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FOLIAGE YIELD OF FLUTED PUMPKIN (*Telfairia occidentalis* HOOK F.) AS INFLUENCED BY ORGANIC MANURE AND CUTTING FREQUENCIES ON SOIL OF CALABAR, NIGERIA.

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ABSTRACT

Field experiment was conducted in the 2019 and 2020 early cropping seasons at the University of Calabar Teaching and Research Farm, Calabar, to assess the foliage yield of fluted pumpkin (*Telfairia occidentalis* Hook F.) as affected by organic manure and cutting frequency on soil of Calabar. The experiment was a factorial combination of four poultry manure rates (0, 3, 6 and 9 tonnes per hectare) and three cutting frequency (2, 3 and 4 weekly intervals), laid out in randomized complete block design (RCBD) with three replications. Data were collected on vine length, number of leaves, internode length, fresh leaves, dry matter weights and soil physico-chemical properties, and analyzed. Significant means were compared using Fisher's Least Significant Difference (FLSD) at 5 % probability. Results indicated that the sand proportions decreased after harvest while the silt and clay proportions, the soil pH, total nitrogen, organic carbon, organic matter, potassium, magnesium, effective cation exchange capacity (ECEC) and base saturation all increased after harvest in both cropping years. There were significant (p <.0. 05) effects of PM, cutting frequency and their interactions on vine length, number of leaves, internode length, fresh leaves and leaves dry matter weights in both years of study. Plots treated with 9 t/ha of PM produced the longest vines, higher number of leaves, heavier fresh leaf and leaf dry matter. This was followed by plots treated with 6 t/ha of PM while the lowest was the plot with zero PM treatment. Foliage harvest at 3-weekly cut intervals produced the highest cumulative number of leaves, fresh leaf and leaf dry matter weights, followed by the 4-weekly cut intervals while the lowest was the 2-weekly cut intervals. The interaction of 9 t/ha PM with 3-weekly cut intervals produced the best effect and is therefore recommended.

KEYWORDS: *Telfairia occidentalis*, poultry manure, cutting frequency, soil physico-chemical properties, foliage yield.

INTRODUCTION

Third world countries such as Nigeria, have continued to record increasing rates of malnutrition despite the rise in world food output (GHI, 2021). The most deficient nutrients include protein, vitamin A and iron (WFP, 2020). To reduce the ravaging menace of protein and iron malnutrition in Nigeria, increasing the production and supply of protein and iron rich vegetables such as fluted pumpkin (*Telfairia occidentalis* Hook F.) has become a necessity.

Fluted pumpkin is a dioecious, creeping vegetable crop that spreads low across the ground and climbs by means of creeping vines and often coiled tendrils. The crop is indigenous to West Africa (Kuku *et al*., 2014). In Nigeria, the leaves, flowers and seeds are consumed locally as vegetables by humans and fodder for livestock (Idem *et al*., 2012). It is an important vegetable crop that has high nutritional and commercial value (Kajihausa *et al.,* 2010). According to Muoneke *et al*. (2011), the leaves have about 700 ppm of iron, 11% ash, 3% oil, 25% carbohydrate, 11% crude protein and 86%

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moisture. Besides the nutritional importance of fluted pumpkin, the crop has been reported to possess medicinal and therapeutic properties such as anti-diabetic, anti-cholesterol, anti-bacterial and anti-inflammatory properties (Oluwole *et al*., 2003). However, commercial production of the succulent fresh leaves of fluted pumpkin in southern Nigeria is facing the challenge of poor soil fertility and harvesting interval dilemma.

The use of organic manure to improve soil fertility and enhance the vegetative performance of fluted pumpkin has been reported in Nigeria (Muoneke *et al*., 2011; Shiyam and Binang, 2013). Poultry manure (PM) is very rich in organic carbon which has been reported to improve soil bio-physical properties and support optimum crop performance (Idem *et al*., 2012). It also contains high amounts of major soil nutrients such as nitrogen, calcium, magnesium, potassium and phosphorus (Shiyam and Binang, 2013). Generally, the incorporation of PM to the soil increases its organic matter content, reduces erosion, enhances infiltration and retention of soil moisture, promotes the biological activities on the rhizosphere, improves the structure, neutralizes soil pH and makes more nutrients available to the soil. Field experiments conducted by Idem *et al*. (2012) and Shiyam and Binang (2013) in Uyo and Calabar respectively, showed that the application of poultry manure improved the soil physico-chemical properties and enhanced the performance of fluted pumpkin.

There is dearth of information on the effect of the frequency of fluted pumpkin fresh and succulent leaves harvest on its sustainable foliage production. Available literatures considered the effect of harvesting frequency on fruit yield (Ogar and Asiegbu, 2005; Chukwudi and Agbo, 2014) and proximate composition (Osadebe *et al.*, 2014). However, majority of fluted pumpkin farmers in the Calabar Metropolis and neighbouring communities engage in commercial production of its fresh and succulent leaves necessitating research that will clearly highlight the best cutting frequency for optimum leaf production of the crop. This field experiment was therefore conducted to evaluate the effect of organic manure and cutting frequency on the foliage yield of fluted pumpkin on soil of Calabar, Nigeria.

MATERIALS AND METHODS

A Field experiment was conducted in the 2019 and 2020 early cropping seasons at the University of Calabar Teaching and Research Farm, Calabar, to determine the impacts of organic manure and cutting frequency on foliage yield of fluted pumpkin on soil of Calabar, Nigeria. Calabar is located at the southeastern rainforest agro-ecological zone of Nigeria (4.5^0N - 5.2^0N, 8.3^0E), about 39 m above sea level and has a bimodal annual rainfall distribution that ranges from 3,000 mm to 3,500 mm with mean annual temperature range of 27 ^{0}C to 35 ^{0}C and relative humidity of 75 % to 88 % (Effiong, 2011). The experimental site was cleared with machete and the debris packed. The land was mapped out into uniform experimental plot units to meet the design specifications. Raised seed beds measuring 4 m x 5 m were made, harrowed and levelled using a spade. The experiment was a 4 x 3 factorial laid out in Randomized Complete Block Design (RCBD) with three replications. The twelve treatment combinations comprised of four PM levels (0, 3, 6 and 9 t / ha) and three harvesting frequencies (2, 3 and 4 week- periods). Composite soil samples were taken randomly 5 meters apart at a depth of 0 – 30 cm each of the study years using soil auger, before cropping and after harvest. The soil samples were thoroughly mixed, air-dried, sieved through a 2 mm sieve and analyzed for physico-chemical properties in the laboratory following the procedures described by Udo *et al*. (2009). The poultry manure was allowed to cure properly and applied by thoroughly mixing into the soil two weeks before the introduction of fluted pumpkin seeds. Fluted pumpkin seeds were sourced from Marian market in Calabar, Cross River State, Nigeria, and sown at 1 m × 1 m spacing, two per hole, and later thinned to one, giving a population of 10,000 plants per hectare. Growth parameters and foliage yield data were collected on vine length, number of leaves, internode length, fresh leaves weight and dry matter weight, from six middle plants per plot at 2-weekly, 3-weekly and 4-weekly intervals according to treatment specifications over a period of six months, after an initial uniform cut at 4 weeks after planting and the cumulative means recorded. Data collected were subjected to two-way analysis of variance (ANOVA) using the GenStat Package Version 8.1 of 2015. Significant means were compared using the Fishers Least Significant Difference (FLSD) method at 5% level of probability described by Wahua (2010).

RESULTS

Chemical properties of PM and physico-chemical properties of soils of the experimental site

The chemical properties of poultry manure used for the experiment and the physico-chemical properties of the preplanting and after harvest soils of the experimental site in both years of cropping are presented in Table 1. The results of the PM showed that it has pH values of 6.02 and 6.27 for 2019 and 2020 respectively, with moderate total nitrogen, organic carbon, magnesium and calcium, but low in available phosphorous, potassium and sodium. The soil results showed that the textural class was loamy sand. The sand proportions, available phosphorous and exchangeable acidity (H^+) decreased after harvest while the silt and clay proportions, soil pH, total nitrogen, organic carbon, organic matter, potassium, magnesium, effective cation exchange capacity (ECEC) and base saturation all increased after harvest in both cropping years. The values of exchangeable sodium before planting and after harvest were similar in 2019, but slightly decreased after harvest in 2020.

Effect of PM, cutting frequency and the interaction of PM and cutting frequency on vine length, number of growth parameters, fresh and dry leaf weights of fluted pumpkin in 2019 and 2020 cropping seasons

The effects of PM, cutting frequency and their interaction on vine length, number of leaves, number of vines, internode length, fresh leaf weight and dry leaf weight of fluted pumpkin in 2019 and 2020 cropping seasons are presented in Table 2. Results indicated significant effect of PM on all the components of foliage yield of fluted pumpkin measured. Plants in the plots treated with PM had significantly ($P \leq 0.05$) longer vines, higher number of vines, higher number of leaves, longer internodes, heavier fresh leaves and heavier dry matter than those in the plots not treated with PM in both cropping seasons, though, the number of vines obtained from plots treated with 3 t/ha of PM and those not treated with PM were statistically similar ($P > 0.05$) in both years. Significantly more vines that were longer with more leaves, longer internodes, heavier fresh leaves and heavier leaf dry matter were obtained from the plots treated with 9 t/ha of PM in both years of planting followed by 6 t/ha of PM, while the lowest values were obtained from the plots not treated with PM.

Table 1: Chemical properties of poultry manure (PM) and physico-chemical properties of soil in the experimental site for both cropping seasons

	2019			2020		
	PM	Preplanting soil	Soil after harvest	PM	Preplanting soil	Soil after harvest
Physical properties						
Sand (%)	-	82.90	76.30	-	80.25	75.00
Silt (%)	-	9.00	11.00	-	10.25	11.82
Clay (%)	-	8.10	12.70	-	9.50	13.18
Texture	-	Loamy sand	Loamy sand	-	Loamy sand	Loamy sand
Chemical properties						
pH (H_2O)	6.02	5.3	5.88	6.27	5.18	5.90
Total nitrogen (%)	3.76	0.10	0.86	5.41	0.06	0.98
Available phosphorus (mg/Kg)	1.69	123.01	88.50	2.00	94.50	77.57
Organic carbon (%)	31.49	1.30	25.89	26.88	1.89	22.17
Organic matter (%)	54.16	2.24	44.53	46.23	3.25	38.13
Exchangeable potassium (cmol/kg)	1.02	0.78	1.07	1.19	0.87	1.20
Exchangeable calcium (cmol/Kg)	16.88	6.00	14.93	15.34	6.63	11.86
Exchangeable magnesium (cmol/Kg)	5.86	1.80	4.74	7.29	1.74	3.88
Exchangeable sodium (cmol/Kg)	0.42	0.07	0.07	0.41	1.32	1.10
Exchange acidity (H^+)	-	1.68	0.92	-	1.82	0.90
Effective cation exchange capacity	-	10.33	21.73	-	12.38	18.94
Base saturation (%)	-	83.74	95.77	-	85.30	95.25

Table 2: Effect of poultry manure and cutting frequencies on foliage yield of fluted pumpkin

Treatments	2019 early planting season							2020 early planting season						
	Number of vines	Vine length (cm)	Leaves number	Internode length (cm)	Weight of leaf and vine (g)	Leaf fresh weight (g)	Leaf dry weight (g)	Number of vines	Vine length (cm)	Leaves number	Internode length (cm)	Weight of leaf and vine (g)	Leaf fresh weight (g)	Leaf dry weight (g)
Poultry Manure														
0 t/ha (Pm_0)	8.56	241.8	84.3	27.32	139.70	132.6	20.92	8.04	243.0	89.4	26.32	151.60	137.8	18.91
3 t/ha (Pm_3)	9.22	346.8	115.7	30.29	260.90	255.8	31.09	10.56	357.9	124.1	27.00	263.20	263.7	34.12
6 t/ha (Pm_6)	9.89	403.3	143.1	30.49	457.00	273.7	37.63	11.44	418.5	153.1	28.82	474.30	282.3	41.30
9 t/ha (Pm_9)	10.56	410.9	168.9	33.42	502.80	315.6	45.39	12.22	418.0	183.6	28.76	522.60	323.4	47.77
$FLSD_{(0.05)}$	1.10	50.17	14.65	1.51	31.54	29.48	3.81	1.78	33.49	12.94	3.43	28.39	20.56	5.37
Cut interval														
2 weeks (W_2)	10.92	120.3	93.0	22.44	211.70	101.7	23.74	12.00	127.9	105.3	23.23	210.10	108.1	25.80
3 weeks (W_3)	9.42	404.7	163.9	33.24	398.30	393.9	42.08	11.00	410.6	170.6	29.99	423.50	246.7	42.30
4 weeks (W_4)	8.33	527.1	127.1	35.46	410.20	237.7	35.45	9.08	539.7	136.8	29.96	425.20	400.6	38.47
$FLSD_{(0.05)}$	0.95	43.45	12.69	1.31	27.31	25.53	3.30	1.55	29.00	11.21	2.97	32.79	17.80	4.65
PM x Cut interval														
$PM_0 W_2$	10.00	100.9	78.3	21.70	101.90	81.0	13.68	9.33	110.9	80.3	23.03	108.60	83.0	12.16
$PM_0 W_3$	8.00	301.2	93.7	29.10	153.90	208.7	25.63	9.00	297.9	91.0	27.10	196.20	114.4	23.61
$PM_0 W_4$	7.67	323.3	81.0	31.17	163.40	108.1	23.43	7.33	320.3	97.0	28.83	150.00	216.0	20.97
$PM_3 W_2$	10.87	119.3	89.0	22.60	175.20	97.2	19.10	12.00	126.0	99.0	21.07	148.50	102.2	22.67
$PM_3 W_3$	9.00	383.3	155.3	31.20	300.50	449.9	38.53	10.33	393.3	111.3	30.20	314.10	233.1	39.87
$PM_3 W_4$	8.00	537.7	102.7	37.07	306.90	220.1	35.63	9.33	554.3	162.0	29.73	326.90	455.6	39.83
$PM_6 W_2$	11.00	127.2	108.3	22.03	270.20	108.5	27.63	13.00	132.8	115.0	24.03	270.20	116.9	30.50
$PM_6 W_3$	10.00	465.3	186.3	34.70	540.30	421.2	47.13	12.00	472.0	148.0	31.70	563.60	301.5	49.81
$PM_6 W_4$	8.67	617.3	134.7	34.73	560.40	291.5	38.13	9.33	650.7	196.3	30.73	589.10	428.6	43.60
$PM_9 W_2$	12.00	133.7	96.3	23.43	299.50	120.2	34.56	13.67	141.7	127.0	24.77	313.20	130.2	37.87
$PM_9 W_3$	10.67	469.0	220.3	37.97	598.80	495.7	57.00	12.67	479.0	196.7	30.97	620.10	337.7	55.93
$PM_9 W_4$	9.00	630.0	190.0	38.87	610.20	331.0	44.60	9.00	633.3	227.0	30.53	634.50	502.4	49.50
$FLSD_{(0.05)}$	1.91	86.89	25.38	2.62	54.62	51.06	6.60	3.09	58.01	22.42	5.94	56.79	35.61	9.31

The effect of cutting frequency on all the components of foliage yield of fluted pumpkin measured was significant. The highest number of vines was from bi-weekly cut intervals while the lowest was obtained from the 4-weekly cut interval. On the contrary, the longest vines and internodes were obtained from the 4-weekly cut interval, followed by the 3-weekly cut interval while the shortest vines and internodes were obtained from the bi-weekly cut interval. On the other hand, the 3-weekly cut intervals had the highest number of leaves, heavier fresh leaves and heavier leaf dry matter than the 4-weekly and bi-weekly cut intervals. Weight of vine with leaves was highest from the 4-weekly cut interval treatment, followed by the 3-weekly cut interval while the lowest was from the bi-weekly cutting frequency.

The interaction of PM and cutting frequency on all the components of foliage yield of fluted pumpkin measured was significant ($P \leq 0.05$). The highest number of vines was from the interaction of 9 t/ha PM and bi-weekly cut intervals while the lowest were from the interaction of 0 t/ha PM and 4-weekly cut interval. The longest vines and internodes were obtained from the interaction of 9 t/ha PM and 4-weekly cut interval while the shortest were from the interaction of 0 t/ha PM and bi-weekly cut interval. However, the interaction of 9 t/ha PM and 3-weekly cut intervals produced the highest number of leaves, heavier fresh leaves and heavier leaf dry matter compared with the other treatment combinations.

DISCUSSION

The reduction in the sand proportions after harvest suggests that the addition of the poultry manure had enhanced the soil texture by increasing the finer particles of the soil through the improvement of the organic matter contents of the soil. This observation corroborates with the reports of Adebayo *et al.* (2019) and Ojeniyi *et al*. (2013), that addition of PM to the soil improves the physical characteristics and conditions of the soil. The increased total nitrogen, organic carbon, potassium, magnesium, effective cation exchange capacity (ECEC) and base saturation after harvest in both cropping years suggests that using organic soil amendments such as PM can supply nutrients to the soil throughout the vegetative phase of fluted pumpkin and still leave residual nutrients for continuous growing of the crop into reproductive phase and or for growing a succeeding crop. Similarly, Shiyam and Binang (2013) while evaluating the effect of poultry manure and plant population on productivity of fluted pumpkin in Calabar, Nigeria, observed that the application of PM resulted in soil organic matter enrichment and long-term release of the bound nutrients in the PM to the soil.

The superiority of fluted pumpkin foliage yield in the plots treated with PM relative to the one without PM treatment (control) could be attributed to the availability of essential nutrient elements such as nitrogen, calcium and magnesium in the PM, which had enhanced the soil physico-chemical properties and might have benefited the crops more. This observation is in line with the assertion of Akanbi *et al.* (2007) that plants supplied with balanced nutrients in sufficient quantities will have their cells increase in sizes and number, thereby yielding more. The increase in the foliage yield of fluted pumpkin by PM as observed in this present research is consistent with the findings from studies in other vegetables such as okra (Umoetok *et al.,* 2007) and spinach (Dikinya and Mufwanzala, 2010).

The disparity in the components of foliage yield of fluted pumpkin across the various levels of PM applied in this present study, suggests that PM contains essential nutrient elements needed for the growth of fluted pumpkin and availability of this nutrients varies with the quantity of PM applied. Also, the higher number of vines that were longer with more leaves, longer internodes, heavier fresh leaves and heavier leaf dry matter obtained from the plots treated with a higher PM rate of 9 t/ha compared with 3 and 6 t/ha suggests that increasing the levels of PM increased the quantities of the essential elements available in the soil for effective uptake by plants roots, thereby enhancing the foliage production of the crop. In line with this observation are the reports of Muoneke *et al*. (2011) and Shiyam and Binang (2013) that PM at high levels of 15 t/ha and 24 t/ha respectively, resulted in relatively high leaf production by fluted pumpkin.

The higher number of vines recorded on the more frequently (bi-weekly) cut intervals is more or less due to the greater number of cuts within the sampling periods relative to the other cut intervals. For instance, within the period of 24 weeks that sampling was done, the bi-weekly cut intervals were cut 12 times while the 4-weekly cut intervals were cut only 6 times. On the other hand, the shorter vines with lower number of leaves and lighter fresh leaves and leaf dry matter obtained from the frequently (bi-weekly) cut treatment might be attributed to several factors: firstly, the cutting wounds exposes the crop to rapid transpiration that can result in excessive loss of water and consequent reduction in the general metabolism of the plant. Secondly, the increasing cutting pressure and constant removal of the vines and leaves with abundant supply of stomata might have affected gaseous exchange in the plant. Finally, the constant removal of the leaves that serves as both source and partial sink for photosynthates had obstructed the crop for effective photosynthesis leading to stunted growth and reduced dry matter accumulation. Ogar and Asiegbu (2005), and Chukwudi and Agbo (2014), had previously reported declines in marketable leaf yield of fluted pumpkin as a result of increased frequency of cut.

CONCLUSION:

Poultry manure improved the soil physico-chemical properties and enhanced the foliage yield of fluted pumpkin with 9 t/ha being outstanding from this study. The frequency of harvesting the fresh and succulent leaves also influenced the rate of fluted pumpkin foliage production with 3-weekly cut interval proving to be ideal for optimum fresh and succulent fluted pumpkin foliage production. The combination of 9 t/ha PM and 3-weekly cutting frequency produced the highest fresh and succulent fluted pumpkin foliage and is therefore recommended.

REFERENCES

Adebayo, J. A., Akingbola, O. O. and Ojeniyi, S. O. 2019. Effects of poultry manure on soil infiltration, organic matter contents and maize performance on two contrasting degraded alfisols in southwestern Nigeria. International Journal of Recycling of Organic Waste in Agriculture, 1, 1 – 8.

Akanbi, W. B., Adeboye, C. O., Togun, A. O., Ogunrinde, J. O. and Adeyeye, S. A. 2007. Growth, herbage and seed yield and quality of Telfairia occidentalis as influenced by cassava peel compost and mineral fertilizer. World Journal of Agricultural Science, 3 (4): 508 – 516.

Chukwudi, U. P. and Agbo, C. U. 2014. Effect of trellis height and cutting frequency on leaf and fruit yield of fluted pumpkin Telfairia occidentalis Hook F. Journal of Animal and Plant Sciences, 24, (4): 1190 – 1197.

Dikinya, O. and Mufwanzala, N. 2010. Chicken manure-enhanced soil fertility and productivity: Effects of application rates on spinach. Journal of Soil Science and Environmental Management, 1, (3): 46 – 54.

Effiong, J., 2011. Changing Pattern of Land Use in the Calabar River Catchment, Southeastern Nigeria. Journal of Sustainable Development, 4, (1), 92 – 102.

GHI (Global Hunger Index). 2021. Countries that are most affected by hunger and malnutrition. (www.statista.com). Retrieved 4th February, 2022.

Idem, N. U. A., Ikeh, A. O. Asikpo, N. S. and Udoh, E. I. 2012. Effect of organic and inorganic fertilizer on growth and yield of fluted pumpkin (Telfaria occidentialis, Hook F.) in Uyo, Akwa Ibom State, Nigeria. Journal of Agriculture and Social Research, 12, (2): 74 – 84.

Kajihausa, O. E., Sobukola, O. P., Idowu, M. A. and Awonorin, S. O. 2010. Nutrient contents and thermal degradation of vitamins in organically grown fluted pumpkin (Te/fairia occidentalis) leaves. International Food Research, 1, (17): 795 – 807.

Kuku, A., Etti, U. J. and Ibironke, I. S. 2014. Processing of fluted pumpkin seeds, Telfairia occidentalis (Hook F) as it affects growth performance and nutrient metabolism in rats. African Journal of Food, Agriculture, Nutrition and Development, 14, (5): 9192 – 9214.

Muoneke, C. O., Ndukwe, O. O. and Onuoha, C. 2011. Growth and Yield Responses of Fluted Pumpkin (Telfairia occidentalis Hook F.) as Affected by Organic Manure Sources and Rates in an Ultisol of South-Eastern Nigeria Journal of Agriculture and Biological Science, 3, (1): 1 – 15.

Ogar, E. A. and Asiegbu, J. E. 2005. Effect of fertilizer rates and cutting frequency on the marketable vegetable and fruit yields of in fluted pumpkin in southern Nigeria. Agroscience, 4, (1): 66 – 69.

Ojeniyi, S. O., Amusan, O. A. and Adekiya, A. O. 2013. Effect of poultry manure on soil physical properties, nutrient uptake and yield of cocoyam (Xanthosoma saggitifolium) in southwest Nigeria. American European Journal of Agriculture and Environmental Science, 13, (1): 121 – 125.

Oluwole, F. S., Falade, A. O. and Ogundipe, O. O. 2003. Anti-inflammatory effect of some common Nigeria vegetables. Nigerian Journal of Physiology, 18, 35 – 38.

Osadebe, V. O., Echezona, B. C. and Bakare, S. O. 2014. Effect of weed management and cutting frequency on the leaf yield and proximate composition of fluted pumpkin (Telfairia occidentalis Hook F.). American-Eurasian Journal of Agriculture and Environmental Science, 14, (7): 664 – 673.

Shiyam, J. O. and Binang, W. B. 2013. Effect of poultry manure and plant population on productivity of fluted pumpkin (Telfaiaria occidentalis Hook F.) in Calabar, Nigeria. Journal of Organic Systems, 8, (2): 1 – 7.

Udo, E. J., Ibian, T. O., Ogunwale, J. A., Ano, A. O. and Esu, I. E. 2009. Manual of soil plant and water analyses. Sibon Books Limited, Festac, Lagos.

Umoetok, S., Uko, A., Archibong B., Ukeh, D. and Udo, I. 2007. Effects of application of inorganic fertilizer and poultry manure on insect pests and yield of soybeans (Glycine max L) in the rainforest of Nigeria. .Journal of Food, Agriculture and Environment, 5, (2): 149 – 152.

Wahua, T. A. T. 2010. Applied statistics for scientific studies. Transparent Earth Nigeria Ltd., Port Harcourt, 360p.

WFP World Food Programme. 2020. Global report on food crisis. (www.wfp.org). Retrieved 20th December, 2021.