

EFFECTS OF CULTIVATIONS AND HEIGHTS AND DIRECTIONS OF STAKING ON YIELD AND GENERAL PERFORMANCE OF EIGHT YAM CULTIVARS

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SUMMARY

At Nsukka in East Central State of Nigeria in 1971 and 1972 heights and orientation of rows of stakes and ridging or flat land were compared using eight cultivars within six species of yams (*D. alata*, *D. rotundata* (cv. Abi), *D. rotundata* (cv. Aga), *D. rotundata* (cv. Ji-igwe), *D. dumetorum*, *D. esculenta*, *D. cayenensis* and *D. bulbifera*). Highly significant fresh weight yield differences were observed between cultivars and between staking treatments. Staking effects on yield were mainly due to differences in height rather than orientation of the rows of stakes. Tuber yields decreased with decreasing height of stakes. In both years the order of yield among cultivars was *D. rotundata* (Ji-igwe) > *D. rotundata* (Aga) > *D. rotundata* (Abi) > *D. alata* \approx *D. cayenensis* > *D. dumetorum* > *D. bulbifera*.

RESUME

En 1971 et 1972 à Nsukka, dans l'Etat du Centre-Est du Nigéria, la hauteur et la direction des lignes de treillis, le semis en buttes ou sur terrain plat ont été comparés en utilisant huit cultivars tirés de 6 espèces d'igname (*D. alata*, *D. rotundata* (var. Abi), *D. rotundata* (var. Aga), *D. rotundata* (var. Ji-igwe), *D. dumetorum*, *D. esculenta*, *D. cayenensis* et *D. bulbifera*). Des écarts très importants de poids frais de rendement ont été observés entre les cultivars et les méthodes de tuteurage. L'effet du tuteurage était surtout dû aux différences de niveau plutôt qu'à la direction des lignes de treillis. Plus les treillis sont courts, plus le rendement est bas. Sur les deux années, l'ordre du rendement des cultivars était *D. rotundata* (Ji-igwe) > *D. rotundata* (Aga) > *D. rotundata* (Abi) > *D. alata* > *D. cayenensis* > *D. dumetorum* > *D. bulbifera*.

RESUMEN

En 1971 y 1972 se compararon en Nsukka, en al Estado Este Central de Nigeria, alturas y orientación del estacado así como terreno en plano y alomado. Se usaron ocho cultivares con seis especies de ñame (*D. rotundata* (var. Ji-igwe), *D. alata*, *D. rotundata* (var. Abi), *D. rotundata* (var. Aga), *D. dumetorum*, *D. esculenta*, *D. cayenensis* y *D. bulbifera*). Se observaron diferencias altamente significativas en rendimiento de peso fresco, entre cultivares y entre tratamientos de estacado. El efecto del estacado sobre el rendimiento se debió principalmente a diferencias en altura, más que a la orientación de las hileras. El rendimiento de tubérculos decreció con la altura del estacado. En ambos años el orden que siguió el rendimiento por cultivares fué: *D. rotundata* (Ji-igwe) > *D. rotundata* (Aga) > *D. rotundata* (Abi) > *D. alata* > *D. cayenensis* > *D. dumetorum* > *D. bulbifera*.

INTRODUCTION

Types of support of wild and cultivated yams

Wild yams are climbers depending on forest trees and shrubs for support and to expose their leaves to sunlight. Staking practices for cultivated yams were reviewed by Coursey². Stakes vary in height from less than 1 to over seven metres. Sometimes, in drier areas when small setts are planted, yam vines are unstaked. Height and thickness of stakes are often selected depending on the size of setts since larger setts tend to produce stouter vines. Where stakes are scarce, as in the savannah areas of the Northern States of Nigeria, yam vines are either unstaked or allowed to grow on the dry stems of maize, sorghum or pearl millet. Yam vines are also grown up castor beans, pigeon pea or cotton plants. In compound farms of the humid southern areas of Nigeria, yams are supported on tall bamboo poles, palm petioles or various living plants such as *Newbouldia leavis*, *Ficus* spp. etc. or on heavily pruned oil palms or other trees. Yams may be supported by a single stake but very often stout and tall yam vines are first trained on smaller stakes which are in turn tied to stronger and taller stakes. Single stakes may be tied together in twos, threes or fours for greater stability. Stakes may be branched or unbranched. Trellises of wood, bamboo, chicken wire netting, wire net fence or just ordinary wire slung across two or more poles^{2,8} may also be used in place of stakes.

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Previous staking experiments

Experiments at Ilorin showed no significant yield differences among staking treatments from no staking to the use of 2.1 metre stakes¹. However, staking has been reported by various authors to have beneficial effects on yam yields with substantial yield increases being associated with increasing heights of staking^{3,4,5,7}. In Waitt's review⁸ staking was reported as necessary for some species but not for others. Thus *D. dumetorum* was reported not to require staking, *D. cayenensis* and *D. alata* suffered reduced yields (on a staked control) by as much as 35-66 percent as a result of no staking while *D. esculenta* on the other hand showed 50 percent yield increase from staking (on an unstaked control), and long stakes gave higher yields than short ones. Rouanet⁷ detected no yield differences from staking in *D. alata* in Guadeloupe. Doku³ reported effects of staking on yield differed with both cultivars and locations, but higher yields were obtained with both 1.8 and 3.6 m high stakes as compared to no staking. Staking of *D. esculenta* in Sierra Leone resulted in 50 percent yield increase over no staking⁴. Staking is generally recognized as a very high cost factor in the production of yams, so that it is important to assess the use of staking in economic as well as yield terms.

Soil preparation

Planting yams on mounds is the most widespread traditional practice in West Africa while planting on ridges is practised on experimental farms and sometimes elsewhere, especially when mechanical cultivation is used. Planting on the flat is practised in deep light soils or alluvial soils on river flood plains such as those of the Niger. In places subject to high water tables during certain months of the year, for example, at Abakaliki in the East Central States of Nigeria, mounds of up to 1 metre high and over 2 metres in diameter are used. Studies by Brown in 1931 reported by Coursey² indicated no significant yield differences for yams grown on mounds and ridges under similar soil conditions and Doku³ found that either mounds or ridges 1.8 metres apart gave best yields in experiments in Ghana. Growing yams on ridges and supporting them on trellises instead of stakes involved less labour and also gave better yields than the traditional method.

Most of the yield trials, staking trials and preplanting cultivation experiments reported in the literature in West Africa and elsewhere have involved only the most commonly cultivated species of yams, namely *Dioscorea rotundata*, *D. cayenensis* and *D. alata*.

MATERIALS AND METHODS

Treatments are given in Table 1. Preplanting cultivations comprised ploughing and levelling of the soil to leave a flat surface followed by moulding up into ridges and mounds. Individual stakes were laid out in rows running either east to west or north to south. However, the yam vines were trained not on stakes but on ropes slung along a few stakes at a height specified in the staking treatment. A spacing of 1 metre along ridges 1 metre apart was used so as to give a square planting pattern that would not further complicate the effects of direction of staking. Fertilizers were applied at 600 kg of nitrogen, 305 kg of phosphorus and 375 kg of potassium per hectare. Randomization procedures were those appropriate for the split split-plot design, i.e. each cultivar treatment was applied at random to each main plot, each height and direction of staking was allocated at random to each sub-plot and, similarly, each preplanting cultivation treatment was applied at random to each experimental unit within each sub-plot. The main treatments were replicated four times.

Sub-subplot size was 3m x 3m, i.e. 6 yam stands. Each sub-subplot was surrounded by a guard row of 1 metre wide. Each subplot was surrounded by 2 metres of planted guard rows and in the same way main plots and replicates were surrounded by guard rows 3 metres wide. The experiment was carried out on the Faculty of 3 metres wide. The experiment was carried out on the Faculty of Agricultural Sciences farm, University of Nigeria, Nsukka, in 1971 and 1972. Planting was done on 13th May in 1971 and on April 25th in 1972. Observations made included the following:

1. Fresh weight of tubers
2. Plant population at harvest.
3. Number of vines per stand.
4. Number of tubers per stand.

Harvesting which involved topping of 'milking' in November for *D. cayenensis*, *D. rotundata* and *D. alata* were harvested earlier. Thus the fresh weight yields included all the tubers harvested by topping, where applicable, in addition to final harvests from all cultivars. Statistical analysis was carried out on the data at the end of the experiment according to the routine analysis for the split-split plot design, with partitioning of degrees of freedom for meaningful comparisons. Duncan's multiple range tests were used to compare means.

RESULTS

Tuber yields

Data on yields expressed in metric tons fresh weight of tubers obtained in 1971 and 1972 are presented in Tables 1a, 1b, 2a, 2b, 3a and 3b.

Note that in 1971 and 1972 there were highly significant differences among both directions and heights of staking (Fig. 1, 2) but while in 1972 differences in height accounted for the main differences among staking treatments, in 1971 there was a significant difference between yam cultivars staked in an east to west direction with a mean of 10.2 metric tons/ha and those staked in a north to south direction with a mean of 9.6 tons/hectare. In 1972, not only was the difference insignificant but yams staked north to south with a mean of 8.1 tons slightly outyielded those staked east to west with a mean of 7.8 tons. The 3.6 metre stakes in north to south direction, and 1.8 metre stakes in east to west direction in 1971 and 1972 gave significantly higher yields than no staking in north to south and east to west direction in both years (Tables 1a and 1b and Figs. 1 and 2). It would appear that, although in general the yields decreased with decreases in height of staking in 1971, at each height of staking east to west staking, with the exception of 3.6 metre stakes running in a north to south direction, gave slightly higher yields than the north to south direction, while in 1972 the reverse was true (Tables 1a, 1b, Figs. 1, 2). A combined analysis of the yield data for both years resulted in an insignificant direction effect. Consequently there is a significant year x direction interaction if the two years can be treated as part of a single experiment. However, the interaction may not be a real one because in 1971 the north to south direction, on account of the slope of the site, was at right angles to the direction of ridges and mounds, while in 1972 it was the east to west direction which ran at right angles to the direction of ridges and mounds, thus making the experiments not strictly comparable.

There were significant stakings x cultivars interactions in both 1971 and 1972 (Fig. 1, 2).

There were significant differences resulting from land preparation in 1972 but not in 1971 (Tables 2a, 2b). The actual yields observed were 9.8, 10.0 and 10.2 tons per hectare in 1971 and 7.6, 8.3 and 8.1 tons in 1972 on the flat, mounds and ridges respectively. A higher percentage of the yam tubers produced on the flat were shorter than those produced in ridges and mounds. Moreover, some of the yam tubers on the flat,

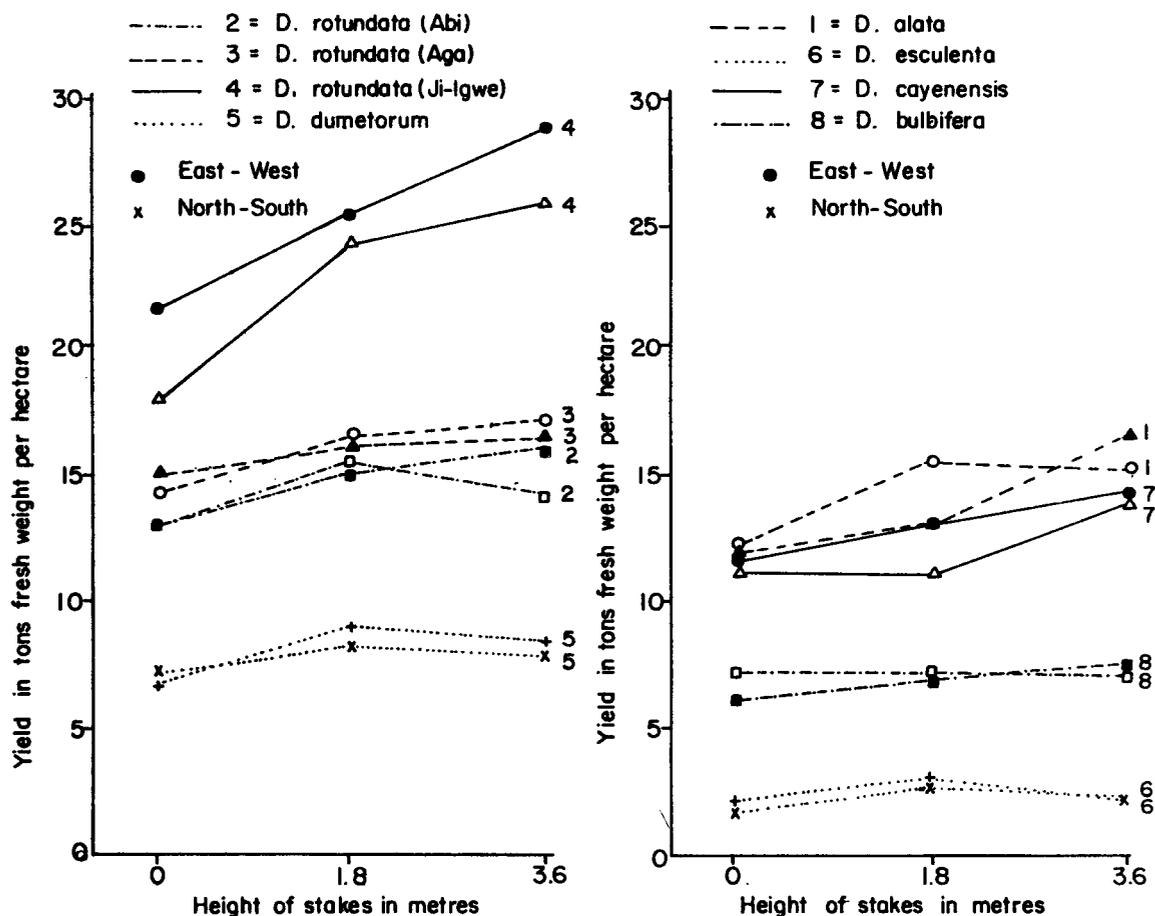


Figure 1. Mean yields (Tons fresh weight per hectare) of eight yam cultivars supported on no stakes, 1.8m and 3.6m stakes on rows running to East to West and North to South at Nsukka in 1971.

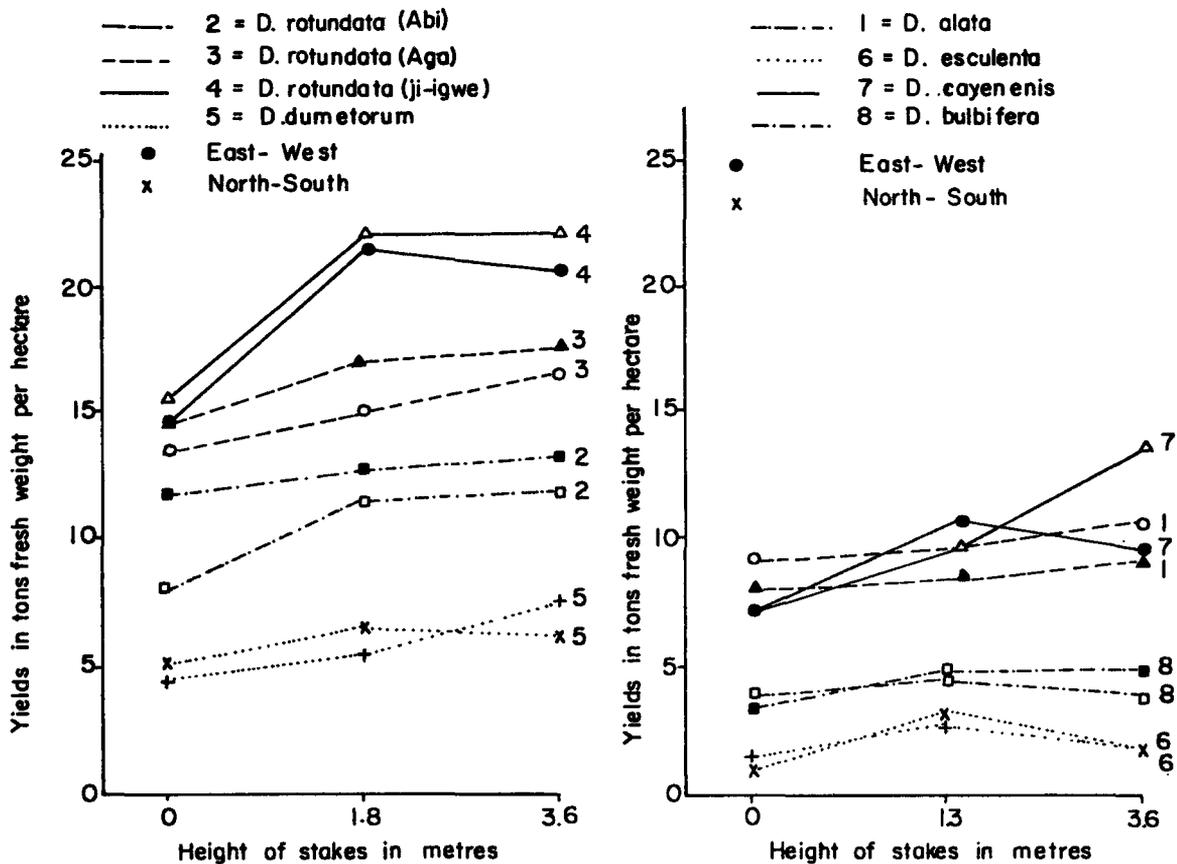


Figure.11. Mean yields (Fresh weight t/ha) of eight yam cultivars supported on no stakes, 1.8m and 3.6m stakes on rows running East to West or North to South at Nsukka in 1972.

which could not readily penetrate into the soil, grew out of the soil, thereby exposing and rupturing many of the roots. In both years the lowest yields were observed on the flat but yield differences between planting on ridges or mounds were not high enough to pay for the labour of ridging and making of mounds.

Plant population

In 1971 populations at harvest of *D. cayenensis* and *D. rotundata* (cv. Ji-igwe) were significantly greater than for *D. alata*, *D. dumetorum* and *D. rotundata* (cv. Aga) (Tables 3a, 4a).

In view of the irregularities in plant population observed at harvest in 1971, population counts were made in 1972 100 days after planting. These counts were compared with those at harvest so as to have an indication of the number of plants that might have suffered premature senescence as a result of leaf diseases (Tables 5, 6). Plant population at 100 days after planting did not markedly differ from plant population at harvest. Observations in the field however indicated that leaf spot diseases in *D. alata*, *D. rotundata* (Aga) and *D. rotundata* (Ji-igwe) may adversely affect yield. Pronounced variability in disease incidence was observed between individual plants in each cultivar.

Number of tubers per plant

Data for 1971 are presented in Tables 7a and 8a. There were highly significant differences between cultivars in the number of tubers produced per plant. *D. bulbifera* and *D. esculenta* which usually produce numerous small tubers, as expected, significantly exceeded all the other cultivars in tuber number. No significant differences in tuber number were observed in the group including *D. alata*, all the *D. rotundata* cultivars, and *D. cayenensis* (Table 7a). The smallest average numbers of tubers were observed in *D. rotundata* (Aga), *D. rotundata* (Ji-igwe) and *D. cayenensis* which were also among the highest yielders.

Highly significant effects on tuber number were observed among heights and directions of staking. The 3.6 metre staking in east to west and north to south directions gave significantly higher tuber numbers than no staking in north to south or east to west direction (Table 7a). No marked difference was observed overall between north-south and east-west directions of staking. There was a highly significant cultivar x staking interaction (Table 7a) attributable to the fact that while there was a general tendency for tuber number to decrease with height of staking irrespective of direction, some cultivars showed no such effect.

Plants grown on mounds and ridges produced significantly more tubers than those on the flat. (Table 8a) The highly significant interaction in tuber numbers between cultivations x cultivars is attributable to the tendency for *D. alata*, *D. rotundata* (Aga) and *D. rotundata* (Ji-igwe) to produce lower number of

tubers on mounds and ridges than on the flat, while other cultivars do not respond in this way.

Data for 1972 are presented in Tables 7b and 8b. *D. bulbifera* and *D. esculenta* again produced the highest number of tubers. Effects of directions and heights of staking were similar to those apparent in 1971, except that tall (3.6 m) stakes running in east-west direction gave significantly lower tuber numbers than the same stakes orientated in a north-south direction. There was a significant staking & cultivar interaction, but no significant cultivation x cultivar interaction in 1972.

Number of vines per plant

In both 1971 and 1972 there were highly significant differences among cultivars in number of main vines produced per stand or per sett (Tables 10a, 10b, 11a and 11b). From the data obtained it can be concluded that number of vines per stand or per sett is a characteristic which depends more on cultivar than environmental factors which do however influence it to some extent. No significant interactions among the various treatments were observed.

DISCUSSIONS AND CONCLUSIONS

Dioscorea rotundata cultivars, the traditional species of yam in the Nsukka area appear to give the highest yields, followed by *D. alata* and *D. cayenensis*. *D. cayenensis* is known to give higher yields in higher rainfall areas than at Nsukka. Yields of *D. alata* which has high yielding potential may exhibit low or fluctuating yields due to early senescence associated with incidence of leaf diseases such as that caused by *Glomerella cingulata*.

The effect of the preplanting cultivation on yam yields depends on the soil type, and although it has been suggested from other data not included in this paper that it is not profitable at paid labour rates to plant yams on ridges or mounds as compared to the flat, nevertheless harvesting yams on ridges and mounds requires less labour.

The yields obtained in these trials are comparable to those reported elsewhere, but this has been the first attempt in Nigeria to assess yields and characteristics of all the important yam cultivars at the same time in relation to cultural practices. The low yields observed in the species *D. esculenta*, *D. dumetorum* and *D. bulbifera* may be due to the spacing used not being suited to them. Apparent effects of direction of staking still need further attention since in these experiments there may be hidden effects of slope.

In future experiments it may be desirable to use several spacings for the different directions of staking and probably eliminate the no staking treatment: to reduce the complex effect of directions and heights of staking by using a split block design in which the staking treatments are more or less main plots for the other treatments: include observations on such physiologically important measurements such as leaf area index, leaf area duration, dry matter accumulation and tuber development which are at present lacking for some of the species: separate the cultivars into high yielders and low yielders and use them separately in different experiments with the same treatments in order to reduce the coefficient of variation and improve the homogeneity of various error components: to include more heights of staking treatments to enable a regression relationship of yield on height to be obtained.

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TABLE 1a

Mean yields in metric tons/ha fresh weight observed in 8 yam cultivars in relation to heights and directions of stakings at Nsukka in 1971

Yam cultivars	Height and direction of staking						Cultivar means
	3.6m		1.8m		0		
	E-W	N-S	E-W	N-S	E-W	N-S	
	t/ha	t/ha	t/ha	t/ha	t/ha	t/ha	t/ha
<i>D. alata</i>	11.7	13.5	12.6	10.8	9.9	9.0	11.3a
<i>D. rotundata</i> (Abi)	11.5	13.0	12.6	12.3	10.5	10.5	11.8a
<i>D. rotundata</i> (Aga)	13.9	13.2	13.2	13.2	11.7	12.1	12.9a
<i>D. rotundata</i> (Ji-igwe)	23.1	20.6	20.6	17.9	17.5	14.3	19.5
<i>D. cayenensis</i>	12.3	11.2	11.0	9.0	9.4	9.6	10.5a
<i>D. dumetorum</i>	6.7	6.3	7.4	6.5	5.6	5.8	6.4b
<i>D. esculenta</i>	1.8	1.8	2.2	2.2	1.8	1.6	2.0c
<i>D. bulbifera</i>	5.8	6.1	5.8	5.6	6.1	5.2	5.8bc
Staking means	10.8a	10.8a	10.8a	9.6	9.0ab	8.5b	

Means with the same letter opposite them are not significantly different from each other at 5% level.

Lsd for comparison of mean fresh weight yields of different cultivars for a given height and direction of staking = 4.3

Lsd for comparison of mean fresh weight yields of different heights and directions of staking for a given cultivar = 2.8.

TABLE 1b

Mean yields in metric 5/ha fresh weight observed in 8 yam cultivars at different heights and directions of staking at Nsukka in 1972

Yam cultivars	Height and direction of staking						Cultivar means
	3.6m		1.8m		0		
	E-W	N-S	E-W	N-S	E-W	N-S	
	t/ha	t/ha	t/h	t/ha	t/ha	t/ha	t/ha
<i>D. alata</i>	9.9	8.5	8.1	7.0	7.6	6.7	8.1cd
<i>D. rotundata</i> (Abi)	10.1	10.8	9.4	10.3	6.7	9.6	9.6bc
<i>D. rotundata</i> (Aga)	13.8	13.9	12.1	14.1	11.2	11.9	12.6ab
<i>D. rotundata</i> (Ji-igwe)	16.8	18.2	17.5	17.9	11.9	12.6	15.7a
<i>D. cayenensis</i>	8.7	11.2	8.7	8.1	6.1	5.8	8.1cd
<i>D. dumetorum</i>	6.3	4.9	4.7	5.4	3.8	4.0	4.9de
<i>D. esculenta</i>	1.6	1.6	2.0	2.2	1.3	0.9	1.6e
<i>D. bulbifera</i>	3.4	4.3	3.6	3.8	3.1	2.9	3.6e

Means with the same letter opposite them are not significantly different from each other at 5% level.

Lsd for comparison of mean fresh weight yields of different cultivars for a given height and direction of staking = 3.6.

Lsd for comparison of mean fresh weight yields of different heights and directions of staking for a given cultivar = 2.6

TABLE 2a

Mean yields in t/ha fresh weight observed in 8 cultivars grown on flat, mound and ridge at Nsukka in 1971

Yam cultivars	Flat	Mounds	Ridge	Cultivar means t/ha
	t/ha	t/ha	t/ha	
<i>D. alata</i>	12.0	10.8	11.0	11.3a
<i>D. rotundata</i> (Abi)	10.5	12.1	12.8	11.1a
<i>D. rotundata</i> (Aga)	12.1	12.8	13.7	12.9a
<i>D. rotundata</i> (Ji-igwe)	20.4	19.1	19.1	19.5
<i>D. cayenensis</i>	10.5	10.3	10.5	10.5a
<i>D. dumetorum</i>	6.1	6.5	6.5	6.4b
<i>D. esculenta</i>	1.6	2.0	2.0	2.0b
<i>D. bulbifera</i>	5.4	6.5	5.6	5.8b
Cultivation means	9.8a	10.0a	10.2a	

Means with the same letter opposite them are not significantly different from each other at 5% level.

Lsd for comparison of mean fresh weight yields of different cultivars for a given preplanting cultivation = 3.5

Lds for comparison of mean fresh weight yields of different preplanting cultivations for a given cultivar = 1.7

TABLE 2b

1972

Yam cultivars	Flat	Mounds	Ridge	Cultivar means
	t/ha	t/ha	t/ha	
<i>D. alata</i>	9.2	7.0	7.8	8.1cd
<i>D. rotundata</i> (Abi)	8.1	10.1	10.3	9.6bc
<i>D. rotundata</i> (Aga)	11.9	13.45	13.0	12.6ab
<i>D. rotundata</i> (Ji-igwe)	14.3	17.9	15.2	15.7a
<i>D. cayenensis</i>	8.1	8.1	8.1	8.1cd
<i>D. dumetorum</i>	4.9	4.7	4.9	4.9de
<i>D. esculenta</i>	1.5	1.7	1.7	1.73
<i>D. bulbifera</i>	3.6	3.4	3.6	3.63
Cultivation means	7.6	8.3a	8.1a	

Means with the same letter opposite them are not significantly different from each other at 5% level.

Lsd for comparison of mean fresh weight yields of different cultivars for a given preplanting cultivation = 2.8

Lsd for comparison of mean fresh weight yields of different preplanting cultivations for a given cultivar = 1.8

TABLE 3a

Mean plant population per hectare observed in 8 yam cultivars at harvest of 8 cultivars grown at different heights and direction of staking. Nsukka 1971

Yam cultivars	Staking treatments						Cultivar means
	3.6m High E-W	3.6m High N-S	1.8m Med. E-W	1.8m Med. N-S	0 Low E-W	0 Low N-S	
	<i>D. alata</i>	6379	6379	6645	6645	6777	
<i>D. rotundata</i> (Abi)	5714	5714	5714	5316	6246	5449	6714b
<i>D. rotundata</i> (Aga)	7708	6910	7043	7043	7708	7043	7176ab
<i>D. rotundata</i> (Ji-igwe)	7575	7841	7973	7575	7841	7841	7707a
<i>D. cayenensis</i>	7973	7973	7973	7973	7841	7708	7973a
<i>D. dumetorum</i>	6246	4113	6379	5980	6910	6379	6379b
<i>D. esculenta</i>	6309	7708	7575	7309	7309	7708	7442ab
<i>D. bulbifera</i>	7309	7176	7575	7708	7408	7408	7442ab
Staking means	7043a	6910a	7043a	6910a	7309a	7043a	

Means with the same letter opposite them are not significantly different from each other at 5% level

Lds for comparison of mean plant population/ha of different cultivars for a given height and direction of staking = 370

Lsd for comparison of mean plant population/ha of different heights and direction of staking for a given cultivar = 269

TABLE 3b
1972

Yam cultivars	3.6m E-W	3.6m N-S	1.8m E-W	1.8m N-S	0 E-W	0 N-S	Culti- var means
<i>D. alata</i>	7575	7708	7708	7973	7707	7841	7708a
<i>D. rotundata</i> (Abi)	7708	7575	7708	7973	7973	7973	7841a
<i>D. rotundata</i> (Aga)	7708	7708	7973	7973	7973	7973	7841a
<i>D. rotundata</i> (Ji-igwe)	7841	7841	7841	7841	7973	7708	7841a
<i>D. cayenensis</i>	7309	7708	7708	6910	7442	7309	7442a
<i>D. dumetorum</i>	7841	7973	7973	7973	7708	7841	7841a
<i>D. esculenta</i>	7708	7309	7841	7841	7708	7309	7575a
<i>D. bulbifera</i>	7043	7575	7841	7708	7309	7708	7575a
Staking means	7708a	7708a	7841a	7708a	7708a	7708a	

Means with the same letter opposite them are not significantly different from each other at 5% level.

Lsd for comparison of mean plant population/ha of different cultivars for a given height and direction of staking = 524

Lsd for comparison of mean plant population/ha of different heights and direction of staking for a given cultivar = 476

TABLE 4a

Mean plant population per hectare of 8 cultivars observed at harvest on the flat, mounds and ridges at Nsukka in 1971

Yam cultivars	Flat	Mound	Ridge
<i>D. alata</i>	6113	6045	7043
<i>D. rotundata</i> (Abi)	5449	5714	5714
<i>D. rotundata</i> (Aga)	7043	7043	7442
<i>D. rotundata</i> (Ji-igwe)	7841	7841	7708
<i>D. cayenensis</i>	7841	7973	7973
<i>D. dumetorum</i>	6246	6645	6113
<i>D. esculenta</i>	7442	7575	7309
<i>D. bulbifera</i>	7442	7575	7309
Cultivation means	6910a	7165b	7043ab

Means with the same letter opposite them are not significantly different from each other at 5% level.

Lds for comparison of mean plant population/ha of different cultivars for a given preplanting cultivation = 303

Lsd for comparison of mean plant population/ha of different preplanting cultivations for a given cultivar = 153

TABLE 4b
1972

Yam cultivars	Flat	Mound	Ridge	Culti- var means
<i>D. alata</i>	7841	7708	7708	7707a
<i>D. rotundata</i> (Abi)	7841	7841	7841	7841a
<i>D. rotundata</i> (Aga)	7841	7841	7941	7841a
<i>D. rotundata</i> (Ji-igwe)	7708	7973	7973	7841a
<i>D. cayenensis</i>	7309	7309	7574	7442a
<i>D. dumetorum</i>	7841	8106	7841	7841a
<i>D. esculenta</i>	7309	7973	7574	7574a
<i>D. bulbifera</i>	7309	7309	7575	7442a
Cultivation means	7708a	7841a	7708a	

Means with the same letter opposite them are not significantly different from each other at 5% level.

Lsd for comparison of mean plant population/ha of different cultivars for a given preplanting cultivation = 361.

Lsd for comparison of mean plant population/ha of different preplanting cultivations for a given cultivar = 260

TABLE 5

Mean plant population/ha observed in 8 yam cultivars 100 days after planting in relation to heights and directions of staking Nsukka 1972

Yam cultivars	3.6m	3.6m	1.8m	1.8m	0	0	Cultivar means
	E-W	N-S	E-W	N-S	E-W	N-S	
<i>D. alata</i>	7973	7973	7973	7973	7973	7973	7973a
<i>D. rotundata</i> (Abi)	7708	7708	7973	7973	7708	7873	7841a
<i>D. rotundata</i> (Aga)	7973	7708	7973	7973	7973	7973	7973a
<i>D. rotundata</i> (Ji-igwe)	7841	7973	7973	7841	7973	7941	7973a
<i>D. dumetorum</i>	7841	7973	7973	7841	7708	7973	7841a
<i>D. esculenta</i>	7841	7575	7575	7708	7043	7309	7442b
<i>D. cayenensis</i>	7176	7708	7708	6778	7708	7309	7442b
<i>D. bulbifera</i>	6910	7575	7708	7043	7043	7841	7309b
Staking means	7708a	7708a	7841a	7708a	7708a	7841a	

Means with the same letter opposite them are not significantly different from each other at 5% level.

Lsd for comparison of mean plant population/ha at 100 days after planting of any two heights and direction of staking for a given cultivar = 98.

Lsd for comparison of mean plant population/ha at 100 days after planting of any two cultivars for a given height and direction of staking = 128.

TABLE 6

Mean plant population/ha observed on eight yam cultivars 100 days after planting on different pre-planting cultivations at Nsukka in 1972

Yam cultivars	Flat	Mound	Ridge	Cultivar means
	<i>D. alata</i>	7973	7973	
<i>D. rotundata</i> (Abi)	7708	7973	7841	7841a
<i>D. rotundata</i> (Aga)	7973	7973	7973	7973a
<i>D. rotundata</i> (Jiigwe)	7841	7973	7973	7973a
<i>D. dumetorum</i>	7973	7841	7973	7841a
<i>D. exculenta</i>	7043	7708	7575	7442b
<i>D. cayenensis</i>	7442	7442	7309	7442b
<i>D. bulbifera</i>	7309	7176	7575	7309b
Cultivation means	7708a	7708a	7708a	

Lsd for comparison of plant population/ha at 100 days after planting of any two cultivars for a given preplanting cultivation = 108.

Lsd for comparison of plant population/ha at 100 days after planting of any two preplanting cultivations for a given cultivar = 28.

TABLE 7a

Mean number of tubers per stand observed in 8 cultivars grown at different heights and directions of stakings 1971 at Nsukka

Yam cultivars	3.6m	3.6m	1.8m	1.8m	0	0	Cv. means
	E-W	N-S	E-W	N-S	E-W	N-S	
<i>D. alata</i>	4.2	4.2	3.4	4.0	3.9	3.5	3.9ab
<i>D. rotundata</i> (Abi)	4.1	3.4	4.0	4.5	3.5	4.7	4.0ab
<i>D. rotundata</i> (Aga)	1.6	1.9	1.6	1.6	1.4	1.7	1.6b
<i>D. rotundata</i> (Ji-igwe)	2.4	2.0	2.0	1.7	1.8	1.7	1.9b
<i>D. cayenensis</i>	1.7	1.9	1.7	1.7	2.0	1.7	1.8b
<i>D. dumetorum</i>	6.2	6.4	6.7	5.8	4.9	5.2	5.8a
<i>D. esculenta</i>	12.5	10.9	10.7	12.2	11.4	9.8	13.2c
<i>D. bulbifera</i>	50.5	45.4	42.0	40.0	29.3	30.3	39.9d
Staking means	10.4a	9.5a	9.0ab	9.0ab	7.3b	7.3b	

Lsd for comparison of mean number of tubers per plant for different heights and directions of staking for a given cultivar = 8.5

Lsd for comparison of mean number of tubers per plant for different cultivars at a given height and direction of staking = 8.7

TABLE 7b

1972

Yam cultivars	3.6m	3.6m	1.8m	1.8m	0	0	Cv. means
	E-W	N-S	E-W	N-S	E-W	N-S	
<i>D. alata</i>	2.0	2.4	2.2	2.3	2.2	1.9	2.2a
<i>D. rotundata</i> (Abi)	1.5	1.4	1.4	1.5	1.5	1.4	1.4a
<i>D. rotundata</i> (Aga)	1.6	1.7	1.7	2.0	1.9	1.9	1.8a
<i>D. rotundata</i> (Ji-igwe)	1.7	1.9	1.8	1.7	1.5	1.3	1.7a
<i>D. dumetorum</i>	4.3	4.3	4.1	4.5	4.0	4.8	4.3a
<i>D. esculenta</i>	10.7	10.5	14.8	14.0	12.7	11.4	12.4b
<i>D. cayenensis</i>	1.9	1.9	2.0	1.8	2.0	1.5	1.8a
<i>D. bulbifera</i>	32.0	50.2	41.5	39.1	26.6	25.7	33.9a
Staking means	7.0abc	9.3d	8.7cd	8.4bcd	6.6ab	6.2a	1.7

Lsd for comparison of mean number of tubers per plant for different heights and directions of staking for a given cultivar = 9.1

Lsd for comparison of mean number of tubers per plant for different cultivars at a given height and direction of staking = 8.9

Means with the same letter opposite them are not significantly different from each other at 5% level.

TABLE 8a

Mean number of tubers per stand observed in 8 cultivars grown on flat, mounds and ridges at Nsukka in 1971

Yam cultivars	Flat	Mound	Ridge	Cv. means
<i>D. alata</i>	4.0	3.9	3.6	3.8ab
<i>D. rotundata</i> (Abi)	3.9	4.1	4.2	4.1ab
<i>D. rotundata</i> (Aga)	1.8	1.7	1.5	1.7b
<i>D. rotundata</i> (Ji-igwe)	2.0	1.9	1.9	1.9b
<i>D. cayenensis</i>	1.7	1.8	1.8	1.8d
<i>D. dumetorum</i>	5.8	5.5	6.3	5.9a
<i>D. esculenta</i>	9.5	11.1	12.6	11.1
<i>D. bulbifera</i>	33.9	45.4	38.2	38.2
Cultivation means	7.8a	9.1b	8.8ab	

Lsd for comparison of mean number of tubers per plant for different cultivars for the same preplanting cultivation = 1.09

Lsd for comparison of mean number of tubers per plant for different preplanting cultivations for a given cultivar = 2.5

TABLE 8b

1972

Yam cultivars	Flat	Mound	Ridge	Cv means
<i>D. alata</i>	2.1	2.3	2.2	2.2a
<i>D. rotundata</i> (Abi)	1.4	1.6	1.4	1.5a
<i>D. rotundata</i> (Aga)	1.8	1.7	1.8	1.8a
<i>D. rotundata</i> (Ji-igwe)	1.7	1.7	1.6	1.7a
<i>D. cayenensis</i>	1.8	1.9	1.9	1.8a
<i>D. dumetorum</i>	4.4	4.3	4.1	4.3a
<i>D. esculenta</i>	12.1	12.2	12.7	12.3b
<i>D. bulbifera</i>	38.5	33.6	35.1	35.7c
Cultivation means	7.9a	7.4a	7.4a	

Lsd for comparison of mean number of tubers per plant for different cultivars for the same preplanting cultivation = 6.3

Lsd for comparison of mean number of tubers per plant for different preplanting cultivations for a given cultivar = 2.1

Means with the same letter opposite them are not significantly different from each other at 5% level

TABLE 9

Number of tubers/plant observed in 8 cultivars on flat, mound and ridges for different heights and directions of staking, 1972.

Yam cultivars	FLAT						Cv. means
	3.6m E-W	3.6m N-S	1.8m E-W	1.8m N-S	0 E-W	0 N-S	
<i>D. alata</i>	1.7	2.2	2.1	2.3	1.9	2.3	2.1
<i>D. rotundata</i> (Abi)	1.3	1.4	1.4	1.4	1.1	1.6	1.4
<i>D. rotundata</i> (Aga)	1.9	2.1	1.8	1.8	1.7	2.0	1.7
<i>D. rotundata</i> (Ji-igwe)	1.8	2.3	1.8	1.8	1.5	1.2	1.7
<i>D. dumetorum</i>	4.3	3.8	4.2	4.1	4.1	6.1	4.4
<i>D. esculenta</i>	10.1	8.3	12.1	16.1	12.1	12.3	11.8
<i>D. cayenensis</i>	2.3	1.5	1.5	2.1	2.0	1.6	1.8
<i>D. bulbifera</i>	33.1	45.5	34.4	43.8	24.9	25.9	34.6
Staking means	7.1	8.4	7.4	9.2	6.2	6.6	7.5

Yam cultivars	MOUND						Cv. means
	3.6m E-W	3.6m N-S	1.8m E-W	1.8m N-S	0 E-W	0 N-S	
<i>D. alata</i>	2.2	2.2	2.1	2.3	2.4	1.9	2.2
<i>D. rotundata</i> (Abi)	1.6	1.5	1.5	1.6	1.8	1.3	1.6
<i>D. rotundata</i> (Aga)	1.3	1.8	1.8	2.1	1.7	1.9	1.8
<i>D. rotundata</i> (Ji-igwe)	2.8	1.8	1.6	1.8	1.7	1.5	1.9
<i>D. dumetorum</i>	4.5	4.4	4.1	5.3	3.6	4.6	4.4
<i>D. esculenta</i>	8.4	7.3	16.3	14.6	15.6	10.5	12.1
<i>D. cayenensis</i>	1.5	2.1	2.9	1.5	1.8	1.6	1.9
<i>D. bulbifera</i>	32.5	44.0	48.7	29.4	21.5	24.4	33.4
Staking means	6.9	8.1	9.9	7.3	6.3	6.0	7.4

Yam cultivars	RIDGE						Cv. means
	3.6m E-W	3.6m N-S	1.8m E-W	1.8m N-S	0 E-W	0 N-S	
<i>D. alata</i>	2.1	2.1	2.5	2.3	2.4	1.6	2.2
<i>D. rotundata</i> (Abi)	1.6	1.2	1.3	2.1	1.9	1.8	1.7
<i>D. rotundata</i> (Aga)	1.8	1.5	1.6	2.1	1.9	1.8	1.8
<i>D. rotundata</i> (Ji-igwe)	1.5	1.7	1.9	1.6	1.4	1.3	1.6
<i>D. dumetorum</i>	4.0	4.6	4.0	4.2	4.2	3.6	4.1
<i>D. esculenta</i>	12.2	15.0	15.4	11.2	10.5	11.6	14.8
<i>D. cayenensis</i>	2.1	2.1	1.8	1.7	2.2	1.4	1.9
<i>D. bulbifera</i>	29.9	35.5	31.3	40.0	33.2	25.8	31.0
Staking means	6.9	8.0	7.5	8.2	7.2	6.1	7.4

Lsd for comparison of any two cultivar number of tubers per plant means for the same height and direction of spacing or preplanting cultivation = 35.6

TABLE 10a

Mean number of vines per plant observed in 8 cultivars in relation to heights and directions of staking at Nsukka, 1971

Yam cultivars	3.6m	3.6m	1.8m	1.8m	0	0	Cv. means
	E-W	N-S	E-W	N-S	E-W	N-S	
<i>D. alata</i>	3.8	3.6	3.1	3.7	3.5	3.4	3.5a
<i>D. rotundata</i> (Abi)	4.0	3.6	3.7	4.3	3.7	4.0	3.9a
<i>D. rotundata</i> (Aga)	1.5	1.6	1.3	1.7	1.4	1.6	1.5b
<i>D. rotundata</i> (Ji-igwe)	1.6	1.3	1.3	1.3	1.4	1.3	1.4b
<i>D. dumetorum</i>	3.3	3.5	3.7	3.6	3.1	3.1	3.4a
<i>D. esculenta</i>	2.2	2.4	2.2	2.5	2.4	2.7	2.4b
<i>D. cayenensis</i>	2.0	2.1	1.9	1.9	1.9	2.0	1.9b
<i>D. bulbifera</i>	1.6	1.5	1.5	1.5	1.3	1.3	1.4b
Staking means	2.4a	2.4a	2.3a	2.4a	2.3a	2.3a	

Lsd for comparison of mean number of vines per plant for different cultivars for a given height and direction of staking = 2.1

Lsd for comparison of mean number of vines per plant of different heights and directions of staking for a given cultivar = 1.9

TABLE 10b
1972

Yam cultivars	3.6m	3.6m	1.8m	1.8m	0	0	Cv. means
	E-W	N-S	E-W	N-S	E-W	N-S	
<i>D. alata</i>	2.3	2.5	2.5	2.4	2.4	2.3	2.4b
<i>D. rotundata</i> (Abi)	1.8	1.6	1.5	1.4	1.5	1.4	1.5a
<i>D. rotundata</i> (Aga)	1.7	1.6	1.6	1.8	1.6	1.8	1.7a
<i>D. rotundata</i> (Ji-igwe)	1.4	1.5	1.6	1.8	1.8	1.3	1.6a
<i>D. dumetorum</i>	3.4	3.7	3.2	3.3	3.1	2.9	3.3c
<i>D. esculenta</i>	2.0	2.0	2.1	2.0	1.9	1.6	1.9ab
<i>D. cayenensis</i>	2.6	2.3	2.1	2.1	1.8	1.8	2.0b
<i>D. bulbifera</i>	1.2	1.2	1.2	1.2	1.4	1.9	1.4a
Staking means	2.0a	2.0a	2.0a	2.0a	1.9a	1.9a	

Lsd for comparison of mean number of vines per plant for different cultivars for a given height and direction of staking = 2.0

Lsd for comparison of mean number of vines per plant of different heights and directions of staking for a given cultivar = 1.9

TABLE 11a

Mean number of vines per plant observed in 8 cultivars grown in flat, mounds and ridges at Nsukka in 1971

Yam cultivars	Flat	Mound	Ridge
<i>D. alata</i>	3.5	3.8	3.2
<i>D. rotundata</i> (Abi)	3.9	4.0	3.8
<i>D. rotundata</i> (Aga)	1.6	1.5	1.4
<i>D. rotundata</i> (Ji-igwe)	1.4	1.4	1.4
<i>D. dumetorum</i>	3.3	3.3	3.6
<i>D. esculenta</i>	2.4	2.4	2.5
<i>D. cayenensis</i>	1.8	1.9	2.0
<i>D. bulbifera</i>	1.4	1.5	1.4
Cultivation means	2.4a	2.5a	2.4a

Lsd for comparison of mean number of vines per plant of different cultivars for a given preplanting cultivation = 1.8

Lsd for comparison of mean number of vines per plant of different preplanting cultivations for a given cultivar = 2.2

TABLE 11b

1972

Yam cultivars	Flat	Mound	Ridge
<i>D. alata</i>	2.3	2.4	2.5
<i>D. rotundata</i> (Abi)	1.4	1.5	1.6
<i>D. rotundata</i> (Aga)	1.7	1.7	1.6
<i>D. rotundata</i> (Ji-igwe)	1.6	1.6	1.5
<i>D. dumetorum</i>	3.0	3.6	3.1
<i>D. esculenta</i>	1.9	1.9	2.2
<i>D. cayenensis</i>	1.9	2.0	1.9
<i>D. bulbifera</i>	1.2	1.4	1.4
Cultivation means	1.9a	2.0bc	2.0bc

Lsd for comparison of mean number of vines per plant of different cultivars for a given preplanting cultivation = 1.9

Lsd for comparison of mean number of vines per plant of different preplanting cultivations for a given cultivar = 2.2

Means with the same letter opposite them are not significantly different from each other at 5% level

TABLE 12

Coefficient of variability based on smallest units (sub-sub-plots) calculated on different characteristics observed in 8 yam cultivars at different heights and directions of staking and preplanting cultivations at Nsukka in 1971 and 1972

Observations	1971	1972
Tuber yield	29.59	25.21
Plant population at harvest	6.83	12.77
Number of tubers/plant	56.81	59.80
Number of vines per stand	27.32	32.28