Journal of Agricultural Technology 2012 Vol. 8(3): 1109-1118
Available online http://www.ijat-aatsea.com
ISSN 1686-9141

Response of water hyacinth manure on growth attributes and yield of *Celosia argentea* L (Lagos Spinach)

Sanni, K.O.[1] and Adesina, J.M.[2*]

[1]Department of Crop Production and Horticulture, Lagos state Polytechnic, Ikorodu, Lagos, Nigeria, [2]Department of Crop, Soil and Pest Management Technology, Rufus Giwa Polytechnic, P. M. B. 1019, Owo, Ondo State Nigeria

Sanni, K.O. and Adesina, J.M. (2012) Response of water hyacinth manure on growth attributes and yield of *Celosia argentea* L (Lagos Spinach). Journal of Agricultural Technology 8(3): 1109-1118.

Water hyacinth *Eichhornia crassipes* (Pontederiaceae, Liliales) is a floating aquatic weed and the world most harmful weed because of its negative effects on waterways and people's livelihood. Efforts made to combat the water hyacinth problems were not at all successful. It is against this backdrop that the experiment was conducted to evaluate the responses of water hyacinth manure (WHM) on the growth and yield of *Celosia argentea* (Lagos spinach) at the Teaching and Research Farms of Lagos State Polytechnic, Ikorodu in 2011 cropping season. There were 3 treatments replicated 3 times: 1.32kg/plot (30g/plant); 2.64 kg/plot (60g/plant) and control treatment with no water hyacinth manure application. Treatments were compared on the basis of number of leaves, plant height, stem girth before and 3 weeks after manure application and yield at maturation. The results revealed that application of water hyacinth manure significantly influenced the growth and yield of *C. argentea* and among the treatments water hyacinth manure (WHM) applied at the rate of 2.64kg/plot (60g/plant) performed best in all the parameters evaluated. From the study it can be concluded that water hyacinth is locally available, plentiful and cost free, its effective use as organic soil amendment would be an interesting method for soil restoration and would minimize partially and/ or totally the negative impacts of this weed on the aquatic ecosystem and socioeconomic activities.

Key words: aquatic weed, evaluate, manure application, negative, water hyacinth.

Introduction

Efforts at remediating soil fertility over the years have basically been achieved using traditional resources of farmyard manure and crop residues in composted forms as well as use of inorganic fertilizer (Lata & Veenapani, 2011). The use of manure application enhances soil productivity, increases the soil organic carbon content, soil micro-organisms, improves soil crumb structure, the nutrient status of the soil and enhances crop yield (Beckman,

* Corresponding author: Adesina, J.M.; e-mail: moboladesina@yahoo.com

1973). Organic manure is also very cheap and effective as a good source of nitrogen for sustainable crop production, but its availability remains an important issue due to its bulky nature, while inorganic fertilizer is no longer within the reach of poor-resource farmers due to its high cost (Rahman, 2004).

The use of other technologies such as organic fertilizers from unexploited natural resources would be a better alternative to improve soil fertility and increase crop yield; and over the years one largely overlooked resources available for soil fertility improvement is the use of non-traditional organic materials such as weeds.

Water hyacinth *Eichhornia crassipes* (Pontederiaceae, Liliales) is a floating aquatic weed and the world most harmful weed because of its negative effects on waterways and people's livelihoods (Epstein, 1998; Ghabbour *et al.* 2004; Wilson *et al.* 2005).

However findings from many investigators have shown that the water hyacinth weeds have a useful role for other purposes. They are considered as a valuable source of macronutrients such as phosphorus, nitrogen and potassium that are essential for plant nutrition (Woomer *et al.* 2000; Sahu *et al.* 2002; Center *et al*. 2002; Sannigrahi *et al*. 2002; Gupta *et al*. 2004). Ponddar *et al.* (1991) indicated that the nutrient concentration found in water hyacinth vary with the environment where it grows such as lakes, marshlands, ponds and ditches. Efforts made to combat the water hyacinth problems were not at all successive.

Celosia argentea L., known also as Lagos spinach (Badra, 1991), is a leaf vegetable crop belonging to the family Amaranthaceae. The crop is very popular in south western Nigeria due to the softness of the leaf texture, popularly called „sokoyokoto by the Yorubas (Schippers, 2000). *Celosia* has a very high nutritive value, and both the grain and the leaf is widely used and processed into many food items, supplements and additives (NIHORT, 1986; Akingbala *et al.* 1994). The vegetable is accredited with possession of high nutritional values of essential nutrients like calcium, phosphorous, iron and other important components such as vitamins C, fiber, carbohydrate, fat and a high calorific value (Badra, 1991). It contains a high level of protein with C3 cycle of photosynthesis which allows it to perform optimally under partly shaded conditions (Badra, 1991; Schippers, 2000).

The crop is predominantly produced in Nigeria by resource-poor farmers and compound gardens where it is intercropped with arable starchy staples to produce enough food to satisfy their dietary and cash requirements (Akinyemi and Tijani-Eniola, 1997), and to minimize the risk of crop failure. The average yield of this crop (7.60 ton ha-1) has been limited by obsolete cultural practices employed in its production, such as non-use of manure/fertilizer input among

others (FAO, 2004). For commercial production, optimum performance of the crop must be desirable through changes in cultural practices (Sterrett and Savange, 1989) including soil fertilization of the crop, with organic to increase plant growth and crop yield. Therefore this study was carried out to find another alternative method of water hyacinth management by using it as an organic fertilizer on the growth and performances of *Celosia argentea.*

Materials and methods

This research was carried out on a 102.9m^2 piece of land at the Teaching and Research Farms of Lagos State Polytechnic, Ikorodu, Lagos state (Latitude 5^0 10' N and Longitude 3^0 16') in 2011 cropping season. The land has been previously cropped with maize intercropped with cassava. The land was manually cleared using cutlass and debris parked and seedbed manually prepared using hoe. The experimental plots were marked out; each bed had a dimension of 2.7m × 1.5m, with 1m discard between plots. A composite sample of the soil was taken randomly using soil auger to determine the soil physiochemical properties before the commencement of the experiment. Soil pH was taken using digital pH meter. Soil organic carbon was determined by the Walkley Black Modified method, while Ca, Mg, K, P, Na, Mn, Cu, Zn and Fe were determined by the Mehlich-3 extraction procedure (Mehlich, 1984). Total nitrogen was analyzed by the Technicon AA II method (IITA, 1982). Particle size distribution was determined with a hydrometer (Bouyoucos, 1962) using sodium hexa meta-phosphate as the dispersing agent. Physiochemical composition of the soil is shown in Table 1.

Preparation of water hyacinth manure

Large quantity of water hyacinth was collected from river Majidun in Ikorodu area of Lagos State. The roots were washed to remove the attached dirt and was pounded using mortar and pestle into slurry; this to make fermentation to be faster, thereafter 20 kg of pounded water hyacinth was thoroughly mixed with 200cm^3 (2 litres) of water, and the whole mixture was kept in a clean plastic buckets and covered for 3 months in order to allow for fermentation to take place (Sanni & Adesina, 2012). The purpose of allowing the slurry to undergo fermentation is to enable the toxic elements of cadium, lead, zinc and nickel to be reduced to the lowest concentration (Lawal, 1988 personal com; So *et al.* 2003). Sample of the pounded water hyacinth were taken to the laboratory for analysis of its chemical composition (Table 2).

Experimental Design and Treatments

The experiment was laid out in Randomized Complete Block Design (RCBD) with three treatments replicated three times. The treatments are: control (with no water hyacinth compost) (Treatment I); water hyacinth manure (WHM) applied at the rate of 1.32kg/bed with 30g applied per plant (Treatment II) and water hyacinth manure (WHM) applied at the rate of 2.64kg/plot with 60g applied per plant (Treatment III). The treatments were allocated to the plots using an efficient randomization procedure (balloting).

The seeds local red variety of *C. argentea* used for the study was obtained from Ogun State Agricultural Development Project (OGADEP), Abeokuta, Nigeria. Sowing of the seed was done by broadcasting 18th May, 2011 on well prepared seedbed to serve as nursery and covered with palm frond to provide shade for the growing seedlings. Three weeks after sowing, the seedlings were transplanted to a well-constructed seedbed at a spacing 30cm × 30cm. Selective weeding was carried out in the nursery and 3 weeks after transplanting (WAT) to ensure efficient use of the manure applied. Foliage insect was control using cypermethrin at 2 WAT. The water hyacinth manure (WHM) was applied 1 WAT using ring application method and was done by placing the manure 5cm away round the base of the plant. Fresh shoot were harvested at fresh succulent stage using sickle and harvesting was at weekly interval.

Data Collection and Analysis

Ten (10) plants were randomly selected and tagged from each replicate and the following data were collected: number of leaves before manure application (BMA); plant height BMA; stem girth BMA; number of leaves 3 weeks after manure application (WAMA); plant height 3 WAMA; stem girth 3 WAMA and yield of the plant at maturation. Data collected on growth parameters and yield were analysed statistically using one way Analysis of Variance (ANOVA) procedure (SAS, 1990) and significance of treatment means was tested using least significant difference test at 5% probability level. Pooled analyses were carried out within location across years/seasons (Gomes & Gomes, 1984).

Results

Pre cropping soil analysis determined showed that the soil contained total N, 0.25%; available P, 7.60 mgkg^{-1}; and exchangeable bases of Ca, Mg and K, with values of 0.18, 7.0 and 0.21mol kg^{-1} respectively, and soil pH of 6.4 with a sandy loam textural class (Table 1). Water hyacinth manure analysis revealed

organic matter 33%, N, 2.56; P, 1.90; K, 1.35; Mg, 1.70 Ca, 1.85 and Fe, 0.70 (Table 2).

Table 1. Physio-chemical composition of the soil at the experimental site

Composition Chemical properties	Value	Class/grade
pH	6.4	Slightly acidic
Total Nitrogen %	0.25	very low
% Organic matter	0.73	very low
Available P (mg/ kg^{-1})	7.6	low
Ca (mol/kg^{-1})	0.18	low
Mg (mol/kg^{-1})	7.0	low
K (mol/kg^{-1})	0.21	very low
Iron (ppm)	6.9	low
Manganese (ppm)	7.0	low
Sulphur (ppm)	128.0	moderately low
Chloride (ppm)	12.5	very low
Physical properties	63.8	
Sand %	25.0	
Silt %	11.2	
Clay %	sandy loam	
Textural class		

Table 2. Chemical composition of water hyacinth manure

Nutrient	Value (%)
Potassium	1.35
Calcium	1.85
Nitrogen	2.56
Phosphorus	1.90
Organic carbon	33.0
Magnesium	1.70
Iron	0.70

Growth parameter before water hyacinth manure application

Results showed non-significant ($P<0.05$) effect of water hyacinth manure (WHM) on the number of leaves, plant height and stem girth before application (Table 3). The growth parameter recorded close number of leaves for plant treated with 2.64kg/plot (15.5), followed by T2 (15.3) and control treatment being the lowest (15.1). Lowest plant height growth (12.9cm) and stem girth development (2.33cm^2) was observed in the plot treated with 1.32kg and 2.64kg WHM application; and the tallest plant (13.5cm) and highest stem girth

(2.36cm^2) was recorded in plot treated with 2.64kg and 1.32kg WHM respectively (Table 3).

Table 3. Mean number of leaves, plant height and stem girth before water hyacinth manure application

Treatments	No of leaves	Plant height (cm)	Stem girth (cm^2)
T_1	15.1	13.2	2.34
T_2	15.3	12.9	2.36
T_3	15.5	13.5	2.33
LSD (5%)	NS	NS	NS
SE	0.22	0.86	0.02

Growth parameter after water hyacinth manure application

Water hyacinth manure (WHM) had significant ($P<0.05$) effect on the leaf number, plant height and stem girth 3 weeks after manure application (Table 4). The trend obtained from the result shows an increase in the growth parameters with the increased in the WHM application rates. The highest leaf number (127.2 leaves plant $^{-1}$) was recorded in plot treated with 2.64kg WHM, followed by plot treated with 1.32kg (84.1 leaves plant $^{-1}$) and the lowest is control treatment (61.9 leaves plant $^{-1}$). Similar trend was observed in plant height growth, plot treated with 2.64kg WHM recorded tallest height (40.30 cm), followed by T2 (31.20 cm) and the shortest being plot with no WHM (26.30 cm) and there was significant difference among the treatments compared to control. Highest stem girth development (5.44cm^2) was recorded in the plot treated with 2.64kgWHM, followed by plot treated with 1.32kg WHM and lowest stem girth in plot with no WHM.

Table 4. Mean number of leaves, plant height and stem girth 3 weeks after water hyacinth manure application

Treatment	No of leaves	Plant height (cm)	Stem girth (cm^2)
T_1	61.9	26.3	3.46
T_2	84.1	31.2	4.16
T_3	127.2	40.3	5.44
LSD (5%)	3.52	2.95	0.22
SE	0.98	1.73	0.06

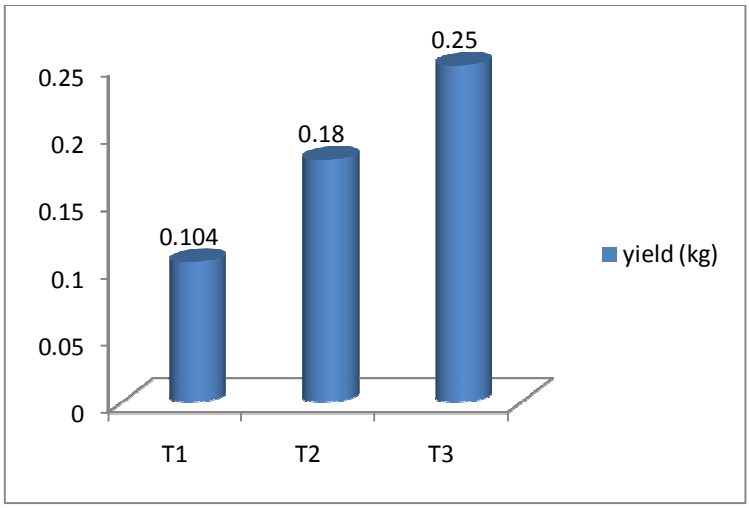

Fig. 1. Mean yield (kg) at harvesting

Yield

There was significant ($P<0.05$) effect of WHM on the yield of *Celosia argentea* with the highest yield obtained from plot treated with 2.64kg WHM (0.25 kg), followed by plot applied to 1.32kg WHM (0.18 kg), while plot applied to no WHM recorded lowest yield (0.10 kg) (Figure 4). The trend obtained from this result indicates that *C. argentea* respond with increase in the rate of WHM application rates.

Discussion

The benefit of using either crop residues such as water hyacinth residues has been reported by Widjajanto *et al*. (2001, 2002). The study of water hyacinth as organic manure revealed that the incorporation of water hyacinth into soil crop system increased the performance yield of the crop plant. Different rates of water hyacinth manure (WHM) used in this study was found to be more effective for the growth and yield of the test plant over the control.

Increase in plant growth and yield as a result of application of water hyacinth manure is expected in that manure contained and released considerable amount N and Mg for plant use during the process of mineralization. These are essential for formation of chlorophyll for photosynthesis in plants and the variation in growth parameters due to nutrient sources was considered to be due to variation in the availability of major nutrients. This conforms with the findings of Frank (2000) that a general increase in vegetative growth and yield was obtained when manures are applied

to plants; and also agrees with the findings of Majambu *et al*. (1985) that growth parameter sand yield of okra increased significantly as the fertilizer rate increased. The result of this study is in agreement with previous research of Majid (1980, 1983, and 1992), Kayum *et al.* (2008) Amitava *et al.* (2008), Chukwuka & Omotayo (2008, 2009) who reported enhancement in growth and yield/plant in rice, corn, sesame, brinjal, onion, gourd and maize using water hyacinth compost as well manure of water hyacinth. Gunnarssen & Petersen (2006) also highlighted that using composted water hyacinth material could serve as quality manure for improving soil fertility conditions and thus crop yields on the whole.

Conclusion

Since water hyacinth is locally available, plentiful and cost free, its effective use as organic soil amendment would be an interesting method for soil restoration and would minimize partially and/ or totally the negative impacts of this weed on the aquatic ecosystem and socioeconomic activities.

References

Akingbala JO, Adeyemi SA, Sangodoyin SO, Oke OI (1994) Evaluation of amaranth grains for oil manufacture. Plant Food for Human Nutrition 46:19-26.

Akinyemi, S.O.S. and Tijani-Eniola, H. 1997. Effects of cassava density on productivity of productivity of plantain and cassava intercropping system. Fruits 50: 17-23.

Amitava R., Sarkar N.C., Debashish S. (2008) Influence of organic manures on productivity of two varieties of rice. J. Cent. Eur. Agric. 9 (4): 629-634.

Badra T (1991) Lagos spinach in pulses and vegetables. In: Williams JT (ed) London, Chapman and Hall, pp 131-163.

Beckman E.O., (1973). Organic fertilization: vegetable farming luxury or necessity. Tech. Commun. ISHA. 29: 247.

Bouyoucos, G. J. 1962. Hydrometer methods improved for making particle size analysis of soils. Soil Science Society of America Proceeding 26: 464-465.

Center, T. D., Hill, M. P., Cordo, H. and Julien, M. H. (2002) Water hyacinth. In Van Driesche, R. (ed.) Biological control of invasive plants in the eastern United States. USDA Forest Service Publication FHTET, 41 – 46.

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

Chukwuka K. S., 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. Res. J. Soil. Biol. 1(1): 20-30.

FAO. 2004. Food and Agriculture Organisation statistical database. FAOSTAT website, http//faostat.fao.

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.

on different substrates. Journal of Food Science and Technology 41: 584 – 586.

IITA (1982) Automated and Semi Automated Methods for soil and plant analysis. Manual series No. 7. Published by International Institute for Tropical Agriculture (IITA), Ibadan-Nigeria.

Kayum M. A., Asaduzzaman M., Haque M. Z. (2008) Effects of Indigenous Mulches on Growth and Yield of Tomato. J. Agric. Rural. Dev. 6 (1-2): 1-6.

Lata, N. and Veenapani, D. (2011) Response of water hyacinth manure on Growth attributes and yields in *Brassica Juncea*. Journal of Central European Agriculture, 12(2), p.336-343 DOI: 10.5513/JCEA01/12.2.921.

Majambu, I.S, Ogunlela, J.D and Ahmed, M.K (1985) Response of two okra (*Abelmoschus esculentus* L Moench) varieties to fertilizer as influenced by nitrogen and phosphorus application. Fertilizer Research 6: 251 – 267.

Majid F .Z. (1983). Aquatic weeds and algae, the neglected natural resources of Bangladesh (Booklet).

Majid F.Z. (1992). Aquatic weeds, Utility and development (Ed. By S. S. Purohit), AgroBotanical Publishers (India), Dhaka Bangladesh, India.

Majid F .Z., Lutfun N., Sajeda B., Rahima K., Akhatar N. (1980) Use of naturally occurring algae as biofertilizer or organic manure. National Workshop on Algal systems proceedings. Madras, India. 26: 11-14. Oct. 3-4.

Mehlich, M. (1984) Mehlich-3 soils test extractant: A modification of the Mehlich 2 extractant. Comm. Soil Sci. Plant Anal. 15: 1409-1416.

NIHORT (1986) Advances in fruit and vegetable research at NIHORT (1978-1986) 62 pp

Rahman S.A., (2004).The place of organic manure in sustaining agricultural development in Nigeria. Paper presented at science technology and society national workshop in Lafia, Nasarawa state. 11th July.

Sahu, A.K., Sahoo, S. K., and Giri, S. S. (2002) Efficacy of water hyacinth compost in nursery pond for larval rearing of Indian major carp, *Labeo robitta*. Bioresource Technology 85: 309 – 311.

Sanni, K. O. & Adesina, J. M. (2012) Utilization of water hyacinth (*Eichhornia crassipies* mart solms) as liquid fertilizer on the growth and yield of fluted pumpkin (*Telfairia occidentalis*). South Asian Journal of Experimental Biology (in press).

Sannigrahi, A. K., Chakrabortty, B. and Borah, B. C. (2002). Large scale utilization of water hyacinth (*Eichhornia crassipes)* as raw material for vermi composting and surface mulching in vegetable cultivation. Ecology Environment Conservation 8: 269 – 271.

SAS, (1990) SAS Statistical Users guide, Statistical Analysis system, 5th Edition, SAS Institute Inc. Carry USA, pp. 1028.

Schippers RR (2000) African indigenous vegetables – an overview of the cultivated species. Natural Resources Institute ACP – EU Technical Centre for Agricultural and Rural cooperation chat harm, United Kingdom, 214pp

So, L. M., Chu, L. M. and Wong, P. K. (2003) Microbial enhancement of CU^{2+} removal capacity of *Eichhornia crassipes* (Mart). Chemosphere 52: 1499 – 1503.

Sterrett, S.B. and Savange, G.P. 1989. Culinary herbs as alternative crops. The Vegetable Growers News 42: 3-4.

Widjajanto D.W., Matsushila K., Honmura T., Miyanch N. (2001) Studies on the release of N from water hyacinth incorporated into soil-crop systems using 15N-labeling techniques. Part J. Biol. Sci. 4: 10754-1077.

Widjajanto D.W., Honmura T., Miyauchi N. (2002) Nitrogen release from green manure of water hyacinth in rice cropping systems. Pak. J. Biol. Sci. 5:740-743.
Wilson, J. R. Holst, N. and Rees, M. (2005) Determinants and patterns of population growth in water hyacinth. Aquatic Botany 81: 51 – 67.
Woomer, P. L. Muzira, R., Bwamiki, D., Metutikka, D., Amoding, A. and Bekunda, M. A. (2000) Biological management of water hyacinth waste in Uganda. Biology Agriculture Horticulture 17: 181 – 196.

(Published in May 2012)