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MICROBIAL VALORIZATION OF WATER HYACINTH (*EICHHORNIA CRASSIPES*) INTO COMPOST AS A COST-EFFECTIVE BIOFERTILIZER

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ABSTRACT

Water Hyacinth (Eichhornia crassipes) is an invasive aquatic weed whose management presents a challenge in water bodies. This study sought to evaluate eco-friendly and cost-effective products from water hyacinth. The efficacy of water hyacinth compost (WHC) product was tested on 3 different plants namely Abelmoschus esculentus, Zea mays and Cucurbita pepo for 60days. Their seeds were planted in 2kg of Agricultural soil mixed with 100g and 200g WHC and controls (without WHC). The microbial counts and physicochemical parameters of the dry water hyacinth compost were assessed using standard methods. The growth of the three plant species was measured at 5 days interval. Results of the microbial count ranged from 2.50 ±1.50×10^3 to 1.58±0.43×10^8 CFU/g for Total Heterotrophic Bacteria (THB), Total Heterotrophic fungi (THF), Total Hydrocarbon Utilizing Bacteria (THUB) and Total Hydrocarbon Utilizing fungi (THUF). The nitrate, phosphate, potassium and trace metal concentrations in the water hyacinth compost (WHC) were 8.38, 0.4, 6.75 and 0.003mg/kg respectively. The nitrate, phosphate, potassium and heavy metal concentrations in the soil before planting were 10.56, 2.70, 1.30 and 0.01-0.03 mg/kg respectively. After planting, the microbial count of the treated soil ranged from 3.23 ±2.70x10^3 to 2.97 ±1.54×10^8 CFU/g, representing 56.07% increase; nitrate was 14.04, phosphate 5.30, potassium was 5.00 and heavy metals 0.01mg/kg. There was an overall increase in the growth of the plant. This study has demonstrated that Eichhornia crassipes compost is an appropriate organic amendment for soil conditioning and the potential to benefit the environment and economy from water hyacinth.

Keywords: Water Hyacinth, Agricultural soil, Growth, Compost,microbial count

INTRODUCTION

Eichhornia crassipes commonly called water hyacinth is a free-floating, perennial hydrophyte believed to have originated from South America, the plant has been reported to be invasive in most aquatic ecosystems in Africa and it belongs to the family Pontederiaceae (El-Chaghaby *et al*., 2022; Dwivedi and Dwivedi (2018). It is said to constitute nuisance to aquatic life and activities which go as far as depleting biodiversity, ecological and socio-economic gains (Ilo *et al*., 2020). The covering of the surface of aquatic ecosystem has been reported to negatively affect water transportation. It has also been reported to cause the blockage of canals worsening the outbreak of diseases and breeding of disease (El-Chaghaby *et al*., 2022). It is widely known to be 'world's worst weed' because of its successful reproductive rate as it can out-compete other hydrophytes in water and reduce the penetration of solar radiation ~~in~~ which in turn affects other living organisms in water and ultimately reduces the concentration of dissolved oxygen. Increased temperature levels and minerals such as nitrogen, phosphorus and potassium have been described to enhance the proliferation of water hyacinth. According to Auchterlonie *et al*. (2021) water hyacinth can grow beyond 60 meters per month while the seeds can remain viable and resist harsh environmental condition for 20 years.According to some researchers, in biorefineries, water hyacinth has been widely reported to provide a more biodegradable lignocellulosic material compared to alternatives present in economic crops (Wang *et al*., 2019). The proximate composition of water hyacinth, according toAdeyemi and Osubor (2016) revealed 56.38% and 33% crude protein and crudefat while Rufchaei *et al*. (2020) reported the presence of antioxidants which may confer nutraceutical benefits. The control of water hyacinth can be categorized into three (3) namely biological, chemical and mechanical. The biological control includes infection from biological agents such as bacteria and fungi which can lead to wilting and formation of rots.The chemical approach has been identified as being rapid and unsustainable as it could lead to loss of aquatic life. The mechanical approach has been reported as being more intrusive. Mechanical approaches may employ simple pulling of the plants. The high moisture of water hyacinth which could be as high as 96% (Abdel-Sabour, 2010) has posed a lot of challenges to the harvesting and processing of the biomass. Water hyacinth is a promising feedstock for several bioprocesses, this is because it is amenable to microbial action during the drying and storage processes. Composting is an inexpensive biochemical process that involves the conversion of organic matter into highly valuable humic substances. Microbial metabolism of organics changes most waste materials into biotechnological and agro-allied feedstock. It is believed that reduced microbial activity can lead to reduced forms of compost. Microbial composting can be used to achieve valorisation because it converts a less useful material into a much more useful one (Ali *et al*., 2017). During compositing there is a breakdown of lignocellulosic rich biomass to create components that can be used as biofertilizers. The nature and source of starter culture and inoculum size affect the rate of composting. Some of the bacteria identified in composting are *Sphingobium* sp. and *Pseudomonas* sp. (Rath *et al*., 2022). In another study, Nath & Singh (2016) employed vermicomposting of water hyacinth where they added organic waste like dungs that contained earthworms. After the duration of the vermicomposting,the vermin wash was adjudged satisfactory with adequate amount of organic nutrients needed to support growth of plants. In another study, Vidya & Girish (2014) identified that the incorporation of the WHC improved the growth of Wheat. The physical parameters like proportion germination, length of root, length of shoot, biomass content and root:shoot ratios showed a clear distinction between the WHC incorporated plants and the control. In this study we sought to evaluate the role of locally producedwater hyacinth compost as a biofertilizer for the cultivation of selected indigenous local crops.

MATERIALS AND METHODS

The Water hyacinth plant grows in the wild in the Niger Delta region of South-South Nigeria, where it has become a nightmare to water transporters, fishermen and aquaculture farmers. The weed grows in other regions of Nigeria such as the South -West, as well.

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Fig 2.1 A Mature Water Hyacinth (*Eichhornia crassipes*) with clearly distinguishable leaves, stems and roots.

Production of Water Hyacinth Compost (WHC)

Water hyacinth compost (WHC) was produced using *Eichhornia crassipes* plants harvested from the wild, and following a documented procedure (Abu *et al*., 2024). The compost is stored inside polythene bags at ambient conditions for further use.

Microbiological and Physicochemical Analysis

Microbiological analysis of the set-ups was done using standard methods. The microbiological parameters include total aerobic heterotrophic bacterial count, total aerobic heterotrophic fungal count, and identification of bacterial and fungal isolates using microscopy and biochemical tests (Cheesebrough, 2004).

The soil was analyzed physicochemically and proximally using conventional techniques. A digital pH meter was used to measure the pH of the soil. The Walkley Black Modified method was used to estimate the amount of organic carbon in the soil, and the Mehlich-3 extraction procedure was used to quantify the amounts of Ca, Mg, K, P, Na, Mn, Cu, Zn, and Fe (Mehlich et al., 1984). The Technicon AA II method was used to analyze the total nitrogen.

Treatment of Agricultural (Farmland) soil with Water Hyacinth Compost and testing of crop performance

The WHC (water hyacinth Compost) was applied at 100g and 200g to 2kg of Agricultural soil in triplicates for each of the loadings; Controls had no water hyacinth compost but only 2kg of arable soil.

The seeds of the crops were obtained from a local market in Choba, Rivers State, Nigeria. The procedure ensured that viable seeds were planted to perform the experiments. The viability test was based on different morphological criteria such as colour, size and being free from insect bites. The seeds were planted equidistantly at the seeding of 15 plants/labeled polythene bag of equal size and volume. The bags were first filled with 2kg of agricultural soil, after which one set of experimental bags was loaded with 100g WHC and another set with 200g of WHC; a third set of the triplet bags contained no WHC. The bags were perforated for aeration.

The seeds of Okra (*Abelmoschus esculentus),* Maize *(Zea mays)* and Fruited pumpkin (*Cucurbita pepo)* were grown for 2 months under atmospheric conditions with minimum and maximum temperature of 27 and 35^{0}C respectively. The following parameters were used to measure and evaluate the growth of the seedlings of the three plant species under different loadings of WHC: number of leaves, average leaf length and shoot length of whole plants (Sridhar et al, 2003). The data obtained was subjected to statistical analysis.

RESULTS

Microbiological Properties of the Experimental Setups

The microbial population of the Agricultural soil samples is shown in Table 3.1. The population of bacteria and fungi in the soil of $1.58 \pm 0.43 \times 10^8$ (CFU/g) for bacteria and $1.50 \pm 0.5 \times 10^8$(CFU/g) for fungi. The following genera of bacteria were identified in the soil according to Bergey's Manual of determinative Bacteriology (1994), namely *Acinetobacter* sp. *Pseudomonas* sp, *Bacillus* sp. and *Klebsiella* sp. while the fungal genera identified were *Aspergillus flavus* and *Fusarium* sp. The population of hydrocarbons utilizing bacteria (HUB) accounted for 0.1% of the total heterotrophic bacterial population. The population of hydrocarbon utilizing fungi accounted for 0.16% of the total heterotrophic fungi.

Table 3.1. Microbial load of Agricultural soil obtained from the University of Port Harcourt

Microbial count	**Concentrations (Mean±S.D)**(CFU/g)	
	Day 0	**Day 60**
THBC	$1.58 \pm 0.43 \times 10^8$	$2.97 \pm 1.54 \times 10^8$
TFC	$1.50 \pm 0.50 \times 10^8$	$1.58 \pm 0.43 \times 10^8$
HUBC	$2.75 \pm 3.50 \times 10^3$	$3.35 \pm 0.00 \times 10^3$
HUFC	$2.50 \pm 1.50 \times 10^3$	$3.23 \pm 2.70 \times 10^3$

Values are mean ± standard deviation (M±S.D) of triplicate determinations (n=3).

THBC- Total Heterotrophic Bacterial Count, TFC- Total Fungal Count, HUBC- Total Hydrocarbon Utilizing Bacterial Count; HUFC-Hydrocarbon Utilizing Fungal Count

Table 3.2. Physicochemical Properties of agricultural soil

Parameters	Day 0	Day 60
pH	7.45± 0.02	7.45± 0.02
Conductivity (µs/cm)	4.00±0.56 [a]	6.00± 0.56
Sulphate (SO_4) (mg/kg)	5.00±0.01 [a]	11.00±0.01 [a]
Nitrate (NO_3) (mg/kg)	8.38±1.00	12.04 ±1.00 [a]
Nitrate-Nitrogen (NO_3-N) (mg/kg)	6.20±0.02 [b]	7.20± 0.02
Calcium (Ca) (mg/kg)	0.20±0.00	0.27 ±0.00 [a]
Magnesium (mg/kg)	0.14±0.00	0.20 ±0.00
Sodium (Na) (mg/kg)	5.56± 1.00 [a]	7.56 ±1.00 [b]
Potassium (K) (mg/kg)	1.30±0.50	1.30± 0.50
Nickel (Ni) (mg/kg)	0.00± 0.00	0.00± 0.00
Mercury (Hg) (mg/kg)	0.00± 0.00	0.00±0.00
Lead (Pb) (mg/kg)	0.31± 0.02	0.67 ±0.02 [a]
Copper (Cu) (mg/kg)	0.05±0.00	0.05± 0.00
Iron (Fe) (mg/kg)	3.89± 0.09 [a]	3.89 ±0.09
Zinc (Zn) (mg/kg)	5.24± 0.24	6.24±0.24 [b]
CEC (mg/kg)	0.56±0.01	0.56±0.01
Total Organic Carbon (%)	21.60±1.10	25.60±1.00 [a]
Phosphate (P_2O_5) (mg/kg)	3.40±0.40	5.40 ±0.40
Phosphorous (P) (mg/kg)	2.20± 0.30 [b]	7.20± 0.30 [b]

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Phosphate (PO_4^{3-}) (mg/kg)	3.40± 0.20	3.40±0.20 [a]
Ash content (%)	5.00±0.50	5.00±0.50
Total Organic Matter	26.20±1.20[a]	29.20± 1.20 [a]

Values are mean ± standard deviation (M±S.D) of triplicate determinations (n=3).

Data represents duplicate Mean± Standard Error; Superscripts letter 'a and b' reflect homogenous subsets, Columns with similar superscripts are significant at $p<0.05$ and otherwise are not significant at $p>0.05$k

3.3 Growth performance of Okra plant cultivated in WHC

The performance of Okra plant in soil amended with 100g WHC is presented in Fig.3.1. There are two peaks in the response of the okra plant, in the soil amended with 100g WHC, one at day 15 and at the end. The peak at day 15 is almost the value the length measured at day 35. There is an early response of the okra plant in the WHC amended soil. The leaf length was observed to be 9cm in 60 days.

The performance of okra in soil amended with 200g WHC is presented in Fig.3.2. There are three peaks in the response of the okra plant, in the soil amended with 200g WHC, one at day 5 another one at day 20 and at the end. The peak at day 20 is almost the value as the length measured at 50 days. There is an early response of the okra plant (5 days) in the WHC amended soil. The leaf length is about 5.5cm in 60 days.

The shoot length measurements for okra in soil amended with 100g WHC showed a rapid and gradual increase (Fig. 3.3). There are no peaks in the response. There is a significant difference between the WHC amended and the Control soils, and almost double the shoot length on a five-day period in the WHC amended soil compared to the Control soil. The 100g WHC amendment to the soil presents a higher overall shoot length of okra than the 200g WHC amended soil.

There is a gradual increase in the response (Fig 3.4) of the okra to the 200g WHC amendment of the soil. There is a significant difference between the WHC amended and the Control soils. There is a significant difference between the WHC amended and the Control soils almost doubling on a five-day period from day 45.

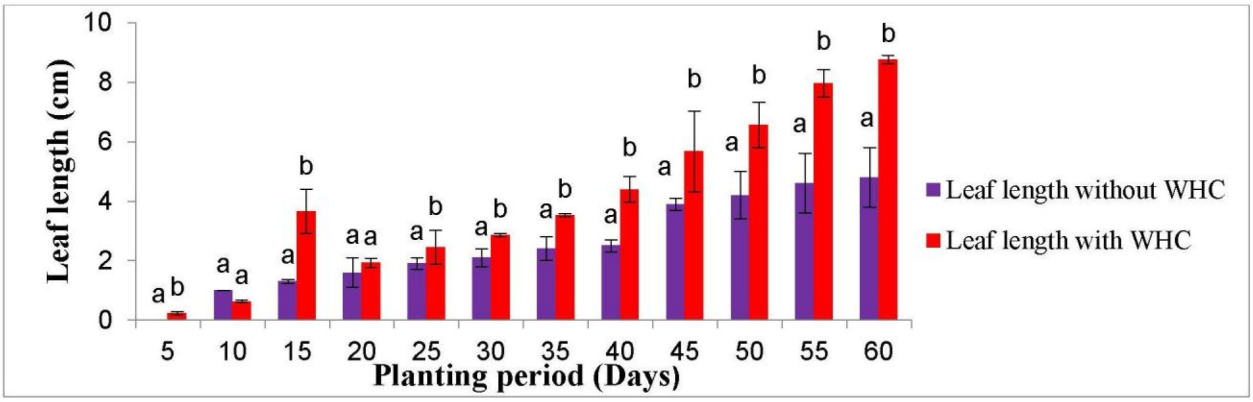

Figure 3.1: Leaf length of *Abelmoschus esculentus* (Okra) plant in 100g WHC and Control soil

Bars are mean±S.D of triplicate determinations. Bars bearing different superscript letters "a,b" show significant difference ($p<0.05$) when compared with one another.

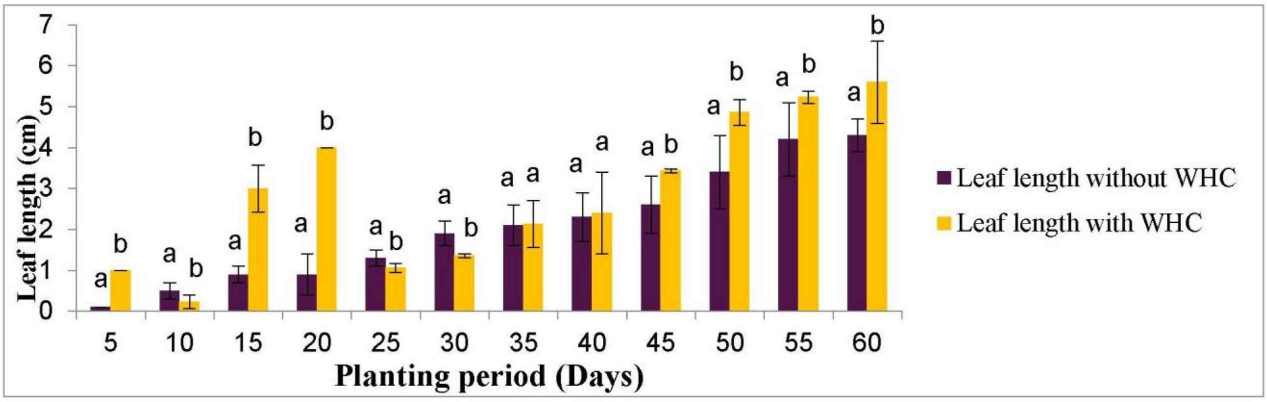

Fig.3.2: Leaf length of *Abelmoschus esculentus* plant in 200g WHC and Control soil

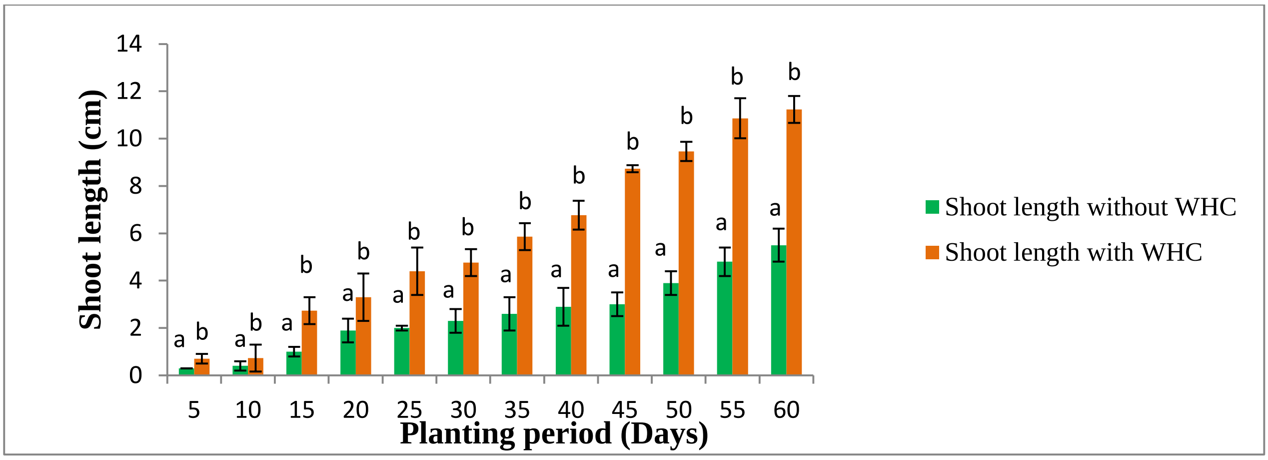

Fig. 3.3: Shoot length of *Abelmoschus esculentus* (Okra) plant in 100g WHC and Control soil

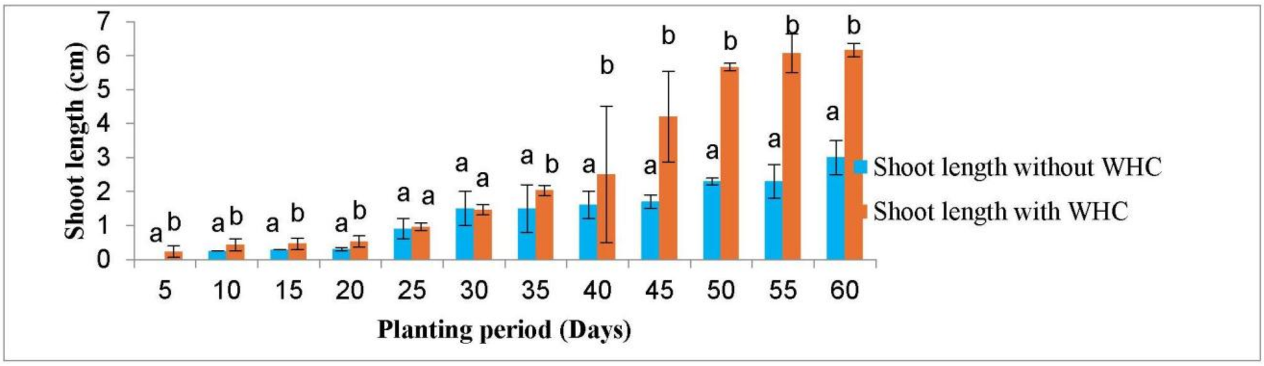

Fig. 3.4: Shoot length of *Abelmoschus esculentus* plant in 200g WHC and Control soil

Growth Performance of Maize cultivated with WHC

The leaf length measurements for Maize (Fig 3.5) show gradual increase and there is a significant difference between the 100g WHC amended and the Control soil. There is more than a doubling in the leaf length on a 5-day period from day 45 for the WHC amended soil compared to the Control soil.

The leaf length measurements for Maize (Fig 3.6) show gradual increase for both the 200g WHC amended and the Control soil. The Control soil showed a flattening from day 45, at which point the

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response of the WHC amended soil showed higher values; before day 45, the response from the Control soil was higher than in the amended soil.

The measurements for the shoot length for Maize (Fig 3.7) for both the 100g WHC amended, and Control soils showed a gradual increase, with the amended soil being more dramatic. Right from day 5, the 100g WHC amended soil showed values more than double the values in the Control soil.

The shoot length values for Maize in 200g WHC amended soil (Fig 3.8) showed two peaks, one on day 15 and the other one on day 50. The values for the control soil increased gradually up to day 60, without any peaks. For the WHC amended soil, the value for the shoot length at day 15 is greater than the values for days 20, 25, 30, 35 and 40.

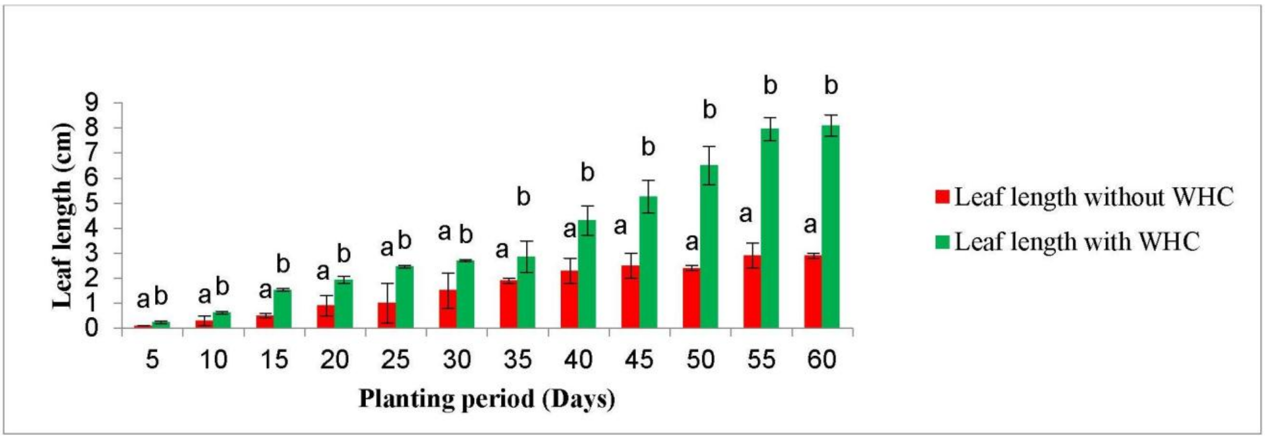

Figure 3.5: Leaf length of *Zea mays* (Maize) plant in 100g WHC and Control soil

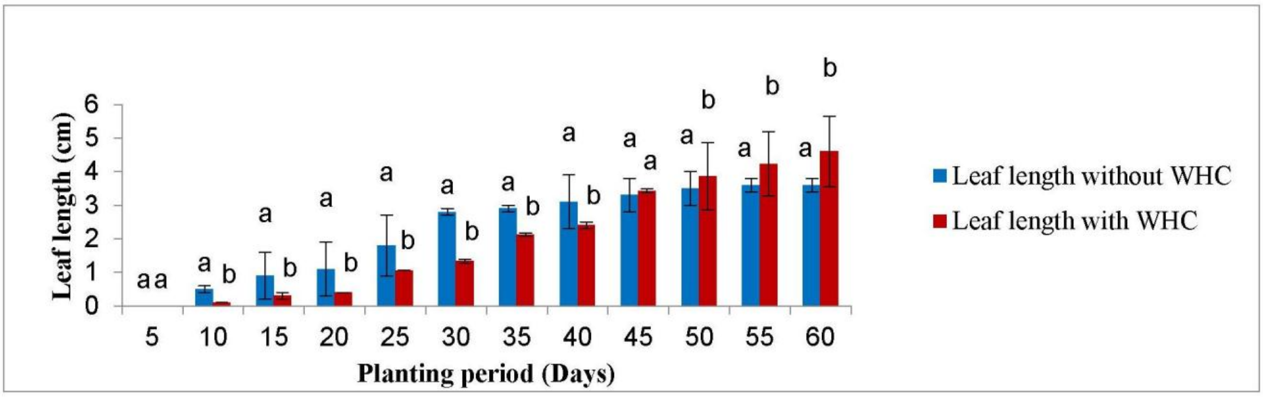

Figure 3.6: Leaf length of *Zea mays* (Maize) plant in 200g WHC and Control soil

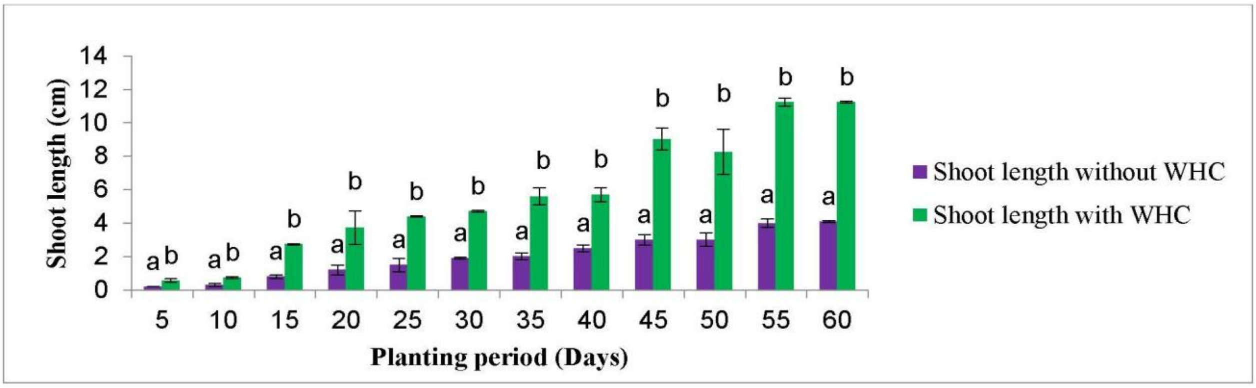

Figure 3.7: Shoot length of *Zea mays* plant in 100g and Control soil

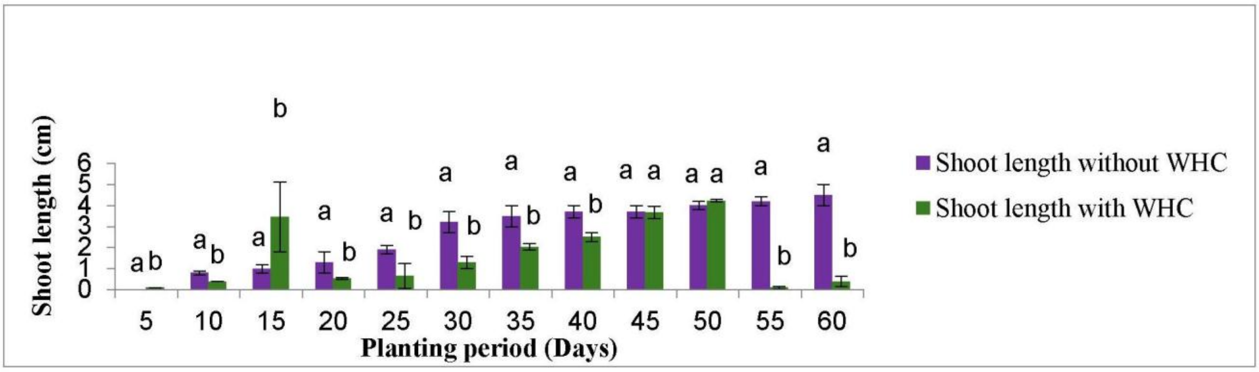

Figure 3.8: Shoot length of *Zea mays* plant in 200g WHC and Control soil

Growth Performance of Fruiting pumpkin

The leaf length measurements for the fruiting pumpkin showed a gradual increase for both the 100g WHC amended soil and the Control soil (Fig 3.9). By day 45, the measurements for the WHC amended soil were more than double the values for the Control soil. There were no peaks in the observed recordings.

The leaf length measurements for the fruiting pumpkin for the 200g WHC amended soil (Fig 3.10) showed three peaks on day 10, day 20 and day 55. The control soil showed a peak on day 5, went down on days 10, 15, 20, 25 and day 30; there was a gradual increase till day 60.

The shoot length measurements for fruiting pumpkin in the 100g WHC amended soil (Fig 3.11) showed gradual and rapid increase over the 60 days of measurements. There was a gradual increase in the values for the Control soil. From day 25, the values for the WHC amended soil more than doubled the values for the Control soil.

The measurements for the shoot length for the fruiting pumpkin in the 200g WHC amended, and the Control soil (Fig 12) showed a gradual increase. The final value for the WHC amended soil on day 60 is less compared to the value for the 100g WHC amended soil. From day 50, the values for the shoot length are almost double for the WHC amended soil compared to the Control.

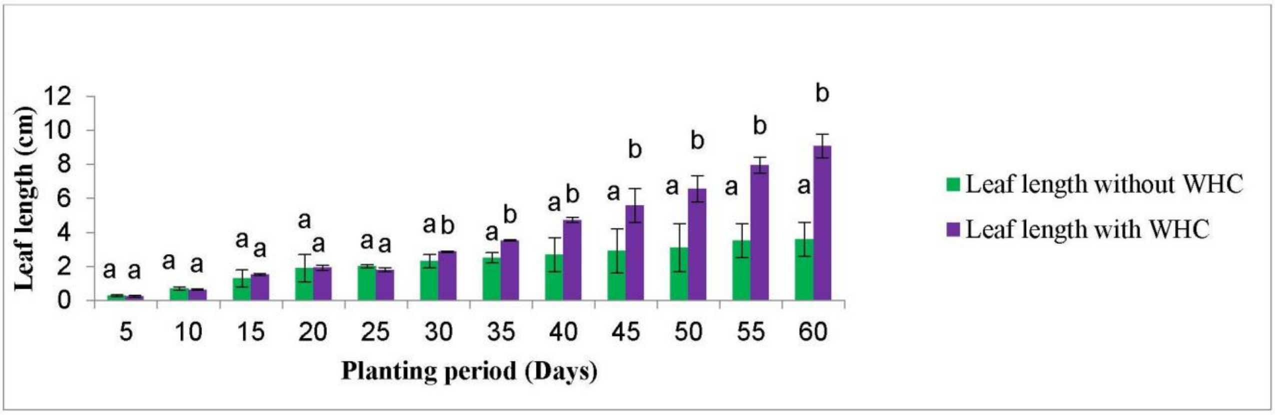

Figure 3.9: Leaf length of *Cucurbita pepo* plant in 100g WHC and Control soil

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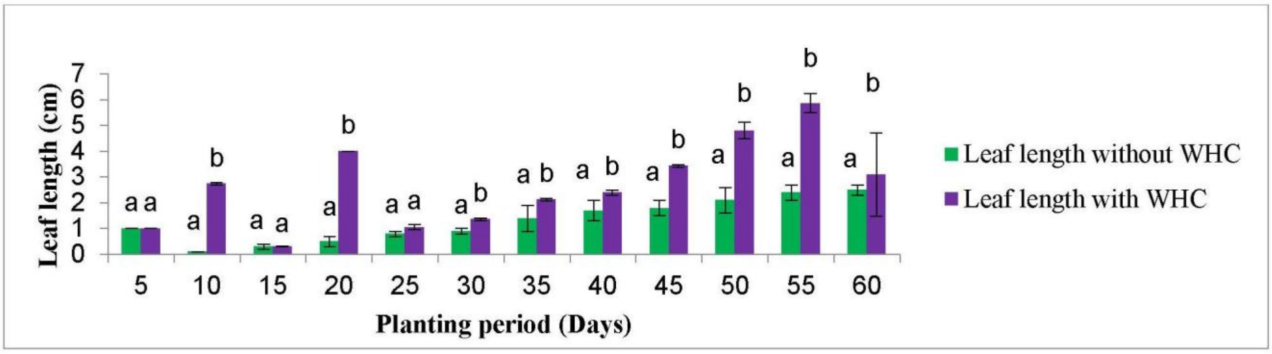

Figure 3.10: Leaf length of *Cucurbita pepo* plant in 200g WHC and Control soil

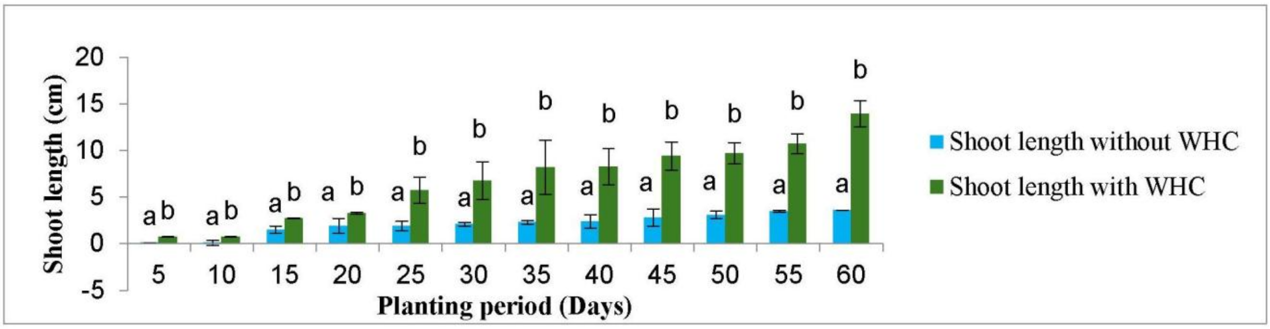

Figure 3.11: Shoot length of *Cucurbita pepo* plant in 100g WHC and Control soil

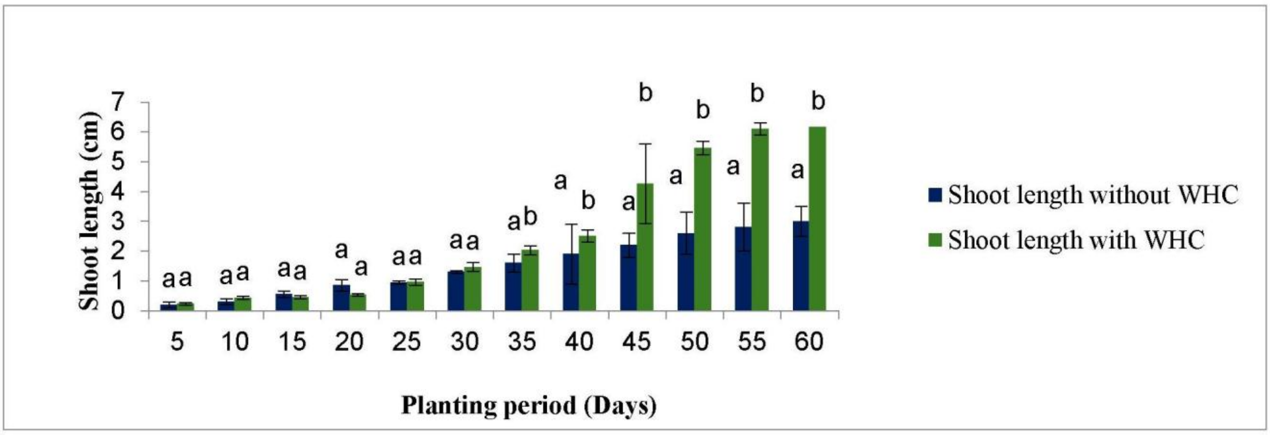

Figure 3.12: Shoot length of *Cucurbita pepo* plant in 200g WHC and Control soil

Leafing of *Abelmoschus esculentus*, *Zeamays* and *Cucurbito pepo* cultivated with WHC-amended soil

The number of leaves observed for the *Abelmoschus esculentus* cultivated in WHC- amended soil and control are presented in Table 3.3. During planting period between 30-60 days the number of leaves reported for 100g-WHC amended soil rose from 9 to 13 leaves while the control went from 5 to 6 leaves while for 200g – amended soil the leaves increased from 5 to 8 leaves.The number of leaves observed for*Zea mays* cultivated in 100g WHC-amended soil was increased from 8 to 9 leaves between 30 to 60 days while for 200g -WHC amended had increased from 4 to 5 leaves, the control was observed to increase from 2 to 3 leaves as can be seen in Table 3.4 below. The number of leaves observed for *Cucurbito pepo* cultivated with 100g-WHC was observed to increase from 8 to 18 leaves between 30 to 60 days while the set up planted with 200g of the WHC was observed to increase from 5 to 8 leaves as presented in Table 3.5

Table 3.3: Number of *Abelmoschus esculentus* (Okra) leaves in 100g WHC and 200g WHC and Control soils

	Control soil	100g WHC	Control soil	200Gwhc
Planting period (Days)	**Number of leaves without WHC**	**Number of leaves with WHC**	**Number of leaves without WHC**	**Number of leaves with WHC**
5	1	2	1	1
10	3	4	2	2
15	4	5	2	4
20	4	6	3	4
25	5	8	3	5
30	5	9	4	5
35	5	10	5	6
40	6	10	5	7
45	6	11	5	7
50	6	13	6	8
55	6,	13	6	8
60	6	13	6	8

Table 3.4: Number of *Zea mays* leaves in 100g WHC and 200g WHC and Control soils

	Control soil	100gWHC	Control soil	200gWHC
Planting period (Days)	**Number of leaves without WHC**	**Number of leaves with WHC**	**Number of leaves without WHC**	**Number of leaves with WHC**
5	1	1	0	0
10	1	3	1	2
15	2	5	1	2
20	2	6	2	3
25	3	8	2	4
30	3	8	2	4
35	3	8	3	4
40	4	8	3	5
45	4	9	3	5
50	4	9	3	5
55	5	9	3	5
60	5	9	3	5

Table 3.5:Number of *Cucurbito pepo* leaves with 100g WHC and 200g WHC and Control soils

	100g WHC	Control soil	200g WHC	Control soil
Planting period (Days)	**Number of leaves without WHC**	**Number of leaves with WHC**	**Number of leaves without WHC**	**Number of leaves with WHC**
5	2	2	1	1
10	4	4	2	2
15	5	5	4	4
20	6	6	4	5
25	6	8	5	6
30	7	8	5	8
35	7	9	6	9
40	8	10	7	9
45	9	11	7	10
50	9	13	8	11
55	10	15	8	11
60	11	18	8	12

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DISCUSSION

Over the years, efforts to restore soil fertility have primarily been accomplished through the use of artificial fertilizer and traditional resources such as composted agricultural wastes and farmyard manure. However, it has been acknowledged that weeds have a major impact on the yield of agricultural products and the sustainability of soil nutrient supplies (Oyetunji et al., 2003). There have been reports of the advantages of employing plant residues, such as water hyacinth residues (Widjajanto et al., 2022). According to a study on water hyacinth compost as biofertilizer, adding water hyacinth to the soil ecosystem improved the chosen plants' yield performance.The microbial population of the soil sample for the composting and cultivation of economic crops was observed to have a total heterotrophic bacterial count of 1.58 ±0.43 x10^8 CFU/g,after 60 days it was almost double at 2.97 ±1.54x10^8CFU/g. Total fungal count was 1.50± 0.50x10^8CFU/g, after 60 days it was 1.58 ±0.43x10^8 CFU/g. There was a rich microbial population of both bacteria and fungi. Chinakwe *et al*. (2019) reported a microbial population for their composting studies for the initial total heterotrophic bacterial count (THBC) of 2.4 x10^7CFU/g which increased to 2.5x10^8CFU/g after 14 days. They reasoned that the flora in agricultural soils is diverse and is affected by soil nutrition as shown for Proteobacteria, Bacteroidetes, Actinobacteria, and Firmicutes which are fast-growing copoiotrophs when nutrients are abundant andare also referred to as indicators during composting and soil improvement while Acidobacteria are slow-growing oligotrophic bacteria but adaptable to low nutrients (Agular-Paredes *et al*. 2023). The bacterial isolates associated with the composting activity were *Acinetobacter* sp, *Pseudomonas* sp., *Bacillus* sp. and *Klebsiella* sp. while fungal flora observed were *Aspergillus* sp. and *Fusarium* sp. In a related study, Rath *et al*. (2022) identified *Pseudomonas*, *Acinetobacter*, *Steroidobacter*, *Bacillus* and *Sphingobacterium*; this observation strongly agreed with the findings of the present study. Joseph *et al*. (2007) reported the presence of *Pseudomonas*, *Azospirillum*, *Azotobacter*, *Klebsiella*, *Enterobacter*, *Arthrobacter*, *Bacillus* and *Serratia* in amended soil for growth promoting features. Furthermore, Sarwari*et al*. (2024) also observed *Aspergillus*, *Penicillium*, and *Trichoderma* to be responsible for soil improvement and composting. Wang *et al*.(2022)identified that during warm phase composting:*Cellvibrio*, *Pedobacter*, *Devosia*, *Planococcus*, and *Microbacterium* were the dominant genera while during the hot-phase composting, *Pedobacter*, *Pseudomonas*, and *Cellvibrio*were weredominant, mainly of the Bacteroidetes and Proteobacteria phyla. This supports the earlier position of Ros *et al*. (2006) that the amendment of soil can have a long-lasting impact on the quality of microbial populationpresent in the soil.

The physicochemical composition showed that the soil had a pH of 7.45 during the 60-day duration and was observed to remain slightly alkaline. This corroborates the findings of Chang *et al*. (2021) who reported a slight change in pH from 7.56 to 7.8 which was considered insignificant. Decrease in the pH has been identified to have a change in the microbial population dynamics and could create a harsh condition for the microbes (Ma *et al*., 2018). The fluxes in pH during composting can lead to decomposition of organic acids and volatilization of ammonia (Rashad *et al*., 2010).The conductivity of soil was observed to be 4.0 µs/cm before and rose to 6.0µs/cm. The concentration value observed in the present study was within the range for growth of crops as reported by other researchers (Liu *et al*. 2011). The soil did not have ammonia and ammonia nitrogen but the concentration of nitrate 8.38 mg/kg at day 0 and 12.04 mg/kg after 60 days agrees with the work of Chang *et al*. (2021) whose report observed a rise from 1.14 mg/kg to 4.90 mg/kg. The potassium concentration of the soil was 1.30 mg/kg for initial and final periods of the study. Potassium is an essential mineral as it regulates growth of plants through enzymatic, metabolic and synthetic processes (Mashavira *et al*., 2015). The cation-exchange concentration (CEC) was 22 mg/kg at the initial day and 25 mg/kg after 60 days. The (CEC) is index shows the presence of trace minerals that could enhance the growth and metabolic activities and uptake of nutrients in plants. The phosphorus concentration of 2.2 mg/kg at day0 and 7.20 mg/kg at day 60 and the concentration of potassium of 1.3mg/kg for initial and day 60 agree with earlier report of Hartz *et al*. (2005) who reported that potassium improves crop yield and fruiting.

It was discovered that water hyacinth compost, in varying amounts of 100g and 200g, was more beneficial to the test plants' development and yield than the control. Majid (1980) found that utilizing water hyacinth compost increased yields in rice, corn, sesame, brinjal, onion, and gourd. They also found that crops treated with compost and water hyacinth manure, when combined with other aquatic weeds, produced more. Our findings are consistent with earlier research (Harris et al., 1994; Widjajanto et al., 2021) that found that adding water hyacinth to soil-crop systems improved Brassica rapa performance. Composted water hyacinth material could be used as high-quality manure to improve soil fertility and, consequently, crop yields overall, according to Gunnarssen & Petersen (2006). Water hyacinth has been shown to have improved tomato and rice productivity (Kayum et al., 2008; Amitava et al., 2008). Chukwuka and Omotayo (2008) demonstrated the water hyacinth compost's capacity to improve soil fertility and its increased impact on Zea mays crop productivity. According to our study's findings, adding the microbial water hyacinth compost most likely increased the amount of nitrogen that was released from the compost during the mineralization process. This is the microbial valorization technique/technology. According to the classical ecological Liebig's law of the minimum, the microbes can use the biomass of water hyacinth to create an agricultural fertilizer that is appropriate for plant growth. This supports the findings of Contantinides & Fownes (1994), who proposed that the amount and quality of organic materials added to soil may affect the rate of mineralization and decomposition (Widjajanto et al. 2022).

CONCLUSION

According to this study, *Eichhornia crassipes* compost is a good organic soil amendment. *Eichornia crassipes*that had been turned into a rich soil amendment product (Abu et al., 2024)through the microbial breakdown of the tissues of the "beautiful blue devil" (water hyacinth), improved crop plant development and soil productivity. This is one of the approaches in the valorization of this invincible hydrophyte.The application of microbial WHC is a viable and affordable bioentrepreneurial technology with significant promise for farmers because of its beneficial impact on crop plant growth. The biotechnology of microbial biocomposting of water hyacinth involves the activity of microorganisms, such as fungi and bacteria. By applying *Eichhornia crassipes* compost in granular form, this study has demonstrated that it is a suitable organic amendment for soil and that water hyacinth offers both economic and environmental benefits, thereby reducing negative effects and eco-toxicity from ongoing use of inorganic fertilizers.

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Data availability statement,

Data will be made available on request.

Declaration of interest's statement

The authors declare no conflict of interest.

REFERENCES

Abdel-Sabour, M. F. (2010)."Water hyacinth: available and renewable resource." *Electronic Journal of*

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© Faculty of Science, University of Port Harcourt, Printed in Nigeria *ISSN 1118 – 1931*

Environmental, Agricultural & Food Chemistry 9(11):1746-1759.

Abu, G.O., Vincent-Akpu, I.F., Akwukwaegbu, R.N., Stanley. H.O., & Udume, O.A.(2024). Laboratory Production and Testing of Biocompost from Water Hyacinth (*Eichhornia crassipes*) for Bioremediation of Crude Oil-Impacted Agricultural Soil. *International Journal of Research and Technopreneurial Innovations* 1(1): 85-91

Adeyemi, O., &Osubor, C. C. (2016). Assessment of nutritional quality of water hyacinth leaf protein concentrate. *The Egyptian Journal of Aquatic Research*, *42*(3), 269-272.

Aguilar-Paredes, A., Valdés, G., Araneda, N., Valdebenito, E., Hansen, F., & Nuti, M. (2023). Microbial community in the composting process and its positive impact on the soil biota in sustainable agriculture. *Agronomy*, *13*(2), 542.

Ali, S., Rizwan, M., Qayyum, M. F., Ok, Y. S., Ibrahim, M., & Riaz, M., (2024). Biochar soil amendment on alleviation of drought and salt stress in plants: a critical review. *Environmental. Science. Pollution. Resource* . 24, 12700–12712. doi: 10.1007/s11356-017-8904-x

Amitavar R, N. C. Sarkar & Debashish, S (2008), Influence of organic manures on productivity of two varieties of rice, *Journal of Central European Agricultural*., 9(4), 629-634.

Auchterlonie, J., Eden, C. L., & Sheridan, C. (2021). The phytoremediation potential of water hyacinth: A case study from Hartbeespoort Dam, South Africa. *South African Journal of Chemical Engineering*, *37*, 31-36.

Chang CH, & Yang SS (2021). Thermotolerant phosphate solubilising microbes for multifunctional bio-fertilizer preparation. *Bioresearch Technology*, 100: 1648–1658.

Cheesbrough, M. (2004). Laboratory practice in tropical countries part 2. Cambridge university press. Pg 299-312

Chinakwe, E. C., Ibekwe, V. I., Ofoh, M. C., Nwogwugwu, N. U., Adeleye, S. A., Chinakwe, P. O., ... & Ihejirika, C. E. (2019). Effect of temperature changes on the bacterial and fungal succession patterns during composting of some organic wastes in greenhouse. *Journal of Advances in Microbiology*, *15*(1), 1-10.

Chukwuka K. S, & O. E. Omotayo, (2009), Soil fertility restoration potentials of Tithonia green manure and water hyacinth compost on a nutrient depleted soil in Southwestern Nigeria using *Zea mays* L. as test crop, *Resource Journal of Soil Biology*., 1(1), 20-30.

Chukwuka K.S. & O. E. Omotayo. (2008) Effects of Tithonia Green Manure and Water Hyacinth Compost Application on Nutrient Depleted Soil in South-Western Nigeria, *International Journal of Soil Sciences*, 3(2), 69-74.

Contantinides & J. H. Fownes, (1994). Nitrogen mineralization from leaves and litter of tropical plants: Relationship to nitrogen, lignin and soluble polyphenol concentrations, *Soil. Biology and Biochemistry*, 26, 49-55.

Dwivedi, M., & Dwivedi, A. K. (2018). Valuable product from water hyacinth–review paper. *Int. Resource Journal Engineering Technology*, *5*, 838-843.

El-Chaghaby, A. (2022). A review on potential uses of invasive aquatic weed; water hyacinth. *Egyptian Journal of Aquatic Biology and Fisheries*, *26*(1), 457-467.

Gunnarsson, C, C and C. M. Petersen, (2006). Water hyacinth as a resource in agriculture and energy production: A literature review, *Waste Manage.*, 27, 117-129.

Harris G. H., Hesterman,O. B., Paul E. A. & Janke R. R (1994) Fate of legume and fertilizer nitrogen-15 in a long-term cropping system experiment, *Agronomy*. 86, 910-915.

Hartz, T. K., Johnstone, P. R., Francis, D. M., & Miyao, E. M. (2005). Processing tomato yield and fruit quality improved with potassium fertigation. *HortScience*, *40*(6), 1862-1867.

Ilo, O. P., Simatele, M. D., Nkomo, S. P. L., Mkhize, N. M., & Prabhu, N. G. (2022)The benefits of water hyacinth (Eichhornia crassipes) for Southern Africa: A review. *Sustainability*, *12*(21), 9222.

Joseph, K., Esakku, S., & Nagendran, R. (2007). Mining of compost from dumpsites and bioreactor landfills. *International Journal of Environmental Technology and Management*, *7*(3-4), 317-325.

Kayum, M, A, J M. Asaduzzaman & M. Z. (2008), Haque Effects of Indigenous Mulches on Growth and Yield of Tomato, *Journal of Agricultural and Rural Development*., 6(1-2), 1-6.

Liu, D., Zhang, R., Wu, H., Xu, D., Tang, Z., Yu, G., ... & Shen, Q. (2011). Changes in biochemical and microbiological parameters during the period of rapid composting of dairy manure with rice chaff. *Bioresource technology*, *102*(19), 9040-9049.

Ma J C, Ibekwe A M, & Yang C H. (2018). Bacterial diversity and composition in major fresh produce growing soils affected by physio-chemical properties and geographic locations. Science of the Total Environment, 563, 199–209

Majid, F Z, N. Lutfun, B. Sajeda, K. Rahima & N. Akhatar, (1980), Use ofnaturally occurring algae as biofertilizer or organic manure, Proc. 26th National Workshop on Algal systems, Madras, India, 1980, 11-14

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. *American Journal of Plant Sciences*, *6*(4), 545-553.

Oyetunji, O, I I. J. Ekanakaye & Osonubi O, (2003) Influence of arbuscular mycorrhizae fungus, mulch and fertilizer application on yield of-yams in an agroforestry system in Southwestern Nigeria, Maurik. Bull, 6, 75-82.

Rashad, F. M., Saleh, W. D., & Moselhy, M. A. (2010). Bioconversion of rice straw and certain agro-industrial wastes to amendments for organic farming systems: 1. Composting, quality, stability and maturity indices. *Bioresource Technology*, *101*(15), 5952-5960.

Rath PP, Das K, & Pattanai k S. (2022) Microbial Activity during Composting and Plant Growth Impact: A Review. *Journal of Pure Applied Microbiology*;16(1):63-73.

Ros, M., Klammer, S., Knapp, B., Aichberger, K., & Insam, H. (2006). Long-term effects of compost amendment of soil on functional and structural diversity and microbial activity. *Soil use and management*, *22*(2), 209-218.Chang et al. (2021)

Rufchaei, R., Mirvaghefi, A., Hoseinifar, S. H., Valipour, A., & Nedaei, S. (2020). Effects of dietary administration of water hyacinth (*Eichhornia crassipes*) leaves extracts on innate immune parameters, antioxidant defence and disease resistance in rainbow trout (*Oncorhynchus mykiss*). *Aquaculture*, *515*, 734533.

Sarwari, A., Abdieva, G. Z., Hassand, M. H., Mohammad, U. K., & Niazi, P. (2024). Role of Microbial Communities in Compost and Plant Growth: Structure and Function. *European Journal of Theoretical and Applied Sciences*, *2*(2), 23-37.

Sonke D, (1997) Tithonia weed a potential green manure crop, Echo. Development. Notes. 57, 1997, 5-6.

US.EPA, (1988), Design manual-constructed wetlands and aquatic systems for municipal wastewater treatment. U.S.Environmental Protection Agency. Report No. EPA/625/1-88/022. Office of Research and Development, Cincinnati, OH.

Vidya, S., & Girish, L. (2014). Water hyacinth as a green manure for organic

Scientia Africana, Vol. 23 (No. 5), December, 2024. Pp 255-270
© Faculty of Science, University of Port Harcourt, Printed in Nigeria *ISSN 1118 – 1931*

farming. *International Journal of Research in Applied, Natural and Social Sciences*, *2*(6), 65-72.

Wang, W. Y.; Soh, E. J. Y.; Yong, G. W. J.; Wong, M. K. L.; Guénard, B.; Economo, E. P.; Yamane, S. (2022). Remarkable diversity in a little red dot: a comprehensive checklist of known ant species in Singapore (Hymenoptera: Formicidae) with notes on ecology and taxonomy.*Asian Myrmecology* 15: e015006:1-152.

Widjajanto, W, D. K. Matsushila, T. Honmura and N. Miyanch, (2021), Studies on the release of N from water hyacinth incorporated into soil-crop systems using 15N-labeling techniques, *Pakistan Journal of Biology and Science*., , 1075-1077.

Wijayanto, F., Khairuddin, M. S., Alfitra, N. Z., Tsaqif, N., & Hanafi, F. I. (2022). The Ecofriendly Polybag: Natural Polybag, as an Alternative for Plastic Polybag Problem. *Journal Integrasi Sains dan Qur'an (JISQu)*, *1*(2).