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Vegetative Growth, Nutrient Uptake and Yield of Pumpkin under Liquid Organic Manures in a Tropical Agroecosystem

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Abstract: *A field trial was conductedduring the dry season of 2012 in the Research Farm of the Agricultural Education Unit (Department of Vocational Education), Delta State University, Abraka (latitude 5^0 46'N and longitude 6^0 5'E) within the humid forest of Southern Nigeria. The trial was aimed at assessing the growth and yield of flutedpumpkin in response to application of liquid organic manures made from water hyacinth and various animal manures.The experiment was a randomized complete block design. Five treatments which were replicated three times were used namely; control (P1), water hyacinth alone (P2), water hyacinth + pig manure (P3) , water hyacinth + cow dung (P4) and water hyacinth + poultry manure (P5). Liquid manures made from mixture of animal manure with water hyacinth significantly increased the vine length, branch number and leaf number, shoot fresh marketable yield and dry weight of pumpkin. Higher concentration and uptake of nitrogen, phosphorus and potassium was observed in the shoot of the plants which received liquid organic manures. Liquid organic manure made from mixture of poultry manure and water hyacinth out performed others. The study recommends that resource poor vegetable farmers to adopt this technology to improve on the productivity of their vegetables.*

Keywords*: fluted pumpkin, liquid organic manures, water hyacinth, vine growth*

I. Introduction

Fluted pumpkin (*Telfairia occidentalis* Hook. F), a creeping vine, trellised plant is one of leafy vegetables indigenous to Africa and cultivated for its leaf and edible seeds in Southern Nigeria (Horsefall and Spiff, 2005).Vegetables generally are nutrient demanding crops, and as such adequate soil fertility is require for crop growth. This is in view of the fact that most African soils are deficient in nutrients required for optimum crop growth, with special emphasis on low organic matter content (Shiyam et al., 2007). The need for soil fertility restorative measures using available and abundant organic wastes has been recognized by both farmers, extension agents and researchers (Adediran et al., 2003).

Unlike solid organic fertilizers which has already gained global recognition, liquid organic manures has limited use especially in tropical Africa. Liquid manures which form part of organic farming is rarely practiced by farmers in Nigeria. However, great potential exist for their integration into existing organic based farming practices, since smallholder crop farmers generally lack sufficient financial resources to acquire inorganic fertilizers. With the depleted nature of the soils of the Niger Delta which have low fertility with inherent multiple deficiencies in nutrients, low base saturation and cation exchange capacity (Opuwaribo et al., 1990), the need for organic amendments become very urgent, if the crops are to yield their potential productive capacity.

Significant increase in growth attributes such as leaf number, leaf area branch number, vine length, shoot fresh weight and total shoot yield of pumpkinhas been reported with use of organic fertilizer (Okoro, 2006; Fubara-Manuel et al. 2012). Shiyam and Binang (2014) also observed significant increase in proliferation of leaves, fresh and dry weights of plant and biomass production with organic manure applications in pumpkin.

This study was therefore aimed at evaluating the extent to which varied water hyacinth/animal manure mix liquid manures will influence the growth, nutrient uptake and yield of pumpkin.

II. Materials and Methods

A field trial was conductedduring the dry season of 2012 in the Research Farm of the Agricultural Education Unit (Department of Vocational Education), Delta State University, Abraka(latitude 5^0 46'N and longitude 6^0 5'E) within the humid forest of Southern Nigeria . Pre-planting soil analysis (0-15cm) showed: 791g kg^{-1} sand, 89gkg^{-1} silt, 120g kg^{-1} clay; pH (in water) 5.6; 0.77 g kg^{-1}total nitrogen and 49.6g kg^{-1} organic matter.

The experiment consist of five treatments namely; control (P1), water hyacinth alone (P2), water hyacinth + pig manure (P3) , water hyacinth + cow dung (P4) and water hyacinth + poultry manure (P5). The randomized complete block design was used, while the five treatments were replicated thrice.

Water hyacinth was collected from a polluted water source by the Warri River, while the animal manures were obtained from animal farms. Water hyacinth was shredded into pieces of less than 5cm. In co-

digested mixtures water hyacinth: animal manures were mixed in 75%:25% by dry weight. The liquid manures were made by fermentation process. In other to make the liquid organic manures, solid to water ratio by weight was 1:8. This is in line with recommendations for organic farming (Hills, 2003; Ituen et al., 2007; Organic, 2007). All the liquid manures were made with same proportion of total solid to water in the fermentation process, using 6.25kg of solid to 50 litres of water. Containers were sealed to exclude flies, prevent moisture loss, dropping of rainwater and reduce odour. Fermentation process was within a 21 day period, with periodic stirring at 7 days interval. Final products after the fermentation process were subjected to laboratory analysis using standard procedures described by IITA (1982). Results are shown in Table 1.

Table 1. Chemical composition of liquid organic manures

	Water hyacinth alone	water hyacinth + pig manure	water hyacinth + cow dung	water hyacinth + poultry manure
pH	6.5	6.3	6.1	6.0
N (%)	3.41	3.55	3.87	4.20
P (%)	2.91	3.06	3.11	3.27
K (%)	2.88	2.95	3.09	3.18
Mg (%)	0.09	0.17	0.14	0.21
Ca (%)	0.10	0.20	0.17	0.25
Zn (%)	0.07	0.11	0.13	0.12

The test crop was fluted pumpkin (*Telfairia occidentalis* Hook. F). Seeds were planted at a spacing of 1m x 1m to give a plant population of 10, 000m^2 on 3m x 3m beds. Two seeds were sown per hole and later thinned to one.Liquid manures were applied at a rate of 250 litres/ha. At 12 weeks after planting 3 plants were randomly selected for vegetative growth attributes and yield. Data collected include vine length, number of leaves, and number of branches, marketable shoot fresh weight and dry matter. Dried plant samples were milled and passed through 0.5mm sieve before analysis. Samples were analysed for nitrogen (N), phosphorus (P) and potassium (K) contentsusing methods described by AOAC (1990). Nutrient uptake was derived from the product of the dry matter and mineral content in plant tissues.In other to obtain crude protein content, nitrogen content in tissues was multiplied by 6.25.

` Data obtained were subjected to analysis of variance (ANOVA), and means found to be significant were separated using the least significant difference (LSD) at 5% level of probability using procedures described by Gomez and Gomez (1984).

III. Results and Discussion

The application of water hyacinth: poultry manure and other animal manure mixed with water hyacinth gave significantly ($p<0.05$) higher vegetative growth parameters such as vine length, number of branches and number of leaves when compared to the control (Table 2). The control was significantly ($p<0.05$) reduced compared to the organic liquid manure applications for the vegetative growth parameters studied. Liquid manure application with only water hyacinth had significantly ($p<0.05$) lower vine length, branch number and leaf number, but was however higher than the control. Mix of animal manure with water hyacinth generally increased vine length by 68%(water hyacinth + poultry manure), 48%(water hyacinth + cow dung) and 31% (water hyacinth + pig manure). Similar trend was observed with branch number and leaf number of pumpkin plantswith water hyacinth + poultry manure, giving the best vegetative growth attributes. The significant increase in vine length, branch number and leaf number is due to the high macronutrient content (Table 1) of the liquid organic manures. As noted by Ingham (2005),organic soil amendments made from a mixture of less woody green materials (such as water hyacinth) and animal manure will produce manure dominated with bacteria and other organisms which will facilitate biodegradation and release of nutrients into the soil for crop growth. The high nitrogen content of the water hyacinth may be due to its polluted source. Several authors (Satyakala. Et al, 1986; Simbarashe et al., 2011) have documented that the nutrient content of water hyacinth is dependent on whether the source of collection (polluted) is rich in nutrients or poor in nutrients (unpolluted). Various sections of the Warri River are polluted with organic wastes which would have enriched the river.

The application of liquid organic manures significantly ($p<0.05$) increased the fresh shoot marketable yield and dry weight of pumpkin. The highest fresh marketable yield and dry weightwere obtained from plants which received liquid manure made from water hyacinth/poultry manure mixture, with yields of 589.8kg/ha and 164.2kg/ha respectively. The least fresh marketable yield and dry weight was obtained from the plants which did not receive any manure (control) with value of 258.6kg/ha and 61.5kg/ha respectively. Increased fresh marketable yield due to liquid organic manure application over the control was 128.1%, 68.8%, 50.7%, 16.0% in water hyacinth/poultry manure, water hyacinth/cow dung, water hyacinth/pig manure and water hyacinth alone respectively.Improvements in growth parameters with application of organic manure confirms the findings of other researchers (Awodun, 2007; Mohammad et al., 2010; Agbo et al., 2012) which also observed significant increase in growth and yield of *T. occidentalis* and other vegetables with applied organic manures. Increased

vegetative growth and yield of *Celosia argentea* was also reported with water hyacinth based organic manures (Sanni and Adesina, 2012).

Table 2. Vine growth and yield of *Telfairia occidentalis*

Liquid Organic manure	Vine length (cm)	Branch number	Leaf number	Fresh shoot marketable yield(kg/ha)	Dry weight (kg/ha)
Control	93.6^{e}	3.6^{b}	28.3^{c}	258.6^{e}	61.5^{d}
Water hyacinth alone	128.0^{d}	5.2^{b}	40.5^{b}	300.1^{d}	77.8^{cd}
water hyacinth + pig manure	168.4^{c}	7.1^{ab}	48.6^{ab}	389.7^{c}	96.2^{c}
water hyacinth + cow dung	189.6^{b}	8.0^{a}	51.5^{a}	436.5^{a}	117.3^{b}
water hyacinth + poultry manure	215.2^{a}	9.2^{a}	54.3^{a}	589.8^{a}	164.2^{a}
LSD (5%)	23.6	2.6	6.3	42.7	20.2

Means with the same letters within the column are not significantly different (P <0.05)

The mineral content of *Telfairia occidentalis* shoot are shown in Table 3. Application of liquid organic manures significantly improved the macronutrient content and crude protein of pumpkin shoot. *Telfairia occidentalis* plants that received liquid manure made from water hyacinth + poultry manure had higher N (3.4%), P (0.78%) and K (0.58%) content. On the average the order of performance of the liquid manures based on mixture of water hyacinth and animal manures was as follows: poultry manure>cow dung>pig manure>. Water hyacinth alone had the least nutrient content. Crude protein was within the range of 12.88 to 21.31%.

Table 3.Mineral content of *Telfairia occidentalis* shoot

Liquid organic manure	Macronutrients			
Treatment	N (%)	P (%)	K (%)	C.P
Control	2.06^{b}	0.38^{b}	0.31^{c}	12.88^{c}
Water hyacinth alone	2.44^{b}	0.55^{ab}	0.38^{bc}	15.25^{b}
water hyacinth + pig manure	2.86^{a}	0.60^{a}	0.46^{abc}	17.88^{ab}
water hyacinth + cow dung	3.03^{a}	0.63^{a}	0.55^{ab}	18.94^{a}
water hyacinth + poultry manure	3.41^{a}	0.78^{a}	0.58^{a}	21.31^{a}
LSD (5%)	.0.95	0.23	0.18	3.42

Means with the same letters within the column are not significantly different (P <0.05)

Nutrient uptake for the three macronutrients studied which is a product of the nutrient content and shoot dry matter of the pumpkin is presented in Table 4. Nitrogen uptake in water hyacinth + poultry manure was significantly (P<0.05) higher than other liquid manures and the control. The least nitrogen uptake was observed in control and water hyacinth alone. Nitrogen uptake ranged from 126.69 to 559.92kgha^{-1}.Similar trend of nitrogen uptake was also recorded in phosphorus and potassium uptake. The phosphorus uptake had values within the range of 23.37 and 128.08kgha^{-1}, while potassium uptake ranged from 19.07 to 95.24kgha^{-1}.The higher nutrient composition in the shoots of *T. occidentalis* plants that received liquid organic manure as shown in both nutrient concentration and uptake was due to an unconstrained nutrient supply of soil applied nutrients to the plants. This is shown in the higher level of the crude protein, phosphorus and potassium in the organic applications. This implies that the use of organic soil amendments could be means of improving the food quality of *T. occidentalis*. This results agrees with earlier reports of Waring et al. (1985) and Giami et al. (1999) on the improved growth and chemical composition of crops which received balanced soil nutrients.

Table 4. Nutrient uptake (kg ha^{-1}) in *Telfairia occidentalis* shoot

Liquid Organic manure	N	P	K
Control	126.69^{e}	23.37^{d}	19.07^{d}
Water hyacinth alone	189.83^{d}	42.79^{c}	29.56^{cd}
water hyacinth + pig manure	275.13^{c}	57.72^{c}	44.25^{c}
water hyacinth + cow dung	355.42^{b}	74.03^{b}	64.52^{b}
water hyacinth + poultry manure	559.92^{a}	128.08^{a}	95.24^{a}
LSD (5%)	28.7	19.3	21.1

Means with the same letters within the column are not significantly different (P <0.05)

IV. Conclusion

Liquid organic manure made from a mixture of poultry manure and water hyacinth increased the vegetative growth and dry matter production of fluted pumpkin. This indicates that resource poor vegetable farmers in Nigeria can harness this biodynamic organic farming technology to improve the productivity of their vegetables.

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