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Effects of mulching materials and NPK fertilizer on the growth, yield and quality of *Telfairia occidentalis*

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Abstract

Field experiments were conducted at the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso (8^o 10`N and 4$^o$ 10`E) to determine the effect of mulching materials and rates of NPK fertilizer application on the growth and yield of fluted pumpkin (*Telfairia occidentalis*). The trials consisted of three levels (0, 250 and 350 kg ha^{-1}) NPK and four types of mulching materials (white polyethylene, black polyethylene, saw dust and *Panicum* grass). A factorial arrangement fitted into complete randomized block was used and replicated three times. Plant height and number of leaves increased as the NPK rate increased, irrespective of the mulching materials. The yield and yield components of telfairia increased as the NPK rate increased from 0 up to 250 kg ha^{-1} and then declined at 350 kg NPK ha^{-1}. These were significantly ($P \leq 0.05$) improved by the main effects of fertilizer and mulching materials. Although, the best performance of telfairia in term of yield and quality were obtained from white polyethylene mulching material, this was comparable with that of dry *Panicum* grass mulching material. Except for fibre and vitamin C contents, telfairia seeds contained higher quality attributes investigated under this study than leaves. Therefore, the yield and quality of telfairia could significantly be improved by the application of NPK fertilizer at the optimum rate of 250 kg ha^{-1} with and without mulching.

Key words: *Telfairia occidentalis*, growth, yield, NPK fertilizer application rates, mulching materials.

Introduction

Fluted pumpkin (*Telfairia occidentalis* Hook.F) is an important seed and leafy vegetable crop of the humid tropics of Africa (Okigbo, 1977; Oyolu, 1978). It is a native to West Africa (Van Epenhuijsen, 1974; Okoli and Mgbeogu, 1983) but occurs mostly in its cultivated form and grown in Sierra, Leone, Ghana, Benin Republic, Southern Nigeria, Equatorial Guinea and Cameroon. Its other relative *Telfairia pedata* Hook F. is widely grown in East Africa (Esiaba, 1982).

Fluted pumpkin belongs to the cucurbitaceae family and cultivated for its edible leaf and seed. The leaf is nutritionally important (Taylor *et al.*, 1983) and its seed is a potential source of commercial vegetable oil which may be used for cooking or soap making (Okoli and Mgbeogu, 1983). The young immature seeds can be cooked and eaten or ground unto paste included in soups. Telfairia seeds are rich source of protein and calories (Longe *et al.*, 1983). The seeds kernels which contain 53% oil and protein (Longe *et al.*, 1983) have a high nutritional and industrial value (Tindall, 1968). The oily seeds are believed to have lactating properties and as such are in demand by women with young babies (Schippers, 2000).

Fluted pumpkin prefers a loose, friable soil with ample humus and shaded position. Organic manure is used with no application of inorganic fertilizers (Adelaja, 1978) in the traditional farming system. Nitrogen is essential for adequate vegetation and should ideally be given in the form of manure and applied before planting. The use of well-decomposed manure is essential for fruit production and in this case it is recommended that about 1 kg manure/plant be applied. For higher yield, top dressing with nitrogen fertilizers immediately after each harvest is advisable. Manure also contains phosphorus and other nutrients needed for seed production (Schippers, 2000). Applications of compound fertilizers (NPK 15-15-15) have been reported to increase the seed yield of Egusi melon (Olaniyi, 2000; Anyim and Ayodele, 1983; Denton and Adeniran, 1990) which belongs to the same family as fluted pumpkin. Right quantity of fertilizer(s) need to be applied to a crop in order to increase its yield potential.

Mulching of telfairia is uncommon in the cultivation of the crop since planting is done at the beginning of rainy season. In dry weather, mulching is very important in both the nursery and the vegetable beds, as it helps the soil retain moisture and stops it from getting too hot. Chopped grass and black polythene are useful as mulch (MacDonald and Low, 1984). Good results have been reported from the use of black polyethylene for crops such as tomatoes, peppers and sweet corn on porous soils of very low fertility. Warm-season crops, such as cucumbers, musk-melon, egg plant and peppers, usually respond to paper mulch by maturing earlier and by yielding more. The response by these crops is probably due to higher soil temperature (Hernandez, 1982).

Mulching is a popular mode of weed control in fluted pumpkin and help in reducing the labour requirement for hand weeding because the weeds are effectively smothered by the mass thrush. Besides controlling weeds, mulch conserves the soil water, certain soil insects and millipedes may also develop large population when grass mulches are applied. Most workers (Hermandez, 1982) have found that the mulch conserves moisture directly by preventing evaporation and indirectly by controlling weeds. Ossom (1985) recorded higher leaf yield with fresh grass of *Panicum maximum* than with saw dust and dry grass mulch. The least yield was obtained with saw dust but dry grass mulch gave the best weed control.

Despite the popularity of the crop, information is scanty on the response of fluted pumpkin to fertilizer and mulching. This study aimed at determining the optimum NPK fertilizer rate and mulching materials for growth, yield and quality of fluted pumpkin.

Materials and methods

Experiments were conducted during two cropping seasons at the Ladoke Akintola University of Technology, Teaching and Research farm, Ogbomoso (8° 10'N and 4° 10'E), Nigeria. The bimodal rainfall of the area is between 1100-1250 mm. The temperature regime is high all year round. The mean minimum temperature was 28°C and the maximum temperature was 33°C with a high humidity of about 74% all year round except in January, when the dry wind blows from the North (Olaniyi, 2000).

The soil was sandy loam and well drained, cropped previously for a few years with inorganic fertilizer. Initial soil samples were collected from the soil depth of 15 cm for analysis before the field was cleared. The soil particle size was determined by hydrometer method (Bouyoucos, 1951). The pH was determined in 1:2 soil: water suspension using a pH meter. The organic carbon was determined by dichromate oxidation (Walkley and Black, 1934), total N by the Micro-Kjedahl method (Jackson, 1973) and available P by the Bray P-1 method (Bray and Kurtz, 1945). The exchangeable bases were displaced by neutral N NH_4OAC. The displaced K and Na in the extract were determined with atomic absorption spectrophotometer. The exchangeable acidity (A1 and H) was extracted with N KCl and estimated titrimetrically.

The conventional tillage operation which includes land clearing and preparation of beds were carried out to conserve the soil and its nutrient availability. The plot was divided into three blocks each containing 12 beds to give a total of 36 beds. Each bed size was 22 x 1.2 m and about 0.5m spacing between beds. The blocks were spaced 1 m apart to ease movement during cultural operations. The treatments involved four mulching materials *viz*., sawdust, dry grass, white and black polyethylene, three levels of NPK 15-15-15 fertilizer, 0, 250 and 350 kg ha^{-1}. The twelve mulching and NPK treatment combinations were assigned into a factorial experiment and fitted into a randomized complete block design with three replicates.

Before seed sowing, the beds were irrigated to improve soil moisture content, seed germination and seedling emergence (Oladiran, 1986). Planting was done in early October, with fluted pumpkin seeds procured from the Agronomy Department, LAUTECH, Ogbomoso. Two seeds were sown at a spacing of 1 x 1 m and later thinned down to one seedling per stand at four weeks after sowing (WAS). The different mulching materials were laid out into their respective beds according to the treatment combinations. The fertilizer application was by band placement. Watering of seedling was done every morning at two days interval during the drought periods to avoid wilting and to improve the growth and development. Weeds were controlled twice manually by hoeing at 4 and 8 weeks after sowing. Other crop management included spraying with karate at 2 weeks interval after sowing against defoliating insect pests.

Data on growth parameters were collected from five plants selected from each plot. Data collected at the early bloom stage (10 WAS) include vine length, number of vines, number of leaves, and plant fresh and dry shoot yield per hectare. Dry matter yield was determined by placing the harvested plant in brown envelops, and drying in an oven at 65°C till constant weight was obtained. The dried plant and seed samples were separately ground in a Wiley mill, and passed through a 0.5 mm sieve. Total N was determined by the macro-kjeldahl procedure. The P and K contents of the plants were determined by wet digestion with a mixture of nitric, sulphric, and perchloric acids. Phosphorus concentration was determined by the vanadomolybdate yellow colorimetry method (Jackson, 1973). Digested samples were diluted and used to determine the concentration of K using an atomic absorption spectrophotometer. Concentrations of nutrient were expressed on the dry weight basis. All data collected were subjected to analysis of variance (ANOVA) using the SAS-GLM procedure. The differences between treatment means were evaluated using the least significant difference at P=0.05.

Results and discussion

Soil analysis: Result of the pre-cropping soil analysis is presented in Table 1. The soil was sandy loam with moderate organic carbon content and slightly acidic properties. Most of the nutrients in this soil were below the critical level hence there was need for the application of soil amendment in the form of inorganic or organic fertilizers.

Growth parameters: The mean growth parameters increased as the plant aged (Tables 2 and 3). The plant height and number of leaves were not significantly ($P \leq 0.05$) affected by NPK application. The optimum plant height was recorded at 250 kg NPK ha^{-1}, then declined thereafter. Likewise, the highest mean values were obtained for number of leaves from plots receiving 250 kg ha^{-1} of NPK fertilizer. White polyethylene gave the highest values for plant height and number of leaves closely followed by dry grass while saw dust recorded the least values. Except for the number of leaves at 10 week after sowing, the growth parameters were not significantly influenced by the combined NPK and mulching materials at different sampling occasions.

The significant increase in number of leaves and plant height observed with NPK application when compared with the control might probably be due to increased N content of the applied fertilizer. This is in agreement with Branley and Warren (1960) who observed increase in number of leaves when N level was increased from 0-168 kg N.ha^{-1}. As this might be due to the effective use of applied fertilizer at this rate. Olaniyi (2000) attributes increase in growth parameters of melon plants as the NPK rates increased to the availability of high N in the applied fertilizer. The presence of P in the fertilizer seems to increase the absorption of N (Jones *et al.*, 1991), which promotes vegetative production.

Shoot and seed yields: The number of branches, fresh and dry shoots yields of telfairia significantly ($P \leq 0.05$) increased as the applied NPK rates increased up to 250 kg NPK ha^{-1}, then declined thereafter (Table 4). Mulching had significant influence on the shoot yield of fluted pumpkin. Although, white polyethylene gave the highest values for number of branches, fresh and dry shoot yield, there was no significant difference between the values obtained from white polyethylene and dry grass mulching.

Table 1. Chemical and physical properties of the soil at the experimental site before planting

Parameters	Value
pH	6.00
Total N (%)	0.10
Available P (ppm)	5.77
Organic Carbon (mg/kg)	2.39
Exchangeable cations (c mol/kg)	
Ca^{2+}	2.25
Mg^{2+}	1.12
K^{+}	0.24
Na^{+}	0.40
Physical characteristics	
Sand (%)	86.70
Silt (%)	9.20
Clay (%)	4.10
Textural class	Sandy loam

The yield and yield components (number of fruits, length of fruit, diameter of fruit, number of seeds per fruit, weight of 20 seeds and seed diameter) were significantly ($P \leq 0.05$) affected by the treatments (Table 5). The seed yield and yield components increased as NPK fertilizer rate increased from 0 kg up to 250 kg NPK ha^{-1} and declined at higher NPK rate. The result of this study is in agreement with other researchers (Olaniyi, 2000; Denton and Adeniran, 1990; and Anyim and Ayodele, 1983), who reported an increase in the yield of *Egusi* melon with applied NPK 15-15-15 fertilizer.

Although white polyethylene gave the highest values for yield and yield components, there was no significant difference between white polyethylene and dry grass mulching. The significant effects of mulching materials on telfairia yield might be due to their ability to retain soil moisture and preventing it from getting too hot (MacDonald and Low, 1984). The solarization effect on soil exhibited by white polythene makes it an outstanding mulching material than others. It was observed that yield and

Table 2. Effect of different levels of NPK fertilizer and mulching materials on the average plant height of *T. occidentalis*

Mulching material	Four weeks after sowing				Six weeks after sowing				Eight weeks after sowing				Ten weeks after sowing			
	NPK applied (kg ha^{-1})				NPK applied (kg ha^{-1})				NPK applied (kg ha^{-1})				NPK applied (kg ha^{-1})			
	0	250	350	Mean	0	250	350	Mean	0	250	350	Mean	0	250	350	Mean
Panicum grass	6.5	7.4	33.0	15.6	29.0	24.4	34.3	29.2	50.5	51.0	54.6	52.0	200.5	252.5	123.5	192.1
Sawdust	10.7	6.6	8.6	8.6	22.3	29.0	29.3	26.8	37.5	51.3	149.1	79.3	112.5	118.5	137.5	75.5
Black polyethylene	5.8	9.4	7.5	7.5	23.5	31.6	23.7	26.3	38.0	63.2	39.5	46.9	172.5	167.0	185.0	93.5
White polyethylene	10.4	8.4	27.6	15.4	28.2	27.8	49.7	35.2	46.2	41.8	167.0	85.0	104.2	169.5	167.0	101.8
LSD (P=0.05) NPK				NS				NS				NS				NS
LSD (P=0.05) Mulching				NS				NS				NS				NS
LSD (P=0.05) NPK x Mulching				NS				NS				NS				28.1

NS – not significant

Table 3. Effect of different levels of NPK fertilizer and mulching materials on the average number of leaves of *T. occidentalis*

Mulching material	Four weeks after sowing				Six weeks after sowing				Eight weeks after sowing				Ten weeks after sowing			
	NPK applied (kg ha^{-1})				NPK applied (kg ha^{-1})				NPK applied (kg ha^{-1})				NPK applied (kg ha^{-1})			
	0	250	350	Mean	0	250	350	Mean	0	250	350	Mean	0	250	350	Mean
Panicum grass	6.1	7.7	8.2	7.3	29.4	28.9	32.5	30.2	42.2	55.2	33.5	43.6	115.0	163.0	58.5	112.2
Sawdust	8.4	5.5	8.1	7.3	22.6	26.2	22.3	23.7	34.4	37.5	45.1	39	68.0	73.0	85.5	75.5
Black polyethylene	7.6	9.6	7.1	8.1	15.7	26.9	28.1	23.5	31.0	42.5	46.9	40.1	97.5	71.5	111.5	93.5
White polyethylene	6.8	8.3	6.7	7.2	25.0	23.9	16.6	21.8	38.0	39.2	42.3	39.8	105.0	112.0	88.5	101.8
LSD (P=0.05) NPK				NS				NS				NS				NS
LSD (P=0.05) Mulching				NS				NS				NS				NS
LSD (P=0.05) NPK x Mulching				Ns				NS				NS				NS

NS – not significant

Table 4. Effect of different levels of NPK fertilizer and mulching materials on the number of branches and shoot yields of *T. occidentalis*

Mulching material	No of branches				Fresh shoot yield (kg)				Dry shoot yield (g)			
	NPK applied (kg ha^{-1})				NPK applied (kg ha^{-1})				NPK applied (kg ha^{-1})			
	0	250	350	Mean	0	250	350	Mean	0	250	350	Mean
Panicum grass	5.5	8.3	3.5	5.7	1.0	1.6	0.9	1.2	38.5	80.7	30.4	81.2
Sawdust	5.0	6.0	8.0	6.3	0.8	10.7	0.8	4.1	22.1	53.6	89.5	55.1
Black polyethylene	4.8	6.0	7.5	6.1	0.9	1.1	1.3	1.1	68.1	86.2	115.4	89.9
White polyethylene	4.5	6.0	5.0	5.2	1.5	3.0	1.3	1.9	65.1	104.3	74.3	81.2
LSD (P=0.05) NPK				NS				NS				NS
LSD (P=0.05) Mulching				NS				NS				22.9
LSD (P=0.05) NPK x Mulching				NS				NS				19.8

NS – not significant

yield component of telfairia was generally low when no NPK fertilizer was applied. The low seed yield from the plant receiving no and low fertilizer might be due to the low P in the applied level of NPK fertilizer. This is similar to the findings of Adepetu (1986) and Anon (1990) who observed that soils of Southwestern Nigeria are low in P and may require 25-50 kg P ha^{-1} to boost tomato yield.

Furthermore, the comparable yield performance of telfairia plants under white polyethylene and dry grass might be due to the addition of nutrient elements through decomposition of the dry grass which is one of the major advantage of using grass as mulching materials. The positive response of telfairia plants to the applied NPK fertilizer and mulching materials revealed that adequate or proper cultural practices need to be applied to fluted pumpkin in order to increase its yield.

Nutritive value: Except for N, fibre and vitamin C; P, protein, K, Ca and Fe were significantly ($P \leq 0.05$) affected by the treatments (Table 6). The nutrient contents increased as NPK rates increased up to 250 kg NPK ha^{-1}, and declined thereafter. Although, white polyethylene gave the highest values for the nutrient composition, there was no significant difference between white polyethylene and dry grass. There was no significant difference among the treatment combinations but the highest values were obtained for combined 250 kg NPK ha^{-1} and white polyethylene treatment. Except for fibre and vitamin C contents, seeds recorded the highest nutritive values than the leaves in this study. The results revealed that both the leaves and seeds are very rich in protein, calories, vitamin and minerals. This might be the reason of their most intense use as leaf and seed vegetable in southeast Nigeria.

The study revealed that the yield and quality of telfairia could significantly be improved by the application of NPK fertilizer at the optimum rate of 250 kg ha^{-1} with and without mulching.

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Table 5. Effect of different levels of NPK fertilizer and mulching materials on the yield and yield components of *T. occidentalis*

Mulching materials	NPK (kg/ha)	Number of fruits	Diameter of fruit (cm)	Length of fruit (cm)	No of seeds per fruit	Weight of fruit (kg)	Weight of seed per fruit (g)	Weight of 20 seeds (g)	Seed diameter (cm)
	0	2.0	43.2	55.0	54	2.5	210	150	3.4
Panicum grass	250	2.0	46.0	56.5	58	3.6	700	300	3.8
	350	2.0	42.0	45.0	56	3.2	610	190	2.9
	0	2.0	42.0	60.5	66	3.0	380	120	2.7
Sawdust	250	2.0	44.2	51.8	54	3.1	560	251	3.5
	350	2.0	30.7	35.5	76	2.7	490	140	3.3
	0	2.0	39.8	45.3	74	2.8	300	110	3.0
Black Polyethylene	250	3.0	47.5	56.0	100	3.9	830	210	3.2
	350	2.0	43.0	51.5	43	2.6	450	300	3.2
	0	3.0	38.5	52.2	56	2.7	580	210	3.2
White Polyethylene	250	4.0	48.8	54.5	69	5.7	1120	380	3.5
	350	2.0	55.0	68.0	57	3.2	690	260	3.2
LSD (P=0.05)									
NPK (F)		0.4	2.5	1.5	0.99	0.35	73.3	64.2	0.21
Mulching (M)		NS	2.98	1.83	1.14	0.49	84.6	94.1	0.34
M x F		0.004	NS	19.8	NS	NS	NS	NS	NS

NS–not significant

Table 6. The nutritional values of Telfairia as affected by the mulching materials and NPK fertilizer application

Mulching materials	NPK (kg. ha^{-1})	N (%)		P (%)		Protein (%)		K (%)		Ca (%)		Fibre (%)		Fe (ppm)		Vit. C (mg/100g)	
		Leaf	Seed	Leaf	Seed	Leaf	Seed	Leaf	Seed	Leaf	Seed	Leaf	Seed	Leaf	Seed	Leaf	Seed
Dry Grass	0	3.47	4.15	0.25	0.49	21.7	25.9	0.38	0.47	0.82	0.93	21.83	2.68	1,456.06	1,999.76	21.55	1.05
	250	4.12	4.89	0.46	0.77	25.8	30.6	0.45	0.65	1.14	2.12	23.51	3.13	2,224.94	4,939.81	24.66	1.20
	350	3.85	4.41	0.37	0.50	24.1	27.6	0.42	0.47	0.90	1.58	23.05	3.00	1,715.38	2,520.11	22.58	1.08
Sawdust	0	3.18	3.56	0.22	0.45	19.9	22.3	0.35	0.40	0.68	0.76	21.29	2.46	1,219.75	1,506.21	20.04	1.01
	250	3.65	4.43	0.41	0.56	22.8	27.7	0.39	0.45	0.93	1.21	22.84	2.74	1,855.26	3,892.18	22.18	1.12
	350	3.45	4.19	0.35	0.48	21.6	26.2	0.34	0.39	0.88	1.05	22.75	2.65	1,295.07	3,715.23	22.05	1.02
Black Polyethylene	0	3.45	4.00	0.24	0.46	21.6	25.0	0.35	0.40	0.77	0.90	21.58	2.53	1,285.12	1,725.53	21.10	1.03
	250	3.81	4.69	0.43	0.57	23.8	29.3	0.43	0.46	0.98	1.25	23.06	2.98	2,005.03	4,168.25	23.01	1.12
	350	3.52	4.25	0.40	0.52	22.0	26.6	0.35	0.40	0.95	1.22	21.92	2.91	1,456.00	2,108.16	22.89	1.07
White Polyethylene	0	3.51	4.07	0.27	0.49	21.9	25.4	0.40	0.44	0.84	0.91	22.18	2.68	1,414.29	1,926.60	21.26	1.03
	250	4.45	4.75	0.48	0.57	27.8	29.7	0.48	0.58	1.18	1.89	23.66	3.05	2,020.76	4,679.01	23.04	1.16
	350	33.75	4.34	0.39	0.57	23.4	27.1	0.34	0.48	0.99	1.04	23.65	2.90	1,639.23	2,154.16	23.00	1.05
LSD (P=0.05)																	
NPK (F)		NS	NS	0.06	0.08	2.94	1.05	NS	0.08	0.11	0.17	NS	NS	NS	1397.3	NS	NS
Mulching(M)		NS	NS	NS	NS	3.40	1.21	NS	0.09	0.13	0.20	NS	NS	NS	NS	NS	NS
M x F		NS	NS	NS	NS	NS	NS	NS	NS	NS	1.45	NS	NS	NS	NS	NS	NS

NS – not significant

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