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Growth, Herbage and Seed Yield and Quality of *Telfairia occidentalis* as Influenced by Cassava Peel Compost and Mineral Fertilizer

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Abstract: The use of both mineral fertilizer and organic manure has been found to be a sustainable technology for crop production and integration of mineral fertilizer with crop residue compost could further increase crop yield. This assertion was tested in Nigeria by nourishing *Telfairia occidentalis* with Cassava Peel Compost (CPC) with or without mineral fertilizer. The treatments tested were: 0, 45 and 60 kg N from NPK; 45 and 60 kg N from CPC; 45 kg N from NPK + 15 kg N CPC; 30 kg N from NPK + 30 kg N from CPC and 15 kg N from NPK + 45 kg N from CPC. The treatments were laid out in randomized complete block design replicated thrice. Results obtained were statistical analyzed and significant means separated with Duncan Multiple Range Test ($p \leq 0.05$). Application of 45 kg N from NPK + 15 kg N from CPC brought about significant improvement in growth, shoot and fruit yield as well as shoot and seed quality of *Telfairia occidentalis.* This treatment produced herbage yield, shoot protein and N, P and K mineral elements that are similar to what was obtained with application of 60 kg N from NPK alone or joint application of 15 kg N from NPK + 45 kg N from CPC. These results support the concept of synergy between composts and mineral fertilizer and provide further stimulus to employ blends instead of sole application of compost or mineral fertilizer for crop production.

Key words: Cassava peel, compost, manure, *Telfairia occidentalis*, inorganic fertilizer, herbage yield, nutritional properties

INTRODUCTION

Telfairia occidentalis Hook F. (fluted pumpkin) is one of the most important vegetables grown in Southern Nigeria. It is generally regarded as a leaf and seed vegetable. The leaves and young shoot are edible. The leaf has a high nutritional, medicinal and industrial values being rich in protein (29%), fat (18%) and minerals and vitamins (20%) (Tindall, 1986; Badifu and Ogunsua, 1991). Apart from the leaves, the seeds, which can be cooked /roasted and eaten, or ground and added in soup contained 20.5, 45, 23, 2.2 and 4.8g $100g^{-1}$ protein, fat, carbohydrate, fibre and total ash, respectively (Tindall, 1986; Badifu and Ogunsua, 1991). The oil in the seeds is non-drying and is useful in soap making and in cooking (Fashina *et al.*, 2002). In the recent time, fluted pumpkin had gained medicinal recognition. It has been discovered to be blood purifiers (Aletor *et al.*, 2002) and could therefore, be useful in maintenance of good health most especially among poor resource ruralities in developing countries.

Despite the importance of *Telfairia* in Nigerian diet, farmers are facing a lot of problems concerning its production on the field. Yield and quality of the leaves and seeds realized by farmers are usually lower than what is being reported under experimental conditions (Fashina *et al.*, 2002). In addition improved soil nutrients could also improve the quality of these minerals, vitamins and protein content of this vegetable. Research efforts are therefore required to formulate and recommend fertilizer requirement for sustainable production of this vegetable.

Application of fertilizer has been documented to enhance plant growth and development. Many research activities have reported an increase in the vegetative development of crops with fertilizer application. However, there are contrary views on the role of fertilizer on the

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quality of crop produced. Reports of Drake and Fellman (1987) and Stefano *et al.* (2004) revealed that fertilizer may be applied to produce crop fruit and seed that will conform to the consumer's demand. Fruit size and colour, fruit firmness and absence of deficits and injuries could be influence by the types and levels of applied nutrients (Drake and Fellman, 1987). In another report, the use of farmyard manure benefited fruit set in eggplant and generally enhanced size characters in both onion and eggplant when compared to non-fertilized plants (Asiegbu and Uzo, 1984). Growth, yield and flavour intensity of onion bulbs are dependent on genotypic characteristics. This could be modified largely by agronomic practices most especially fertilizer application (Abbey *et al.*, 2002). Conclusions from most of these research works pointed out that crop could only manifest its full potential only if it is nourished with appropriate type and quantity of nutrients. Fruit size and composition are major criteria for fresh fruit vegetables. Such have been reported in tomato to be positively correlated with the amount of N nutrient available for plant use during fertilization, cell mitotic activity and cell enlargement (Jullien *et al.*, 2001). Moreso, N availability could affect the sink function of fruit and this play a role in the control of carbohydrate accumulation (Gyllapsy *et al.*, 1993). This latter activity determines the number, size and chemical components of fruits like tomatoes (Joubes and Chevalier, 2000). These parameters are equally important in assessing the quality and number of seed produced in *T. occidentalis.*

Many African countries continue to require increasing amount of food aid because their agricultural products do not match population growth. This is most evident in countries where population growth is very high and yet soil tends to be highly weathered and have low inherent fertility. In Nigeria, farmers realize the need for soil amendments by using available resources such as crop wastes, farmyard manure and poultry waste (Adediran *et al.*, 2003). However, the quantity and quality required of these materials limit their use. In addition, farmers appreciate the use of mineral fertilizers but their ever-increasing costs often prohibit their application at recommended rates (Akanbi, 2002). In some areas, crop residue such as sorghum/guinea corn straw, cassava peel and maize stovers are left on the land but their decomposition rate is very low because of the high C: N ratio. The crop residues can not be applied or ploughed directly as such into the soil because of this. They are known to reduce the availability of important mineral nutrients to growing plants through immobilization into organic forms (Elliot *et al.*, 1981) and also may produce some phyto-toxic substances during their decomposition.

Cassava peels which are regarded in many areas in Nigeria as waste are rich in crude protein (5.29%) and fat (1.18%) (Oyenuga, 1968). It is usually burnt or used to feed livestock (most especially small ruminants) as source of protein and roughages (Tewe, 1975). However, not more than 10% of the cassava peels produced is utilized in feeding livestock. The remaining is commonly found in farm locations and processing sites as heap that are generally perceived as a nuisance. These materials, however, could be utilized more effectively and sustainably through recycling rather than being destroyed through burning as commonly practiced by many and this causes air pollution.

Cassava peel like many organic waste materials is a potential sources of organic matter and plant nutrients. Management of cassava peel includes direct incorporation into the soil, feeding them to livestock, burning or processes them into a more stable organic fertilizer called compost (Rogers and Milner, 1983). Compost is a mixture of the remnants of degraded plant material and the by-products of the degrading organisms. It is produced through a process referred to as 'composting'. Preparing compost from cassava peel offers many advantages. It provides incentive for communities to recover locked nutrients in the peel, eliminate the problem of waste disposal and increases the manurial values of the materials (Edward and Daniel, 1992; Adediran *et al.*, 2003; Ashutosh *et al.*, 2006).

In the recent past some studies have been conducted to elucidate the beneficial effects of adding crop residue compost into the soil. The practice improves soil physical, chemical and biological activities as well as improving crop yields and nutritional values (Manna *et al.*, 1999; Akanbi and Togun, 2002; Adediran *et al.*, 2003; Maharishnan *et al.*, 2004; Ghosh *et al.*, 2004; Ashutosh *et al.*, 2006). The supply of organic materials on farms, even with the use of farm yard manure and or compost from crop residues, will likely be insufficient to overcome soil nutrient deficiency. The integration of small amount of inorganic fertilizer with the organic materials available on farms offers a strategy to meet the nutrient requirements of crops. It minimizes nutrient leaching, particularly in poor sandy soil and subsequent groundwater contamination (Manna *et al.*, 1999). This maximizes the use of available organic resources and minimizing the use of costly purchased mineral fertilizers (Manral and Saxena, 2003; Ghosh *et al.*, 2004). The Faculty of Agricultural Sciences at Ladoke Akintola University of Technology, Ogbomoso, Nigeria is developing a technology to recycle plant nutrients from cassava peels, maize stover and poultry manure. This technology involves compositing of these residues and combine application of the product with small dose of mineral fertilizers. The present report form parts of the series of experiments carried out to:

- Evaluate the potential fertilizer values of cassava peel found in abundance in Nigeria.
- To compare its effectiveness with recommended rate of commercial inorganic fertilizer as source of plant nutrients for *Telfairia occidentalis* (fluted pumpkin).

MATERIALS AND METHODS

The field experiment was conducted during rainy (February-November) season of 2003 at the Research Farm of Department of Agronomy, Ladoke Akintola University of Technology, Ogbomoso (log 40° 10^1, lat 8° 10^1), Nigeria. The soil of the experimental site is sandy loam in texture and contained pH 6.2 and organic carbon 0.19%. The soil N (g kg^{-1}), P (mg kg^{-1}) and K (cMol kg^{-1}) were 0.36, 7.93 and 0.23, respectively. The region has a hot humid tropical climate and receives 1,080 mm rainfall annually. A major part of the rain is received during April-October.

Eight treatments were applied as presented in Table 1. The recommended dose of N is 60 kg ha^{-1} for fluted pumpkin in Nigeria (FPDD, 1990). The rate of CPC used was based on N equivalent and applied on dry weight. Cassava peel compost was prepared using dry cassava peel and well-cured poultry manure in the ratio 3:1 (dry weight basis). The materials were allowed to decompose for a period of eight weeks. Samples of poultry manure, cassava peel and matured compost were subjected to chemical analysis and the results are presented in Table 2. Quantity of CPC applied for 100% situation was 3.0 t. ha^{-1} and this is equivalent to materials that will supply 60 kg N ha^{-1} during the current growing season.

Matured pods of fluted pumpkin were split and seeds extracted. The seeds were sown in containers and seedlings raised and transplanted 28 Days After Sowing (DAS). Land preparation involved a single ploughing and harrowing. The experimental area was 25 m×19 m (475 m^2) and was subdivided into three blocks of 19 m×7 m with a working path of 2.0 m. Each block was further sub-divided into 8 plots of 4.0 m×3.0 m with a working path of 1.0 m between each plot. Four-week-old-greenhouse grown fluted pumpkin seedlings were transplanted in with an inter-and intra-row spacing of 1m each. This is equivalent to 12 and 10,000 plant plot^{-1} and hectare, respectively. The experiment was a randomized complete block design. Treatments were randomized and replicated three times. The CPC treatments were applied a week before transplanting while the NPK treatment, were applied in two equal splits at 2 and 12 Weeks After Transplanting (WAT). The crop was staked using 2m long bamboo pole at 4 WAT. Hoe weeding and other cultural practices were carried out as at when required (Fashina *et al.*, 2002).

Data collection was at every fortnight starting from 8WAT till 14WAP. Parameters assessed were length of primary vines, number of secondary vines, number of leaves per plant, leaf area, shoot dry matter and herbage (leaves + shoot) yield and nutritional contents. Cumulative herbage yield was obtained by adding together shoot from the four harvests and expressed on hectare basis. Samples were taken from 1st shoot harvest, washed and separated into their component parts; leaves and stems, cut into pieces, dried (80°C for 48 h), ground and processed for nutritional content analysis. Proximate compositions for nutrients were determined using AOAC (1984) method. Total shoot tissue N was determined by a semi micro-kjeldahl procedure (Bremner, 1965; Ulger *et al.*, 1997). Shoot protein was calculated from the Kjeldahl nitrogen using the conversion factor 6.25. Lipid was estimated by exhaustively extracting a known weight of sample with petroleum ether (BP 60°C) using a Tecator Soxhlet apparatus. Ash content was determined by ignition in a muffle furnace for 4 h at 525°C. Fibre content was estimated from the loss in weight of the crucible and its content on ignition. Carbohydrate was determined when the sum of the percentage of moisture, ash, crude protein, ether extracts and crude fibre were subtracted from 100. Mineral elements were estimated using the AOAC (1984) method. The atomic absorption spectrometer was used to determine Ca, K and Fe. Phosphorus (P) was determined using the colorimetric molybdenum-blue procedure (Murphy and Riley, 1962).

Six months after transplanting and when the crop leaves have dried, matured pods were harvested. From this, pod attributes such as mean number per plant, length and weight were taken. Six pods were randomly taken from each treatment, carefully split and seeds extracted to determine per pod number of seeds, seed weight, percent filled and unfilled seed. Twenty representative seed samples were taken per treatment, prepared and subjected to chemical nutrient and proximate laboratory analysis for N, P, K, crude protein,%oil, crude fibre, carbohydrate, calcium, iron and ascorbic acid. The analyses were carried out following the procedure of A.O.A.C. (1984).

Statistical analysis of data collected was carried out using standard analysis of variance (Gomez and Gomez, 1984). The significance of the treatment was determined using the F-test. To determine the significance of the difference between the means of the treatments, Duncan Multiple Range Test (DMRT) was computed at the 5% probability level.

Table 1: Details of nutrient treatments

Treatment symbol	Fertilizer nutrient source/quantity
0%NPK (T1) (Control)	O kg N ha^{-1}
75% NPK (T2)	45 kg N ha^{-1} through NPK
100% NPK* (T3)	60 kg N ha^{-1} through NPK
100% CPC** (T4) Compost (CPC)	60 kg N ha^{-1} through Cassava Peel
75% CPC (T5)	45 kg N ha^{-1} through CPC
75% NPK + 25% CPC (T6)	45 kg N ha^{-1} through NPK + 15 kg N ha^{-1} through CPC
50% NPK + 50% CPC (T7)	30 kg N ha^{-1} through NPK + 30 kg N ha^{-1} through CPC
25% NPK+ 75% CPC (T8)	15 kg N ha^{-1} through NPK + 45 kg N ha^{-1} through CPC

*100% NPK= 300 kg ha^{-1} NPK 20-10-10, **100% CPC = 3.0 t ha^{-1} CPC, CPC contained 2.01% N and this is available to the crop in the year of application

Table 2: Chemical composition of poultry manure, cassava peel compost and matured compost

Properties	Poultry manure	Cassava peel compost	Matured compost
N (%)	6.24	1.60	2.01
P (%)	0.25	0.16	0.22
K (%)	0.82	1.14	0.51
Ca (%)	0.07	0.88	0.78
Mg (mg kg^{-1})	25.49	31.37	32.80
Zn (mg kg^{-1})	33.32	32.29	43.14
Cu (mg kg^{-1})	31.38	39.22	44.00

+ Matured compost was prepared from poultry manure and dry cassava peel in ratio 3:1 dry weight basis

RESULTS AND DISCUSSION

Telfairia occidentalis showed significant ($p \leq 0.05$) growth response to applied fertilizer (Table 3). Primary vine lengths, number of secondary vines and per plant number of leaves plant were all improved with application of fertilizer. Length of primary vine varied from 137.7cm in control (no fertilizer) plants to 210.1 cm in plants that received 75%NPK + 25% CPC. The value obtained from this fertilizer combination was significantly higher than that of 100% NPK and 100% CPC treatments by 11.8 and 5.5%, respectively. The 75% CPC treated plants had the highest number of secondary branches and this value was significantly higher than all other treatments with the exception of 75% NPK + 25% CPC. In case of number of leaves, application of 75% NPK + 25% CPC and 25% NPK + 75% CPC were similar, but their values were significantly higher than the values of other (Table 3).

The applied fertilizer had significant ($p \leq 0.05$) effect on leaf area/plant. But, apart from treatment where 75% NPK were applied, all other treatments showed similar response. Dry matter yield improved considerably with increase in proportion of NPK component of the treatment that involved combine application of NPK and CPC. The order of increase was 0<75<100% NPK. But when compared with increase in proportion of applied CPC, the reverse was the case. Plants fertilized with 75% of the recommended rate of CPC produced dry matter that was 29.2% over those fertilized with 100% CPC. In addition, increase in quantity of CPC under the situation where both NPK and CPC were used reduced the dry matter yield. The dry matter yields were 86.1, 74.1 and 70.3 g $plant^{-1}$ where 25, 50 and 75% CPC where combined with appropriate quantity of NPK fertilizer.

Combine application of 75% NPK + 25% CPC produced the highest cumulative herbage yield. This is closely followed by 100% NPK while non fertilized plants recorded the least. The herbage yield of the first two harvests was higher in situation where either NPK alone was used or where higher proportion of the nutrient was supplied through NPK mineral fertilizer. However, at 3rd and 4th harvests the situation was reversed. Application of all nutrients through mineral fertilizer (100% NPK) gave herbage yield that is 39.8 and 28.7% higher than what was observed with the use of 100% CPC and 75% NPK, respectively.

Pod and seed attributes of *T. occidentalis* are presented in Table 4. All pod and seed characteristics assessed were statistically significant and in most cases (with the exception of% unfilled seed), the use of 75% NPK + 25% CPC gave the best values and compared favourably with what was observed under the use of 100% NPK. Number of pods /plant varied significantly from 0.6 in no fertilizer situation to as high as 5.0 under 75% NPK + 25% CPC treatment. The value obtained with the latter treatment compared favourably with 4.3 and 4.0 pods/plant realized form 100% NPK and 50% NPK + 50% CPC. The longest pod of 81.7cm was produced by 75% NPK + 25% CPC treatment while the least 23.7 cm from unfertilized plants. The pod length obtained from 75% NPK + 25% CPC was similar to those of plants fertilized with 100% NPK, 100% CPC, 75% NPK and 25% NPK + 75% CPC. Mean pod weight and number of seeds/pod varied significantly among fertilized plants. For both parameters 75% NPK + 25% ha^{-1} CPC treatment proved to be the best and similar to result obtained from plants nourished with 100% NPK and 100% CPC.

Percent filled seed was highest in 100% NPK treatment. This is closely followed by 75% NPK + 25% CPC and 50% NPK + 50% CPC treatment. The least percent filled seeds were recorded with 0 and 75% NPK treated plants. These same treatments produced the highest proportion of unfilled seeds. Seed weight/pod show similar trend to different fertilizer types as with what was observed with% filled seed. Joint application of 75% NPK + 25% CPC had the highest seed weight/pod and this was significantly higher than 0. 75% NPK, 75% CPC, 50% NPK + 50% CPC and 25% NPK + 75% CPC by 316.7, 201.7, 140.0, 126.7 and 139.3 unit seeds, respectively. The seed weight/pod produced by 75% NPK + 25% CPC were as good as the ones from 100% NPK or 100% CPC.

Table 3: Effect of different fertilizer treatments on the growth parameters of *Telfairia occidentalis*

Fertilizer components	Primary vine length (cm)	Number of vines	Number of leaves	Leaf area (cm^2)	Shoot dry weight(g $plant^{-1}$)	Cumulative shoot yield (t ha^{-1})
0%NPK (Control)	137.7e	5.3d	28.0c	1643ab	27.7h	19.7f
75% NPK	173.0d	4.3d	36.0b	926b	32.0g	23.1ef
100% NPK*	185.3c	8.0bc	36.0b	2450ab	90.3a	32.3b
100% CPC**	199.2b	8.1bc	22.7d	2004ab	63.7f	25.1d
75% CPC (T5)	143.4e	10.0a	36.3b	6583a	82.3c	28.0c
75% NPK + 25% CPC	210.1a	9.4ab	43.0a	2563ab	86.1b	35.1a
50% NPK + 50% CPC	164.1d	7.1c	27.0c	1940ab	74.1d	26.4cd
25% NPK+ 75% CPC	182.3c	8.2bc	42.3a	2116ab	70.3e	24.3de
Mean	174.3	7.5	34.0	2528	65.8	26.5

Means followed by the same letter along the column are not significantly different using Duncan Multiple Range Test at 5% probability level. CPC = Cassava Peel Compost, *100% NPK= 300 kg ha^{-1} NPK 20-10-10, **100% CPC = 3.0 t ha^{-1} CPC, CPC contained 2.01% N and this is available to the crop in the year of application

Table 4: Effect of different fertilizer treatments on the pod and seed attributes of *Telfairia occidentalis*

Fertilizer components	Number of pods $plant^{-1}$	Pod length (cm)	Mean pod weight (kg)	Number of seeds pod^{-1}	Percent filled seed	Percent unfilled seed	Seedweight/ pod (g)
0% NPK (Control)	0.6c	23.7c	23.3d	28.7c	48.0c	52.0a	123.3c
75% NPK	3.1b	35.1c	35.3cd	36.1c	48.0c	52.0a	238.3bc
100% NPK*	4.3a	78.3ab	75.0ab	88.3ab	75.7a	24.3c	336.3ab
100% CPC**	3.0b	67.7ab	44.1bcd	77.7ab	54.0ab	46.0abc	350.67ab
75% CPC	3.0b	77.1ab	50.1abc	87.1ab	52.7bc	47.3ab	300.0b
75% NPK + 25% CPC	5.0a	86.7a	78.3a	106.7a	72.7ab	27.3bc	440.0a
50% NPK + 50% CPC	4.0ab	62.1b	62.7abc	72.1b	63.3abc	36.7abc	313.3b
25% NPK + 75% CPC	4.3a	73.0ab	45.7bc	83.0ab	63.0abc	37.0abc	300.7b
Mean	3.4	62.4	48.0	72.4	59.7	40.3	300.3

Means followed by the same letter along the column are not significantly different using Duncan Multiple Range Test at 5% probability level. CPC = Cassava Peel Compost, *100% NPK= 300 kg ha^{-1} NPK 20-10-10, **100% CPC = 3.0 t ha^{-1} CPC, CPC contained 2.01% N and this is available to the crop in the year of application

Table 5: Effect of different fertilizer treatments on the *Telfairia occidentalis* shoots nutritional contents

Fertilizer components	Nitrogen	Phosphorus	Potassium	Crude protein	% Oil	Crude fibre	Carbo-hydrate	Calcium	Iron	Ascorbic acid
	------------------------------------	--(g 100 g^{-1}	edible portion)--	----------	----------	----------	----------	-------(g 100 mg^{-1}	edible portion)	------
0% NPK	0.43a	30.0d	11.7d	2.1e	1.3b	1.9a	5.5d	251.0g	0.91a	18.3c
75% NPK	0.41a	33.7c	14.3c	2.0e	1.4b	1.7b	5.5d	300.7f	0.92a	16.0c
100% NPK*	0.42a	44.0b	18.5a	3.6a	2.2a	1.3d	7.9ab	363.0b	1.17a	30.0a
100% CPC**	0.38a	48.0a	18.7a	2.7cd	2.1a	1.6b	7.2c	300.1f	1.13a	23.2b
75% CPC	0.46a	42.3b	18.2ab	3.1b	2.0a	1.7b	7.3c	324.7e	1.03a	25.4b
75% NPK + 25% CPC	0.41a	51.3a	19.3a	3.1b	2.0a	1.4c	8.2a	407.3a	1.41a	31.3a
50% NPK + 50% CPC	0.40a	41.1b	17.2b	2.4de	2.0a	1.7b	7.4bc	342.3d	1.40a	29.2a
25% NPK+ 75% CPC	0.40a	44.1b	18.3ab	3.0bc	2.1a	1.7b	8.1a	354.7c	1.30a	31.1a
Mean	0.41	41.8	17.0	2.8	1.9	1.6	7.1	330.3	1.16	25.5

CPC = Cassava Peel Compost, *100% NPK= 300 kg ha^{-1} NPK 20-10-10, **100% CPC = 3.0 t ha^{-1} CPC, CPC contained 2.01% N and this is available to the crop in the year of application, Means followed by the same letter along the column are not significantly different using, Duncan Multiple Range Test at 5% probability level

Fertilizer types affect most of the shoot nutritional contents of T. occidentalis (Table 5). The P and K contents had their least values with 0% fertilizer while both recorded the highest values with application of 75% NPK + 25% CPC treatment. The Crude Proteins (CP) content as well as percent oil of the shoot were associated with the fertilizer types, but with inconsistent trend. For instance, the highest CP was obtained with the use of 100% NPK. This was equally true of% oil content, however, the value obtained with 100% NPK was statistically similar to other treatments except in situations where 0 and 75% NPK where applied. The Crude Fibre (CF) contents of the fertilized plants were lower than non-fertilized ones. The higher the N content of the applied fertilizer type, the less the CF. In case of Fe and ascorbic acid contents, only the latter showed significant response to the fertilizer types. Application of 75% NPK + 25% CPC had the best Fe and ascorbic acid. The ascorbic acid contents of 100% NPK, 50% NPK + 50% CPC and 25% NPK + 75% CPC were similar.

Table 6: Effect of different fertilizer treatments on the *Telfairia occidentalis* seeds nutritional contents

Fertilizer components	Crude protein	% Oil	Carbo-hydrate	Crude fibre	Calcium	Phosphorus
	(g 100 g^{-1} edible portion)			(mg 100 g^{-1} edible portion)		
0% NPK	14.3b	31.7b	15.3c	2.4a	50.0b	370.0a
75% NPK	18.1ab	33.3ab	20.3b	2.3a	61.7ab	366.7a
100% NPK*	20.7a	43.6a	23.0ab	1.7a	74.7a	513.3a
100% CPC**	18.0ab	33.7ab	19.3bc	2.0a	53.3b	443.1a
75% CPC	19.6b	34.0ab	21.0ab	1.7a	69.0ab	387.0a
75% NPK + 25% CPC	21.1a	43.7a	24.7a	1.6a	76.3a	478.2a
50% NPK + 50% CPC	18.1ab	35.6ab	21.3ab	2.1a	58.7ab	383.4a
25% NPK+ 75% CPC	16.7a	39.0ab	22.3ab	1.9a	65.3ab	380.1a
Mean	18.3	36.8	20.9	2.0	63.6	415.3

*100% NPK= 300 kg ha^{-1} NPK 20-10-10, **100% CPC = 3.0 t ha^{-1} CPC, CPC contained 2.01% N and this is available to the crop in the year of application, Means followed by the same letter along the column are not significantly different using Duncan Multiple Range Test at 5% probability level

The summary of the proximate composition of *T. occidentalis* seed is shown in Table 6. The crude protein of the seeds varies between 14.3 and 21.1 g 100g^{-1} edible portion. The value obtained with 75% NPK + 25% CPC (21.1g) compared favourably with 20.7, 18.0 and 16.7g /100 g edible portion obtained with 100% NPK, 100% CPC and 25% NPK + 75% CPC, respectively. The% oil was highest in plants nourished with 100% NPK and 75% NPK + 25% CPC. The carbohydrate, Ca and P content of the seed show similar response to the applied fertilizer types. In most cases, the use of 100% NPK gave similar results to situations where 75% NPK + 25% CPC and 25% NPK + 75% CPC were applied.

DISCUSSION

The better performance of fertilized plants compared to non fertilized ones is in line with the observation of Fashina *et al.* (2002) and probably due to the low precropping soil nutrients particularly P. It was reported that for optimum vegetative growth and development of fluted pumpkin, adequate fertilization is required. In there study, availability of sufficient growth nutrients was reported to improved cell activities, enhanced cell multiplication and enlargement, all that resulted into luxuriant growth. In the present study, better performance of nourished plants could be in line with this observation. However, when compared across different fertilizer types, the better performance of plants fertilized with 75% NPK + 25% CPC over all other fertilizer types might be attributed to the fact that the combination enhanced adequate uptake of available nutrients. The inorganic fraction of the combination releases its nutrients early enough for plant use while the organic portion could stimulate microbial activities and prevent loss of nutrients. This was in line with the observation of Akanbi (2002) and Maharishan *et al.* (2004).

Developments of pod and seed attributes were enhanced with fertilizer application. In all cases where fertilizers were applied, these parameters were better. Availability of sufficient nutrients has been reported to facilitate the sink function of fruit (Elliott *et al.*, 1981; Gyllapsy *et al.*, 1993). This play a role in the control of carbohydrate accumulation and partitioning. Plant nourished with sufficient amount of nutrients in adequate proportion expected to have higher numbers and size of cells. This could explain the large fruit size and better seed quality obtained in this study when the plants were fertilized with 75% NPK + 25% CPC or 100% NPK compared with the control and other fertilizer types.

The nutritional contents of *T. occidentalis* were improved with adequate fertilizer application. The Crude Protein (CP), Fe and ascorbic acid contents were better in plants that received 100% NPK and combination of 75% NPK + 25% CPC. The values of leaf CP obtained with these treatments were higher than those reported by (Tindal, 1986; Badifu and Ogunsua, 1991). The intake of this vegetable could be expected to contribute a large proportion of the mineral requirement in the body, most especially when supply with adequate soil nutrients. The percent oil was higher in plant nourished with 75% NPK + 25% CPC than other fertilizer types. Also, the percent oil value obtained with this treatment was higher than those reported earlier by Fashina *et al.* (2002). The implication of this is that fertilization of *T. occidentalis* with this fertilizer combination could produce crop with higher energy efficiency at a given caloric intake.

Generally, minerals from plant sources are less bioavailable than those from animal sources. The more important minerals involved in the building of rigid structures to support the body i.e. calcium, phosphorus and magnesium were all furnished by the vegetable species studied. These elements are well supplied by applying 100% NPK or 100% CPC or combination of 75%

NPK + 25% CPC. The P and Ca values obtained with application of any of these treatments were higher than what was reported by Badifu and Ogunsua (1991).

From this study combine application of 75% NPK + 25% CPC is recommended for the production of *T. occidentalis* in the study area. This treatment was as effective as application of 100% NPK or 25% NPK + 75% CPC. Further research efforts are going on to extend this trial to other vegetable crops and to further reduce the quantity of inorganic fertilizer required whenever the two are needed to be applied together.

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