Nutrient Restoration Capacity of *Eichhornia crassipes* Compost on a Nutrient-depleted Soil

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Abstract: - *Eichhornia crassipes* is an invasive water plant that can cause severe problems to society and ecosystem in many parts of the world. This weed can withstand varied extreme environmental conditions in temperature, wind, humidity, illumination, acidity, alkalinity, and salinity. The probable means of combating its propagation and the various means of getting rid of this weed not proved much. This study investigated the potentials of *E. crassipes* in replenishing macronutrients specifically nitrogen, phosphorus and potassium (NPK) in a nutrient-depleted soil. Using an experimental study, water hyacinth was explored by comparing two conditions: (1) the sundried compost; and (2) the fresh compost in soil. The composting lasted for 31 days, enough for the water hyacinth to decompose. The data gathered were then analyzed using single-factor analysis of variance (ANOVA). Results revealed that NPK improved from low to medium and high levels. Among sundried and fresh water hyacinth composts, there were significant effects in the nitrogen and phosphorous level in sundried treatment. Others do not have significant differences in NPK content before and after the composting, however all nutrient level means increased.

Key-Words: - compost, *Eichhornia crassipes*, NPK, nutrient restoration, water hyacinth

1 Introduction

Threats and Opportunities from Water Hyacinth

Eichhornia crassipes or as well-known as water hyacinth is a fast growing aquatic plant which can endure varied ecological circumstances such as temperature, acidity, pH, salinity, etc.[1]. This elastic plant reproduce and disperse in a rapid manner even under unfavorable environmental situations that made it invade other species [2]. *Eichhornia crassipes* is a serious problem to the society and ecosystem in many parts of the world [3],[4]. It is a noxious aquatic weed that pollutes all fresh water bodies and diminish the abundance of diversity of endemic species, thus reducing the genetic variability of organisms in the ecosystem [5]. Other environmental hazards and economic risks include obstruction of rivers, irrigation, and other water ways that causes flooding, an increase in transportation cost, and reduced fish catches [5],[7]. These economic and ecological problems associated to water hyacinth are due its ease of reproduction and capacity to combat other aquatic organisms.

Despite of the problems caused by *Eichhornia crassipes*, scholars have identified some of its benefits. *E. crassipes* is recognized to produce attractive flowers and leaves being utilized in gardening [8]. It has been reported to be valuable in alternative medicine, sewage and water purification, fiber board and rope production, green manure, and mushroom bedding and compost material. Also, this plant is accounted for 64% of methane that may be extracted to produce biogas [8],[9],[10],[11].

The weed can absorb nitrogen, phosphorus and potassium (NPK) from water and can be recommended to be used as primary material for composting [1]. A compost containing water hyacinth with manure and leaves hold N, P and K in about 2.2, 1.5, and 0.8%, respectively [13]. Water hyacinth is potentially high in terms of nitrogen supplement as 3.2% in its dry mass can be deposited [4],[9]. These chemical characteristics of water hyacinth can generally provide macronutrients to soil when composted.

Required Nutrients for Plants

For a developing plant to grow properly, it must be able to absorb nutrients necessary for the process, namely; nitrogen, phosphorus, and potassium. Nitrogen is chemically combined with carbon, hydrogen, oxygen, and sulfur to construct biological building blocks of proteins which are amino acids. Proteins are essential in all life forms for it play a vital role in the survival of each organism. In plants reactions that involve enzymes require nitrogen. Phosphorous promotes the development roots, fruits, flowers, and seeds through assisting the entire plant in storing and

transferring energy, thus it improves the quality of the plant. Finally, potassium regulates the water content of the plant through directing the opening and closing of the stomata [14]. Most of the nutrients needed by plants could be given by water hyacinth compost. Composting is the economical and best technique for disposal of organic waste and converts it in to valuable product [15].

Significance of the study

Composted *Eichhornia crassipes* may be utilized as fertilizers in an industrialized scale, due to the species' high rate of reproduction. The ease of acquisition of the weed would also affect the price of the fertilizer, making it very affordable to be loaned to farmers.

Aside from the capacity of the weed to be utilized in an industrialized scale, it may also be utilized in an individual scale, mostly by common people living beside waterways or with ease of access towards invaded areas. Common homeowners who seek cheap fertilizers for their personal utilization in their gardens may use the results of this study.

Persons of authority may find this study useful in a greater scale. Should they use this to inform their local constituents regarding the ways of utilizing the common weed that is *Eichhornia crassipes*, expected results would not only be the reduction of the weed from common waterways, but also the ease of aquatic transportation in areas severely affected by the invasion. This would greatly contribute to the efficiency of logistics personnel frequently hampered by the presence of the common water hyacinth.

2 Problem Formulation

The objective of this study was to determine the soil nutrient restoration potentials of *Eichhornia crassipes* compost on a nutrient depleted soil.

This study also answered the following specific questions:

2.1. What are the characteristics of the sundried and fresh of *E. crassipes* compost in terms of the nitrogen, phosphorous, and potassium level?

2.2. Are there significant differences on the characteristics of sundried and fresh *E. crassipes* compost in terms of the nitrogen, phosphorous, and potassium level?

3 Problem Solution

Characteristics of the compost with sundried and fresh *Eichhornia crassipes*

Table 1. Summary of the Nitrogen Level of Sundried Water Hyacinth Treatments

Treatments	Nitrogen level (Mean)	Qualitative Description
A	1.00	Low
B	2.33	Medium
C	3.00	High
D	2.33	Medium

Table 2. Summary of the Nitrogen Level of Fresh Water Hyacinth Treatments

Treatments	Nitrogen level (Mean)	Qualitative Description
A	1.00	Low
B	1.67	Medium
C	1.67	Medium
D	2.33	Medium

The nitrogen level of the compost generally increased as shown in tables 1 and 2. The mean levels of nitrogen provided by the sundried water hyacinth are higher compared to those of the fresh variety and this is due to the findings that fresh water hyacinth contain 0.4% N, while the water hyacinth, on a zero moisture basis, contains 1.5% N [6].

Table 3. Summary of the Phosphorous Level of Sundried Hyacinth Treatments

Treatments	Phosphorous level (Mean)	Qualitative Description
A	1.00	Low
B	2.67	High
C	2.33	Medium
D	1.67	Medium

Table 4. Summary of the Phosphorous Level of Fresh Water Hyacinth Treatments

Treatments	Phosphorous level (Mean)	Qualitative Description
A	1.00	Low
B	2.00	Medium
C	2.33	Medium

D	2.00	Medium

Based on the data presented in Table 3 and 4, the sundried water hyacinth provided more phosphorus levels to the compost compared to the fresh variety. This can be seen from the high yield of sundried setup, while all setups of fresh water hyacinth only go so far as medium yield when phosphorus is concerned. Andika, et al. (2016) found out that fresh water hyacinth contains 0.06% P_2O_5, on the other hand sundried water hyacinth can contain 7.0% P_2O_5

Table 5. Summary of the Potassium Level of Sundried Hyacinth Treatments

Treatments	Potassium level (Mean)	Qualitative Description
A	1.00	Deficient
B	1.67	Sufficient
C	2.00	Sufficient
D	1.67	Sufficient

Table 6. Summary of the Potassium Level of Fresh Water Hyacinth Treatments

Treatments	Potassium level (Mean)	Qualitative Description
A	1.00	Deficient
B	1.67	Sufficient
C	1.67	Sufficient
D	2.00	Sufficient

Based on the data shown in Table 5 and 6, the potassium levels of both sundried and fresh water hyacinth after the composting process do not have differences in terms of the qualitative descriptions. Both yielded almost identical values, despite the other setup being sundried. The data gathered has been surprising, especially as fresh water hyacinth contains 0.20% K_2O, while sundried water hyacinth contains 28.7% K_2O. Thus, the researchers expected a higher potassium yield for the sundried setups.

Significant differences on the characteristics of the compost with sundried and fresh of *Eichhornia crassipes*

Table 7. ANOVA of Means of Nitrogen Level of Sundried Water Hyacinth Treatments

Source of Variation	F	P-value	F crit
Between Groups	12.67	0.0021	4.0662

Nitrogen is an essential element for plants to grow and develop properly. When this element is combined with other elements particularly C, H, O, and S, it could synthesize an amino acid which is a building block of proteins like enzymes. Enzymatic reactions in plants play a vital role to sustain photosynthesis [14].

Table 7 shows the computed data of the analysis of variance in the nitrogen level of the different quantity of sundried water hyacinth compost. Having 12.67 as the computed F-value being greater than 4.0662 F-critical value would mean that there is a significant difference in nitrogen level in the soil in the different amount of sundried water hyacinth.

Table 8. ANOVA of Means of Nitrogen Level of Fresh Water Hyacinth Treatments

Source of Variation	F	P-value	F crit
Between Groups	3.56	0.0672	4.0662

Based on the Table 8, there is no significant difference on the nitrogen content on the different treatments of fresh water hyacinth. The F value is a little reduced than the F critical value, proving that the nitrogen yield of fresh water hyacinth is insignificant.

Table 9. ANOVA of Means of Phosphorous Level of Sundried Water Hyacinth Treatments

Source of Variation	F	P-value	F crit
Between Groups	6.56	0.0151	4.06612

Table 9 shows the computed data of the analysis of variance in the phosphorous level of the different amount of sundried water hyacinth compost. Having 6.56 in the F-value and being greater than 4.066181 in the F-critical value would mean that there is a significant increase in phosphorous level in the soil in the different amount of sundried water hyacinth. The null hypothesis was rejected due to a greater F value than the F critical value.

Table 10. ANOVA of Means of Phosphorous Level of Fresh Water Hyacinth Treatments

Source of Variation	F	P-value	F crit
Between Groups	3	0.095	4.06618

The computed F value is lower than the F critical value which made the different quantity of fresh water hyacinth treatments insignificant.

Table 11. ANOVA of Means of Potassium Level of Sundried and fresh Water Hyacinth Treatments

Source of Variation	F	P-value	F crit
Between Groups	3.1667	0.08545	4.0662

Based on the computed data shown in table 11, there are no significant differences on the potassium content on both fresh and sundried water hyacinth treatments. The amount of water hyacinth is not enough to significantly escalate the potassium in soil.

4 Conclusion

After all the processes of investigation were accomplished, the following were concluded:

1. Generally, composting water hyacinth can increase the NPK content in soil.
2. Composting using sundried water hyacinth could restore a significant amount of nitrogen and phosphorous content in a nutrient-depleted soil.
3. This aquatic weed, above and beyond being a nuisance in nutrient-enrich bodies of water, is a low-cost alternative source of organic fertilizer in abundant supply. The weed is able to take up the nitrogen, phosphorous, and potassium from the water and can be used as a substrate in composting.

References:

[1] Labrador, J., Gordilli, J., Ruiz T., & Moreno M. (2015). Re-use of invasive plant (water hyacinth) as organic fertilizer through composting and vermicomposting (Extremadura, Spain). Geophysical Research Abstracts, 17

[2] Hossain M.E., Sikder H., Kabir M.H. and Sarma S.M. 2015. Nutritive value of water hyacinth (Eichhornia Crassipes). Online J. Anim. Feed Res., 5(2): 40-44. Scienceline/Journal homepages: http://www.science-line.com/index/; http://www.ojafr.ir

[3] Nath, S., & Singh, K. (2015). Analysis of different nutrient status of liquid bio-fertilizer of different combinations of buffalo dung with gram bran and water hyacinth through vermicomposting by Eisenia fetida. Environment, Development and Sustainability, 18(3), 645-656. doi:10.1007/s10668-015-9666-6

[4] Gunnarsson, C. C., & Petersen, C. M. (2007). Water hyacinths as a resource in agriculture and energy production: A literature review. Waste Management, 27(1), 117-129. doi:10.1016/j.wasman.2005.12.011

[5] Vidya, S., & Girish, L. (2014). Water hyacinth as a green manure for organic farming. IMPACT: International Journal of Research in Applied, Natural and Social Sciences, 2(6), 65-72.

[6] Andika, D. O., Ogada, J, A., & Hayombe, Po. (2016). Producing liquid organic fertilizer from water hyacinth; a case of lake Victoria, Kenya. International Journal of Science and Research. 5 (2), 1229-1238.

[7] Umsakul, K., Dissara, Y., & Srimuang, N. (2010). Chemical, Physical and Microbiological Changes during Composting of the Water Hyacinth. Pakistan Journal of Biological Sciences, 13(20), 985-992. doi:10.3923/pjbs.2010.985.992

[8] Téllez, T. R., López, E., Granado, G., Pérez, E., López, R., & Guzmán, J. (2008). The Water Hyacinth, Eichhornia crassipes: An invasive plant in the Guadiana River Basin (Spain). Aquatic Invasions, 3(1), 42-53. doi:10.3391/ai.2008.3.1.8

[9] Mashavira, M., Chitata, T., Mhindu, R. L., Muzemu, S., Kapenzi, A., & Manjeru, P. (2015). The Effect of Water Hyacinth (Eichhornia crassipes) Compost on Tomato (Lycopersicon esculentum) Growth Attributes, Yield Potential and Heavy Metal Levels. AJPS American Journal of Plant Sciences, 06(04), 545-553. doi:10.4236/ajps.2015.64059

[10] Jafari, N. (2010). Ecological and socio-economic utilization of water hyacinth (Eichhornia crassipes Mart Solms). Journal of Applied Sciences and Environmental Management, 14(2). doi:10.4314/jasem.v14i2.57834

[11] Alade, G., & Ojoawo, S. (2009). Purification of domestic sewage by water-hyacinth (Eichhornia crassipes). International Journal of Environmental Technology and Management, 10(3/4), 286. doi:10.1504/ijetm.2009.023735

[12] Gowariker, V., Krishnamurthy, V. N., & Gowariker, S. (2009). The Fertilizer Encyclopedia. John Wiley & Sons, Inc. New Jersey

[13] Polprasert, C., Kongsricharoern, N., & Kanjanaprapin, W. (1994). Production of Feed and Fertilizer From Water Hyacinth Plants in

the Tropics. Waste Management & Research, 12(1), 3-11. doi:10.1177/0734242x9401200102

[14] Uchida, R. (2000) Essential Nutrients for Plant Growth: Nutrient Functions and Deficiency Symptoms. In: Silva, J.A. and Uchida, R., Eds., Plant Nutrient Management in Hawaii's Soils, Approaches for Tropical and Subtropical Agriculture, College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa, Honolulu, 31-55.

[15] Makhania, M.,& Upadhyay, A. (2015). Study of Flower Waste Composting to Generate Organic Nutrients. International Journal of Innovative and Emerging Research in Engineering, 2(2), 145-149.

[16] Pace, M. G., Miller, B. E., Farrell-Poe, K. L. (1995). The Composting Process. All Archived Publications.