Establishment and yield of minisetts of yam (*Dioscorea rotundata* Poir) as influenced by size and position of minisett on mother tuber and by staking in the field

C. E. S. OGBU & O. U. OKEREKE
Department of Crop Science, University of Nigeria, Nsukka, Nigeria (C.E.S.O.'s present address: Anambra State College of Education, Eha-Amufu, Nigeria)

SUMMARY

Two experiments were conducted in 1985 and 1986. Yam vines emerged earlier from the head and tail minisetts than the middle minisetts. Higher percent plant establishment recorded in bigger minisetts occurred only in those setts that originated from the head and tail positions of the mother tuber (head, middle and tail). However, there was no difference between treatments in the final percent plant establishment at 12 weeks after transplanting (WATP). In the 1985 experiment, effect of staking on yield of yam plants derived from minisetts was significant. Yields of seed yam were, however, higher from plants derived from bigger (25-35 g) than smaller (10-20 g) setts. In 1986, this pattern was maintained. Seed yams produced by head minisetts weighed significantly more (314.7 g/plant) than those produced by the middle minisetts (265.8 g/plant). Tuber yield per hectare followed the same pattern. The percent yield of marketable tubers (200 g or more per tuber) from the head minisetts (68.8 %) was similar to that from the tail (61.7 %) but differed significantly ($P = 0.01$) from that of the middle minisetts (49.3 %). Higher percentage of marketable tubers was obtained with increase in minisett size.

Original scientific paper. Received 9 Jan 89; revised 15 Feb 90.

RÉSUMÉ

OGBU, C.E.S. & OKEREKE, O.U.: *L'influence du tuteur et de la taille et la position de trés petites tubercules sur l'établissement et rendement d'igname (*Dioscorea rotundata, *Poir) dans le champ.* Deux expériences ont été suivi en 1985 et 1986. Des grimpantes d'igname ont surgi plus précocement de petites tubercules qui se trouve sur la tête et les bouts des tubercules majeures que des petites tubercules situées sur le milieu. Un haut niveau d'établissement enregistré dans de grosses tubercules s'est produit seulement dans des tubercules qui se trouve sur de la tête et le bout de la tubercule majeure. Cependant, il n'y a aucune difference entre les traitements dans le pourcentage final de l'établissement à 12 semaines après le repiquage. Dans l'expérience de 1985, l'effet du tûteur sur le rendement des plantes d'igname provenant de petites tubercules n'était pas importante. Les rendements d'igname étaient, cependant, plus élevés dans des plantes provenant de grosses tubercules (25-35 g) que ceux provenant de petites tubercules (10-20 g). En 1986, ces résultats se sont produits encore. Les semis d'igname produit par de petites tubercules situé sur la tête de grosses tubercules ont plus du poids (314.7 g/plante) que ceux produit par de petites tubercules situé sur le milieu de grosses tubercules (265.8 g/plante). Le rendement des tubercules par hectare suivait le même schema. Le rendement par le pourcentage de la tubercule de bonne vente (≥ 200 g/tubercule) provenant de petites tubercule de la tête (68.8 %) était égale à celui provenant du bout (61.7 %) mais était significativement different ($P \leq 0.01$) de celui provenant du milieu (49.3 %). Le pourcentage plus élevé des tubercules de bonne vente a été obtenue avec l'augmentation du poids de petites tubercules.

Introduction

Staking of yam plants is beneficial in the humid tropics (Waitt, 1960; Chapman, 1965; Lyonga, Fayemi & Agboola, 1973). In the forest areas of Nigeria, where yams are produced, plants for ware yam production are normally staked. However, staking is laborious and accounts for about 23 per cent of the total cost in yam production (Onwueme, 1978). Similarly, planting materials constitute at least 33 per cent of the production cost (NRCRI, 1985). Research has been directed towards saving part or all of tubers used as planting materials for humans for food. The methods already investigated include the use of vine cuttings (Njoku, 1963; Akoroda & Okonmah, 1982), use of true seeds (Sadik & Okereke, 1975) and recently the minisett technique (Okoli, 1978; Okoli *et al.*, 1982). Of all these methods, the minisett technique has been adopted to a limited extent by farmers for commercial seed yam production in the forest ecological belt (Igbokwe, Okoli & Ene, 1983). Field plantings of yam minisetts in other ecologies where yams are produced yield varying results in terms of plant establishment and proportion of seed yam of marketable size.

This study evaluated the establishment of yam (*Dioscorea rotundata* Poir) minisett as influenced by its position on the mother tuber, its size and staking of yam plants in the field in Nsukka, Nigeria.

Materials and methods

Experimental site

The experiments were conducted at the University of Nigeria, Nsukka Research Farm (6° 52' N, 7° 24' E, altitude 400 m). This site lies in the derived savanna belt of Nigeria. The soil is well drained, acid sandy loam of the Nkpologu series (Unamba-Oparah, 1976), on a gentle slope.

Experiment 1: Effect of minisett size and staking on establishment and yield of seed yams

There were six minisett sizes (10, 15, 20, 25, 30 and 35 ± 1 g) obtained from yam tubers cv. "Nwopoko", each weighing 250 - 500 g, and two staking treatments (staking and non-staking). A stake was placed beside a yam stand in staked plots as soon as a vine emerged above the soil. Adjacent stakes were tied together. Four ridges spaced 1 m apart constituted a plot. There were 27 stands of yam plants derived from minisetts in each ridge, giving a total of 108 plants per plot. These plants were spaced 25 cm along each ridge. The experimental design was a split plot in randomized complete blocks with four replications. Staking was factor A in main plots while minisett size was factor B in sub-plots.

Minisetts were cut and treated with a mixture of insecticide/fungicide ("Minisett dust", NRCRI, Umudike, Nigeria). A satchet of the mixture weighing 10 g was used to treat 200 minisetts in a horizontally-placed rotating drum. After dusting with the mixture, the minisetts were left under a shade overnight for cut surfaces to heal. Thereafter, they were sown directly in the field. The plots were weeded at 3, 6, 11 and 15 weeks after planting (WAP). Mixed N-P-K fertilizer (15-15-15) was applied to the plots at 16 WAP at the rate of 450 kg/ha by side band method. This is a recommended fertilizer rate for root crop production in this location.

Plant establishment was estimated at 14 WAP by counting the number of yam stands established from the planted setts. This was expressed as a percentage. Tubers were harvested and weighed at 26 WAP.

Experiment 2: Effect of minisett size and its position on the mother tuber on percent establishment and yield of seed yams

Yam minisetts were prepared as in 1985. The treatments were minisett size (15, 25, 35 and 45 ± 1 g) and position on the tuber (head, middle and tail). Healthy tubers were selected from the 1985 experiment. Each tuber was cut into three equal segments by length (head, middle and tail), before each segment was then cut into the required sizes.

It was a factorial experiment in randomized complete block design with six replications. Each plot was made up of a ridge with 28 yam stands derived from minisetts. Plants were spaced 25 cm apart on 1m ridges. One metre space separated the blocks. Initially, minisetts were sown in baskets containing saw-dust and kept in a shade where they were watered.

At 5 WAP, the minisetts were examined to determine the quantity of planted materials that sprouted. A minisett was taken as sprouted once a bud showed visible sign of vegetative activity. Thereafter, sprouted minisetts were transplanted in field plots. The plots were weeded at 4, 6, 10 and 14 weeks after transplanting (WATP). Some symptoms of nutrient deficiency were observed on the yam plants in 1985 despite the application of the recommended rate of fertilizer. The fertilizer rate was therefore increased to a total of 560 kg/ha in 1986. This quantity of fertilizer was applied in two doses by side band method. The first dose was applied at 7 WATP and the second at 16 WATP.

Percent plant establishment was estimated as in 1985. This was recorded every 2 weeks till 12 WATP. At 23 WATP, 12 yam stands in each plot were harvested and data collected on the following:

(i) tuber yield per stand (g): tuber yield harvested per plot divided by the number of yam stands per plot.
(ii) weight per tuber (g): tuber yield per plot (kg) divided by the number of tubers harvested in that plot.
(iii) total tuber yield (tonnes/ha): weight of tuber harvested per plot expressed in tonnes per hectare.
(iv) number of marketable tubers (weighing 200 g or more per tuber) per hectare: number of marketable tubers harvested in a plot expressed as number of tubers per hectare.
(v) marketable tubers as percent of total number of tubers produced per hectare: number of marketable tubers expressed as a percentage of total number of tubers produced per hectare.

Results

Minisett size and staking experiment

Highest percentage in plant establishment was recorded from 35 g minisetts (36.5 %) and the lowest (14.5 %) from 10 g minisetts (Table 1). Percent plant establishment from 25 and 30 g minisetts were not significantly different but were significantly lower (P=0.05) than for 35 g minisetts. Minisett size also influenced yield of fresh tubers. The 10 and 15 g minisetts produced similar yield of tubers while the yield from 20, 25, 30 and 35 g minisetts were similar. Staking had no significant effect on percent plant establishment at 14 WAP and tuber yield at harvest.

TABLE 1

Effect of Minisett Size on Plant Establishment and Yield of Fresh Seed Yams

Minisett size (g)	*Plant establishment (%)*	*Tuber yield (tonnes/ha)*
10	14.5	1.2
15	15.6	1.5
20	22.4	4.1
25	27.0	6.0
30	26.8	5.4
35	36.5	6.5
$LSD_{0.05}$	7.5	3.0

Effect of minisett size and position on the mother plant establishment

Yam plants established earlier (4 WATP) from minisetts derived from the head position (head minisetts) than those from the middle (middle minisetts) and tail (tail minisetts). At 6 WATP, 17.9 per cent of head minisetts had established (Table 2), which significantly differed (P=0.01) from the middle (1.8%) and tail minisetts (5.5%). Differences in percent plant establishment from minisetts due to the position of origin on the mother tuber were significant only at 4, 6 and 8 WATP. At 10 WATP, percent establishment was not significantly different for the treatments; therefore, head minisetts sprouted and established earlier, but middle and tail minisetts caught up with them with time.

As in the 1985 experiment, there were significant differences (P = 0.01) in initial percent plant establishment due to minisett size. At 10 WATP, however, these differences disappeared (Table 3). There was significant size of minisett × position on

TABLE 2

Effect of Position of the Tuber on Percent Plant Establishment from Yam Minisetts

Position of minisett on mother tuber	*Plant establishment (%)* 4 WATP[1]	6 WATP	8 WATP	10 WATP	12 WATP
Head	8.9	17.9	50.2	92.1	98.9
Middle	0	1.8	48.5	89.0	99.3
Tail	0	5.5	64.7	94.5	99.3
$LSD_{0.01}$		6.1	7.3	NS[2]	NS

[1] WATP = Weeks after transplanting.
[2] NS = Not significant.

the mother-tuber interaction (Table 4).

At the earlier recording dates (4 and 6 WATP) percent plant establishment was higher in bigger minisetts only for those setts which originated from the head positions of the mother tuber. Percent plant establishment from the middle and tail minisetts were similar irrespective of minisett size.

TABLE 3

Effect of Yam Minisett Size on Percent Establishment

Minisett size (g)	*Plant establishment (%)* 4 WATP[1]	6 WATP	8 WATP	10 WATP	12 WATP
15	0	2.1	32.5	94.0	96.7
25	4.0	6.4	45.0	99.3	99.3
35	6.5	9.8	67.8	99.3	99.3
45	8.2	15.0	70.2	99.8	99.8
$LSD_{0.01}$	-	7.6	11.4	NS[2]	NS

[1] WATP = Weeks after transplanting.
[2] NS = Not significant.

Yield of fresh tubers

Middle minisetts produced 50.8×10^3 tubers per hectare which was statistically higher than the number of tubers produced by the head and tail minisetts (Table 5).

TABLE 4

Effect of Position of the Tuber on Percent Plant Establishment from Yam Minisetts

Position of minisett on mother tuber	*Plant establishment (%) Minisett size (g)* 15	25	35	45
Head	1.8	13.7	26.8	29.2
Middle	0.0	1.2	0.6	5.4
Tail	1.8	5.4	10.1	4.8

$LSD_{0.01}$ = 10.5 for comparing any two positions on the mother tuber and same minisett size means.

However, the head and tail minisetts produced bigger sizes of seed yams per plant and bigger total yield per hectare.

Minisett size did not influence the number of tubers produced, but there was a gradual increase in weight of tubers produced per plant as minisett size increased from 15 to 45 g (Table 6). This led to a general increase in yield of tubers/ha ($P = 0.01$) as the minisett size increased from 15 to 45 g. However, compared with 15 and 25 g minisetts, the 35 and 45 g minisetts produced lower yield of tubers

TABLE 5

Effect of Position of Origin on the Mother Tuber of Yam Minisett on Yield of Fresh Seed Yams

Position of minisett on mother tuber	*Yield of fresh tubers Minisett size (g)* No. per hectare $\times 10^3$	*Weight per plant (g)*	*Total (tonnes/ha)*
Head	41.7	314.7	12.6
Middle	50.8	265.8	10.6
Tail	44.0	291.5	11.7
$LSD_{0.05}$	2.8	24.2	1.4

for the 10 g increase in minisett size.

There was a significant ($P = 0.05$) minisett size × position on the mother-tuber interaction (Table 7). The 45 g minisett (the biggest size) from the

TABLE 6

Effect of Size of Yam Minisett on Yield of Fresh Seed Yams

Minisett size (g)	Yield of fresh tubers weight per plant (g)	Total (tonnes/ha)
15	186.6	7.5
25	283.1	11.3
35	304.1	12.2
45	388.8	15.6
$LSD_{0.01}$	39.5	2.1

TABLE 8

Effect of Position of Origin of Yam Minisett on Yield of Marketable[1] Seed Yams

Position of minisett on mother tuber	Yield of marketable[1] tubers (tonnes/ha)
Head	9.5
Middle	5.8
Tail	8.4
$LSD_{0.01}$	2.7

[1] Marketable seed yams weighing 200 g or more.

middle portion of the mother tuber produced 12.6 tonnes of seed yams per hectare which was similar to 11.7 tonnes/ha produced by 25 g minisett from the head portion of the mother tuber.

Yield of seed yams weighing 200 g or more (marketable seed yams) was influenced by the position of the minisett on the parent tuber (Table 8). Head minisetts produced 9.5 tonnes/ha marketable seed yams while the middle minisetts yielded 5.8 tonnes/ha marketable seed yams. The number and yield/ha of seed yams weighing 200 g or more increased significantly ($P=0.01$) as the size of minisetts increased from 15 to 45 g (Table 9). Minisett size × position on the mother-tuber interaction on yield of marketable seed yams was significant ($P=0.05$). Data in Table 10 show this as yield of marketable seed yams in tonnes/ha increased with increase in minisett size only for the head and tail minisetts but not for the middle minisetts. There was no significant increase in yield of marketable seed yams with increase in the size of middle minisetts.

More than 68 per cent of the 12.6 tonnes/ha of tubers produced by head minisetts were marketable seed yams (Table 11). As shown earlier (Table 3), the middle minisetts produced greater number of tubers per hectare (50.8×10^3) than the head (41.7×10^3) and tail minisetts (44.0×10^3) but only 49.3 per cent of tubers from middle minisetts were marketable

TABLE 7

Position of Origin on Mother Tuber × Yam Minisett Size Interaction on Yield of Fresh Seed Yams

Position of minisett on mother tuber	Yield of fresh tubers (tonnes/ha) Minisett size (g) 15	25	35	45
Head	7.9	11.7	14.1	16.1
Middle	7.9	10.8	11.2	12.6
Tail	6.6	11.5	11.1	17.4

$LSD_{0.05}$ = 2.7 for comparing any two positions on the mother tuber and same minisett size means.

TABLE 9

Effect of Yam Minisett Size on Yield of Marketable[1] Seed Yams

Minisett size (g)	Number of marketable[1] tubers per hectare $\times 10^3$	Weight of marketable[1] tubers (tonnes/ha)
15	15.2	2.9
25	27.9	7.9
35	28.2	8.1
45	34.6	12.6
$LSD_{0.01}$	5.7	3.1

[1] Marketable seed yams weighing 200 g or more.

TABLE 10

Interaction of Position on the Mother Tuber and Size of Minisett on Yield of Marketable[1] Seed Yams

Position of minisett on mother tuber	*Yield of marketable tubers (tonnes/ha) Minisett size (g)*			
	15	*25*	*35*	*45*
Head	3.2	8.7	11.4	14.8
Middle	3.5	6.3	5.8	7.6
Tail	2.2	8.7	7.1	15.5

$LSD_{0.05}$ = 4.1 for comparing any two positions on the mother tuber and same minisett size means.
[1] Marketable seed yam weighing 200 g or more.

seed yams. The 45 g minisetts yielded 77 per cent marketable seed yams and differed significantly from other minisett sizes (Table 12). Percentage marketable seed yams from the 25 and 35 g minisetts were not significantly different but differed (P = 0.01) from that of the 15 g minisetts.

TABLE 11

Effect of Minisett Position on the Mother Tuber on Percent of Seed Yams Produced that was Marketable[1]

Position of minisetts on mother tuber	*Marketable[1] seed yams as % of total number of tubers produced*
Head	68.8
Middle	49.3
Tail	61.7
$LSD_{0.01}$	11.9

[1]Marketable seed yams weighing 200 g or more.

TABLE 12

Effect of Minisett Size on Percent Seed Yams Produced that was Marketable[1]

Minisett size (g)	*Marketable[1] seed yams as % of total number of tubers produced*
15	34.8
25	63.6
35	62.4
45	77.0
$LSD_{0.01}$	13.8

[1] Marketable seed yams weighing 200 g or more.

Discussion

Effect of staking

The results of 1985 experiment showed that yam minisetts can be grown without stakes with no significant loss in yield of seed yams. Because staking had no significant effect on plant establishment and yield of seed yams in the 1985 experiment, the plants were not staked in 1986 yet the yield of seed yams in 1986 were high. In the Guinea savanna belt of Nigeria, yams are not usually staked (Okoli, 1980) because of the economics of staking. With increasing deforestation resulting in scarcity and high cost of wooden stakes, yam minisetts can be grown without stakes even in the derived savanna and forest ecological belts.

Size and position of minisetts on the mother tuber

Percent plant establishment in the 1985 experiment was generally low because the setts were planted directly in the field without pre-sprouting. Pre-sprouted minisetts in 1986 established better and percent plant establishment was comparable to the figure Igbokwe, Onaku & Opara (1984) reported.

The position of the minisett on the mother tuber had no significant effect on percent plant establishment because all the setts were pre-sprouted and only those setts which showed signs of biological activity were transplanted. However, the earlier emergence above the soil of head and tail minisetts after transplanting in the field gave them a lead in production of source organs which resulted in significantly higher yield of seed yams from these portions of the mother tuber than the middle portion.

The size of minisetts consistently influenced total weight of fresh tubers harvested. Weight of harvested tubers from all sizes of minisett were generally low in 1985 because of poor plant establishment which was due to planting the setts directly in the field, among other causes. Nevertheless, the pattern of higher tuber yield with increase in sett size was manifested. Following pre-sprouting, tuber yields were greatly improved in 1986. In some cases, tuber yield from comparable minisett size and yam cultivar even without staking were better than were reported for staked plants by Igbokwe, Onaku & Opara (1984). This was due to a combination of pre-sprouting and separation of setts from different parts of the mother tuber.

The results of this study have shown that the position of origin of minisett on fresh tuber yield should be taken into account while planning research with yam minisetts. The effects of the position of origin of minisett were evident in yield/ha, tuber size and percentage of marketable tubers. The middle minisetts produced many tubers per stand, but a large proportion of these were tiny tubers which were not marketable. A larger number of tubers per middle minisett resulted from observed higher proportion of multiple vines per stand in setts from this portion of the mother tuber than head and tail portions. The portion of origin of minisett was a more important determinant of yield of tubers in terms of number and proportion of tubers of marketable size, than size of minisett in the range 25 - 35 g. A researcher should, therefore, use minisetts from the same portion of the tuber or equal proportions of minisetts from different portions of the mother tuber be deliberately included in each experimental plot. Alternatively, minisetts from different portions of the mother tuber can be planted in different blocks. This is to reduce the effect of variability of planting materials on the experimental results. Similarly, a commercial seed yam producer wishing to produce fairly uniform size of tubers should recognize the differences in yield of seed yams due to the position of origin of the minisetts. Since 25 g head and tail minisetts produced similar size and quantity of seed yams as 35 g middle minisetts, middle portions of the mother tuber should be cut into bigger minisett sizes than the head and tail portions in order to obtain a high percentage of marketable seed yams by the minisett technique.

Acknowledgement

Financial assistance from Anambra State College of Education, Eha-Amufu to the senior author is appreciated. The authors also express sincere thanks to the late Dr C. Oyolu for helpful advice.

REFERENCES

Akoroda, M. O. & Okonmah, L. U. (1982) Sett production and germplasm maintenance through vine cuttings in yams. *Trop. Agric.* **59**(4), 311-314.

Chapman, T. (1965) Some investigations into factors limiting yields of the white Lisbon yam (*Dioscorea alata* L.) under Trinidad conditions. *Trop. Agric. Trin.* **42**, 145-151.

Igbokwe, M. C., Okoli, O. O. & Ene, L. S. O. (1983) Population for saleable seed yam production using the minisett technique. *Paper presented at the 19th Annual Conference of Agricultural Society of Nigeria, Ilorin, Nigeria.*

Igbokwe, M. C., Onaku, B. C. & Opara, F. A. (1984) Performance of yams grown from minisetts as influenced by portion of tuber. *Paper presented at the 20th Annual Conference of Agricultural Society of Nigeria, Port Harcourt, Nigeria.*

Lyonga, S. N., Fayemi, A. A. & Agboola, A. A. (1973) Agronomic studies on edible yams (*Dioscorea* spp.) in the grassland plateau region of the United Republic of Cameroon. *Paper presented at the 3rd International Symposium on Tropical Root Crops, Ibadan, Nigeria.*

National Root Crop Research Institute, Umudike, Nigeria (NRCRI) *1985 Annual Report.*

Njoku, E. (1963) The propagation of yams (*Dioscorea* spp.) by vine cuttings. *J. W. Afr. Sci. Assoc.* **8**, 29-32.

Okoli, O. O. (1978) Stimulating auxillary buds in yams (*Dioscorea* spp.). *Expl. Agric.* **14**, 89-92.

Okoli, O. O. (1980) Dry matter accumulation and tuber sprouting in yams (*Dioscorea* spp.). *Expl. Agric.* **16**(2), 161-167.

Okoli, O. O., Igbokwe, M. C., Ene, L. S. O. &

Nwokoye, J. U. (1982) Rapid multiplication of yam by minisett technique. *Res. Bull.* No. 2, 1-12. National Root Crops Research Institute, Umudike, Nigeria.

Onwueme, I. C. (1978) *The tropical tuber crops: Yams, cassava, sweet potato and cocoyams,* 234 pp. Chichester: John Wiley and Sons.

Sadik, S. & Okereke, O. U. (1975) A new approach to improvement of yam (*Dioscorea rotundata*). *Nature Lond.* **254**, 134-135.

Unamba-Oparah, I. (1976) New aspects of the so-called acid sand soils of southern Nigeria. *E. Afr. Agric. For. J.* **42**(1), 8-17.

Waitt, A. W. (1960) Yams. *Report of Agricultural Research in Nigeria* 1959-60, 16-19.