

EFFECTS OF MIXED FERTILIZER LEVELS AND HARVEST INTERVALS ON THE YIELD AND MINERAL CONCENTRATION OF THE FLUTED PUMPKIN, *TELFAIRIA OCCIDENTALIS* HOOK.

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ABSTRACT: Fluted pumpkin is a viny vegetable crop whose leaves and seeds are commonly cooked and eaten by humans in eastern Nigeria. The plant is also a palatable leafy feed for goats, as owners of unfenced fluted pumpkin gardens often learn. The leaf of the vegetable is eaten mainly for carbohydrate and protein, whereas the seeds are eaten mainly for carbohydrate, oil, and vitamins. Experiments were conducted in Port Harcourt, Nigeria, to evaluate the effects of mixed fertilizer (15-15-15) levels and harvest intervals on the yield and mineral concentration of fluted pumpkin. The results showed that harvests at 2-weekly intervals gave significantly ($P = 0.05$) higher yields than harvests at 4-weekly intervals. Increases in fertilizer levels had no significant effect on total fresh weight yield. However, as fertilizer levels increased, the leaves were greener and more attractive; higher concentrations of N, P, and K in the leaf blades were obtained from the 2-weekly harvests rather than the 4-weekly harvests. These results suggest that for increased yield of leaves and vines and for tender, fresher, and more nutritious leaves, the fluted pumpkin should be harvested every two weeks. Farmers who grow the fluted pumpkin in the dry season should fertilize the crop at the moderate rate of 200 kg/ha of 15-15-15 (as $N-P_2O_5-K_2O$) and adopt the practice of a 2-weekly harvest interval.

KEYWORDS: Fertilizer response, fluted pumpkin, harvest interval, mineral concentration, *Telfairia occidentalis* Hook., yield.

INTRODUCTION

The study of the interaction between fertilizer level and harvest interval has received considerable research attention, especially in crops such as cowpea (*Vigna unguiculata*; Godfrey-Sam-Aggrey, 1973), onion (*Allium cepa*; Hassan and Ayoub, 1978), alfalfa (*Medicago sativa*; Ossom, et al., 1983), and rye (*Secale*

cereale; Shim, 1976). Only a few such studies have been conducted on the fluted pumpkin (*Telfairia occidentalis* Hook.). In eastern Nigeria, despite the widespread cultivation of the crop, little attention has been paid to how fertilization and harvest frequency affect its yield. Ossom (1986) established that 2-weekly harvests gave significantly higher total dry matter yield than 6- and 8-weekly harvests. Nangju (1976) reported that decreasing harvest intervals reduced cowpea seed yield. Workers at the International Institute of Tropical Agriculture (1972) observed that fertilizer rates had no significant effect on total yield and yield of the edible portion of jute (*Corchorus olitorius*); they also reported that fertilizer levels had no significant effect on yield of swamp cabbage (*Ipomoea reptans*). Application of fertilizers is known to increase the quality and mineral concentration in most crops (Cochran, *et al.*, 1978; Hageman, *et al.*, 1978; Mathias, *et al.*, 1978; and Ossom, *et al.*, 1991). For the fluted pumpkin, more information is required on the effect of fertilizers on the concentration of minerals in the plant's leaves and stems as a first step to improving the nutrient quality of this vegetable crop.

Farmers who cultivate the fluted pumpkin in Nigeria do not use any specific harvest interval or fertilizer level; they harvest the crop as the need arises. Little or no artificial fertilizer is applied. The present study was aimed at gaining information on the influence of different fertilizer levels and harvest intervals on the yield and mineral concentration of the leaves and vines of the fluted pumpkin to enable husbandry and management recommendations to be made to local farmers.

MATERIALS AND METHODS

The experiment was conducted in the dry season from December 1988 to June 1989 at the Teaching and Research Farm of the University of Science and Technology, Port Harcourt, that lies on latitude 4°46' N and longitude 7° 01' E, with a mean annual rainfall of 2,000 mm (Food and Agricultural Organization, 1984). The soil, a Typic Paleudult (sandy loam), contained at 0-15 cm depth 0.09 percent total N (determined by the semi-micro Kjeldahl Method), 20.18 ppm available P (determined by Bray and Kurtz No. 1 Method), and 42.50 ppm exchangeable K (determined by flame photometry) and had a pH of 4.6. The land was plowed and harrowed before planting. The factorial experiment with 3 fertilizer (15-15-15) levels of 0, 200, and 400 kg/ha (Ethirveerasingam, *et al.*, 1985) and 2 harvest intervals at 2 and 4 weeks (Ossom, 1986) was arranged in a randomized complete block design. Each of the 6 treatments was replicated 4 times; plot measurements were 5 m by 5 m.

Crop Establishment and Maintenance. Three pre-sprouted seedlings were planted at a spacing of 1.5 m by 1.5 m giving 13,333 plants/ha (Cochran, *et al.*, 1978). Four weeks after planting, a mixed fertilizer (15-15-15 as N-P₂O₅-K₂O) was ring-applied around each stand at rates of 0, 200, and 400 kg/ha after weeding. Weeds were controlled by hoeing at 4 weeks after planting and, thereafter, every 6 weeks.

Table 1. The distribution of rainfall during the period of this experiment.

Date	Rainfall (mm)	Irrigation (mm)	No. of Days With up to 0.1 mm	Total Water Use (mm)
Dec. 1988	30.2	5.1	4	35.3
Jan. 1989	0.0	20.6	4	20.6
Feb. 1989	0.0	20.6	4	20.6
Mar. 1989	117.3	0.0	11	117.3
Apr. 1989	191.1	0.0	11	191.1
May 1989	124.3	0.0	13	124.3
June 1989	173.4	0.0	16	173.4

Watering. Watering was done at the rate of 2.57 mm irrigation/week for the first 2 weeks after planting and increased to 5.14 mm/week from 3-9 weeks after planting. Watering was discontinued at 10 weeks after planting, when the first heavy rain occurred. Table 1 shows the monthly rainfall and irrigation distribution during the period of the experiment.

Harvesting and Mineral Analysis. The first harvest was taken at 8 weeks after planting; subsequent harvests were at the specified intervals until 24 weeks after planting. At harvest, each vine was cut off at a node about 50 cm from the growing tip, and the total fresh weight/plot of harvested leaves and vines was recorded. Sub-samples of 300 g/plot were collected from the weighed samples and separated into leaf blades, petioles, and vines; these samples were weighed separately, bagged, and dried to constant weight in a ventilated hot-air oven at 80° C for 7 days. The dried leaf blade samples were ground using a micro-hammer mill and sieved through a 0.025 mm mesh screen. N, P, and K analyses were carried out on the samples at 8, 10, 20, 22, and 24 weeks after planting. N was determined by the conventional micro-Kjeldahl Method; P was assessed after dry ashing by the vanadomolybdate method with absorption read at a wavelength of 430 nm; and K was determined by flame photometry (Allen, *et al.*, 1974). The effect of treatments on yield was assessed by analysis of variance for a 2-factor factorial in a randomized complete block design.

RESULTS AND DISCUSSION

Fresh Weight Yields. Fresh weight yields of leaves and vines from 2-weekly harvests were significantly ($P = 0.01$) greater at 20 weeks after planting than yields from the 4-weekly harvests (Table 2). Since the period of significant fresh weight yield increase coincided with the time of greatest rainfall, it seems reasonable to assume that the crop achieved the greatest water use at this time. Compared to earlier periods of water shortage, increased temperatures, and drying winds typical of the dry season, there must have been increased transpiration, reduced evaporation, and increased water use efficiency at 20 weeks after planting. The highly significant fresh weight yields obtained from the 2-weekly har-

Table 2. The effect of mixed fertilizer levels (15-15-15 as N-P₂O₅-K₂O) and harvest intervals on the fresh weight yield (t/ha) of fluted pumpkin.

Harvest Interval (weeks)	Fertilizer Level (kg/ha)	Weeks After Planting					Total	Mean**
		8	12	16	20	24		
2*	0	0.59	1.37	2.48	0.76	3.22	8.42	1.68
	200	0.65	2.19	2.76	1.07	3.78	10.44	2.09a
	400	0.49	1.96	2.98	0.11	3.47	9.82	1.96a
4	0	0.33	1.49	2.26	0.59	1.98	6.64	1.33b
	200	0.42	2.06	5.17	0.62	3.09	11.36	2.27b
	400	0.52	1.80	3.76	0.54	2.85	9.47	1.89a

* For easy comparison with four weekly harvests, the yields for the two weekly harvests were recorded as totals of four weeks; thus, at 16 weeks after planting, 2.48 t/ha is the total for 14 and 16 weeks after planting.

** Means followed by the same letters do not differ significantly at $P = 0.05$, according to Duncan's Multiple Range Test.

vests point to the fact that total yield in some vegetables tends to decrease with an increase in the interval between harvests. These results are in accord with observations (Greensill, 1970) on *Basella alba* (Indian spinach) in which increased frequency of harvests led to increased yields. The results also confirm previous findings (Ossom, 1986) on the fluted pumpkin in which a reduced harvest interval caused profuse branching resulting in more vine and leaf growth from the 2-weekly harvests than from the 4-weekly harvests. The results of this work also agreed with observations (Thomas, 1965) that indicated that the more quickly vegetable plants grow, the larger their yield of leaves. The stimulatory effect of more frequent harvests appears to be associated with the frequent release from apical dominance (Meyer, *et al.*, 1960) in the vines, giving rise to more profuse branching, more production of leaves, and, consequently, increased fresh weight yields.

Fertilizer Effects. Fertilizer levels were not found to significantly affect total fresh weight yields, except at 20 weeks after planting (Table 2). The reason for this was not determined in this study. However, at about 15 weeks after planting, flowers of the fluted pumpkin start to form (Orgu, 1989). Translocation of nutrients out of the leaves into the flowers could have taken place at about 15 weeks after planting, and this movement could have adversely affected leaf and vine yield at 20 weeks after planting.

Earlier, workers at International Institute of Tropical Agriculture (1972) had shown that there were no significant effects of fertilizer levels on the total yield of jute, but greener and more attractive leaf blades were observed at higher fertilizer levels. At later harvests in this experiment, the older leaves on the plants in the unfertilized plots were chlorotic in pattern, indicating a lack of N in the tissues.

Table 3. The effect of mixed fertilizer levels (15-15-15 as N-P₂O₅-K₂O) and harvest intervals on N concentration (%) in the leaf blades of the fluted pumpkin. Each figure is the mean of three replicate determinations.

Harvest Interval (weeks)	Fertilizer Level (kg/ha)	Weeks After Planting						Mean	Std. Dev.
		8	10	12	16	20	24		
2	0	3.48	4.16	3.44	2.78	1.98	1.77	2.94	0.93
	200	4.47	4.47	5.04	4.86	3.45	3.81	4.40	0.63
	400	5.45	6.11	6.35	5.53	4.53	4.83	5.47	0.70
Mean		4.47	5.01	4.35	4.49	3.32	3.47		
Std. Dev.		0.99	1.00	1.46	1.43	1.28	1.56		
4	0	3.45	—	3.36	2.26	—	1.59	2.67	0.90
	200	4.47	—	4.91	4.58	—	3.09	4.26	0.80
	400	5.23	—	6.24	5.15	—	4.16	5.20	0.85
Mean		4.39	—	4.48	4.00	—	2.9		
Std. Dev.		0.89	—	1.44	1.53	—	1.29		

Table 4. The effect of mixed fertilizer levels (15-15-15 as N-P₂O₅-K₂O) and harvest intervals on P concentration (%) in the leaf blades of the fluted pumpkin. Each figure is a mean of three replicate determinations.

Harvest Interval (weeks)	Fertilizer Level (kg/ha)	Weeks After Planting						Mean	Std. Dev.
		8	10	12	20	22	24		
2	0	0.39	0.30	0.45	0.37	0.36	0.33	0.37	0.05
	200	0.36	0.30	0.43	0.39	0.34	0.31	0.36	0.05
	400	0.30	0.37	0.36	0.41	0.30	0.46	0.37	0.06
Mean		0.35	0.32	0.41	0.39	0.33	0.37		
Std. Dev.		0.05	0.04	0.05	0.02	0.03	0.08		
4	0	0.37	—	0.41	0.26	—	0.28	0.33	0.07
	200	0.35	—	0.36	0.32	—	0.30	0.33	0.03
	400	0.33	—	0.36	0.35	—	0.34	0.35	0.01
Mean		0.35	—	0.38	0.31	—	0.31		
Std. Dev.		0.02	—	0.03	0.05	—	0.03		

Table 5. The effect of mixed fertilizer levels (15-15-15 as N-P₂O₅-K₂O) and harvest intervals on K concentration (%) in the leaf blades of the fluted pumpkin. Each figure is a mean of three replicate determinations.

Harvest Interval (weeks)	Fertilizer Level (kg/ha)	Weeks After Planting						Mean	Std. Dev.
		8	10	12	20	22	24		
2	0	4.63	4.35	4.25	4.16	4.16	3.88	4.24	0.25
	200	4.56	4.97	4.69	4.44	4.16	5.25	4.67	0.39
	400	4.44	4.94	5.10	4.78	5.28	5.41	4.99	0.35
Mean		4.60	4.75	4.68	4.46	4.53	4.85		
Std. Dev.		0.10	0.35	0.43	0.31	0.65	0.84		
4	0	5.50	—	4.03	4.13	—	3.14	4.20	0.97
	200	4.25	—	4.41	4.28	—	4.08	4.23	0.14
	400	3.56	—	5.03	4.31	—	4.25	4.29	0.60
Mean		4.44	—	4.49	4.241	—	3.82		
Std. Dev.		0.98	—	0.50	0.10	—	0.60		

Foliar Concentrations of N, P, and K. Mineral concentrations in the leaf lamina (Tables 3-5) indicated that plants that received the higher levels of fertilizer also had higher N, P, and K concentrations as compared to plants that received lower amounts of fertilizer. As the fertilizer levels increased, the leaf blades became greener and more attractive. This change probably resulted from the increased mineral (particularly N) concentrations in the leaves of those plants that received higher amounts of fertilizer. Plants harvested every 2 weeks had a higher concentration of N, P, and K in their leaves than those cut every 4 weeks. Okugie and Ossom (1988), Omueti (1982a), Ossom, *et al.* (1983), and Schmid, *et al.* (1979) achieved similar results with other crop plants. In this work, the 2-weekly harvests continually gave more tender and fresher leaves in contrast to the 4-weekly harvests whose leaves were more fibrous. Omueti (1982b) reported that vegetable leaves cut at intervals of more than 2 weeks were higher in crude fiber than those cut at shorter intervals. From a dietary point of view, fluted pumpkin leaves should be harvested every 2 weeks, when they are most nutritious.

K concentration (Table 5), like N and P concentration, also decreased steadily with time, particularly from 12 weeks after planting. Similar observations had been made on other tropical vegetables (Omueti, 1977). The decreased mineral concentration could be associated with leaf aging and the movement of minerals from the leaves and vines to sites undergoing vegetative and reproductive growth (Orgu, 1989). K is rapidly translocated to meristems (Meyer, *et al.*, 1960). The decrease in K concentration in the leaves was probably due to such outward movement.

SUMMARY

This experiment was conducted to evaluate the influence of mixed fertilizer levels and harvest intervals on the fresh weight yield of the leaves and the N, P, and K concentrations in the leaves of fluted pumpkin planted in the dry season. The results of this research point to the need for farmers to fertilize fluted pumpkin with mixed fertilizer and to harvest the crop every two weeks in order to obtain high yield as well as tender and more nutritious leaves and vines.

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