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Effects of Composted Water Hyacinth (*Eichhornia crassipes* (Mart.) Solm.) on Soil Physical and Chemical Properties and Performance of Maize (*Zea mays* L.)

OPASINA IFEOLUWA O[1], AWODOYIN RASHEED O[2], BABAJIDE PETER A[3]

[1, 2] *Department of Crop Protection and Environmental Biology, University of Ibadan, Nigeria*

[3] *Department of Crop Production and Soil Science, Ladoke Akintola University of Technology, Nigeria*

Abstract- Water Hyacinth (WH), is an invasive, problematic aquatic weed, which is always very difficult to control because of its high regenerative nature. Utilisation of WH for compost production could reduce its abundance and menace on water bodies. Composted WH could enhance soil nutrients and improve crop yield, especially in maize, an important staple in Nigeria. However, information on its use in maize production is minimal. Therefore, the use of WH as compost and its effects on performance of maize and soil physical and chemical properties were investigated. WH was harvested, air-dried and mixed with poultry droppings, cattle dung, swine faeces in ratio 3:1 by weight, to produce Water Hyacinth based Poultry-compost (WHP), Water Hyacinth based Cattle-compost (WHC) and Water Hyacinth based Swine-compost (WHS) using agitated pile method. On the field, seeds of BR-9943-DMR-SR-W maize were sown, each compost or NPK15:15:15 fertilizer was applied at 120 and 150 kg N/ha to maize using Randomized Complete Block Design (r=3). Unamended soil (which received no fertilizer or manure application) served as control. Plant Height (PH-cm) and Plant Biomass (PB-g/ha), Grain Yield (GY-t/ha) were determined. Pre- and post-trial analyses of Total Nitrogen (TN-g/kg) and Organic Matter (OM-g/kg) were carried out using standard procedures. Data were analysed using ANOVA at $\alpha_{0.05}$. On the field, PH of 245.63±7.14 (WHP_{150}) was significantly higher than 221.30±1.92(NPK_{150}), 219.11±6.91(WHS_{120}) and 200.10±8.05 (unamended). The PB of 387.03±129.14(WHP_{150}) was significantly higher than 260.36±87.26(NPK_{150}) and 211.86±71.99 (unamended). The GY of 2.95±0.26 (WHP_{120}) was significantly higher than 1.99±0.14 (NPK_{150}),2.10±0.32 (WHC_{150}),2.24±0.37 (WHS_{150}) and 1.57±0.31 (unamended). Pre-trial TN and OM were 0.50 and 10.20, while post-trial values were, 2.00 and 30.06 (WHP_{120}) and 0.30 and 9.46 (unamended), respectively. Water hyacinth combined with animal manure produced substantial amount of compost. Water hyacinth- poultry dropping compost enhanced maize growth and grain yield.

Indexed Terms: Water hyacinth, Animal manure, Compost, Maize, Grain-Yield

I. INTRODUCTION

The proliferation of invasive aquatic weeds like water hyacinth is a menace to the survival of indigenous aquatic plant species; causing an imbalance and loss of species biodiversity in the aquatic ecosystem (Aloo *et al*., 2013). Water hyacinth belongs to the Pontederiaceae family and sub-family Lilolinaeceae (Sharda and Lakshmi, 2014). It is a free floating aquatic weed, although in water deficit conditions, its root attached to the hydro soil and exhibit like emerged plants. It belongs to the monocot class of angiosperm and can be easily distinguished form other aquatic plants. As a result of its detrimental impacts on waterways, people's livelihood and the environment, it is regarded as the most noxious aquatic and invasive weed in the world (Ghabbour *et al*., 2004; Wilson *et al*., 2005). Water hyacinth had defied many control techniques geared at mitigating against its spread (PIA, 2010; Paul and Wood, 2012). Nevertheless, many control measures are proposed in order to properly manage water hyacinth infestation. However, utilisation of water hyacinth plants for handcraft products including baskets, flower pots, handbags, ropes, pulp material for producing grease proof paper, biogas production, human food, fibre, animal/fish feed, green manure and compost production (composting) are alternative management techniques for its control.

Composting is a decomposition process used for the stabilisation of organic matter in organic materials from plant and animal origins; and converting them into valuable and useful soil amendment through the activities of micro and macro-organisms (Sullivan *et al.,* 2018). However, plant materials like water hyacinth biomass can therefore be biodegraded and its inherent nutrients stabilised by composting (Gunnarsson and Petersen, 2007). Composting of water hyacinth biomass could be a promising method

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of curtailing its proliferation and spread on water bodies and its consequent adverse effects on the aquatic ecosystem. Properly composting water hyacinth biomass result in good and quality soil amendment known as compost. Compost is described as an organic fertiliser made from plant materials, animal dung, urine and left-overs of natural biodegradable materials decomposed by the activities of micro-organisms (Haug, 1993).Water hyacinth is rich in nutrients like potassium, nitrogen and magnesium, utilising it as compost which is environment-friendly offers an alternative means of supplying nutrient to the soil and will reduce absolute dependence on inorganic fertiliser. The purpose of making compost is to recycle the nutrients in plant and animal leftovers back into the soil so as to create humus, which contains high organic matter, thus invariably improves the physical and chemical properties of soil (Francis *et al*., 2006). Compost made from water hyacinth with various animal dungs can therefore be used to increase the production and cultivation of staple crops like maize on soil with low nutrients.

Maize (*Zea mays* L.), a cereal crop, is a member of the Poaceae family. It is indigenous to Mexico (Hugar and Palled, 2008). Maize is a very important staple crop and the most cultivated cereal in the world, in 2019about 1,100 million tonnes was harvested followed by wheat and rice in which 734 million tonnes and 495 million tonnes were harvested in 2019 respectively (STATISTA, 2019).According to Purseglove (1992), maize is commonly known in America as corn or Indian corn. Osagie and Eka (1998) reported that maize could have been introduced by the Portuguese into Nigeria during the 16th century. According to Eleweanya *et al*. (2005) studies in Nigeria, maize is grown on a commercial and small scale; and it serves as a staple food for man's consumption, fodder or straw for animals and raw material for industries. Maize is grown mainly for its carbohydrate rich grain. However, Iken and Amusa (2004) reported that a typical maize grain contains 65% of carbohydrate content, approximately 10-12% of protein content and about 4-8% of fat. According to De Groote (2002), maize grains also contain essential minerals and important minute nutrients such as vitamins A, B, C and E, folic acid, beta-carotene, and tocopherol as well as aneurin. Onuk *et al*. (2010), reported that maize is an integral part of human and animal dietary intakes and when processed in the industry, it can be made into cooking oil and processed into alcohol and starch. Local delicacies such as *pap*, *tuwo*, *gwate* and *donkunu* can be made from maize (Abdulrahaman and Kolawole, 2006). Maize is a voracious feeder and responds to soil fertility status and positively to the application of inorganic or organic fertiliser, and subsist on nitrogen to develop throughout its vegetative stage. Therefore, the study was conducted to prepare water hyacinth based composts from water hyacinth biomass and compare response of maize to the composts with NPK (15:15:15) inorganic fertiliser.

II. MATERIALS AND METHODS

- Sources of Experimental Materials

Water hyacinth-(WH) biomass used for compost production was harvested from two riverine communities Ebute Iga and Baiyeku located in humid rainforest zone, Lagos, Nigeria. Ebute Iga community is located on coordinate 6° 59' N, 3°58' E and 21 m altitude above sea level and Baiyeku community located on coordinate 6° 53' N, 3°55' E and on altitude 6 m above the sea level. Three animal dungs were collected from the animal section of Teaching and Research Farm (T and R farm), located on coordinate (7°45' N and 3°89' E) in University of Ibadan, Ibadan. Maize seed cultivar BR9943-DMR-SR-white was sourced (purchased) from the Institute of Agricultural Research and Training (IAR and T), Moore plantation, Ibadan.

- Research Study Sites

Compost production was carried out at the Animal Section of Teaching and Research Farm (T and R farm), University of Ibadan; and the field experiment conducted in two trials: March and July, 2020 at the Crop Section of the Teaching and Research Farm, which lays on coordinate 7º 27' N and 3° 53' E.

- Climatic Information of the Research Site

The climatic data record of T and R farm, University of Ibadan, obtained from Meteorological Section of the Department of Soil Resources Management showed that the season was a clearly wet season in 2019 and dry and wet season in 2020 (Table 1). Rainfall was experienced throughout 2019, although amount was low from November to February, while the wet season was experienced for eight months in the year 2020 from March to October and dry season for four months from November to February. In 2019, the lowest rainfall amount was recorded in January and highest amount of rainfall was recorded

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in September. In 2020, rainfall was experienced throughout the months of the year, the lowest rainfall amount was recorded in January and the highest amount in October. However, the total rainfall amount of 1904.9 mm and 1071.3 mm was recorded in year 2019 and 2020 respectively. Furthermore, in 2019, low temperature was recorded in December and high temperature in February. However, in 2020, the lowest temperature and the maximum temperature were recorded in January and February respectively. In the year 2019, the lowest relative humidity (RH) was recorded in January and the highest RH was recorded in July. Similarly, in the year 2020, the lowest RH was recorded in February while the highest RH was recorded in August.

Table 1: The Climatic Data at Teaching and Research Farm from 2019 to 2020

	2019					2020				
Month	Total Monthly Rainfall (mm)	Min Temperature (°C)	Max Temperature (°C)	Min Relative Humidity (RH) %	Max. Relative Humidity (RH) %	Total Monthly Rainfall (mm)	Min Temperature (°C)	Max Temperature (°C)	Min Relative Humidity (RH) %	Min Relative Humidity (RH) %
Jan	7.1	22.1	35.0	23.9	90.2	0.0	19.8	34.7	24.1	69.3
Feb	42.9	23.5	35.1	29.5	92.4	0.0	21.7	36.2	23.5	84.1
Mar	110.3	23.9	33.9	43.8	94.6	76.5	24.0	34.5	54.8	98.7
Apr	200.6	24.0	33.0	52.9	94.6	60.5	23.7	33.9	45.4	94.1
May	242.2	23.3	31.5	59.1	95.7	115.7	23.6	32.3	56.1	95.6
Jun	212.0	22.5	30.0	70.7	96.1	179.7	22.4	30.2	64.9	96.2
Jul	206.2	22.5	28.9	73.6	96.5	140.2	22.2	28.3	72.6	96.9
Aug	236.9	22.3	28.9	68.9	95.4	11.1	21.7	28.6	65.1	97.3
Sep	305.3	22.3	29.0	68.2	94.1	177.8	22.0	28.9	66.8	96.9
Oct	300.0	22.0	29.2	64.7	93.5	312.8	22.5	30.5	60.3	94.8
Nov	32.4	23.3	32.3	47.0	93.1	0.0	23.4	33.0	31.6	94.7
Dec	9.0	21.5	33.8	31.2	89.6	0.0	23.3	33.6	28.3	94.9
Total	1904.9	-	-	-	-	1074.1	-	-	-	-
Mean	-	22.8	31.7	52.8	93.8	-	22.5	32.1	49.5	92.8

*Source: Meteorological Section of the Department of Soil Resources Management, University of Ibadan, Ibadan.

- Collection of Soil Samples for Physical and Chemical Analysis

The soil samples field experiment, were taken on the plot used at the Teaching and Research farm crop unit, University of Ibadan, Ibadan. Soil samples were taken at 0-15 cm depth, at 20 different spots with a soil auger within the field, using (X-Y ordinate random sampling). All the soil samples taken were added together to form a bulk sample. Composite portion was taken from the bulked sample for pre-planting physical and chemical analysis, according to standard procedures of International Institute of Tropical Agriculture (IITA, 1982) and International Centre for Agricultural Research in the Dry Areas (ICARDA, 2013). The soil analysis was done at the Analytical Laboratory of the Department of Soil Resources Management, University of Ibadan. Analysis of physical and chemical properties of soil samples were also carried out after the termination of the experiments (post-planting soil analysis). The pH and soil particle size were determined by glass electrode pH meter and Bouyoucos Hydrometer method (ICARDA 2013); Organic Carbon (OC%) by Walkey-black wet oxidation method (IITA, 1979); for Exchangeable Bases: Na was determined by flame photometer while Ca and Mg by Atomic Absorption Spectrophotometer (Mg and Ca) (IITA, 1982); Total Nitrogen(TN-g/kg) and Total Phosphorus were determined by Macro Kjeldahl method and Bray-1 Method (IITA, 1979); Extractable potassium was determined using flame photometer following the procedure of ICARDA (2013). Determination of proximate parameters of maize grain were carried out following standard procedures.

- Compost Preparation

On water hyacinth-(WH) infested water bodies in Ebute Iga and Baiyeku communities, Lagos State, an area of 20 m × 20 m (400 m^2) was measured out on the water surface at 10 m interval with a measuring tape. Fresh WH-plant rooted within thearea was harvested, weighed with a camrySP model analog scale and replicated thrice. The harvested WH biomass was packed in sacks and transported to University of Ibadan T and R farm, Animal Section, where it was shredded into pieces with a sharp cutlass and air dried for two weeks. Three animal dungs: Poultry-droppings, Cattle-dungs and Swine-faeces were collected at the T and R farm. The shredded WH biomass and each animal dung was weighed out in 3:1 following the procedures of Adejumo *et al*. (2016) replicated thrice; to produce three different composts: Water hyacinth based poultry-dropping compost-(WHP); Water hyacinth based cattle-dung compost-(WHC) and Water hyacinth based swine-faeces compost-(WHS). Each compost washeaped separately in black polythene bag (1.2 m long and 1.1 m wide) and filled to the brim and a perforated 2.5 cm pipe was inserted in the middle of the compost material to allow air circulation and was tied with twine.The compost heaps were turned once a week and the temperature was measured with a thermometer.

- Response of Maize to Three Water Hyacinth Based Composts and NPK (15:15:15) Fertiliser at 120 and 150 N kg/ha

Field Experiment

The experiment was conducted at the crop section of University of Ibadan, T and R Farm. It was done in two trials and laid out in Randomized Complete Block Design in three replicates. Field size was 22 m × 8 m (176 m^2) and beds size of 2 m × 2 m (4 m^2) were made; with inter-row spacing of 1 m between block while the intra-row spacing of 0.5 m was between each bed in a block. Nine (9) beds were made per block making a total of 27 beds. The field was cleared manually to remove the existing vegetation cover. The treatments were applied a week prior to sowing to enable mineralisation of the compost and fertiliser. Two maize seeds were sown per hole at1 cm soil depth and spacing of 75 cm × 25 cm. Thinning of maize seedling was done at 2 weeks after germination to reduce to one stand per hole. Each bed had twenty-one maize stands and a total of 567 plants on the whole field. The field was manually cleared to be weed free throughout the period of this experiment. The treatments imposed are as stated below:

C= Control (water only)
NPK_{120} = NPK 15:15:15 at 120 kg N/ha
NPK_{150} = NPK 15:15:15 at 150 kg N/ha
WHP_{120} = water hyacinth based poultry-droppings compost at 120 kg N/ha
WHP_{150} = water hyacinth based poultry-droppings compost at 150 kg N/ha
WHC_{120} = water hyacinth based cattle-dung compost at 120 kg N/ha
WHC_{150} = water hyacinth based cattle-dung compost at 150 kg N/ha
WHS_{120} = water hyacinth based swine-faeces compost at 120 kg N/ha
WHS_{150} = water hyacinth based swine-faeces compost at 150 kg N/ha

- Data Collection

Collection of data commenced at two weeks, after sowing and subsequently at every 2-weeks interval for ten weeks. Data were collected on the plant growth and yield parameters such as:

Plant height (cm): This was done by placing the measuring tape from the soil surface level to the highest leaf tip.

Number of leaves per plant: This was determined by physically counting the maize leaves per plant.

Leaf length (cm): This measurement was taken from the stem to the tip of the longest leaf by using a measuring tape.

Leaf width (cm): This was taken on the same leaf whose length was measured, by placing the measuring tape vertically at the middle of the leaf.

Leaf area (cm^2): The determination of leaf area was d one according to the procedure of Subedi and Ma (2 005). The length and breadth (width) of the leaf was measured with a measuring tape and multiplied by a constant (0.75). The equation used is represented bel ow:

Leaf area = L ×W× 0.75, where L = length, W = Wi dth and 0.75 is a constant.

Stem girth (cm): This was done with a thin thread placed at 5 cm above soil level to avoid placing it on the prop root of the maize subsequently the thread was placed on a measuring tape.

Cob Length (cm): The length of maize cob whose husk had been removed was measured. This was done by placing a measuring tape on the first grain to the tip of the cob.

Cob Fresh Weight and Dry Weight (g): This was don e by placing the fresh cobs per plant on Camry digita l electronic scale (model EK5350) to determine the w eight. Thereafter, the cobs were oven dried at 80°C i n the Gallenkemp model oven to a constant weight. T he cobs were re-weighed on the above named scale t o determine the cob dry weight.

Grain weight per cob (g): The weight of grains from each of the cob was determined using the scale name d above.

Dried-Weight of 1000seeds (g): The weight of one t housand seed was measured with the scale named ab ove and recorded.

Grain Yield Percentage Increase: This was calculate d by the formula below:

$$\text{Percentage Yield} = \left(\frac{\text{Highest Yield Value} - \text{Lowest Yield Value}}{\text{Lowest Yield Value}}\right) \times 100$$

Maize Shoot and Root Dry Weight (g): This was also weighed using the above named scale after harvesting. The plants were uprooted with care, along with a ball of earth and immersed into a bucket filled with clean water to remove the soil attached to the root, so that the roots can be recovered fully as much as possible with no damage (Awodoyin, 2010). Each harvested plant was partitioned into shoot and root, and labelled in envelopes separately. Afterwards, at 80°C temperature, it was oven-dried in the Gallenkemp model oven to a constant weight. Thereafter, weight was determined on the scale.

- Data Analyses

The DSAASTAT ver. 1.101 statistical software pack age was used for the Analysis of Variance-(ANOVA) according to (Gomez and Gomez, 1984). Significan t means were separated with Duncan's Multiple Ran ge Test (DMRT) at 5% level of significance (P < 0.0 5).

III. RESULTS

Response of Maize to Three Water Hyacinth Based composts and NPK Fertiliser at 120 and 150 N kg/ha (Field Experiment)

Plant Height PH (cm)

The maize plant height increased across the weeks in all the treatments (Table 2). At 2 WAS, tallest plants obtained with WHP_{150} treatments were significantly higher than those of NPK_{120} and Control. At 4-WAS the highest PH ($106.26^{a}\pm1.38$) recorded in WHP_{120} was significantly higher than the PH recorded in Control ($75.41^{c}\pm7.25$) and WHC_{120} ($87.08^{bc}\pm2.75$) treatment only (Table 2). At 6-WAS, the PH value recorded in WHP_{150} was not significantly different from the PH recorded in WHP_{120}; WHC_{150} and WHS_{150} (Table 2). However, it was significantly higher than the PH recorded in other treatments while the lowest PH value as recorded in the Control. At 8-WAS, the PH recorded in WHP_{150} was significantly higher than the PH recorded in Control, NPK_{150} and WHS_{120} however, not significantly different from the PH recorded in other treatments (Table 2).At 10-WAS, the highest PH was recorded in WHP_{150} and significantly higher than the PH value recorded in the Control; NPK_{120}; NPK_{150} and WHS_{150} compared to other treatments (Table 2).

Table 2: Mean Plant Height of Maize as Influenced by Three Water Hyacinth Based Composts and NPK Fertilizer at 120 and 150 N Kg/Ha in First and Second Field Experiment in 2020

	Mean Plant Height (cm)				
Treatments	2 WAS	4 WAS	6 WAS	8 WAS	10 WAS
Control	$36.68^{c}\pm5.27$	$75.41^{c}\pm7.25$	$132.80^{d}\pm8.36$	$185.96^{c}\pm10.38$	$200.1^{c}\pm8.05$
NPK_{120}	$38.46^{bc}\pm3.66$	$88.56^{abc}\pm6.12$	$144.60^{d}\pm5.26$	$222.40^{ab}\pm6.43$	$220.46^{b}\pm1.02$
NPK_{150}	$41.76^{abc}\pm3.14$	$89.4^{abc}\pm4.16$	$152.06^{bcd}\pm5.88$	$207.81^{bc}\pm5.16$	$221.30^{b}\pm1.92$
WHP_{120}	$46.50^{abc}\pm2.20$	$106.26^{a}\pm1.38$	$167.96^{abc}\pm9.31$	$231.93^{a}\pm6.71$	$244.50^{a}\pm5.69$
WHP_{150}	$51.71^{a}\pm4.04$	$104.31^{ab}\pm9.63$	$176.18^{a}\pm7.51$	$235.10^{a}\pm6.35$	$245.63^{a}\pm7.14$
WHC_{120}	$40.83^{abc}\pm1.61$	$87.08^{bc}\pm2.75$	$149.3^{cd}\pm6.54$	$222.40^{ab}\pm11.00$	$235.30^{ab}\pm5.27$
WHC_{150}	$46.11^{abc}\pm3.65$	$97.23^{ab}\pm7.09$	$171.^{20ab}\pm6.79$	$232.00^{a}\pm5.75$	$241.73^{a}\pm2.80$
WHS_{120}	$45.21^{abc}\pm2.44$	$95.56^{ab}\pm3.36$	$150.9^{bcd}\pm5.46$	$209.76^{bc}\pm6.71$	$219.11^{bc}\pm6.91$
WHS_{150}	$48.11^{ab}\pm4.39$	$101.2^{ab}\pm5.00$	$170.86^{ab}\pm6.52$	$234.00^{a}\pm9.12$	$243.50^{a}\pm6.81$

*(Values shown are means ± S.E, n = 3). Means were separated by Duncan's Multiple Range Test at P<0.05, statistically means having same alphabet along a column are not significantly different from one another. Control

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(no treatment application); WAS = (Weeks after sowing), WHP= (Water hyacinth based poultry-droppings compost); WHC= (Water hyacinth based cattle-dungs compost); WHS= (Water hyacinth based swine-faeces compost).

Leaf Area LA (cm^2)

At 2-WAS maize leaf area obtained in WHP_{150} was significantly higher than the LA values recorded in the Control, NPK_{120}, NPK_{150} and WHC_{120} (Table 3).However, this was not significantly different from the LA values recorded in the other treatments.At 4-WAS, the LA value recorded in WHP_{150} was not significantly different from the LA value recordedin WHP_{120} and WHS_{120} however, itwas significantlyhigher than the LA value recorded in the other treatments (Table 3). At 6-WAS, the LA values recorded in Control, NPK_{120} and WHS_{120} were lower significantly to the LA values recorded in other treatments. However, WHP_{150} had the highest LA value (Table 3). At 8-WAS, a decline in LA values were observed, however, WHP_{120} had the highest LA value which was not different significantly from the LA values obtained in the other treatments (Table 3).At 10-WAS, the highest LA value was recorded in WHP_{150} which was not significantly different from the LA value recorded in all the treatments (Table 3).

Table 3: Mean Leaf Area (cm^2) of Maize as Influenced by Three Water Hyacinth Based Composts and NPK Fertiliser at 120 and 150 N Kg/Ha in First and Second Field Experiment in 2020

Treatments	Mean Leaf Area (cm^2)				
	2 WAS	4 WAS	6 WAS	8 WAS	10 WAS
Control	$50.05^{c}\pm12.61$	$199.51^{c}\pm26.86$	$429.85^{c}\pm28.13$	$290.40^{a}\pm31.20$	$171.78^{a}\pm11.58$
NPK_{120}	$54.65^{bc}\pm7.57$	$263.10^{bc}\pm29.17$	$505.85^{bc}\pm23.75$	$322.16^{a}\pm42.87$	$171.87^{a}\pm12.13$
NPK_{150}	$62.51^{bc}\pm10.19$	$271.44^{bc}\pm18.02$	$515.67^{abc}\pm29.83$	$250.16^{a}\pm17.34$	$198.63^{a}\pm22.19$
WHP_{120}	$77.36^{abc}\pm7.15$	$326.50^{ab}\pm38.87$	$596.87^{a}\pm34.12$	$310.04^{a}\pm21.26$	$216.59^{a}\pm14.40$
WHP_{150}	$105.91^{a}\pm18.19$	$390.54^{a}\pm32.85$	$603.90^{a}\pm32.61$	$279.79^{a}\pm28.15$	$217.03^{a}\pm12.28$
WHC_{120}	$62.71^{bc}\pm3.64$	$260.10^{bc}\pm13.96$	$551.33^{ab}\pm36.03$	$290.03^{a}\pm10.78$	$191.08^{a}\pm21.70$
WHC_{150}	$77.04^{abc}\pm13.00$	$310.73^{b}\pm33.75$	$598.51^{a}\pm37.34$	$259.55^{a}\pm34.58$	$189.85^{a}\pm24.16$
WHS_{120}	$80.60^{abc}\pm11.75$	$316.95^{ab}\pm19.30$	$466.97^{bc}\pm31.61$	$251.85^{a}\pm24.94$	$188.74^{a}\pm28.03$
WHS_{150}	$86.99^{ab}\pm15.70$	$275.91^{bc}\pm25.28$	$601.41^{a}\pm44.42$	$309.98^{a}\pm28.87$	$210.49^{a}\pm11.60$

*Values shown are means ± S.E, n = 3. Means were separated by Duncan's Multiple Range Test at $P < 0.05$, statistically means having same alphabet along a column are not significantly different from one another. Control (no treatment application); WAS = (Weeks after sowing), WHP= (Water hyacinth based poultry-droppings compost); WHC= (Water hyacinth based cattle-dungs compost); WHS= (Water hyacinth based swine-faeces compost).

Stem Girth (SG-cm)

At 2-WAS, the stem girth (SG) value recorded in WHP_{150} was significantly higher than the Control; however, this was not significantly different from SG values recorded in other treatments (Table 4). At 4-WAS, the SG values recorded in all the treatments were significantly higher compared to the Control (Table 4). However, WHP_{150} had the highest SG value. At 6-WAS, SG value in WHC_{120} was significantly higher than SG values obtained in the remaining treatments (Table 4). At 8-WAS, WHP_{120} had SG value significantly higher than SG value recorded in Control and NPK_{150} (Table 4).At 10-WAS, the highest SG value recorded in WHP_{120} was not significantly different from the SG values recorded in other treatments (Table 4)

Table 4: Mean Maize Stem Girth of Maize as Influenced by Three Water Hyacinth Based Composts and NPK Fertiliser at 120 and 150 N kg/ha in First and Second Trial Field Experiment in 2020

	Mean Stem Girth (cm)				
Treatments	2 WAS	4 WAS	6 WAS	8 WAS	10 WAS
Control	$1.14^{d}\pm0.23$	$3.40^{c}\pm0.21$	$5.68^{b}\pm0.41$	$5.52^{b}\pm0.47$	$5.46^{a}\pm0.45$
NPK_{120}	$1.55^{cd}\pm0.22$	$4.93^{b}\pm0.40$	$6.46^{b}\pm0.45$	$6.11^{ab}\pm0.41$	$5.86^{a}\pm0.36$

NPK_{150}	1.69^{bcd}±0.27	5.07^{ab}±0.12	6.31^{b}±0.41	5.71^{b}±0.40	5.68^{a}±0.47
WHP_{120}	2.16^{ab}±0.23	5.88^{a}±0.26	6.94^{b}±0.35	6.84^{a}±0.33	6.29^{a}±0.24
WHP_{150}	2.44^{a}±0.22	4.91^{b}±0.41	6.97^{b}±0.41	6.31^{ab}±0.36	6.18^{a}±0.38
WHC_{120}	2.04^{abc}±0.10	5.12^{ab}±0.28	9.87^{a}±2.32	6.39^{ab}±0.43	6.05^{a}±0.44
WHC_{150}	2.05^{abc}±0.20	5.04^{ab}±0.31	6.80^{b}±0.46	6.37^{ab}±0.44	6.15^{a}±0.45
WHS_{120}	2.32^{a}±0.15	4.93^{b}±0.31	6.04^{b}±0.48	6.00^{ab}±0.55	5.67^{a}±0.54
WHS_{150}	2.11^{ab}±0.22	5.10^{ab}±0.46	6.67^{b}±0.56	6.4^{ab}±0.56	6.08^{a}±0.56

*Values shown are means ± S.E, n = 3. Means were separated by Duncan's Multiple Range Test at P < 0.05, statistically means having same alphabet along a column are not significantly different from one another. Control (no treatment application); WAS = (Weeks after sowing), WHP= (Water hyacinth based poultry-droppings compost); WHC= (Water hyacinth based cattle-dung compost); WHS= (Water hyacinth based swine-faeces compost).

Number of Leaves (NOL)

At 2-WAS the highest number of leaves (NOL) produced in WHP_{150} treatment was similar to those of WHP_{120}, WHS_{120} and WHS_{150} all of which were significantly higher than the Control only (Table 5).At 4-WAS, the NOL recorded in WHP_{150} was significantly higher than the NOL recorded in Control and NPK_{120} only (Table 5). At 6-WAS, the NOL recorded in WHP_{120} was significantlyhigher than the NOL recorded in the Control (Table 5). However, other treatments had NOL that was not significantly different from WHP_{120} (Table 5). At 8-WAS, the NOL recorded in WHS_{150} was significantly higher than the NOL recorded in the Control and not significantly different from the NOL in other treatments (Table 5). At 10-WAS, the NOL recorded in WHS_{150} was significantly higher than the NOLrecorded in Control and not significantly different from the NOL recorded in other treatments (Table 5).

Table 5: Mean Maize Number of Leaves as Influenced by Three Water Hyacinth Based Composts and NPK Fertiliser at 120 and 150 N kg/ha in First and Second Field Experiment in 2020

	Mean Number of Leaves/ plant				
Treatments	2 WAS	4 WAS	6 WAS	8 WAS	10 WAS
Control	5.13^{b}±0.27	8.50^{c}±0.35	12.46^{b}±0.76	12.03^{a}±0.85	11.13^{b}±0.72
NPK_{120}	5.63^{ab}±0.34	8.96^{bc}±0.44	12.96^{ab}±0.88	12.93^{ab}±0.55	11.83^{ab}±0.43
NPK_{150}	5.70^{ab}±0.32	9.06^{abc}±0.26	12.66^{ab}±0.71	13.26^{ab}±0.50	11.66^{ab}±0.47
WHP_{120}	6.13^{a}±0.32	9.76^{ab}±0.32	13.46^{a}±0.56	14.06^{a}±0.31	12.53^{a}±0.37
WHP_{150}	6.40^{a}±0.35	9.93^{a}±0.38	13.36^{ab}±0.56	13.50^{ab}±0.48	12.50^{ab}±0.55
WHC_{120}	6.03^{ab}±0.22	8.83^{ab}±0.43	12.56^{a}±0.70	13.96^{a}±0.54	12.53^{a}±0.53
WHC_{150}	5.86^{ab}±0.36	9.55^{ab}±0.55	13.10^{a}±0.81	14.03^{a}±0.84	12.50^{ab}±0.60
WHS_{120}	6.23^{a}±0.26	9.20^{abc}±0.49	12.56^{a}±0.72	13.53^{ab}±0.65	12.03^{ab}±0.60
WHS_{150}	6.13^{a}±0.37	9.40^{abc}±0.50	13.16^{a}±0.83	14.10^{a}±0.72	12.93^{a}±0.64

*Values shown are means ± S.E, n = 3. Means were separated by Duncan's Multiple Range Test at P < 0.05, statistically means having same alphabet along a column are not significantly different from one another. Control (no treatment application); WAS = (Weeks after sowing), WHP= (Water hyacinth based poultry-droppings compost); WHC= (Water hyacinth based cattle-dung compost); WHS= (Water hyacinth based swine-faeces compost).

Shoot Fresh and Dry Weight (g)

Maize shootfresh weight (SFW) value obtained in WHP_{150} was significantly higher than SFW values recorded in NPK_{120}, NPK_{150} and Control only (Table 6).The shoot dry weight (SDW) value obtained in WHP_{150} was significantly higher than SDW recorded in Control; NPK_{120}; NPK_{150} and WHS_{120}only (Table 6).

Root Fresh Weight (RFW) and Root Dry Weight (RDW) (g).

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The highest root fresh weight (RFW) obtained in WHP_{150} was significantly higher thanRFW values recorded in Control and NPK_{150}which however, was not significantly different from the remaining treatments (Table 6). Highest root dry weight (RDW) value obtained in WHP_{150} was not significantly different from the RDW value obtained in the other treatments (Table 6).

Biomass Weight Fresh (BFW) and Biomass Dry Weight (BDW) (g)

Highest biomass fresh weight (BFW) was obtained with WHP_{150} treatment while the lowest was recorded in the Control (Table 6). However, the BFW value recorded in WHP_{150} was significantly higher than the BFW in Control and NPK_{150}, and however not significantly different from the BFW recorded in the remaining treatments. Similarly, BDW recorded in WHP_{150} was significantly higher than the BDW recorded in Control and NPK_{150} and not significantly different from the BDWrecorded in the remaining treatments (Table 6).

Table 6: Mean Weight of Maize Shoot Fresh and Dry Weight, Root Fresh and Dry Weight, Biomass Fresh and Dry Weight (g) as Influenced by Three Water Hyacinth Based Composts and NPK Fertiliser at 120 and 150 N kg/ha in First and Second Field Experiment trial in 2020

Treatments	Mean Weight Field Experiment					
	Shoot Fresh Weight (g)	Shoot Dry Weight (g)	Root Fresh Weight (g)	Root Dry Weight (g)	Biomass Fresh Weight (g)	Biomass Dry Weight (g)
Control	$207.63^{d}\pm32.92$	$59.60^{c}\pm8.70$	$70.00^{c}\pm17.69$	$26.40^{a}\pm6.96$	$386.10^{d}\pm92.79$	$211.86^{c}\pm71.99$
NPK_{120}	$282.96^{bcd}\pm37.50$	$89.40^{bc}\pm10.05$	$105.63^{abc}\pm26.17$	$32.03^{a}\pm8.04$	$520.63^{cd}\pm121.12$	$301.40^{abc}\pm99.39$
NPK_{150}	$274.53^{cd}\pm33.67$	$94.16^{b}\pm16.38$	$78.16^{bc}\pm19.21$	$28.00^{a}\pm6.48$	$546.23^{bcd}\pm137.04$	$260.36^{bc}\pm87.26$
WHP_{120}	$379.30^{ab}\pm31.93$	$126.23^{a}\pm14.93$	$119.50^{ab}\pm19.66$	$34.46^{a}\pm9.22$	$702.00^{ab}\pm137.03$	$356.56^{a}\pm107.33$
WHP_{150}	$397.93^{a}\pm33.86$	$127.76^{a}\pm29.25$	$129.16^{a}\pm41.27$	$36.30^{a}\pm5.77$	$721.60^{a}\pm158.06$	$387.03^{a}\pm129.14$
WHC_{120}	$361.46^{abc}\pm48.03$	$109.36^{ab}\pm11.26$	$122.83^{ab}\pm25.51$	$30.73^{a}\pm4.08$	$599.76^{abc}\pm117.56$	$328.10^{ab}\pm113.19$
WHC_{150}	$352.96^{abc}\pm51.31$	$103.00^{ab}\pm17.54$	$88.56^{abc}\pm16.26$	$31.23^{a}\pm8.86$	$678.10^{abc}\pm169.93$	$363.20^{a}\pm116.34$
WHS_{120}	$369.30^{abc}\pm45.18$	$90.43^{bc}\pm22.06$	$112.70^{abc}\pm31.11$	$29.43^{a}\pm5.87$	$587.6^{abc}\pm135.14$	$347.63^{ab}\pm119.53$
WHS_{150}	$337.13^{abc}\pm57.00$	$124.63^{a}\pm16.21$	$119.70^{ab}\pm32.19$	$31.50^{a}\pm6.57$	$713.13^{ab}\pm203.26$	$380.50^{a}\pm133.29$

*Values shown are means ± S.E, n = 3. Means were separated by Duncan's Multiple Range Test at $P < 0.05$, statistically means having same alphabet along a column are not significantly different from one another. S.E = Standard Error; Control (no treatment application); WAS = (Weeks after sowing), WHP= (Water hyacinth based poultry-droppings compost); WHC= (Water hyacinth based cattle-dung compost); WHS= (Water hyacinth based swine-faeces compost).

Length of Cob (LOC) (cm)

Length of Cob (LOC) value obtained in WHP_{120} was significantly higher than the LOC value recorded in the Control and however not significantly different from the LOC values obtained in the remaining treatments (Table 7).

Cob Fresh and Dry Weight with Grains (CFW) (g)

Maize cob fresh weight (CFW) obtained in WHP_{120} treatment was significantly higher than the CFW recorded in Control, NPK_{120}, NPK_{150}, WHC_{150} and WHS_{150} only (Table 7).Maize cob dry weight (CDW) value recorded in WHP_{120} treatment was significantly higher than the CDW recorded in Control, NPK_{120}, NPK_{150}, WHC_{150} and WHS_{150} and not significantlydifferent from the remaining treatments (Table 7).

Weight of 1000 Dry Seeds per Plot (g)

The value of dry weight of 1000 seeds (1000 seeds-DW) recorded in WHP_{120} was significantly higher than the Control and not significantly different in comparison to the 1000 seeds-DW recorded in other treatments (Table 7).

Grain Yield (tons/ha)

Highest grain yield (GY) obtained in WHP_{120} (2.95±0.26 t/ha) was not significantly different from the GYvalues recorded in WHP_{150}, WHC_{120} and WHS_{120} but had percentage yield increase of 8.06, 17.53 and 13.46 over WHP_{150}, WHC_{120} and WHS_{120} respectively (Table 7). However, WHP_{120} had significantly higher GY value than other remaining treatments while Control had the lowest.

Table 7: Mean Weight of Maize Yield Parameters as Influenced by Three Water Hyacinth Based Composts and WHS and NPK Fertiliser at 120 and 150 N kg/ha in First and Second Field Experiment in 2020

	Mean weight of Maize Yield					
Treatments	Length of Cob (cm)	Cob Fresh Weight with Grain (g) /plot	Cob Dry with Grain(weight (g)/plot)	Weight of 1000 Dry Seeds (g)/plot	Maize Grain Yield/ plot (t/ha)	PercentageYield Increase (%)
Control	12.93^{b}±0.60	1339.66^{d}±222.84	627.00^{d}±125.17	139.44^{b}±8.89	1.57^{d}±0.31	87.89
NPK_{120}	16.17^{a}±0.24	1652.83^{cd}±265.05	780.0°C^{d}±177.73	160.65^{ab}±6.50	1.95^{cd}±0.44	51.28
NPK_{150}	15.35^{ab}±0.73	1615.33^{cd}±149.76	795.83^{cd}±59.90	167.00^{ab}±8.53	1.99^{cd}±0.14	48.24
WHP_{120}	17.36^{a}±0.31	2233.33^{a}±219.44	1178.50^{a}±106.49	182.00^{a}±5.75	2.95^{a}±0.26	-
WHP_{150}	17.00^{a}±1.17	2085.66^{ab}±212.61	1093.83^{ab}±148.96	183.44^{a}±7.99	2.73^{ab}±0.37	8.06
WHC_{120}	15.70^{a}±0.39	2052.66^{ab}±263.93	1003.66^{abc}±137.04	171.94^{a}±5.79	2.51^{abc}±0.34	17.53
WHC_{150}	15.80^{a}±0.65	1860.33^{bc}±230.96	839.00^{bcd}±131.59	170.05^{a}±11.22	2.10^{bcd}±0.32	40.48
WHS_{120}	15.76^{a}±0.65	2027.50^{ab}±239.65	1038.66^{abc}±118.52	169.27^{a}±7.81	2.60^{abc}±0.29	13.46
WHS_{150}	16.76^{a}±0.51	1809.66^{bc}±277.87	894.33^{bcd}±149.86	173.00^{a}±8.95	2.24^{bcd}±0.37	31.70

*Values shown are means ± S.E, n = 3. Means were separated by Duncan's Multiple Range Test at $P < 0.05$, statistically means having same alphabet along a column are not significantly different from one another. Control (no treatment application); WAS = (Weeks after sowing), WHP= (Water hyacinth based poultry-droppings compost); WHC= (Water hyacinth based cattle-dung compost); WHS= (Water hyacinth based swine-faeces compost)

Effect of Three Water Hyacinth Based Composts and NPK Fertiliser on Physical and Chemical Properties for Field Experiment

The soil pH of all the treatments ranged from mildly acidic to slightly alkaline (6.20 – 7.42) (Table 8). The lowest pH was recorded in pre-planting soil sample and NKP_{120} while the highest pH was recorded in WHC_{150} (Table 8). However, the post-planting pH values of all the compost treatments were higher than the values recorded for all NPK treatments. The lowest Organic carbon content (Org. C %) was obtained in Control while highest was reported in WHP_{150} treatment (Table 8). However, Org. C content in all the treatments were higher than the Org. C in the pre-planting soil and Control. Furthermore, the post-planting Org. C content in all the compost treatments were higher than in NPK treatments. The organic matter content (OM) was highest with the application of WHP_{150} and lowest in Control (Table 8). However, the value of OM content recorded in the Control, NPK_{120} and NPK_{150}were lower than the values of OMcontent recorded in the other treatments. Control had the lowest nitrogen (N) content while N content recorded in WHP_{150} and WHC_{150} treatments were the highest (Table 8). However, N contentsof all the treatments were higher than the N content in the pre-planting composite soil sample and Control. Similarly, in the post-plantingsamples, the N content recorded in Control, NPK_{120} and NPK_{150} were lower than the N content in compost treatments. Control had the lowest available P and WHS_{120} had the highest available P. However, post-planting value of available P in all the treatments were higher than available P in the Control and pre-planting composite soil sample (Table 8). Similarly, Control had the lowest K concentration while WHS_{120} treatment had the highest (Table 8).Furthermore, K concentration in the Control,

NPK_{120} and NPK_{150} were lower than the K in the other treatments. However, the post-planting K concentrations in all the treatments were higher than the K content in the pre-planting composite soil sample and Control. The values of all exchangeable bases (Na, Mg and Ca) in the pre-planting soil samples were lower than their corresponding post-planting values (Table 8). However, the exchangeable bases recorded in the Control, NPK_{120} and NPK_{150} were lower than the exchangeable bases in the other treatments.

Soil Particle Size (g/kg)
Soil particle sizes in the pre-planting soil sample and the Control were in the sandy-loam textural class while the soil sample for the other treatments were in the loamy-sand texturalclass (Table 8).

Table 8: Effect of Three Water Hyacinth Based Composts and NPK Fertiliser at 120 and 150 N kg/ha on Physical and Chemical Properties of Soil Pre- and -Post in Field Experiment in 2020

Soil Properties	Soil Properties in Post Field Experiment									
	Pre-planting Soil Properties	Treatments								
		Control	NKP 120	NKP 150	WHP 120	WHP_{150}	WHC_{120}	WHC 150	WHS 120	WHS 150
pH (H_2O) 1:1	6.35	6.56	6.20	6.42	6.83	7.01	6.89	7.42	6.92	7.30
Org. C (g/kg)	5.9	5.50	9.60	9.30	19.80	21.30	15.30	20.70	11.40	11.10
Org. Matter (g/kg)	10.2	9.46	16.51	16.00	30.06	36.64	26.31	35.06	19.61	19.02
Total N (g/kg)	0.50	0.30	1.10	1.80	2.00	2.30	1.70	2.30	1.50	1.80
Avail. P (mg/kg)	17.17	6.84	24.60	13.48	21.32	31.48	16.92	11.80	42.20	32.60
K (cmol/kg)	0.41	0.38	0.53	0.59	0.84	0.61	0.63	0.68	0.78	0.61
Ca (cmol/kg)	2.34	4.49	9.04	4.98	8.29	8.55	7.40	7.61	7.01	7.05
Mg(cmol/kg)	0.43	1.21	2.84	1.48	2.27	2.61	2.07	2.13	1.88	1.78
Na (cmol/kg)	0.21	0.56	0.49	0.61	0.41	0.39	0.47	s0.57	0.46	0.49
Cu (mg/kg)	1.02	1.06	1.27	1.36	1.29	1.13	1.84	1.61	1.70	1.56
Zn (mg/kg)	1.13	1.58	1.79	1.92	1.58	1.63	1.59	1.83	1.90	1.85
Sand (g/kg)	760	760	795	812	800	815	820	803	788	795
Silt (g/kg)	170	160	137	115	120	130	110	134	135	120
Clay (g/kg)	70	80	68	73	80	55	70	63	77	85
Textural class	Sandy loam	Sandy loam	Loamy sand	Loamy sand	Loamy sand	Loamy sand	Loamy sand	Loamy sand	Loamy sand	Loamy sand

*WHP= (Water hyacinth based poultry-dropping compost); WHC= (Water hyacinth based cattle-dung compost); WHS= (Water hyacinth based swine-faeces compost).

IV. DISCUSSION

In this study, all the three water hyacinth based composts significantly influenced the vegetative growth parameters of maize crop in field trials. The composts applied at 150 kg N/ha significantly influenced maize plant height, leaf area, stem girth and number of leaves than the control and also compared quite well with NPK (15-15-15) inorganic fertiliser at the same rates. This corroborated the report of Chukwuka and Omotayo (2008; 2009); and Maingi *et al.* (2013) that when compost prepared from water hyacinth was used as soil amendment for maize cultivation, there was an increase in the morphological parameters of maize crop significantly. In the same vein, Seoudi (2013) also reported significant increase in all the vegetative growth parameters of cowpea after the application of water hyacinth and banana wastes compost. The significantlyhigh increase in the morphological parameters observed in this study could be attributed to the essential secondary macronutrients and micronutrients present in the composts in considerable quantities. Also, the ability of the compost to readily release its nutrients slowly, making it available for the maize crop throughout its lifecycle, which could have enhanced the maize performance to compare well with the NPK (15-15-15) inorganic fertiliser. This consolidated the report of Kamanu *et al.* (2012) and Maingi *et al.* (2014), where an increase in crop morphological parameters were observed, when compost was applied. This could be attributed to the nutrients released from the compost, basically nitrogen and phosphorus, for plant utilisation after mineralisation, and the nurtrients were essential in the formation of chlorophyll for photosynthesis, enhancing optimum plant growth and development. Similar response was evident in the yield parameters of maize crop. Water hyacinth based composts were observed to enhance the maize yield parameters such as fresh and dry biomass weight, length of cob and weight of 1000 dry grains. The grain yield of maize was significantly enhanced by all the water hyacinth based composts than the yield obtained from NPK fertiliser amendment. This was in conformity with the report of Seoudi (2013) that maize crop amended with compost prepared from water hyacinth had the highest value for 1000 dry seed weight per plant. In addition, Abdalla *et al.* (2014) reported high value for straw dry matter and grain yield in wheat, on plots amended with either water hyacinth or banana composts. It was further reported that application of compost produced from water hyacinth and banana peels enhanced wheat grain yield over the use of mineral fertiliser by 61 and 29% respectively. Similarly, Adejumo *et al.* (2016) reported better improvement in the growth and yield of maize crop when compost produced from *Tithonia diversifolia* was applied at the rate of 15 t/ha as soil amendment for the maize cultivation. Likewise, Ojobor *et al*. (2017) asserted that the application of compost enhanced rice yield significantly and increase in compost rate resulted in an increase in growth and yield of rice. However, in this study, the high yield obtained from the compost plot could be attributed to the high potassium concentration in the water hyacinth based composts, as potassium is known to be an essential macronutrient responsible for fruiting and high yield in crops. Also, the nutrients in composts were firmly held and could only be released through mineralisation by microorganisms and may not be lost through leaching or runoff. Hence, the composts were able to have better yield than NPK fertiliser which might have lost most of it nutrients which are loosely held; through leaching, runoff or volatilisation and might not be available to the crop as and when due.

However, the study showed that the three water hyacinth based composts influenced the soil physical and chemical properties. The post-planting soil pH of all water hyacinth compost treated plots increased (neutral to mildly alkaline) compared to the NPK treated plots which were mildly acidic. This increased pH values in compost treated soil might be attributed to the neutralizing impactof compost on acidic soil after continuous application over time and the low pH in the NPK amended soil could be owing to the acid forming nature associated with the use of inorganic NPK fertiliser. This resonated with Ojobor *et al.* (2017) reported an increase in pH values in compost treated soils and lower pH values in NPK treated soil. Furthermore, compost prepared with cattle manure was shown to have cushioned soil acidity, which could be by tightly holding exchangeable aluminum ions together in soils with high acidity (Tejada, 2006; Onwonga and Lelei, 2010). The soil organic matter was also found to have increased in compost treated soils. This consolidated the reports of Oguike *et al*. (2006) and Ojobor *et al.* (2017). The nitrogen and phosphorus concentration in the soil was also influenced by water hyacinth based composts. The N and P in the compost treated soils were observed to be high. This increase could be because of the available nutrients in the composts that was made available in the soil through mineralisation by the soil microbes. The potassium content increase in the soil after the application of water hyacinth composts, this could be due to the high potassium concentration accumulated in the water hyacinth biomass which was invariably present as well in the compost. The exchangeable bases like Na, Mg and Ca were also influenced by the water hyacinth compost. This could be imputed to the rise in soil pH value, in compost treated soil. However, high pH value had been reported to increase cation exchange capacity in the soil. This corroborates the report of Nyle and Brady (2003) that high organic matter present in compost enhanced soil fertility through forming humic clay complex, which might also be responsible for an increase in soil exchangeable bases. The soil textural class was also influenced by water hyacinth composts, changes were observed in the soil textural class after compost application. This resonated with Seoudi (2013) and Maingi *et al.* (2013) assertion that application of organic material and compost were revealed to improve the properties of soil such as biological, physical and chemical attributes of sandy soil and its recovery for production of crops. Abdalla *et al.* (2014) averred that continuous application of compost made from banana and water hyacinth improved the quality and soil physical characteristics. The results obtained fromthis study evidently revealed that compost made from water hyacinth was able to enhance physical and chemical parameters of soil as well as improve the yield of cultivated crop. This supported Seoudi (2013) and Dada *et al.* (2014) reports that recycling and utilisation of biodegradable wastes of basically organic origin like plant residues and farm yard manure in composted form, would improve the fertility of soils and made it available for crop cultivation.

V. CONCLUSION

Water hyacinth combined with animal manure produced substantial amount of compost. All the three water hyacinth based compost performed well and enhanced maize growth, grain yield and improved the physical and chemical properties of the soil compared with the NPK-15:15:15 inorganic fertiliser.

REFERENCES

[1] Abdalla, M.A., Eltaib, I.A.O., Elballa, A.M.M., Elhadi, E.A. and Rezig, F.A.M. 2014.

[2] Utilisation of composted baggase, water hyacinth and banana wastes in reclamation of desert soils. I. effects on yield and nutrients uptake U.of K. Graduate College and Scientific Research. The 5th *Annual Conference Agricultural and Veterinary Research - February 2014, Khartoum, Sudan, Conference Proceedings*, 3:836-851.

[3] Abdulrahman, A. A. and Kolawole, O. M. 2006. Traditional preparations and uses of maize in Nigeria. *Journal of Ethnobotanical leaflets,* 10: 219-227.

[4] Adejumo, S. A., Owolabi, M. O. and Odesola, I. F. 2016. Agro-physiologic effects of compost and biochar produced at different temperatures on growth, photosynthetic pigment and micronutrients uptake of maize crop. *African Journal of Agricultural Research,* 11 (8): 661-673.

[5] Aloo, P., Ojwang, W., Omondi, R., Njiru, J. M. and Oyugi, D. 2013. A review of the impacts of invasive aquatic weeds on the bio- diversity of some tropical water bodies with special reference to Lake Victoria (Kenya). *Biodiversity Journal,* 4 (4): 471–482.

[6] Awodoyin, R. O. 2010. Germination and Growth Dynamics of African bonebract (*Sclerocarpus africanus* Jacq.) and its Critical Period of Interference with Okra [*Abelmonschus esculentus* (L.) Moench] and Cowpea [*Vigna unguiculata* (L.)Walp]. *Global Journal of Pure and Applied Sciences,* 16 (1):47-54.

[7] Chukwuka, K.S. and Omotayo, O. E. 2008. Effects of *Tithonia* green manure and water hyacinth compost application on nutrient depleted soil in South-Western Nigeria. *International Journal of Soil Science,* 3 (2): 69-74.

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

[9] Dada, O.A., Togun, A.O., Adediran, J.A. and Nwilene. F.E. 2014. Effect of Compost on Agro-Botanical Components Responsible for Rice (*Oryza sativa)* Grain Yield in Southwestern Nigeria.*Journal of Agriculture and Sustainability,* 6 (1): 88-109.

[10] De Groote, H. 2002. "Maize yield losses from stemborers in Kenya". *Insect Science Applications,* 22 (2): 89-96.

[11] Eleweanya, N. P., Uguru, M. I. M., Enebong, .E. E. and Okocha, O. O. 2005. Correlation and path Coefficient analysis of grain yield related characters in maize (*Zea mays*. L.) under Umudike conditions of south Eastern Nigeria, *Agro – science Journal of Tropical Agriculture, Food, Environmental and Extension,* 1: 24-28.

[12] Francis, Z., Bobbi, L. H., Francis, J. L., Henry, J., Olalekan, O. A. and Barry, M. O. 2006. Predicting phosphorus availability from soil-applied compost and non composted Cattle feedlot manure. *Journal of Environmental Quality*, *ProQuest Science Journal,* 35 (3): 928-937.

[13] Ghabbour, E.A., Davies, D., Lam, Y. Y. and Vozzella, M.E. 2004. Metal binding by humic acids isolated from water hyacinth plant (*Eichhornia crassipes* (Mart.) Solms-Laubach Pontederiaceae) in Nile Delta, Egypt. *Environmental Pollution,* 131: 445 – 451.

[14] Gomez, K. A. and Gomez, A. A. 1984. *Statistical procedures for Agricultural research* (2nd Edition). John Wiley and sons, New York, 680 pp

[15] Gunnarsson, C. C. and Petersen, C. M. 2007. Water hyacinths as a resource in agriculture and energy production. A literature review.*Waste Management,* 27: 117-129.

[16] Haug, R.T. 1993. The practical handbook of composting engineering, Lewis publishers, ISBN 0-87371-373-7, Boca Raton (Florida)

[17] Hugar, H. Y. and Palled, Y. B. 2008. Studies on maize-vegetable intercropping systems. *Karnataka Journal of Agricultural Sciences,* 21 (2): 162-164.

[18] ICARDA (International Centre for Agricultural Research in the Dry Areas). 2013. Methods of Soil, Plant, and Water Analysis: A manual for the West Asia and North Africa region Es: George Estefan, Rolf Sommer, and John Ryan-Third Edition, 244 pp.

[19] IITA (International Institute of Tropical Agriculture). 1979. *Selected Methods for Soil And Plant Analysis,* Manual Series. I.I.T.A, Ibadan, (1): 4-12.

[20] IITA (International Institute of Tropical Agriculture). 1982. Automated and Semi Automated Selected methods of soil and plant analysis. *International Institute of Tropical Agriculture,* Ibadan Nigeria. IITA Manual series, No. 7, p 25, IITA, Ibadan, Nigeria.

[21] Iken, J.E. and Amusa, N.A. 2004. Maize research and production in Nigeria. Institute of Agricultural Research and Training (IAR&T), Obafemi Awolowo University, PMB 5029, Moor Plantation, Ibadan. Nigeria. Pp. 302-307.

[22] Kamanu, J.K., Chemining'wa, G.N., Nderitu, J.H. and Ambuko, J. 2012. Growth, yield and quality response of snap bean (*Phaseolus vulgaris L.*) plants to different inorganic fertilisers applications in central Kenya. *Journal of Applied Biosciences,* 55: 3944–3952.

[23] Maingi, J. M., Muthini, M., Mukaminega, D., Amoding, A., Muoma, J.O., Ombori, O., Naluyange, V., Kawaka, F. and Osoro, N.O. 2013. Effects of water hyacinth (*Eichhornia crassipes* [mart.] solms) compost on growth and yield of common beans (*Phaseolus vulgaris*) in Lake Victoria Basin, *European International Journal of Science and Technology,* 3 (7): 173-186.

[24] Maingi, J. M., Osoro, N., Muoma, J. O., Amoding, A., Mukaminega, D., Muthini, M. and Ombori, O. M. 2014. Effects of Water Hyacinth (*Eichhornia crassipes* (mart.) solms) Compost on Growth and Yield Parameters of Maize (*Zea mays*). *British Journal of Applied Science and Technology,* 4 (4): 617-633.

[25] Nyle, C. and Brady, R. 2003. Nature and properties of soil. 13th edition, New York, pp 960.

[26] Oguike, P. C., Chukwu, G. O. and Njoku, N. C. 2006. Physico-chemical properties of a HaplicAcrisol in southeastern Nigeria amended with rice mill waste and NPK fertiliser. *African Journal of Biotechnology*, 5: 1058-1061.

[27] Ojobor, S. A., Obiazi C. C. and Egbuchua, C. N. 2017. Effects of different levels of compost manure on upland rice and soil chemical properties in Asaba, Delta State, Nigeria. *Global Journal of Agricultural Research,* 5 (1):25-35

[28] Onwonga, R.N. and Lelei, J.J. 2010. Mineral nitrogen and microbial biomass dynamics under different acid soil management practices for maize production. *Journal of Agricultural Sciences,* 2 (1): 16-30.

[29] Osagie, A.U. and Eka, O. U. 1998. Nutritional quality of plant foods. Post-Harvest *Research Unit*, University of Benin, Benin. pp. 34 – 41.

[30] Paul, R.S. and Wood. R. 2012. Water hyacinth (*Eichhornia crassipes* (Mart.) Solms) seed longevity and the implications for management. Developing solutions to evolving weed problems. 18th*Australasia Weed Conference,* Melbourne, Victoria, Australia. 8th – 11th October, 2012 pp.37-40

[31] PIA (Primary Industries Agriculture). 2010. Water hyacinth: Weed of National Significance. Retrieved October 17th, 2012

[32] Purseglove, J. W. 1992. Tropical Crops: Monocotyledons. Longman Scientific and Technical, New. York. Pp. 300 – 305.

[33] Seoudi, O. A. T. 2013. Utilisation of water hyacinth and banana wastes compost in reclamation of sandy soils for increasing growth, yield of cowpea. *Journal of Advanced Laboratory Research in Biology,* 4 (1): 37-45.

[34] Sharda, V. and Lakshmi, G. 2014. Water hyacinth as a green manure for organic farming. *International Journal of Research in Applied, Natural and Social Sciences,* 2: 65-72.

[35] Subedi, K. D. and Ma, B. L. 2005. Ear position, leaf area, and contribution of individual leaves to grain yield in conventional and leafy maize hybrids. *Crop Science,* 45: 2246-2257.

[36] Tejada, M., Hernandez, M.T. and Garcıa, C. 2006. Application of two organic amendments on soil restoration: effects on the soil biological properties. *Journal of Environment Quality,* 35: 1010–1017.

[37] Wilson, J. R., Holst, N. and Rees, M. 2005. Determinants and patterns of population growth in water hyacinth. *Aquatic Botany,* 81: 51-67.