



## THE IMPLICATION OF TILLAGE PRACTICES AND DECAPITATION TECHNIQUES ON THE GROWTH AND BIOMASS YIELD OF FLUTED PUMPKIN

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### ARTICLE INFORMATION ABSTRACT

Submitted 19 March, 2024

Revised 24 April, 2024

Accepted 30 April, 2024

#### Keywords:

Tillage

Decapitation

Biomass

Yield

Fluted Pumpkin

The implication of tillage practices and decapitation techniques on the growth and biomass yield of fluted pumpkin (*Telfaira occidentalis*) cultivated in an inland swamp land in the dry season was studied. The treatments considered on decapitation were: (A) the control (intact/un-decapitated plants), (B) removal of half the total number of branches on the plant at time of decapitation, (C) removal of all lateral branches and leaves at time of decapitation, (D) removal of all the leaves on the plant at time of decapitation and (E) cutting off half of the entire shoot system. While the treatments considered on tillage practices were: (i) Bed tillage (ii) Ridge tillage (iii) Flat (No tillage). Therefore, the total treatment combinations were fifteen. After the imposition of decapitation, data were collected on growth and yield parameters of the newly developed foliage. The parameters were number of leaves, plant height, total number of new branches, leaf length and breadth, the fresh and dry weight of root, leaves, and shoot biomass. The decapitation (harvesting) techniques and tillage practices adopted in this study affected biomass re-growth and development of fluted pumpkin (*Telfaira occidentalis*). Removal of half number of branches on bed tillage practice gives the best performance, when compared with the intact (control) plant and other treatments.

### 1.0 Introduction

Tillage is a type of soil management that is used globally to prepare land for cultivation. Tillage has been carried out by humans for millennia, and for example early art shows the use of simple plows in ancient Egypt (Frey *et al.*, 2015). The plow has, however, developed remarkably since, particularly after the industrial revolution, and tillage can now be carried out using heavy machines which have high soil disturbing potential. Moldboard plowing (inversion of the soil layer), followed by tillage without soil inversion to smoothen the soil surface before sowing, is generally referred to as the conventional tillage practice (Reicosky, 2015). There are several explanations for why conventional tillage is commonly used for seedbed preparation. For instance, plowing efficiently removes weeds, incorporates crop residues which may otherwise reduce seed-soil contact, it alleviates soil compaction, and redistributes nutrients in the soil

profile (Johansen *et al.*, 2012). Conventional tillage also results in increased soil aeration and break up soil aggregates. The increased soil aeration enhances evaporation, which can be beneficial if done in cold humid climates, as the lower water content reduces the solar energy needed to warm the soil. Thus, compared to undisturbed soils, seeds in conventional tillage soil may germinate earlier (Alam, 2010). Long-term use of conventional tillage has been shown to lead to soil quality degradation because of the increased decomposition and mineralization of soil organic matter (SOM), which lead to soil organic carbon (SOC) loss (Stockmann *et al.*, 2013). One of the reasons why loss of SOC is problematic is due to the fact that SOC is negatively associated with soil erodibility (Six *et al.*, 2000). In America, the problem with erodible soils was vividly illustrated during the Dust Bowl in the 1930, and President F.D Roosevelt (1937) spoke the famous words “A nation that destroys its soil, destroys itself”. In addition to reducing soil quality, soil erosion also generates economic and environmental costs both on and off-site, and among the consequences are increased maintenance costs for infrastructure, nutrient deficiency, air and water pollution (Lal, 2012).

Conservation tillage is characterized by low soil disturbance, and often a crop residue cover on the soil surface (FAO, 2017). In addition to erosion control, conservation tillage has been promoted because of its potential positive effect on the environment as it has been suggested to increase soil sequestration. Furthermore, the use of conservation tillage reduces the amount of labor and fuel needed, as the number of field operations is lower and less energy demanding. Conservation tillage can be implemented on its own, or as one of the main principles within the concept of conservation agriculture (Palm *et al.*, 2014).

To secure future food production, increased knowledge of how to protect the soil and maintain its quality is crucial (FAO, 2008). The human population is growing, and is expected to reach almost 10 billion by 2050 (United Nations, 2015), whereas the area suitable for crop and animal feed production is likely to decrease, if land degradation does not cease. In this paper, the researcher dug into the world beneath the soil surface to ascertain how different types of soil management strategies may influence soil services. Long-term experiments were used as they allow analysis of soil quality changes that occur slowly, such as SOC content changes (Kainiemi *et al.*, 2015)

Fluted pumpkin (*Telfairia occidentalis*) is an important leaf and seed cucurbit in West Africa. It is highly valued in Nigeria where it is an integral part of many households' daily diet (Igbozulike *et al.*, 2019). It belongs to the family Cucurbitaceae about 90 genera and more than 700 species, which are distributed all over the warm parts of the world. Besides their important role in seed production, female plants produce more leaves of better quality than male plants and their rootstocks also survive and do better than male plants (Asoegwu, 2016). The need for more female plants in farms is therefore evident. It is mainly propagated from seed, a fair good percentage of old plants regenerate from rootstocks left in the ground after total or partial shoot senescence at the end of the previous season. *Telfairia occidentalis* is propagated using seed sections, split corm, and also by rooted shoot tips (Ajekenrenbiaghan, 2015). Stakes are used to keep the leaves off the ground and to provide support for the pods (Igbozulike and Amangbo, 2020). The benefits of mechanizing fluted pumpkin production has been highlighted (Igbozulike, 2015). Asoegwu (2016), reported 74% survival of old plants after the dry season, and Ossom (2015), had reported 41- 63% survival of periodically pruned plants at the peak of the dry season. Harvesting of *Telfairia occidentalis* is by various intensities of decapitation/removal of leaves and vines (laterals). Recovery growth following intensities of decapitation may differ.

Tillage practice is customarily carried out to control weed, improve soil physical conditions and consequently increase crop yield. Recent researchers have however questioned the rationale behind the traditional ploughing and harrowing of the soil to create an unstable

equilibrium in the soil environment and have deduced that this secondary tillage was unnecessary, and in some cases had even reduced yields.

Therefore, this study examined the implication of tillage practices and decapitation techniques on the growth and biomass yield of fluted pumpkin (*Telfairia occidentalis*) cultivated in an inland swamp (fadama) during the dry season

## **2.0 Materials and Methods**

### **2.1 Field Experiment**

The experiment was sited within the inland valley swamp (fadama) of the oil palm plantation of teaching and research farm of National Research Institute, Umudike, Abia state. The experiment was conducted during the dry season of 2022; the site had been previously dominated by weeds (Natural Fallow). The vegetation on the land was cleared manually and the debris packed to the borders to ensure a clean seed-bed for sowing the crops.

Viable seeds were collected from the pod and conditioned properly by air drying at ambient temperature. Seedling was first raised on nursery beds containing pulverized soil mixed with organic matter (sawdust and poultry manure) and maintained from three weeks after sprouting before transplanting to the field. The seedlings were properly watered a day before transplanting to the field and only healthy seedlings were used in order to ensure uniformity and avoid any bias on the outcome of the studies.

### **2.2 Data Collection, Sampling Techniques and Analysis**

The total land area used for the experiments was 2000m<sup>2</sup> (50m x 40m) and was divided into three plots (17m x 13m) with 1m spacing between each plot. Transplanting were done on the three different plots (Flat, Bed and Ridge), which were replicated to form five (5) treatments per plot, and fifteen (15) treatments in all. Three (3) plants were tagged per treatment for sampling, which made up forty five (45) sampled plants. The land was prepared manually and seedlings were transplanted after three weeks of planting from the nursery to the different plots selected at a planting distance of 75cm x 75cm and intra and inter spacing. Weeds were manually removed from the plots at two and five weeks after planting.

### **2.3 Treatments Used for Decapitation:**

- The control (intact, un-decapitated plants),
- Removal of half the total number of branches on the plant at time of decapitation (RHTB)
- Removal of all lateral branches at time of decapitation (RAB)
- Removal of all the leaves and branches on the plant at time of decapitation (RTLb).
- Cutting off half of the entire shoot/vine system (HPV).

### **2.4 Treatments Used for Tillage Practices:**

- Bed tillage system (B)
- Ridge tillage system (R)
- Flat (no tillage) system (F)

Thereafter the imposition of treatments, growth, and yield parameters of the newly developed foliage data were collected weekly for fifteen (15) weeks on the following growth and yield parameters on newly developed foliage. The data collected on growth performance of fluted pumpkin, in response to tillage and decapitation techniques were subjected to analysis of variance (ANOVA) and the treatment means were separated using Fisher's least significant difference (LSD) at 5% level of probability followed by Duncan multiple range test (DMRT).

All agronomic practices recommended for cultivating fluted pumpkin were carried out during the field operation, from raising of seedling to the last data collection. Each plot was manually weeded. First weeding was done at 2-3 weeks after planting and supplementary weeding was

done 5-6 weeks after planting to maintain a clean field. Irrigation was applied by manual method twice a week by watering the crop root zone, while it was done mostly at seedling stage and development stage before floral initiation. Therefore germination counts for data were collected on the number of spout plants after 4 weeks of planting. This was repeated every one week interval. These include plant height which was collected by using a measuring tape on every selected tagged plant; number of leaf per plant was done at every week at maturity on every randomly selected tagged plant on each row. Weight of fresh and dry biomass was done by uprooting/harvesting the entire tagged plant from the plots and weighed the biomass separately when fresh and after it had been oven dried. Vine, leaf length, and leaf breadth were done on the randomly selected tagged plants from the net plots; these were measured with measuring tape. Leaf area was also calculated using data obtained on leaf length and breadth, while number of leaf was done by physical counting of the number of leaves on the plant using the randomly tagged plants. The aim was to determine the rate of leaf increase in response to treatments imposed. Physiological maturity was also noted, which is the number of days from planting to when half of the plant population in a plot attained flowering (3- 4months).

### 3.0 Results and Discussion

The results of this experiment provide data on the leaf and vine (lateral branches) regrowth of fluted pumpkin following interactions of tillage operations and intensities of decapitation considered in the dry season. The tillage system as well as decapitation/pruning techniques adopted in this study affected biomass re-growth and development of fluted pumpkin (*Telfaira occidentalis*). The results in Table 1 show that the number of new branches developed was significant on the treatment with removal of half number of total branches, compared to other decapitation treatments imposed due to availability of photosynthesis through the remaining foliage and provision of avenue for new branches to sprout while the control was intact, without decapitation. Table 2 shows the effect of tillage technique on the growth and biomass yield of the crop. Table 3 showed that BRHTB, BRAB, BRTLb and BHPV were significantly different on yield parameters when compared with their respective treatments on ridge and flat tillage system. But BRHTB produced significantly higher mean biomass yield in all treatments considered for decapitation and tillage system. The higher growth of *Telfaira occidentalis* on this treatment (removal of half number of branches) can be attributed to the fact that the plant will quickly recover from the pruning injury, have enough organ for photosynthesis since most of its leaves were still retained on other branches left and consequently its apical part/main vine is not tempered with, as a result its growth pattern and stages were in a continuum, without being altered

**Table 1: Implication of Decapitation on Growth and Biomass Yield of Fluted Pumpkin**

Treatments	Parameters											
	Leaf area (cm <sup>2</sup> )	Breadth of leaf (cm)	Dry weight of leaf (g)	Dry weight of vine (g)	Dry weight of root (g)	Fresh weight of leaf (g)	Fresh weight of vine (g)	Fresh weight of root (g)	Length of branch (cm)	Length of leaf (cm)	Number of leaf	Number of new branches
Intact plant (control)	10d	2.6d	13c	10d	16d	23d	29e	26d	14d	4d	11d	3.2b
Removal of half total branches	7.1c	2.2c	5.9b	4.9c	6c	13c	15d	12c	11c	3c	9c	3.8c
Removal of all lateral branches	6.6bc	2.1bc	5.6b	4.7b	5b	12c	11c	9b	8b	2.9bc	7bc	3.5bc
Removal of total leaves and branches	6.1b	2.0b	4.8a	3.6a	4b	9.0a	9a	8b	7ab	2.8b	6b	3.2b

Half part of shoot/vine cut off	3.6a	1.6a	5.0a	5.2c	3a	8b	10b	6a	6a	2a	4a	2.5a
Std. Error	0.6	0.1	0.3	0.4	0.5	0.4	0.2	0.6	0.9	0.1	0.6	0.1

Mean in the column followed by the same letters are not significantly different at 0.05 levels by Duncan multiple range test (DMRT)

**TABLE 2: Implication of Tillage on Growth and Biomass Yield of Fluted Pumpkin**

Treatments	Parameters											
	Leaf area	Breadth	Dry weight	Dry weight	Dry weight	Fresh weight of leaf	Fresh weight of vine	Fresh weight of root	Length	Length	Number	Number of new branches
Bed tillage system	5.7b	1.8b	4.6b	4.2c	4b	10c	11c	8b	8c	2b	7b	2.5b
Flat tillage system	5.3ab	1.6ab	4.3ab	3.9b	3.8a	9b	10b	7a	7b	1.8ab	6.7ab	2.3ab
Ridge tillage system	4.7a	1.3a	4.0a	3.0a	5c	7.0a	7a	9c	6a	1.5a	6a	1.8a
Std. Error	0.4	0.1	0.2	0.3	0.3	0.2	0.1	0.4	0.6	0.1	0.3	0.1

Mean in the column followed by the same letters are not significantly different at 0.05 levels by Duncan multiple range test (DMRT)

**TABLE 3: Implication of Tillage and Decapitation on Growth and Biomass Yield of Fluted Pumpkin**

Parameters	Treatments												
	BRHT	BRA	BRTL	BHP	RRHT	RRAB	RRTL	RHP	FRHT	FRA	FRTL	FHP	Std.
Leaf area	6.7f	6.3e	5.6cd	5.2c	5.7d	5.3c	4.7b	4.2a	6.3e	5.8d	5.2c	4.6b	0.3
Breadth of leaf	2.8g	2.5f	2.2e	1.8c	2.3e	1.9d	1.4b	1.1a	2.6f	2.2e	1.7c	1.4b	0.1
Length of branch	3.0e	2.8d	2.5d	2.0c	2.5d	2.1c	1.6b	1.2a	2.8de	2.5d	2.2bc	1.7b	0.1
Length of branch	9.0e	8.0d	7.2cd	7.0c	7.0c	6.6b	6.2a	6.0a	8.0d	7.0c	6.5b	6.4b	0.4
Number of leaf	8.0g	7.6f	6.7d	6.2b	7.0de	6.7d	6.2b	5.7a	7.7f	7.2e	6.4c	5.9a	0.4
Number of new	3.5f	3.1de	2.8d	2.5c	2.8d	2.4c	2.0ab	1.7a	3.3e	3.0de	2.5c	2.1b	0.1
Fresh weight of	11.0g	10.4f	10.0e	9.6e	8.0c	7.7b	7.3ab	7.1a	10.0ef	9.8e	9.2de	8.8d	0.5
Fresh weight of	12.0g	11.5f	11.1f	10.6ef	8.0c	7.6b	7.2ab	6.9a	11.0f	10.6ef	10.1e	9.6d	0.6
Fresh weight of	9.0de	8.8d	8.2cd	7.9c	10.0f	9.6e	9.2de	8.9d	8.0c	7.7b	7.3ab	7.0a	0.4
Dry weight of	5.6f	5.2e	4.9d	4.6c	5.0d	4.6c	4.2b	3.8a	5.3e	5.0d	4.7c	4.3b	0.2
Dry weight of	5.2g	4.9f	4.6e	4.3d	4.0d	3.6c	3.3b	3.0a	4.9f	4.3d	4.0d	3.6c	0.2
Dry weight of	5.0d	4.7c	4.4b	4.1a	6.0f	5.6e	5.3de	5.0d	4.8c	4.4b	4.2ab	4.0a	0.2

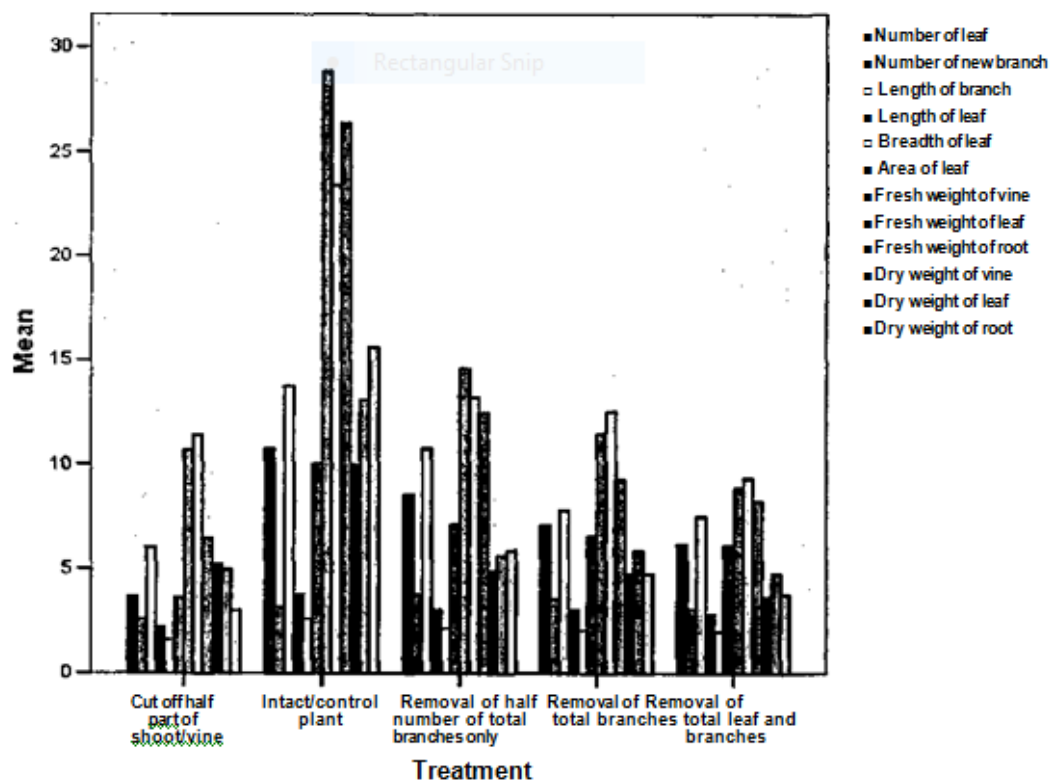
Mean in the row followed by the same letters are not significantly different at 0.05 levels by Duncan multiple range test (DMRT)

**Acronyms and meaning:**

**BRHTB** - Bed, Removal of Half Total Branches  
**BRAB** - Bed, Removal All Branches  
**BRTL** - Bed, Removal of Total Leaves and Branches  
**BHPV** - Bed-Half Part of vine cut-off  
**RRHTB** - Ridge, Removal of Half Total Branches  
**RRAB** - Ridge, Removal All Branches

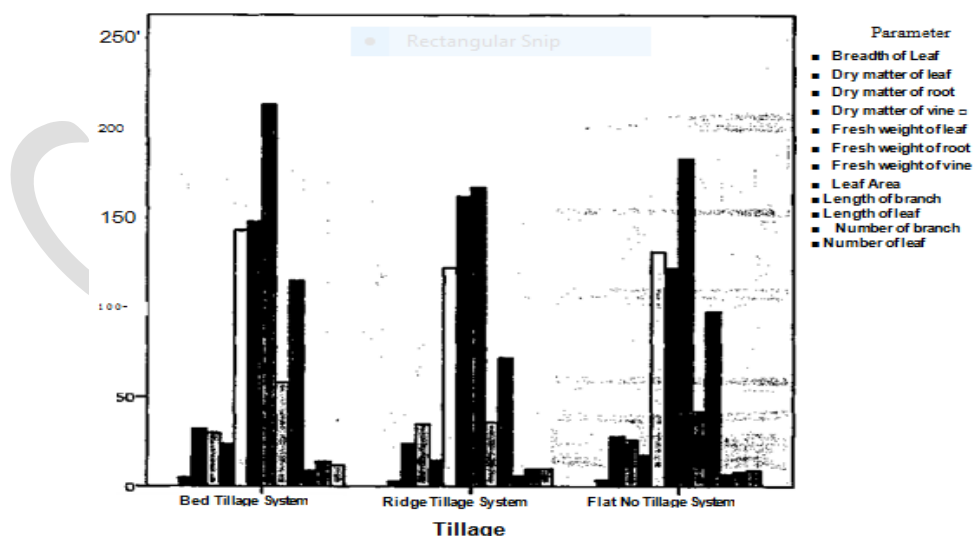
**RRTL** - Ridge, Removal of Total Leaves and Branches  
**RHPV** - Ridge, Half Part of vine cut-off  
**FRHTB** - Flat, Removal of Half Total Branches  
**FRA** - Flat, Removal All Branches  
**FRTL** - Flat, Removal of Total Leaves and Branches  
**FHPV** - Flat, Half Part of vine cut-off

Figure 1 presents trends in the development of *Telfaria occidentalis* following decapitation. Removal of half number of total branches yields best; having the highest mean values on yield performance of 80.3% on growth parameters.



**Figure 1:** Implication of Decapitation on Growth and Biomass Yield of Fluted Pumpkin

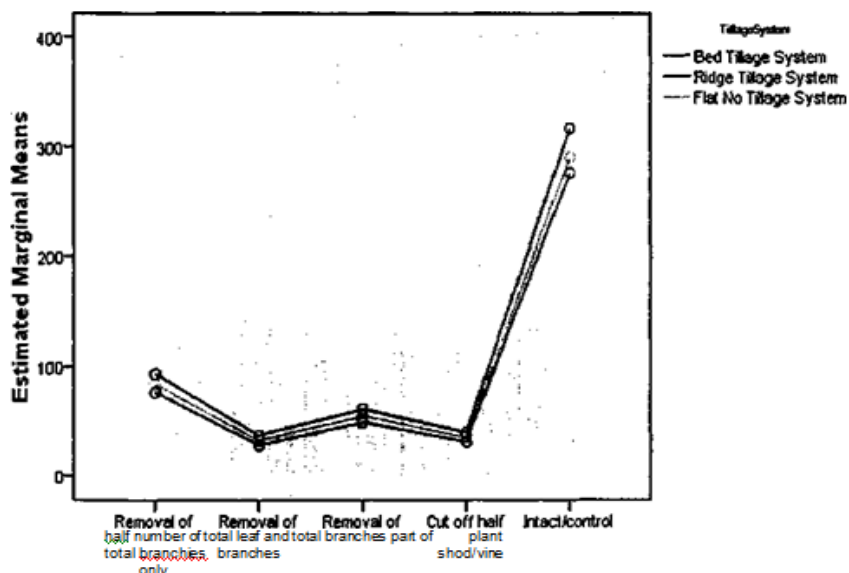
These results were also showed by Duncan Multiple Range Test; that removal of half number of branches was significant on the following growth and yield parameters across decapitation treatments, except the control which was significantly higher. But on the development of new branches, removal of half number of branches was significantly higher than the control. Under the tillage treatments on Figure 2, Bed tillage system was significantly different from all other tillage treatments imposed on the biomass yield of *Telfairia occidentalis*.



**Figure 2:** Effect of Tillage Practices and Decapitation Methods on Fluted Pumpkin (*Telfairia occidentalis*) Grown in an Inland Swamp

Also Fig. 3, showed that Bed tillage system, was highly significant for *Telfairia occidentalis* biomass yield, with 80.3% performance when compared with Flat system of 67.6% and Ridge tillage with 66.2%. But the Ridge tillage system did best on root development than the other tillage system as well, on Table 2.

This implies that root penetration can serve as vegetative regenerating organ, by using ridge tillage system for the production of *Telfairia occidentalis*. Because *Telfairia occidentalis* is an herbaceous facultative perennial plant, whose aerial shoot dies annually but is replaced after an interval of time by new shoots from surviving vines attached to the underground rootstock.



**Figure 3:** Decapitation Techniques

Plants from where removal of half number of total branches on Bed tillage system (BRHTB) produced highest biomass yield parameters Figure 3. The results on Table 3, shows that the mean result of BRHTB was significant on the biomass re-growth and yield parameters across decapitation treatments, which was 12.7% and 14.1% significantly different from that of flat and ridge tillage respectively.

#### 4.0 Conclusion

The decapitation/pruning techniques adopted in this study affected biomass re-growth and development of fluted pumpkin (*Telfairia occidentalis*). Decapitation may enhance consecutive harvest in the long run, which is a good potential fluted pumpkin as a perennial crop. Farmers are encouraged, to adopt harvesting/decapitation method such as the removal of half number of the entire branches as a harvesting technique. And the best tillage system for *Telfairia occidentalis* production was Bed tillage system. This method would improve fluted pumpkin yield, enhance its potential and perennial growth habit for consecutive harvest during peak period. Additionally, there should be effective water management in fluted pumpkin field especially for off season production.

#### References

- Ajekenrenbiaghan, JE. 2015. Influence of planting date on growth and productive life of fluted pumpkin, *Telfairia occidentalis*. Tropical Agriculture, 62(4): 281-28.
- Alam, MK. 2010. Effect of tillage depths and cropping pattern on soil properties and crop productivity. Department of Soil Science, Bangabandhu Sheikh Mujibur Rahman Agricultural University.
- Asoegwu, SN. 2016. Effects of Irrigation on the leaf and pod production of fluted pumpkin (*Telfairia occidentalis*) in Southern Nigeria. Scientia Horticulturae, 34:161-168.
- Food and Agriculture Organization 2008. Conservation Agriculture. FAO, Rome, <http://www.fao.org/ag/ca/index.html> (Accessed online October 10, 2017).

Food and Agriculture Organization 2017. Soil tillage in Africa: FAO needs and challenges. Soil Bulletin 69. Soil resource management and conservation service, Land and water development division. FAO, Rome, <http://www.fao.org/docrep/tl696e/tl696e09.htm> (Accessed online October 10, 2017).

Frey, SD., Drijber, R., Smith, H. and Melillo, J. 2015. Microbial biomass, functional capacity, and community structure after 12 years of soil warming. *Soil Biology and Biochemistry*, 40: 2904-2907.

Igbozulike, AO. 2015. Mechanizing ugu (*Telfairia occidentalis*) production and postharvest operations. *IOSR Journal of Engineering*, 5(7): 31-35.

Igbozulike, AO. and Amamgbo, N. 2019. Effect of moisture content on physical properties of fluted pumpkin seeds. *Journal of Biosystems Engineering*, 44(2): 69-76.

Igbozulike, AO., Amamgbo, N. and Oyinloye, GM. 2020. Mathematical modelling of fluted pumpkin seed drying kinetics. *Agricultural Engineering International: CIGR Journal*, 22(2): 272-278.

Johansen, C., Haque, ME., Bell, RW., Thierfelder, C. and Esdaile, RJ. 2012. Conservation agriculture for small holder rainfed farming: opportunities and constraints of new mechanized seeding systems. *Field Crop Research*, 132: 18 – 32.

Kainiemi, V., Arvidsson, J. and Kätterer, T. 2015. Effects of autumn tillage and residue management on soil respiration in a long-term field experiment in Sweden. *Journal of Plant Nutrition and Soil Science*, 178: 189-198.

Lal, R. 2012. Carbon management in agricultural soils. *Mitigation and Adaptation Strategies for Global Change*, 12: 303-322.

Ossom, EM. 2015. Influence of harvest interval on yield, crude protein, N.P.K. contents, and longevity of the fluted pumpkin (*Telfairia occidentalis*). *Tropical Agriculture*, 63(1): 63-65.

Palm, C., Blanco-Canqui, H., DeClerk, F., Gatere, L. and Grace, P. 2014. Conservation agriculture and ecosystem services: An overview. *Agricultural Ecosystem and Environment*, 187: 87-105.

Reicosky, DC. 2015. Conservation tillage is not conservation agriculture. *Journal of Soil Water Conservation*, 70: 103-108.

Six, J., Elliott, ET. and Paustian, K. 2000. Soil macro-aggregate turnover and micro-aggregate formation: a mechanism for C sequestration under no-tillage agriculture. *Soil Biology and Biochemistry*, 32(14): 2099-2103.

Stockmann, U., Adams, MA., Crawford, JW. and Field, DJ. 2013. The known and unknown of sequestration of soil organic carbon. *Agricultural Ecosystem and Environment*, 164, 80-99.

United Nations. 2015. World population projected to reach 9.7 billion by 2050. United Nations, Department of Economic and Social Affairs. United Nations, Washington DC., [Population/2015-report.html](http://Population/2015-report.html). (Accessed online October 6, 2017)