Proceedings of The Indiana Academy of Science
(1991) Volume 99, p. 191-198

INFLUENCE OF SPACING ON YIELD, WEED INFESTATION AND MINERAL CONCENTRATION OF THE FLUTED PUMPKIN *Telfairia occidentalis* (HOOK)

E.M. Ossom, D.T.T. Minimah, O.S.O. Edet and C.L. Rhykerd
Faculty of Agriculture
University of Science and Technology
P.M.B. 5080, Port Harcourt, Nigeria
and
International Programs in Agriculture
Purdue University
West Lafayette, Indiana 47907

ABSTRACT: Increasing fluted pumpkin plant populations in Nigeria increased fresh weight yield of vines and leaves. Plant population density correlated positively and highly significantly with cumulative fresh weight yield ($r = 0.95$; $P = 0.01$). Weed infestation was decreased by the higher population densities and a non-significant correlation between weed score and fresh weight yields was negative ($r = 0.88$). Plant population densities did not greatly influence mineral concentration. Among the minerals investigated, K concentration was the highest. High plant population of about 30,000 plant/ha was useful for increased yield and for effective cultural weed control. The need has been indicated for more mineral studies in the fluted pumpkin.

INTRODUCTION

The fluted pumpkin *(Telfairia occidentalis* Hook) is a large dioecious perennial vine crop belonging to the Cucurbitaceae, and is one of the leaf vegetables most widely and commonly cultivated in West Africa. Its propagation is usually by seed. Some of the major factors limiting the yields of the fluted pumpkin in the dry season are inadequate supply of minerals in the soil, insufficient water, sub-optimum plant population and weed infestation. It had earlier been reported (Ossom, 1986a) that mixed cropping of cassava and maize at a combined population of 50,000 plants/ha was beneficial in increasing yields and reducing weed infestation. It was, therefore, thought that in the fluted pumpkin, a similar gain in yield and weed suppression might be obtained by increasing plant population.

Farmers who cultivate the fluted pumpkin in Nigeria do not adopt any specific planting distance or crop density. This research was conducted in order to help evolve better production practices in the fluted pumpkin. The study was initiated with a view to achieving the following objectives: to estimate how increased spacing increases or reduces vine and leaf yield; to demonstrate the relative weed suppression abilities of different fluted pumpkin populations and to indicate gains, if any, in mineral content of the fluted pumpkin planted at different population densities in the dry season.

MATERIALS AND METHODS

The experiment was conducted on a Typic Paleudult (sandy-loam) soil at the Teaching and Research Farm of the University of Science and Technology, Port Harcourt

(4.5° N, 7.0° E), Nigeria from the beginning of the dry season in 1987 to the mid-rainy season in 1988. The beginning of the dry season is the usual time for dry season fluted pumpkin establishment in order to produce and sell the crop when the supply is low in the market while the demand is very high. The initial fertility status of the soil was 0.4% total N, 20.18 ppm available P, 42.50 ppm exchangeable K and pH 4.60. These values were typical of the upland soils of Rivers state where the study was done.

Table 1. Rainfall distribution at Port Harcourt, Nigeria, during the growing period of the fluted pumpkin

Date		Rainfall	
		Total (mm)	Days
October	1987	189.6	17
November	1987	50.3	10
December	1987	4.1	2
January	1988	16.1	3
February	1988	52.3	4
March	1988	118.5	8
April	1988	212.3	14
May	1988	232.7	14
June	1988	203.2	19

The experimental design was a randomized complete block design replicated four times with six spacing treatments in each replicate. These treatments (T) were T1, 1x 1m; T2, 1.5 x 1.5m; T3, 2 x 2m; T4, 3 x 3m; T5, 4 x 4m and T6, 5 x 5m. Each plot measured 6 x 6m with an interplot distance of 1m and 1m wide perimeter. Planting was done on 24 October 1987; three sprouted seeds were planted/hill and vacancies were supplied three weeks later to maintain the required plant populations. Because of the onset of the dry season, watering was done at the rate of about 25,000 litres of water/ha twice a week for 15 weeks. The monthly rainfall distribution during the period of the experiment is shown in Table 1. The first weeding was done at 5 weeks after planting (WAP) and subsequent weeding operations were carried out at 17 and 24 WAP. Fluted pumpkin gardens usually become weedy about 3 - 6 WAP; after the first weeding, further weeding is needed every 8 - 12 weeks depending on the degree of weed infestation, the degree of ground coverage attained by the leaves of the plant and the rainfall in the locality, among other possible factors. Weed infestation by dominant species was estimated by counts (200 weeds) within a 100 x 100 cm quadrat. Three random samples/plot was taken with the quadrat. The score of zero (0) was the minimum while 5 was the maximum score for total ground coverage of all weed species within the quadrat. This method of evaluating weed infestation had earlier been used and adopted in previous studies (Orluchukwu and Ossom, 1988; Ossom 1986a).

Two split doses of fertilizer were applied as a band around each stand about 15 cm away from the stand. At 5 WAP, a mixture of the following fertilizers were appleid: urea, 9.3 kg/ha; muriate of potash, 12.0 kg/ha; boronated superphosphate (BSP), 3.6 kg/ha. These initial low rates were applied to simulate the little or no fertilizer application practices of local growers who usually do not apply any artifical fertilizers. At 20 WAP, NPK (15:15:15) fertilizer was applied at the rate of 400 kg/ha (Ethirveerasingam et al.,

Table 2. Influence of spacing on the leaf and vine yield (kg/ha) of the fluted pumpkin

		Spacing (m)	Crop density/ha	Weeks after planning							Total	Means
				8	12	16	20	24	28	32		
T1	:	1.0x1.0	30,000	4539	3013	656	5089	9998	15751	4786	43832	6262a
T2	:	1.5x1.5	13,333	3347	2895	603	4109	6831	13498	5053	36336	5191ab
T3	:	2.0x2.0	7,500	2008	1272	670	2186	3675	9229	3623	22663	3238bc
T4	:	3.0x3.0	3,333	1281	776	239	1481	2236	6456	1689	14158	2023c
T5	:	4.0x4.0	1,875	1364	972	361	1370	1428	5734	2778	14007	2001c
T6	:	5.0x5.0	1,200	942	852	364	1214	1858	5159	2286	12676	1811c
C.V(%)	:	56.04	121.95	241.56	109.90	38.00	75.05	87.39	48.78	51.95	55.53	61.29
S.E. ±	:	0.63	4.56	156.63	195.02	74.81	0.71	1.31	1.76	0.60	5.33	0.79

Only means followed by different letters in the column differ significantly at P = 0.01 according to Duncan's New Multiple Range Test.

1985). The first harvest of leaves and vines was made at 8 WAP; the standard local practice is to harvest from 6 - 10 weeks depending on family need or market demand. Subsequent harvests were made at 4 week intervals (Ossom, 1986b) until 32 WAP. Each vine was cut about 50cm from the growing tip and the total fresh weight (FW) yield from each plot was recorded. At flowering, fruit-bearing vines were not harvested as per local practice. Over-dried (80°C for days) samples of the leaf lamina harvested at 16 and 24 WAP were ground using a microhammer mill and sieved through a 0.5 mm mesh screen for mineral analysis. Nutrient analysis was done for the 16 and 24 WAP samples to evaluate the mineral content of the plant just before the second fertilizer application and the content 4 weeks later (mid-season). A comparison of the values at both periods would probably be instructive on the need or otherwise of a second fertilizer application. A computerized atomic absorption spectrophotometer (AAS) Perkin Elmer Model 2380 was used for quantifying the elements P, K, Ca, Mg and Si following well known procedures (Allen et al., 1974).

RESULTS AND DISCUSSION

FW yield: The FW yield of leaves and vines showed interesting patterns (Table 2). There was a progressive reduction in yield/harvest from 8 - 16 WAP, an effect attributed to the severity of the harmattan season, low level of minerals in the soil and weed infestation. Conversely, there was a progressive increase in yield from 20 - 28 WAP following increased water and mineral availability resulting from the onset of rains and fertilizer application. Also, since weeds were removed at 17 and 24 WAP, this reduced competition for moisture and nutrients thus resulting in improved yields after 16 WAP. The cumulative FW yields showed highly significant differences ($P = 0.01$) between treatments. Least significant differences (LSD) tests gave highly significant ($P = 0.01$) yields between treatment means at 8, 12, 16, 28 and 32 WAP whereas harvests at 20 and 24 WAP showed significant differences in their means at $P = 0.05$. There was a highly significant ($P = 0.01$) linear correlation ($r = 0.95$) between the plant population density and the cumulative FW yield of leaves and vines. The cumulative FW yield was highest at 30, 000 plants/ha and lowest at 1,200 plants/ha. There was no significant difference between T1 and T2 in any harvest. The yield of a crop/unit area is a function of many factors which include interplant competition and plant population. The increases in yield recorded after weeding at 17 and 24 WAP for all treatments emphasize the influence of reduced weed infestation on the yield of this crop.

The highest FW yield/harvest as recorded in T1 from 8 - 24 WAP was probably also attributable to the greatest plant population and the production of more harvestable vegetative materials in T1 than in other treatments. It could probably suggest that the most efficient use of the available land area was made at the highest population density as earlier reported (Tayo, 1982). Since T2 was not significantly less than T1, 13,333 plants/ha appears to be the optimum plant population. However, if yields were converted to the monetary values, it would be more advisable to plant at 30,000 plants/ha. The general drastic reduction in yield at 32 WAP was attributed to the fact that by this time, vegetative growth was declining on account of the onset of the reproductive phase of the crop.

Weed infestation: Table 3 shows the major weed species encountered in the experiment. Monocot weeds were more dominant than dicot species among 200 weeds within the quadrat. This was in agreement with a previous work (Orluchukwu and

Table 3. Effects of population density on weed infestation in the fluted pumpkin

Number of plants/ha	Dominant weed species	Subclass	Relative Abundance (%)	Weed Score 16 WAP	Weed Score 24 WAP
30,000	*Paspalum orbiculare* Forst.	Monocot	40		
	Digitaria horizontalis Willd	Monocot	30		
	Brachiaria lata C.E. Hubbard	Monocot	8		
	Ageratum conyzoides L.	Dicot	8	1.3b	1.9b
	Commelina nudiflora L.	Monocot	8		
	Emilia sonchifolia L. (D.C.)	Dicot	3		
	Ipomoea involucrata Beauv.	Dicot	3		
13,333	*Paspalum orbiculare* Forst.	Monocot	35		
	Brachiaria lata C.E. Hubbard.	Monocot	25		
	Chromolaena odorata (L.) R.M. King & H. Robinson	Dicot	8		
	Sporobulus pyramidalis Beauv.	Monocot	2	2.1ab	2.2ab
	Talinum traingulare Jacq.	Dicot	8		
	Ageratum conyzoides L.	Dicot	10		
	Ipomoea involucrata Beauv.	Dicot	4		
	Calopogonium mucunoides Desv.	Dicot	8		
7,500	*Paspalum orbiculare* Forst.	Monocot	32		
	Digitaria horizontalis Willd	Monocot	23		
	Talinum triangulare Jacq.	Dicot	9		
	Commelina nudiflora (L.) D.C.	Dicot	4		
	Emilia sonchifolia (L.) D.C.	Dicot	5		
	Cynodon dactylon (L.) Pers.	Monocot	4	2.1ab	3.2ab
	Panicum maximum Jacq.	Monocot	6		
	Calopogonium mucunoides Desv.	Dicot	6		
	Ageratum conyzoides L.	Dicot	5		
	Brachiaria lata C.E. Hubbard	Monocot	6		
3,333	*Paspalum orbiculare* Forst.	Monocot	25		
	Eleusine indica (L.) Gaertn.	Monocot	25		
	Talinum triangulare Jacq.	Dicot	20		
	Calopogonium mucunoides Desv.	Dicot	10		
	Ageratum conyzoides L.	Dicot	4		
	Commelina nudiflora L.	Dicot	4		
	Chromoaena odorata (L.) R.M. King & H. Robinson	Dicot	4	2.8ab	3.1a
	Aspilia africana (Pers.) C.D.	Dicot	2		
	Sporobulus pyramidalis Beauv.	Monocot	2		
	Eragrostis tenella Roem. & Schult.	Monocot	4		
1,875	*Brachiaria lata* C.E. Hubbard	Monocot	40		
	Aspilia africana (Pers.) C.D.	Dicot	20		
	Talinum triangulare Jacq.	Dicot	8		
	Digitaria horizontalis Willd	Monocot	5		
	Chromolaena odorata (L.) R.M. King and H. Robinson	Dicot	5		

	Paspalum orbiculare Forst.	Monocot	5	2.4ab	3.6a
	Calopogonium mucunoides Desv.	Dicot	4		
	Eleusine indica (L.) Gaertn.	Monocot	2		
	Sida acuta Burm F.	Dicot	10		
	Ageratum conyzoides L.	Dicot	1		
1,200	*Paspalum orbiculare* Forst.	Monocot	20		
	Briachiaria lata C.E. Hubbard	Monocot	30		
	Commelina nudiflora L.	Monocot	10		
	Ipomoea involucrata Beavu.	Dicot	5		
	Aspilia africana (Pers.) C.D.	Dicot	8	2.7ab	2.7ab
	Calopogonium mucunoides Desv.	Dicot	8		
	Ageratum conyzoides L.	Dicot	7		
	Eragrostis tenella Roem. & Schult.	Monocot	2		
	Talinum triangulare Jacq.	Dicot	5		

Ossom, 1988), on weed coverage. Weed scores were generally higher at 24 WAP than at 16 WAP probably because of increasing rainfall. Linear correlation analyses between weed scores and FW yield showed a non-significant negative correlation ($r = -0.88$). Thus, the results indicated that the higher the intensity of weed infestation was, the lower the crop yield; conversely, the lower the weed infestation, the higher the yield. These results would be very instructive to farmers—that weed control is essential for good yields of the fluted pumpkin.

Fluted pumpkin when planted on the flat, has been shown (Orluchukwu and Ossom, 1988) to establish good ground coverage and suppress weeds effectively. However, with low plant population (T3 - T6), an effective ground cover was not achieved. As a result, the exposed soil surfaces coupled with insufficient sunlight and soil moisture, created favorable conditions for weed establishment hence the heavy weed infestation in the treatments with a low plant population density. On the other hand, T1 and T2 gave better ground coverage and suppressed weeds better and confirmed previous findings (Ossom, 1986a; Wahua, 1985) which pointed out the desirability of high population for effective weed suppression.

Mineral concentration: At 16 and 24 WAP, the concentration of each mineral did not vary appreciably between population densities to clearly point out the mineral content of the crop prior to the second fertilizer application and the content at mid-season (Table 4). However, there were higher levels of all the mineral elements at 24 WAP than at 16 WAP. This was most probably due to the effects of fertilisation at 20 WAP. The levels of K, Ca, Mg, P and Si at both periods were in the order K>Ca>Mg>P>Si.

Normal ranges of mineral concentrations in vegetables (Purvis and Carolus, 1964) indicate that all nutrients were at sufficient levels in the plants. The timely application of fertilizer is important to enable the crop grow vegetatively before reproductive structures form. Results of this work show that prior to the second fertilizer application crop yields and mineral concentration were low whereas after the application, the concentrations and crop yields increased. The higher levels of minerals accumulated after the second fertilizer application stressed the need for the adoption of a minimum of two

Table 4. Effects of population density on the mineral concentration of the fluted pumpkin

Plant population per ha	Mineral concentration (%)					
	WAP	P	K	Ca	Mg	Si
30,000	16	0.21	1.00	0.55	0.42	0.04
	24	0.43	1.07	0.81	0.64	0.14
13,000	16	0.23	0.96	0.51	0.38	0.04
	24	0.42	0.96	0.82	0.61	0.14
7,500	16	0.19	0.81	0.58	0.46	0.04
	24	0.43	1.00	0.58	0.62	0.12
3,333	16	0.20	1.05	0.48	0.35	0.04
	24	0.43	1.07	0.76	0.53	0.13
1,875	16	0.21	1.01	0.57	0.45	0.04
	24	0.42	0.99	0.84	0.65	0.14
1,200	16	0.20	0.76	0.47	0.37	0.05
	24	0.45	1.12	0.79	0.58	0.14

Each value is a mean of four replicate determinations

doses of fertilizer application as lately recommended (Ethirveerasingam et al., 1985). Local growers do not usually apply any artificial fertilizers. The higher levels of minerals obtained in this study compare favorably with the lower concentrations obtained (Orluchukwu and Ossom, 1988; Ossom, 1986b) when a single dose of fertilizer was applied. More mineral content studies are needed in this crop.

SUMMARY AND CONCLUSIONS

This research presents data suggesting that higher planting densities, weed removal and addition of commercial fertilizers in addition to irrigation are essential to optimize yield of the fluted pumpkin in the dry season in Nigeria. Planting densities of 30,000 plants/ha resulted in the highest yields and provided the best weed suppression. Weed removal at 16 and 24 WAP also resulted in improved FW yield in subsequent harvests. Fertilizer applications at 20 WAP also resulted in improved yield. Further research will be required to determine the best timing of weed removal and additions of fertilizers; however, the data do show that plant density is the critical first step in the improvement of crop yields.

ACKNOWLEDGMENTS

The Authors wish to thank Mr. F.O. Harry and Mr. C.B. Whyte for their technical assistance in the conduct of this investigation.

LITERATURE CITED

Allen, S.E., H.M. Grinshaw, J.A. Parkinson, and C. Quarmby. 1974. Chemical analysis of ecological materials, Oxford, Blackwell Scientific Publications, 565p.

Ethirveerasingam, N., N.O. Isirimah, P. Loganathan, U.U. Ebong, K. Zuofa, L.A. Daniel-Kalio, and E.M. Ossom. 1985. Guide to crop production in Rivers State. UNESCO Project, 50p.

Orluchukwu, J.A. and E.M. Ossom. 1988. Effect of management practice on weed infestiation, yield and nutrient concentration of the fluted pumpkin, *Telfairia occidentalis* Hook., Trop. Agric. (Trinidad) 65(4):317-320.

Ossom, E.M. 1986a. Effect of plant population on yield and weed infestation of cassava-maize intercropping, Ind. J. Agric. Sci., 56(10):732-734.

Ossom, E.M. 1986b. Influence of harvest interval on yield, crude protein, N, P, and K contents and longevity of the fluted pumpkin, *Telfairia occidentalis* Hook., Trop. Agric. (Trinidad) 63 (1):63-65.

Purvis, E.R. and R.L. Carolus. 1964. Nutrient deficiencies in vegetable crops, in: Hunger signs in crops (3rd edn.), (Ed. Sprague, H.B.) p. 245-286.

Tayo, T.O. 1982. Growth, development and yield of pigeon pea *(Cajanus cajan* (L.) Millsp.) in the lowland tropics: 1. Effects of plant population density, J. Agric. Sci., Camb. 98:65-69.

Wahua, T.A.T. 1985. Effects of melon *(Colocynthis vulgaris)* population density on intercropped maize *(Zea mays)* and melon, Expl. Agric. 21:281-289.