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INFLUENCE OF K FERTILIZER LEVELS AND PLANT DENSITY ON THE YIELD AND MINERAL CONTENT OF THE LEAVES AND VINES OF THE FLUTED PUMPKIN, *TELFAIRIA OCCIDENTALIS* HOOK.

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ABSTRACT: An experiment was conducted to evaluate the influence of K fertilizer levels and population density on the fresh weight yield and K content of the vines and leaves of the fluted pumpkin. The maximum yield of leaves and a high K content occurred at a population density of 40,000 plants/ha using K_2O at a rate of 100 kg/ha.

KEYWORDS: Fluted pumpkin, K fertilization, mineral content, plant density, *Telfairia occidentalis* Hook., yield.

INTRODUCTION

The fluted pumpkin (*Telfairia occidentalis* Hook.), which originated in West Africa (Irvine, 1969), belongs to the gourd or calabash family (Cucurbitaceae). The fluted pumpkin is a large perennial vine grown as a vegetable crop along the edges of the closed forest zone in southern Nigeria. The crop is usually propagated by seeds obtained from mature gourds of the previous harvest. The gourds are split open to extract the seeds a few days before planting. The crop is usually grown in the rainy season but is more profitably cultivated during the dry season, if the plots are irrigated.

In southern Nigeria, the fluted pumpkin is either inter-cropped with cassava or yam, or it may be cultivated alone. Most farmers do not maintain any specific plant density or level of fertilization; artificial fertilizers are costly, and most peasant farmers cannot afford them. The objective of this study was to evaluate the influence of K fertilizer levels and plant density on the yield and mineral content of the fluted pumpkin.

Table 1. Treatments as a function of fluted pumpkin density and K fertilizer level.

Treatment	Plants/ha	Fertilizer Level
T_1	20,000	50 kg/ha K_2O from 15-15-15
T_2	20,000	100 kg/ha K_2O from 15-15-15
T_3	20,000	133 kg/ha K_2O from KCl
T_4	20,000	266 kg/ha K_2O from KCl
T_5	40,000	50 kg/ha K_2O from 15-15-15
T_6	40,000	100 kg/ha K_2O from 15-15-15
T_7	40,000	133 kg/ha K_2O from KCl
T_8	40,000	266 kg/ha K_2O from KCl

MATERIALS AND METHODS

The investigation was conducted in the dry season (November 1988 - July 1989) at the University of Science and Technology's Research and Teaching Farm in Port Harcourt (4° 46′ N, 7° 01′ E) on a Typic Paleudult soil. The average rainfall was 2,000 mm per annum (Food and Agricultural Organization, 1984). The initial fertility of the soil was: pH, 4.50; total nitrogen, 0.06% (determined by the semi-Kjeldahl Method); available P, 22.36 ppm (ammonium molybdate method with absorbance and transmittance measured at 660 nm); exchangeable K, 41.48 ppm by flame photometry (Allen, *et al.,* 1974). The experiment used a split plot in a randomized complete block design in which two planting densities and four K fertilizer levels were factorially arranged and replicated four times. The planting densities were assigned to the main plots, while K fertilizer levels were in the subplots. Eight treatments (T_1 to T_8) were replicated 4 times in a randomized manner so that treatments had the following plant populations with a spacing of 1 m by 1 m; T_1-T_4, 20,000 plants/ha (2 seeds/stand); T_5-T_8, 40,000 plants/ha (4 seeds/stand). Each subplot measured 8 m by 4 m with an interplot distance of 1 m as well as a 1 m width round the experiment. Seeding was done on 25 November 1988, after plowing and disk harrowing. Manual weeding was done 3 weeks after planting and, subsequently, at 8, 17, and 25 weeks after planting.

Fertilizer Application. Fertilizer was applied at 9 weeks after planting. The ring (30-cm diameter) method was adopted at the following rates (Table 1): T_1 and T_5, 50 kg/ha K_2O from 15-15-15 (N-P_2O_5-K_2O); T_2 and T_6, 100 kg/ha K_2O from 15-15-15 (N-P_2O_5-K_2O); T_3 and T_7, 133 kg/ha K_2O from muriate of potash (KCl); and T_4 and T_8, 266 kg/ha K_2O from muriate of potash (KCl). N from urea and P from single superphosphate were added to T_3, T_4, T_7, and T_8 to bring their levels of N and P up to those of the NPK 15-15-15 used in T_1, T_2, T_5, and T_6. Therefore, only K varied, while similar N and P levels were maintained.

Mulching and Watering. Dry grass mulch (Okugie and Ossom, 1988) was applied at the base of each crop stand at the rate of about 3 t/ha. Watering was done twice a week at the rate of 2.65 mm irrigation/plot for the first 2 weeks after planting. Because of the increasing severity of the dry season, the rate thereafter

Table 2. The distribution of rainfall and irrigation during the course of the experiment.

Date	Rainfall (mm)	Irrigation (mm)	No. of Days With Up To 0.1 mm	Total Water Use (mm)
Nov. 1988	106.8	0.0	12	106.8
Dec. 1988	30.2	21.2	10	51.4
Jan. 1989	0.0	31.8	8	31.8
Feb. 1989	0.0	31.8	8	31.8
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
July 1989	175.1	0.0	19	175.1

was increased to 3.98 mm irrigation/plot twice a week but was discontinued on March 3, when the first heavy rain fell. Typically, farmers do not water their fluted pumpkin plots in the dry season and, as a result, lose much of their crop to drought. In this experiment, minimal irrigation was provided as a way of possibly improving crop growth, avoiding crop failure, and increasing crop yield. Table 2 shows the rainfall and irrigation distribution during the course of the experiment.

Harvesting and Sample Preparation. The first leaves and vines were harvested 7 weeks after planting; subsequent harvests were made every 4 weeks (Ossom, 1986) and continued until 27 weeks after planting. Individual plant yield was not determined. During harvesting, each vine or branch of a vine along with its leaves was cut off about 60 cm from the growing tip, and the total fresh weight of both vines and leaves was recorded. A 200 g sample/plot was taken from the weighed material, wilted overnight in the laboratory, and bagged. The samples were dried in a hot-air oven at 80° C for 5 days. Then, the dried samples were ground in a micro-hammermill using a 0.025 mm mesh screen. Analyses for N, P, and K (Allen, *et al.*, 1974) were conducted at 7, 11, 19, and 27 weeks after planting.

RESULTS AND DISCUSSION

Fresh Weight Yield of Leaves and Vines. Low fresh weight yields were obtained during the early harvests (7, 11, and 15 weeks after planting). Higher yields were recorded during later harvests (19, 23, and 27 weeks after planting), which coincided with the period of heavy rainfall. Though the effect of rainfall on the treatments was not specifically tested, the low yields at 7, 11 and 15 weeks after planting were probably due to the adverse effects of insufficient rainfall during that period. Conversely, the higher yields observed at 19, 23, and 27 weeks after planting can probably be attributed to the higher rainfall experienced during March. Cumulative fresh weight yield showed significant differences

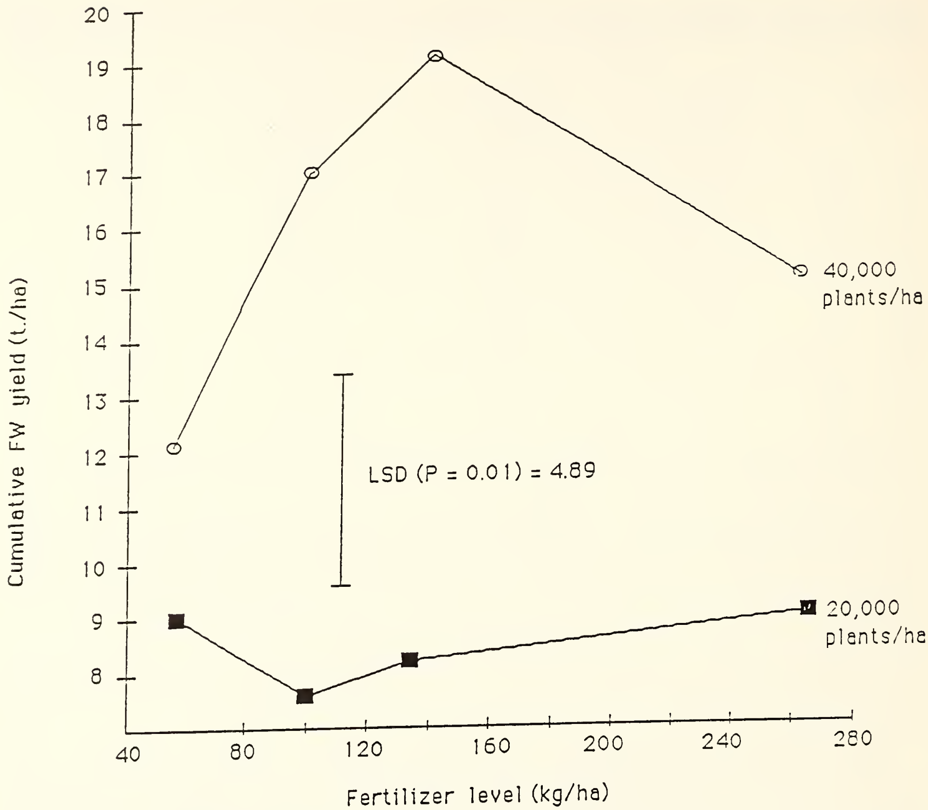

Figure 1. The effect of K fertilizer and plant density on the fresh weight yield (t/ha) of the fluted pumpkin.

($P = 0.05$) between treatments. Least significant difference tests for plant population density, fertilizer levels, and interaction indicated by A, B, and AB, respectively (Table 3), showed significant yield differences ($P = 0.05$) between treatments. Cumulative fresh weight yield was higher at a population density of 40,000 plants/ha than at 20,000 plants/ha.

Effect of Fertilizer Level on Fresh Weigh Yield. Different fertilizer levels did not influence cumulative fresh weight yield. However, a significant increase ($P = 0.05$) in fresh weight yield during harvests 11 and 19 weeks after planting was noted. The increased yields might have resulted from increased fertilizer availability (K fertilizer was applied 9 weeks after planting) and more efficient water use. Singh and Ghosh (1984) noted that graded doses of K increased the dry matter yield of maize, cowpea, and wheat. Hassan and Ayoub (1978) noted that NPK fertilization leads to increased yield in the onion.

Effect of Fertilizer by Plant Density Interaction on Cumulative Fresh Weight Yield. Increased fertilizer levels did not result in significant fresh weight yield increases, but the interaction between fertilizer and plant density did result in increased fresh weight yield at 40,000 plants/ha (Figure 1). At 133 kg/ha K_2O,

Table 3. The mean fresh weight yield (t/ha) of vines and leaves of fluted pumpkin as affected by plant density, K fertilizer, and harvest interval.

		Weeks After Planting							
Plants/ha	Treatment[1]	7	11	15	19	23	27	Total	Mean[3]
20,000	T_1	0.25	0.34	0.67	2.31	3.26	2.27	9.10	1.52bc
	T_2	0.16	0.21	0.43	1.53	2.88	2.23	7.44	1.24c
	T_3	0.23	0.31	0.61	1.79	3.06	2.21	8.21	1.37c
	T_4	0.26	0.35	0.69	2.29	3.49	2.41	9.49	1.58bc
40,000	T_5	0.44	0.54	1.14	2.99	4.13	2.97	12.21	2.04b
	T_6	0.64	0.77	1.57	4.28	6.33	3.83	17.42	2.90ab
	T_7	1.37	1.59	2.95	5.85	4.62	3.02	19.40	3.23a
	T_8	0.52	0.68	1.36	4.43	4.68	2.96	14.63	2.44b
A[2]	LSD[4] ($P = 0.05$)	—	0.32	0.96	1.79	0.80	0.45	4.32	0.86
B[2]	LSD[4] ($P = 0.05$)	0.30	0.32	1.67	0.85	0.96	0.98	5.08	0.85
AB[2]	LSD[4] ($P = 0.05$)	—	0.45	2.36	1.20	1.36	1.39	6.76	1.35

[1] See Table 1.

[2] A, B = Main effects; AB = Interactions.

[3] Means followed by the same letters do not differ significantly at $P = 0.01$, according to Duncan's New Range Multiple Test.

[4] Least significant difference test.

a plant density x fertilizer interaction was noted that resulted in yield differences when treatment means were compared using a least significant difference test ($P = 0.01$).

Effect of Plant Density on Cumulative Fresh Weight Yield. The highest fresh weight per harvest was obtained from T_7. More succulent, harvestable leaves and vines were produced at plant densities of 40,000 plants/ha than at densities of 20,000 plants/ha. The maximum fresh weight yield of leaves and vines was obtained from 15 to 23 weeks after planting. During this period, more soil water from rains was available compared to earlier harvests, when little or no rainfall occurred (Table 2). Since better fertilizer use is achieved in the presence of soil water, the fluted pumpkin probably made more and better use of the fertilizer applied earlier as indicated by the production of more vegetative yield. Plant population density exerts a prominent influence on the yield of a crop; hence, farmers need to increase the number of plants/ha to maximize growth. For most crops, yield is expected to increase with increasing density up to a certain point after which yields would decline. At higher densities, more leaves and longer shoots tend to be produced by the fluted pumpkin in the plant's effort to increase its photosynthetic area that might otherwise be reduced by mutual shading from nearby plants and plant parts. The favorable effect of increasing population density on yield agrees with reports from similar investigations using pigeon pea (*Cajanus indicus*; Abrams and Julia, 1974), cowpea (*Vigna unguic-*

Table 4. N concentration (%) in the leaf blades of the fluted pumpkin as affected by plant density, K fertilizer, and harvest interval.

	Weeks After Planting					
Treatment[1]	7	11	19	27	Mean	Std. Dev.
T_1	1.56	1.90	3.08	1.75	2.07	0.69
T_2	1.80	2.02	2.91	2.17	2.23	0.48
T_3	1.88	2.16	2.86	1.86	2.19	0.46
T_4	1.74	1.87	2.89	1.76	2.07	0.55
T_5	2.59	2.61	3.35	2.79	2.84	0.35
T_6	2.04	2.58	3.15	5.42	3.69	0.75
T_7	2.58	3.15	5.42	3.69	3.71	1.23
T_8	2.25	2.29	2.98	2.69	0.50	0.35
Mean	2.06	2.33	3.47	2.56	—	—
LSD[2] ($P = 0.05$)	0.54	0.28	0.39	0.38	—	—
Std. Dev.	0.39	0.44	0.86	0.82	—	—

[1] See Table 1.

[2] Least significant difference test.

Table 5. P concentration (%) in the leaf blades of the fluted pumpkin as affected by plant density, K fertilizer, and harvest interval.

	Weeks After Planting					
Treatment[1]	7	11	19	27	Mean	Std. Dev.
T_1	0.50	0.50	0.50	0.40	0.50	0.05
T_2	0.50	0.50	0.50	0.40	0.50	0.05
T_3	0.50	0.50	0.50	0.40	0.50	0.05
T_4	0.50	0.50	0.50	0.40	0.50	0.05
T_5	0.50	0.50	0.50	0.40	0.50	0.05
T_6	0.60	0.50	0.50	0.50	0.50	0.05
T_7	0.60	0.60	0.50	0.50	0.60	0.06
T_8	0.50	0.50	0.50	0.40	0.50	0.05
Mean	0.55	0.52	0.52	0.43	—	—
LSD[2] ($P = 0.05$)	0.10	0.02	0.02	0.09	—	—
Std. Dev.	0.05	0.04	0.00	0.05	—	—

[1] See Table 1.

[2] Least significant difference test.

Table 6. K concentration (%) in the leaf blades of the fluted pumpkin as affected by plant density, K fertilizer, and harvest interval.

	Weeks After Planting					
Treatment[1]	7	11	19	27	Mean	Std. Dev.
T_1	2.30	2.80	4.00	2.50	2.90	0.76
T_2	2.30	2.70	3.90	2.60	2.90	0.70
T_3	2.20	2.70	3.90	2.00	2.70	0.85
T_4	2.30	2.80	3.80	2.00	2.70	0.79
T_5	2.80	3.50	4.90	2.40	3.40	1.10
T_6	2.20	3.10	4.90	2.60	3.20	1.19
T_7	2.90	4.50	7.00	3.00	4.40	1.91
T_8	2.50	3.30	5.20	2.60	3.40	1.25
Mean	2.50	3.20	4.70	2.50	—	—
LSD[2] ($P = 0.05$)	0.37	0.55	0.74	0.41	—	—
Std. Dev.	0.27	0.61	1.08	0.33	—	—

[1] See Table 1.
[2] Least significant difference test.

ulate; Adetiloye, 1986), long beans (*Vigna sesquipedalis*; Choo, 1974), maize (*Zea mays*; Choudhary, 1981), sunflower (*Helianthus annus*; Ogunremi, 1979), and common bean (*Phaseolus vulgaris*; Leakey, 1972).

Because of the sparse rainfall and the small amount of irrigation provided during the early stages of the experiment, which was followed by heavy rainfall that improved the water balance within the plant and thus encouraged vegetative growth in the later stages of the experiment, the increased plant density probably resulted in more soil coverage, thus reducing evaporation and increasing yield. Gregory (1988) showed that fertilizer use does promote rapid leaf growth thereby enabling plants to cover the surface of the soil and bring about a reduction in evaporative losses and an increase in water use efficiency.

The increased fresh weight yield observed at a density of 40,000 plants/ha when compared to that at 20,000 plants/ha was in agreement with observations (Thompson and Taylor, 1975) on two cauliflower varieties, "Finney's 110" and "Kangaroo," in which the yield of the former increased considerably with increased planting density. The result also agrees with the findings (Farah, 1975) that yield and quality of tobacco were improved as plant density increased. In the present experiment, yield increases were probably associated with increased plant density and greater vegetative growth at these higher densities; maximum plant density has not yet been conclusively determined for the fluted pumpkin.

Mineral Concentration in the Leaves. At each harvest, irrespective of the plant population/ha, the relative concentration of N, P, and K in the leaf blades was K > N > P (Tables 4, 5, and 6, respectively). At each harvest, the concentration of N was generally higher in plants sown at 40,000 plants/ha than in those sown at 20,000 plants/ha. P concentration did not markedly differ between plant populations at each harvest. K content did not vary proportionately with an increase or decrease in the level of K_2O applied as fertilizer. The observed trend for N accumulation in the vines and leaf blades was in agreement with earlier reports (Hassan and Ayoub, 1978) that noted that increased mineral content in onion resulted from increased NPK fertilization. In the present experiment, how crop density contributed to the differences in the amount of N in the leaves is not clear. However, the results agree with previous investigations (Orluchukwu and Ossom, 1988) that showed a significant difference in the concentration of P and K in the leaf blade of the fluted pumpkin grown under different management practices. At 27 weeks after planting, yellowing of the leaves and laboratory tests indicated a low concentration of N as was also observed at 7 weeks after planting prior to fertilization.

The mineral content of a plant organ depends, among other factors, on the age of the organ and the presence or absence of elements that can either antagonize or promote nutrient reactions, such as chemical fixation and reduction (Brady, 1974). N levels of below 0.05% are indicative of the onset of a deficiency (Purvis and Carolus, 1964). K levels below 0.3% to 0.5% show the onset of a deficiency (Purvis and Carolus, 1964). In this study, mineral levels were in the deficiency range prior to fertilizer application, but after fertilizer was applied, increased mineral concentration was found in the plant tissues. However, continued harvest without additional fertilizer application caused mineral levels to decline, giving rise to the deficiency symptoms observed towards the end of the experiment. The deficiency symptoms could also have resulted from the maturation of the pumpkin plants. Purvis and Carolus (1964) noted that N deficiency might occur during crop maturation.

The moisture holding capacity of the experimental plots was low for three reasons: (1) the sandy loam soil had a low water holding capacity; (2) temperatures during the dry season were high; and (3) desiccating winds were common. The available soil moisture was not at an optimum level in the early stages of the experiment, including the time when the plots were irrigated.

SUMMARY

The results of this experiment indicate that the yield of leaves and vines increases when fluted pumpkin is planted at high densities and fertilized. Maximum yields were obtained at 40,000 plants/ha at a K_2O application rate of 100 kg/ha. If farmers adopt this planting density and level of K fertilization, they should get high yields of leaves and vines from this crop. Though it is costly for farmers to obtain large numbers of fluted pumpkin seeds for planting, the high profits obtained from sales should offset the cost of purchasing the seeds. In the future, the relationship between irrigation and yield of fluted pumpkin vines planted during the dry season should be studied.

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