complete removal of water hyacinth from natural waters could substantially reduce concentrations of nutrients in the aquetic environment. Manual, mechanical, chemical and biological control methods have been used in an attempt to maintain streams, lakes and canels free of water hyacinth growth. It would be very irresponsible not to investigate very seriously whether this be a source of fuel, or of raw material for various products, that could save consumption of other resources.

When growth of the plants can be strictly controlled, water hyacinth may be useful in purifying water, by filtering out excessive toxins and limiting algae. Biological controls are being investigated, such as the introduction of certain weevils and moths, as natural enemies of the plants. Due to extensive and improper use of chemical fertilizers, soil is degrading to an alarming level, causing an imbalance in the ecosystem and environmental pollution as well. To avoid these adverse effects and also

for sustainable agriculture, one should rely on ecological oriented resource conserving technologies. On the other hand, organic matter contents of soil play a major role in natural ecosystems and extensive agriculture (Paul, 1984). In humid tropical region, high temperature and rainfall hasten the decomposition of organic matter. As a result organic matter need to be added in the soil frequently in tropical region. Huge amounts of water hyacinth are found in the lakes, ponds and rivers causing problems in navigation, fisheries as well as deep-water rice production but water hyacinth could be use as an effective source of soil organic matter. If the organic residues added to the soil without being well decomposed it will adversely affect plant growth by producing phyto-toxic compounds (Cocharam et al., 1977; Linch, 1976).

In recent years, researchers (2, 5, 7, 11) have conducted studies into the utilization of water hyacinth plant material as a source of nutrients for plant and animal growth. Knipling et al. (8) analyzed water hyacinths which contained 1.75% N, 0.63% P, 3.07% K, 3.06% Ca, and 0.63% Mg on a dry weight basis. This nutrient content indicates that dried water hyacinths would have utility as a soil amendment and nutrient source in crop production. This opens the possibility that the plant material from water hyacinth growth would have an economical value in animal and plant nutrition. In addition, water hyacinths were shown to be an effective agent in removing nutrients from eutrophic waters (9,10). Nutrient content of water hyacinths varies with location, season of the year, and water quality. The amounts of available plant nutrients and the rate of nutrient release are important factors to consider in the use of water hyacinths as a soil amendment. The objectives of this study were to characterize the chemical composition and nutrient availability of water hyacinths and to evaluate nutrient release after incorporation of harvested plants into the soil.

Botanical Description

Figure 1. Plant of Water Hyacinth

Figure 2. Flowers of Water Hyacinth

Family	-	Pontederiaceae
Genus	-	*Eichhornia*
Species	-	*Eichhornia crassipes*
Botanical name	-	*Eichhornia crassipes* (Mart.) Solms
English name	-	Water Hyacinth
Myanmar name	-	Beda
Part used	-	The wole plant

Fertilizer Uses

Water hyacinth can be used directly from harvesting or dried to be used to mix with the soil or as mulch. It breaks down quickly and can be mixed with ash, other soils and some animal manure to increase soil fertility and crop yield. Such compost production is economically suited to areas of few resources but high labor potential. It does not take much capital to produce large quantities to useable fertilizer in areas with poor soil.

Other Uses

The Chinese grass carp, tilapia, silver carp and the silver dollar fish all consume aquatic weeds, such as water hyacinth. The manatee or sea cow has also been suggested as another herbivore which could be used for weed control.

Aim and Objectives

Aim and objectives of this study are described below.

- to determine the N-P-K content of soil
- to examine the N-P-K content of water hyacinth
- to characterize some physicochemical properties of water hyacinth
- to investigate the quantitative and qualitative properties of the ash of water hyacinth by using EDXRF, XRD, SEM and FT-IR analysis and
- to evaluate the NPK values of soil amended with water hyacinth

Material and Methods

Water Hyacinth sample was collected from Mandalay Kandawgyi Lake. Then the collected sample was dried in the shade and cut into small pieces. The pH of water hyacinth sample was determined by pH meter. Moisture content of water hyacinth was determined by the oven method at 100°C. The ash of a sample is the inorganic residue remaining after the organic matter has been burnt away. The ash content of water hyacinth sample was determined by electric furnace. Quantitative characterizations were carried out on the resulting ash and energy dispersive X-ray fluorescence and X-ray diffraction spectral data of the ash were recorded by Perkin Elmel 700, EDXRF spectrometer and X-ray diffractometer. Examinations of scanning electron microscopic and Fourier-Transform Infrared spectroscopic spectral data were done by their respective microscope and spectrometer. Nitrogen content of water hyacinth was determined by Kjeldahl method and phosphorous determination was made by UV-Vis spectrophotometer (Model-1601). Atomic Absorption spectrophotometer was applied for the examination of potassium. NPK determinations were carried out on water hyacinth, cultivated soil and three types of amended soils.

Result and Discussion

Physicochemical Properties

pH Content of Water Hyacinth

pH content of water hyacinth was determined and the resulting data are described in the following Table (1).

Table (1) pH Content of Water Hyacinth

No	Parts of water hyacinth	Value of pH
1	The whole plant	7.6

Water hyacinth possesses pH content 7.6.

Moisture Content of Water Hyacinth

Moisture determination were conducted water hyacinth and the results obtained are in Table (2)

Table (2) Moisture Content of Water Hyacinth

No	Parts of water hyacinth	Moisture Contents
1	The whole plant	63.50%

Water hyacinth shows the moisture content 63.50%.

Ash Content of Water Hyacinth

The examination of ash content for water hyacinth was carried out and the result is given in Table (3).

Table (3) Ash Content of Water Hyacinth

No	Parts of water hyacinth	Ash Contents
1	The whole plant	14.73%

Characterization on Water Hyacinth

EDXRF Analysis

EDXRF result data of water hyacinth was shown in Table (4). In the EDXRF Spectrum, water hyacinth has the highest levels of K, Ca, Cl, and median for P, S, and Fe. And then lower mineral level are observed in the Mn, Sr, Ti, Zn, Cu, Rb, Ni and Br respectively.

Table (4) Quantitative Minearl Results of the Ash of Water Hyacinth

Analyte	Result
K	41.067%
Ca	26.092 %
Cl	19.064%
P	5.298%
S	3.384%
Fe	2.715%
Mn	0.744%
Sr	0.456 %
Ti	0.298%
Zn	0.292%
Cu	0.212%
Rb	0.166%
Ni	0.113%

XRD Analysis

XRD spectrum of water hyacinth was recorded after heating at 1000°C.

SEM Analysis

According to SEM microgram, the morphology of water hyacinth indicates as the matrix of fibers. SEM photogram showed that the particle is a net work of size 5 μm and amorphous material.

FT-IR Analysis

In FT-IR Spectrum, the frequency at 1508.2 cm' indicates the C=O stretching vibration band and C-H bending of sp^3 aliphatic hydrogen can be observed at 1465.8 and 1419.5 cm'. The band which appears at 1191.9 and 1095.5 cm^{-1} should be the stretching vibration of cellulose C-O back bone.

Table (5) Assignments of Characteristic Absorption Bands

Wave number (cm^{-1})	**Assignments of Functional group**
1508.2	C=O stretching vibration band
1465.8 1419.5	C-H bending of sp^3 aliphatic hydrongen
1191.9 1095.5	cellulose C-O back bone

NPK Values of Water Hyacinth

NPK Values of water hyacinth was examined at Myanmar Pharmaceutical Factory, Sagaing and the resulting data are observed in Table (6).

Table (6) NPK Values of Water Hyacinth

Sample	N(%)	P(%)	K(%)
Water hyacinth	1.29	0.06	2.67

According to the Table (6), potassium (K) is the highest content of water hyacinth.

NPK Values of Cultivated Soil

NPK contents of cultivated soil were measured and the result obtained are tabulated in Table (7).

Table (7) NPK Values of Cultivated Soil

Sample	N(%)	P(%)	K(%)
Cultivated Soil	0.44	0.44	0.31

In the cultivated soil, nitrogen (N) value is higher than postassium (K) and phosphorous (P).

NPK Values of Amended Soil

NPK determinations for three different types of amended soil samples, (9:1), (7:3),(1:1) were performed at Myanmar Pharmaceutical Factory, Sagaing and the resulting data can be observed in the Table (8). In this determinations, 45 and 90 days are taken as the specific duration of the combination of cultivated soil and water hyacinth.The results obtained are informed in Table (8)

Table (8) NPK Values for Amended Soil with the Specific Duration of 45days

Amended Soil (Cultivated soil+ Water hyacinth)	**N(%)**	**P(%)**	**K(%)**
9.1	0.24	0.03	0.45
7:3	0.50	0.04	0.64
1:1	0.79	0.06	1.0

Table (9) NPK values for Amended Soil with the Specific Duration of 90days

Amended Soil (Culitvated soil+ Water hyacinth)	**N(%)**	**P(%)**	**K(%)**
9.1	0.5	0.05	0.50
7:3	0.65	0.05	0.74
1:1	0.97	0.06	1.35

By comparism Table (8) and Table (9), it can be seen that the specific duration is longer, potassium (K) and nitrogen (N) content is higher. Among three of combined samples, (1:1) ratio gave the highest potassium (K) values.

Conclusion

According to literature survey, water hyacinth contain considerable amount of micro and macro nutrients, amino acids, vitamins and hormones which possibly increased mineral content leading to higher nutritional quality. In this study, pH, moisture, ash and mineral contents of water hyacinth were measured. Quantitative and qualitative analysis by EDXRF was taken to characterize the ash constituents of water hyacinth. This

characterization will support the fact that water hyacinth has higher level of K, Ca, Cl and lower level are observed in Mn, Sr, Ti, Zn, Cu, Rb and Ni. It is also the medium source of P, S and Fe. In addition, XRD, SEM and FT-IR analysis on the ash of water hyacinth were done as qualitative analysis. NPK contents of cultivated soil are 0.44%, 0.04%, and 0.31%. Water hyacinth gave the NPK values, 1.29%, 0.06% and 2.67% respectively. It has a high potassium content which is one of 17 nutrients that are essential for plant growth but a low phosphorus content. Application of (1 :1) ratio (cultivated soil and water hyacinth) informs the presence of higher potassium than (9:1) and (7:3) ratios.

In specific durations, there was higher potassium value in 90 days than 45 days. Time used for the combination of the soil and water hyacinth is longer, the more the potassium content is higher during this research. In conclusion, using of water hyacinth as fertilizer is more suitable for the plants which has greater preference of potassium than other. Furthermore, water hyacinth can also be used as mulch, as compost or as ash. Therefore, this research will provide the valuable information about water hyacinth fertilizer to the agricultural production.

Acknowledgement

I would like to acknowledge Rector Dr Aye Kyaw and Pro-rectors Dr Khin Ma Ma Tin and Dr Myintzu Min, Yadanabon University for their encouragement. Grateful thanks are extended to Dr Hlaing Hlaing Myat, Professor and Head of Chemistry Department for providing research facilities.

References

Alexander, M., 1977 Introduction to soil microbiology, 2nd ed., John Wiley and Sons, New Yark,

Archana, S. 1971. Eradication and utilization of water hyacinths. A review. Current Sci. 4:51-55.

Bayer, L.D and H.F Rhoades, 1932 Aggregate analysis as an aid in the study of soil structure relationship .J.Am. Soc. Agron., 24: 920-930.

Blue, W. G.,C.F.Eno, N ,Gammom,Jr ..and D. F Rothwell.1964.Timing liming applications to obtain beneficial effect in clovergrass pasture establishment on virgin flatwood soils. Soils and Crop Sci. of Fla. Proc. 24:162-166. 5. Boyd, C. E. 1968.

Evaluation of some common aquatic weeds as possible feed- stuffs. Hyacinth Contr. J. 7:26-27.

Jackson, M. L. 1960. Soil chemical analysis. Prentice-Hall Inc. Englewood Cliffs, N. J. P. 489.

Kamal, I. A. and E. C. S. Little. 1970. The potential utilization of water hyacinth for horticulture in the Sundan. PANS 16: 488-496.

Knipling, F. C. S., S. II. West, and W. T. Hailer. 1970. Growth characteristics, yield potential, and nutrient content of water hyacinths. Soil and Crop Sci. Soc. Of Fla. Proc. 30:51-63.

Miner, J. R. J. W. Wooten, and 3. D. Dodd. 1971. Water hyacinths to further treat anaerobic lagoon efflunent. In Live stock waste management and pollution abatemint. Intern. Symposium on Livestock Waste. Amer. Soc. Agr. Eng. Proc. 271: 170-173.

Rogers, H. H. and D. F. Davis. 1972. Nutrient removal by water hyacinth. Weed Sci. 20:423-428.

Taylor, K. 0. and R. C. Robbins. 1968. The amino acid composition of water hyacinths (Eichhornia crasszpes) and its value as a protin supplement. Hyacinth Cont. J. 7:24-25.