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Full Length Research Paper

Growth and yield performance of *Corchorus olitorious* L. influenced by levels of poultry manure in Niger-Delta, Nigeria

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A field study was conducted at the Teaching and Research Farm of Delta State University, Asaba Campus in 2010 and in 2011 to investigate the effect of different levels of poultry manure on the growth and yield of *Corchorus olitorious* L. in Asaba, Nigeria. Seeds were sown at the rate of 15 × 30 cm achieving a population density of 222,222 plants/ha in a randomized completely block design, replicated 4 times. Poultry droppings were applied at the rate of 0, 10, 20 and 30 t/ha. Data were collected from net stands on plant height, stem girth, number of primary branches and number of leaves at 2, 4, 6 and 8 weeks after planting (WAP). Harvest was done from 8 WAP by cutting method and weighed for total biomass and later oven dried at 80°C for 24 h for dry weight while 1000 seeds were weighed from each treatment. The result shows that the experimental site was poor in soil fertility. The plant height, girth, number of primary branches and leaves increased with age and application of poultry manure. The plant height (66.00±0.01 and 70.00±0.04), stem girth (4.40±0.02 and 4.60±0.05), number of leaves (50.82±0.02 and 56.10±0.04), fresh weight (21.90±0.05 and 23.62±0.10) and dry weight (5.10±0.02 and 5.49±0.05) were statistically similar at 20 and 30 t/ha while the number of primary branches and 1000 seed weight did not differ ($P > 0.05$) at application of poultry manure. This study hereby recommended that application of 20 t/ha of poultry manure may contribute to improve *C. olitorious* L. production.

Key words: Plant height, stem girth, number of primary branches, number of leaves, dry yield, fresh yield, seed yield, poultry manure, *Corchorus olitorious,* soil fertilization.

INTRODUCTION

Jute mallow or Krin-krin (*Corchorus olitorious* L.) is an important leafy vegetable found in the wild and cultivated in many tropical countries of Africa and Asia (Schippers, 2000; Dhewa, 2003; Fondio and Grubben, 2004). The leaves are mucilaginous like okra fruit, which is prepared as a sauce. The sauce is enhanced with tomato stew for the consumption of starchy balls of cassava, maize, sorghum and yam (Asoegwu and Ibitoye, 1983; Akoroda, 1988).

The leaves of Jute mallow is rich in calcium, galactose, galacturonic acid, glucose, glucuronic acid, rhamnose, magnesium and iron and contains a high percentage of vegetable protein (Fondio and Grubben, 2004; Ndiovu and Afolayan, 2008). It contains fesolate and iron which are used for the prevention on anaemia and it is also used as an effective alternative drug therapy for the treatments of chronic cystitis, fever, gonorrhoea and tumour (Oyedele et al., 2006; Zakaria et al., 2006). Similarly, Grubben (2004), reported that ionone glucoside are extracted from jute mallow leaves which inhibits the activities of histamines. Apart from its uses as mucilage and as an effective alternative drug therapy, it is also used for the production of jute fibre due its strength, durability, availability and low production cost (Edmunds, 1990).

Krin-krin is a very common and popular crop in South-western Nigeria (Akoroda, 1988). This valuable and nutritious crop is becoming popular and gaining acceptability in Niger-Delta Nigeria especially Asaba, Delta State (Nigeria) capital and its surroundings. This may be due to its values has just been realized or cultural interference and diffusion. The yield is estimated at 20 to 41 t/ha for

for herbage and 7.8 to 9.6 t/ha for uprooted (Denton and Olufolaji, 2000). Similarly, Fondio and Grubben (2004) reported a yield of 20 to 25 t/ha in Nigeria, a yield of 5 t/ha in Bangladesh and 38 tonnes/ha in Cameroun, respectively.

For optimum performance of a crop, the nutrient contents of the soil should be adequate. The nutrient status of most tropical soils is low. Nigeria requires about fifty metric tonnes of inorganic or chemical fertiliser per annum while the supply is less than ten metric tonnes per annum (Business Day, 2008). The resource - poor farmer have little or no access to the inorganic manure or chemical fertiliser due to high cost, it may not be available when needed and above all, using fertiliser without soil testing fertiliser recommendation. This seldomly leads to under or over fertilisation of the soil and nutrient imbalance.

Organic fertiliser has been suggested to compliment inorganic or chemical fertiliser and bridge the demand and supply for fertiliser and for economic and environmental reasons (Obatolu, 1995; Adeniyan and Ojeniyi, 2005). Organic manure increases soil nutrient status and enhances the biological, chemical and physical properties of the soil (Agboola, 1988; FAO, 2005). Organic manure increases the nutrient status of the soil through gradual release of nutrients to the soil (Egherevba and Ogbe, 2002; Ibeawuchi et al., 2006) and supports crop performance and yield (Adebayo and Akoun, 2002).

There are many sources of animal manure, which vary in chemical composition. The common sources are cattle manure, pig manure and poultry manure but poultry manure has higher phosphorous, potassium and nitrogen contents than the latter (Hsieh and Hsieh, 1990; Duncan, 2005). Agbede et al. (2008) and Duncan (2005) reported that poultry manure increased the N, P, K, Mg and Ca concentrations in the plant leaves and nitrogen, phosphorous and potassium contents of the soil. Similarly, Ano et al. (2003) and Olanikan (2006) posited that poultry manure increases organic matter status of the soil and enhanced crop production.

The nutrient status of the soil plays a unique and significant role in the quality of eventual crop performance and output (Law-Ogbomo and Nwachokor, 2010). However, there is dearth of information on fertiliser application on this newly realised and valuable *C. olitorious* L. production in Niger-Delta of Nigeria. Hence the objective of this study was to evaluate the effect of poultry manure on growth and yield of *C. olitorious* L. in a bid to optimise yield and productivity, in Asaba, Niger-Delta of Nigeria.

MATERIALS AND METHODS

The study was carried out in two wet seasons of 2010 and 2011 at the Teaching and Research Farm of Delta State University, Asaba campus, Asaba, Nigeria. Asaba is located at 06° 14 ^{1}N and 06° 49^{1}E of the equator with an elevation of 97.5 m above the sea level and a mean annual rainfall of 1505 to 1849 mm, mean temperature of 28±6°C, and a relative humidity of 69 to 80% (NIMET, 2008). Nested soil sampling technique was used for the soil samples which were randomly collected from the experimental sites at 0 to 20 cm depth with an auger. The soil samples were bulked, mixed and air dried under room temperature for 2 weeks and crushed to pass 2mm sieve and later subjected to physico-chemical analysis.

The soil particle size distribution was determined by Hydrometer method (Bouyoucous, 1951) using sodium hexametaphosphate as a dispersing agent. Organic carbon content was determined by modified wet oxidation method of Walkey and Black (1945). The soil pH was measured with the glass pH electrode in 1:1 soil-water ratio suspension. Total nitrogen was determined by a semi-micro kjedahl digestion distillation method (Bermer and Mulvalcy, 1982) while, the available phosphorous was determined by L-ascobic method (Bray and Kurtz, 1945). The total exchangeable acidity was assessed by method described by Maclean (1982), while the cation exchange capacity was determined by Ammonium Acetate technique. Similarly, exchangeable acidity (H^+ and Al^+) were determined using the KCl method and the percentage base saturation was calculated as the sum of exchangeable bases divided by the cation exchange capacity and multiplied by 100.

The experiment was laid in a randomized complete block design with four replicates. Each plot size measured 2 × 2 m with 0.50 m as interblock and interplot spaces. The treatments were 0, 10, 20 and 30 tonnes of poultry manure per hectare. *C. olitorious* L. seeds sourced from Delta State Ministry of Agriculture, Asaba were soaked for five to ten minutes in warm water before planting at the spacing of 30 × 15 cm achieving a population density of 222,222 plants/ha.

Data were collected from net stands on plant height, stem girth, number of primary branches and number of leaves at 2, 4, 6, and 8 weeks after planting (WAP) with a meter rule and vernier calliper while number of primary branches and leaves were visually counted. Harvest was done from 8 WAP by cutting method and the fresh plants were weighed for total biomass with a sensitive scale and later oven dried at 80°C for 24 h for dry weight while 1000 seeds were weighed from harvested fruits. The data for the two (2) years were pooled. All the data were subjected to analysis of variance (SAS, 2005) and means showing significant differences were separated using Duncan multiple range test (Duncan, 1955).

RESULTS

Physical and chemical properties of the soil

The results of the pre-planting physical and chemical properties of the soil are presented in Table 1. The experimental site is sandy loam in texture with dominant fraction of sand as 830 gkg^{-1}(Table 1). The soil pH was 6.20 indicating that the soil was slightly acidic. The organic matter contents of the soil was (1.08 gkg^{-1}) low. The available P, exchangeable K and Ca were low with values of 7.46 ppm, 0.12 and 2.0 $cmolkg^{-1}$ respectively while the Mg contents of the soil was medium with value as 1.80 $cmolkg^{-1}$ (Table 1).

Chemical properties of the poultry manure used for the study

The chemical properties of poultry manure used in the study are indicated in Table 2. The pH was slightly alka-

Table 1. Pre-planting soil physico-chemical properties.

Soil property	Value
Sand (gkg-^{1})	830
Silt (gkg-^{1})	70
Clay (gkg-^{1})	100
pH 1:1 water	6.20
Percentage organic carbon	0.62
Percentage organic matter	1.08
Available P (ppm)	7.46
Ca^{++} (cmol kg-^{1})	2.00
Mg^{++} (mgkg-^{1})	1.80
K^{+} (cmol kg-^{1})	0.12
Na^{+}(cmol kg-^{1})	0.22
H^{+} (cmol kg-^{1})	0.80
Al^{3+} (cmol kg-^{1})	0.10

Table 2. Poultry manure analysis.

Treatment	Value
pH 1:1 water	7.50
Organic carbon (%)	23.80
Organic matter (%)	35.42
Total N (%)	1.21
Available P (mg/kg)	0.87
Ca^{++}	5.70
Mg^{++}	1.30
K^{+}	0.30
Na^{+}	0.11

line (7.50) while the percentage of organic carbon and organic matter contents were 23.80 and 35.42, respectively (Table 2). The poultry manure was high in total N, high in K^{+} (0.30 cmolkg^{-1}), high in Ca^{++} (5.70 cmolkg^{-1}), low in available P (0.81 mglkg^{-1}), and Mg^{++} with value as 1.30 cmolkg^{-1} (Table 2).

Plant height

The effects of different levels of poultry manure on plant height are presented in Table 3. The plant height increased ($P < 0.05$) from 2 (6.54 cm) to 8 WAP (71.75 cm). The plant height was ($P < 0.05$) taller at application of 30 t/ha of poultry manure at 6 to 8 WAP than at application of 0 to 20 t/ha (Table 3). *C. olitorious* L. height was most significantly depressed at application of 0 t/ha of poultry manure as 50.87 cm at 8 WAP (Table 3).

Plant girth

The plant girths as influenced by application of poultry manure are indicated in Table 4. The plant girths were not not ($P > 0.05$) different at 2 to 4 WAP (Table 4). At and beyond the 6th week after planting, plant girth in soils at application of 30 t/ha of poultry manure was ($P < 0.05$) enhanced. At 8 WAP, the plant girth was highest in soils at application of 30 t/ha as 4.60 cm (Table 4).

Number of primary branches

The effects of poultry manure on number of primary branches are presented in Table 5. The number of primary branches increased with increase with age of *C. olitorious* L. crop from 1.21 to 4.27 (Table 5). The number of primary branches were not ($P > 0.05$) different at application of 0 to 30 t/ha of poultry manure at 2 to 8 WAP, although the number of primary branches were higher in the order of application of 30 > 20 > 10 > 0 t/ha of poultry manure (Table 5).

Number of leaves

The leaf productions as influenced by application of poultry manure to soils are indicated in Table 6. The numbers of leaves increased ($P < 0.05$) from 2 to 8 WAP (5.78 to 56.10) across the treatments (Table 6). At 4 to 8 WAP, the numbers of leaves were similar at application of 20 to 30 t/ha but were ($P < 0.05$) higher than at application of 0 to 10 t/ha of poultry manure (Table 6). At final observation, the leaf production were most depressed at application of 0 t/ha of poultry manure as 39.00 (Table 6).

Yield

The influence of different levels of poultry manure soils on total fresh weight; dry fresh weight and 1000 seed weight are presented in Table 7. The fresh weight ranged from 15.30 to 23.62 t/ha and the dry weight ranged from 3.35 to 5.49 t/ha (Table 7). The fresh leaf weight and dry weight did not differ ($P > 0.05$) at applications of 20 to 30 tonnes/ha but were ($P < 0.05$) higher at application of 0 to 10 t/ha of poultry manure (Table 7). These parameter were most significantly depressed at application of 0 t/ha of poultry manure as 15.30 t/hat for fresh leaf weight and 3.35 t/ha for dry leaf weight (Table 7). The 1000 seed weight ranged from 2.01 to 2.45 g but were not ($P > 0.05$) different at applications of 0 to 30 t/ha of poultry manure (Table 7).

DISCUSSION

The pre-planting soil analysis showed that the soil of the experiential site was low in soil nutrient status. The poor nutrient status may be due to leaching of basic cations, intensive rainfall and perhaps due to the parent materials of quartz and sesquioxides which are poor in plants nutrients. This agreed with the findings of Nnaji et al.

Table 3. Effect of different levels of poultry manure on plant height (cm).

Levels of poultry manure	Weeks after planting			
	2	4	6	8
0	$6.54^{b} \pm 0.05$	$40.84^{a} \pm 0.02$	$43.55^{b} \pm 0.03$	$50.87^{c} \pm 0.05$
10	$8.08^{a} \pm 0.01$	$44.61^{a} \pm 0.04$	$50.75^{b} \pm 0.05$	$60.94^{b} \pm 0.03$
20	$8.26^{a} \pm 0.02$	$46.86^{a} \pm 0.05$	$55.43^{ab} \pm 0.04$	$66.00^{ab} \pm 0.01$
30	$8.26^{a} \pm 0.01$	$47.00^{a} \pm 0.01$	$62.38^{a} \pm 0.02$	$70.00^{a} \pm 0.04$

Means in the same row with similar letter superscript are not statistically different at 5% level of probability according to Duncan multiple range test.

Table 4. Influence of different levels of poultry manure on plant girth (in cm).

Levels of poultry manure	Weeks after planting			
	2	4	6	8
0	$0.40^{a} \pm 0.05$	$1.16^{a} \pm 0.04$	$2.18^{a} \pm 0.01$	$3.40^{a} \pm 0.02$
10	$0.54^{a} \pm 0.02$	$1.41^{a} \pm 0.05$	$2.75^{a} \pm 0.05$	$4.04^{a} \pm 0.01$
20	$0.60^{a} \pm 0.02$	$1.75^{a} \pm 0.01$	$2.85^{a} \pm 0.01$	$4.40^{a} \pm 0.02$
30	$0.61^{a} \pm 0.04$	$2.01^{a} \pm 0.03$	$3.04^{a} \pm 0.05$	$4.60^{a} \pm 0.05$

Means in the same row with similar letter superscript are not statistically different at 5% level of probability according to Duncan multiple range test.

Table 5. Effect of different levels of poultry manure on number of primary branches.

Levels of poultry manure	Weeks after planting			
	2	4	6	8
0	$1.21^{a} \pm 0.10$	$2.64^{a} \pm 0.05$	$3.04^{a} \pm 0.01$	$3.43^{a} \pm 0.03$
10	$1.60^{a} \pm 0.02$	$2.80^{a} \pm 0.04$	$3.32^{a} \pm 0.04$	$4.05^{a} \pm 0.01$
20	$1.84^{a} \pm 0.04$	$2.86^{a} \pm 0.03$	$3.63^{a} \pm 0.02$	$4.11^{a} \pm 0.05$
30	$2.04^{a} \pm 0.05$	$3.42^{a} \pm 0.10$	$3.91^{a} \pm 0.01$	$4.27^{a} \pm 0.04$

Means in the same row with similar letter superscript are not statistically different at 5% level of probability according to Duncan multiple range test.

Table 6. Influence different levels of poultry manure on number of leaves.

Levels of poultry manure	Weeks after planting			
	2	4	6	8
0	$5.78^{a} \pm 0.10$	$23.37^{a} \pm 0.05$	$35.40^{b} \pm 0.01$	$39.00^{b} \pm 0.01$
10	$5.94^{a} \pm 0.01$	$31.31^{a} \pm 0.03$	$42.10^{ab} \pm 0.04$	$45.70^{ab} \pm 0.03$
20	$6.00^{a} \pm 0.05$	$32.68^{a} \pm 0.02$	$46.30^{a} \pm 0.01$	$50.82^{a} \pm 0.02$
30	$6.03^{a} \pm 0.02$	$36.62^{a} \pm 0.04$	$48.31^{a} \pm 0.05$	$56.10^{a} \pm 0.04$

Means in the same row with similar letter superscript are not statistically different at 5% level of probability according to Duncan multiple range test.

(2005) and Aberger (2006) who reported large losses of basic cations due to leaching and high intensity and duration of rainfall in Southern Nigeria.

The ($P < 0.05$) higher plant height, girth, number of primary branches and number of leaves at higher application of poultry manure may be attributed to poultry droppings, which were a potential source of nutrients to the soils. The decomposed poultry droppings enhanced mineralization of nutrients in the soils.

Egherevba and Ogbe (2002) and Ibeawuchi et al.

Table 7. Influence of different levels of poultry manure on total fresh and dry weight of leaves (t/ha) and 1000 seed weight (g).

Levels of poultry manure	Fresh weight (t/ha)	Dry weight (t/ha)	1000 seed weight (g)
0	$15.30^{b} \pm 0.05$	$3.35^{b} \pm 0.05$	$2.01^{a} \pm 0.01$
10	$16.20^{b} \pm 0.04$	$3.94^{b} \pm 0.01$	$2.14^{a} \pm 0.05$
20	$21.90^{a} \pm 0.01$	$5.10^{a} \pm 0.02$	$2.28^{a} \pm 0.02$
30	$23.62^{a} \pm 0.10$	$5.49^{a} \pm 0.05$	$2.45^{a} \pm 0.01$

Means in the same row with similar letter superscript are not statistically different at 5% level of probability according to Duncan multiple range test.

(2006) reported that poultry manure and organic manure increased the nutrient status of the soil through gradual release of nutrients to the soil. Similarly, Duncan (2005) and Agbede et al. (2008) reported that poultry manure increased nitrogen, phosphorous and potassium contents of the soil, while Ano et al. (2003) and Olanikan (2006) reported that poultry manure increased organic matter status of the soil and enhanced crop production.

The non significant difference in ($P > 0.05$) leaf production and stem girth at applications of 20 and 30 t/ha and ($P < 0.05$) higher than at application of 0 to 10 t/ha of poultry manure at 8 WAP suggests that application of the latter may be the optimum growth resource for stem and leaf production.

The plant height, girth, number of primary branches and number of leaves being most depressed at application of 0 t/ha of poultry manure suggests, that the nutrient status of the soil was poor and can be adduced to due to high intensity rainfall, leaching of basic cations and perhaps due to the parent materials of quartz and sesquioxides which are poor in plants nutrients (Nnaji et al., 2005; Aberger, 2006). The non significant difference ($P > 0.05$) in number of primary branches at application of 0 to 30 t/ha of poultry manure at 2, 4, 6 and 8 WAP, may be adduced to the genetic makeup of *C. olitorious* L. This confirms the views of Adeniji and Kehinde (2007) who reported a similar effect on *Abelmoschus caillei* [A. chev] Stevels.

The fresh weight of 15.30 to 23.62 t/ha obtained in the study, agreed with the findings of Denton and Olufolaji (2000) who reported a yield of 20.5 to 41.0 t/ha for cuttings and 7.8 to 9.0 t/ha of uprooted yield, respectively. The higher the rate of poultry manure application, the higher the fresh of Krin-krin (*C. olitorious* L.) leaves suggests better growth parameters observed. However, significant differences in fresh leaf weight and dry weight may be due to the rate of poultry manure application and which could have resulted from a positive relationship between nutrients contents in the soil and photosynthate production and accumulation.

Olanikan (2006) posited that poultry manure increased organic matter status of the soil and enhanced crop production. Similarly, Law-Ogbomo and Nwachokor (2010) reported that nutrient status of the soil plays a unique and significant role in the quality of eventual crop performance and output. This result agrees with the findings of Siemonsma (1991) who reported a linear relationship and high positive correlation between nutrient availability and photosynthate accumulation for maximum leaf yield in Okra.

The appreciable but non-significant difference ($P > 0.05$) in weight of 1000 seed at 0 to 30 t/ha of poultry manure application may be due to genetic makeup and size of the seeds. This confirms the findings of Madakadze et al. (2007).

Conclusion

The study reveals that the differences in the growth parameters and yield of *C. olitorious* L. (Jute mallow or Krin-krin) were most probably due to different levels of poultry manure applied to the soils. For higher leaf production, fresh leaf weight and dry weight of this rich, sumptuous and alternative to drug therapy vegetable in Asaba, Niger-Delta of Nigeria, poultry manure application of 20 t/ha is hereby recommended.

REFERENCES

Aberger A (2006). Soil fertility and plant nutrition in the Tropics and subtropics. http://www.fertilizer.org/ifacontent/down/

Adebayo O, Akoun J (2002). Effect of organic manure and spacing on the yield and yield components of *Amaranthus cruentus*. In: Proceedings of 20th Annual conference of Horticultural Society of Nigeria held at National Horticultural Research Institute (NIHORT) Auditorium Ibadan, pp. 30-32.

Adeniyan ON, Ojeniyi SO (2005). Effect of poultry manure, NPK 15 – 15 -15 and combination of their reduced levels on maize growth and soil chemical properties. Niger. J. Soil Sci., 15: 24-41.

Adeniji OT, Kehinde OB (2007). Combining ability and Genetic components for length and width of pods in West Africa okra (*Abelmoschus caillei* [A. Chev] Stevels). Chev.] Stevels). Agric. J., 2(1): 71-76.

Agbede TM, Ojeniyi SO, Adeyemo AJ (2008). Effect of poultry manure on soil physical and chemical properties, growth and grain yield of sorghum in South-western Nigeria. Ame-Eurasian J. Sustain. Agric., 2(1): 72-77.

Agboola AA (1988). The importance of maintaining soil organic matter in African farming systems. 1st Afr. Soil Sci. Congress, Kampala, Uganda.

Akoroda MO (1988). Cultivation of Jute mallow (*Corchorus olitorious* L.) for edible leaf in Nigeria. Trop. Agr., 65(4): 279-299.

Ano AO, Orkwor GC, Ikeorgu JEG (2003). Combination of legumes crops to nutrient availability and productivity of yam based systems. Niger. Agric., J. 34: 44–48.

Asoegwu SN, Ibitoye SN (1983). Effect of water stress on the growth, leaf yield and fruit set in Jews mallow *C. Olitorious*. NHRI. Paper

presented at the Annual Horticultural Society of Nigeria (HORTSON) held at University of Nigeria, Nsukka between November 6–9th, 1983.
Bermer JN, Mulvalcy CW (1982). Nitrogen total :Determination of total nitrogen by Micro-Kjeldahl method of soil analysis, chemical and micro biological properties part II. Am. Soc. Agron., 48: 114-121.
Bray RH, Kurtz LT (1945). Determination of total and organic of phosphate in the soil. Soil Sci. J., 59:45-49.
Bouyoucous GJ (1951). A recalibration of the hydrometer for making chemical analysis of soil. Agron. J., 43: 434-438.
Business Day Nigerian Newspaper (2008). How to produce organic fertilizer from Animal waste. Tuesday, April, 2008 edition.
Denton OA, Olufolaji OA (2000). Nigerian most important vegetable Crop. In: Agronomy in Nigeria, Compiled and Designed by Akoroda. pp. 85-93.
Dhewa C (2003). Post Harvest programme–Southern Africa. Zimbabwe (New Agriculturist online) Fegari, N.K.1992. Maximum crop yield, Mercel Dekker, Inc. New York, USA.
Duncan J (2005). Composting chicken manure.WSU cooperative extension, king county master Gardener and cooperative extension livestock adviser.
Duncan RD (1955). Multiple Range and multiple F test. Biometrics, 11: 25-40.
Edmunds JM (1990) Herbarium survey of African Corchorus species. Systematic and Ecogeographis studies on crop Genepools 4. Rome, Italy, p. 284. IBPGR/IJD
Egherevba RKA, Ogbe FM (2002). The effects of different levels of organic and mineral fertilizers on the yield performance of two Amaranths (*A. cruentus*) cultivars. Plt Sci., 3: 62-72.
FAO (2005). The importance of soil organic matter .Key to drought resistant soil and sustained food production. FAO soils Bulletin 80. Food and Agricultural Organization of the United Nations, Rome, Italy. p. 78.
Fondio L, Grubben GHJ (2004). Corchorus olitorious L. In: Grubben GHJ and Denton OA (Editors) PROTA 2: Vegetables/legumes [CD-Rom] Prota Wageningen.
Grubben GJH (2004). Plant resource of south East Asia. Backhuys publishers, pp. 75-79.
Hsieh SC, Hsieh CF (1990). The use of organic matter in crop production. FFTC Ext. Bull., 360: 20.
Ibeawuchi II, Onwerenmadu EU, Oti NN (2006). Effect of poultry manure on green (*Amaranthus cruentus*) and water leaf (*Talinum triangulare*) on degraded ultisol of Owerri, South Eastern Nigeria. J. Anim. Vet. Adv., 5(1): 53-56.
Law-Ogbomo KE, Nwachokor MA (2010) Soil physico-chemical properties of five soils formed on different parent materials in South Eastern Nigeria. http:www.insipub.com/rjabs.pdf/
Maclean EO (1982). Methods of soil analysis. Part II. Am. Soc. Agron., 9: 978-998.
Madakadze RM, Kodzanayi T, Mugumwa R (2007). Effect of plant spacing and harvest frequency on *Corchorus olitorious* leaf and seed yields. Afri. Crop Sci. Proc., 8: 272-282.
NIMET (Nigeria Meteorological Agency) Asaba, Nigeria, (2008).
Ndiovu J, Afolayan AJ (2008). Nutritional Analysis of South African wild vegetable *Corchorus olitorious*. Plant Sci., 7: 615-618.
Nnaji GU, Asadu CLA, Mbagwu JSC (2005). Morphology and physical characteristics of soil profile under cultivation and Natural forest. Proceedings of the 19th Annual conference of Farm Management Association of Nigeria. pp. 395-399.
Obatolu RC (1995). Nutrient balance sheet after coffee and maize cropping on an Afisols supplied with organic fertilizer in Ibadan, Nigeria. Afri. Soils. 28: 219-224.
Olanikan PC (2006). Organic manure as soil amendments in eroded tropical soils of South western Nigeria. J. Trop. Soils. 5(3): 11-18.
Oyedele DJ, Asonugho C, Awoteye OO (2006). Heavy metals in soil and accumulation by edible vegetables after phosphate fertilizer application. Elect. J. Agric. Food Chem., 5: 1446-1453.
SAS (2005). Statistical Analysis System, Cary, North Carolina.
Schippers RR (2000). African Indigenous vegetable. An overview of cultivated species. National Research Institute./ACP- EU Technical centre for Agricultural and Rural cooperation, Chathan, U.K. pp. 214.
Siemonsma JS (1991). Abelmoschus esclentus, a taxonomical and cytogenetical overview: In reports of International workshop on Okra genetic resources, New Delhi, India. Oct. 1990. Int. Crop Network Series 5, IBPGR Rome.
Walkey A, Black LA (1945). An examination of the oxidation methods for determining soil organic matter and proposed modification of the chronic and titration method. Soil Sci., 37: 29-38.
Zakaria ZA, Somchit MN, Zaiton H, Matjais AM, Sulaiman MR (2006). The *in vitro* antibacterial activity of *Corchorus Olitorious* L. extract. Int. J. Phamacol., 2: 213-215.