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# YIELD OF YAM TUBERS GROWN FROM MINISETTS IN RELATION TO HEIGHT OF STAKES AND INTERCROPPING WITH OKRA (*Abelmoschus esculentus* Moench) IN THE RAINFOREST ZONE OF NIGERIA.

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## ABSTRACT

A study was conducted in the rain-forest zone of Nigeria in 1989 and 1990 to explore the suitability of okra for intercropping with yam minisetts and of using stakes shorter than 2m for supporting the yam vines. Two yam species, *Dioscorea rotundata* cv. Obiaoturugo and *Dioscorea alata* cv. Um 680 were grown from minisetts (25g tuber pieces). Yam population was 40,000 minisetts/ha (about 1 tonne of planting material per ha). Twenty-four yam plots were intercropped with late-maturing okra at a population of 10,000 stands/ha and 24 plots were grown as sole crops. On sprouting, the yam vines were supported on bamboo stakes 1m, 1.5m and 2m high. The yam and the okra were planted on the same dates. In both years, the yields of the yam varieties were not significantly affected by intercropping, or by height of stakes. Okra fruit yields were also not affected by the yams or by height of stakes. Yam tuber yields in 1989 were 4.91 t/ha for Obiaturugo and 5.14 t/ha for Um 680 while the corresponding yields in 1990 were 6.75 t/ha and 10.60 t/ha. Fruit yields of okra were 2.41 t/ha in 1989 and 1.51 t/ha in 1990.

## INTRODUCTION

In the traditional farming system, farmers in West Africa grow yams (*Dioscorea* spp.) in intercrops with cereals, root and tuber crops and vegetables (Okigbo and Greenland, 1976). Since the development of the Minisett Technique of seed yam multiplication, there has been a search for suitable companion crops that could be intercropped with minisetts without causing a reduction in the yield of tubers harvested from minisetts. Tuber size is critically important in the economics of seed yam production using minisetts. Environmental stresses tend to reduce the size more than the number of tubers (Igwilo and Udeh, 1987). Intercropping minisetts with maize at the recommended populations of both crops in this location was found to

reduce the tuber yield in *D. rotundata* cv. Obiaoturugo by 54.3% and in *D. alata* cv. Um 680 by 76.6% with corresponding reduction in tuber size of 69.6% in Obiaturugo and 68.1% in Um 680.

Late-maturing okra *(Abemoschus esculentus* cv. Okwuru-Okochi) is commonly grown in crop mixtures in south-eastern Nigeria. In the experiments reported here, the effects of intercropping yam minisetts with okra was investigated using the sole-crop populations of both crops - 40,000 plants/ha for minisetts and 10,000 plant/ha for okra (Philips, 1972; Okoli *et al,* 1982).

Staking in yam production has been shown to significantly improve tuber yield (Coursey, 1967; Enyi, 1972). Although there is progressive reduction in the availability of staking materials in the south-eastern zone due in part to increasing pressure on land, farmers use stakes as long as 4m. Research results (Phillips, 1972) have shown that stakes 2m long are tall enough to support seed-yam plants. Since minisett plants are smaller than seed-yam plants, it was considered necessary to explore the possibility of using shorter stakes for minisett plants in order to reduce the cost of production while at the same time increasing the productivity per unit land area through intecropping.

## MATERIALS AND METHODS

This experiment was conducted in the farm of the University of Port-Harcourt (05° 01'N, 06 57'E, 24.7MSL) in the rain-forest zone of Nigeria.

In 1989 and 1990, twelve factorial combinations of two yam species *(Dioscorea rotundata* cv. Obiaoturugo and *D. alata* cv. Um 680), 0 and 10,000 plants/ha of okra *(Abelmoschus esculentus* Moench cv. Okwuru-Okochi) and three sizes of stakes (1.0, 1.5 and 2.0m) were planted in randomised complete block design replicated four times. Plot size was 4m long and 3m wide. Each plot contained twelve mounds spaced 1m apart.

Seed tubers of the two yam varieties were cut into 25g pieces called minisetts (Okoli *et al.,* 1982). The minisetts were treated with Furadan at the rate of 15g/200 minisetts. Four minisetts were planted on each mound spaced 25cm apart from each other giving a population of 40,000 minisetts/ha. In the yam/okra mixed plots, okra seeds were sown (three seeds/hole) at the base of each mound on the same dates as the minisetts (24 May, 1989 and 15 May, 1990). On germination, seedings were thinned down to one/stand to give a population of 10,000 stands/ha.

Bamboo stakes (1m, 1.5m and 2m height) were used to support the yam vines. While cutting the stakes, an extra 40cm was added to the stipulated height for insertion into the ground to hold the stake firmly. One stake was fixed between four mounds to support 16 minisett plants. Compound fertilizer

(NPK 15,15,15) at the rate of 30g/mound and 30g/okra plant was applied giving a rate of 300kg/ha for sole crops and 600kg/ha for mixed crops. The plots were hand-weeded three times in both 1989 (21 June, 19 July and 17 September) and 1990 (12 June, 10 July and 13 September). Fertilizer was applied after the second weeding.

Leaf area was determined at the peak of yam foliation at the end of August. Two yam plants/plot were selected at random. Their leaves were detached and a sample of 100 leaves was taken at random and punched with a cork-borer (18mm diameter). One hundred leaf discs were again selected and these and the remaining leaves were dried to constant weight in a ventilated oven at 70°C. The relationship between the area and dry weight of leaf discs were used to determine the leaf area of plant samples. Leaf area of okra plants was determined by selecting one plant/plot at random. The leaves were detached, counted and traced on foolscap duplicating papers of the same weight. Large okra leaves were split into two or more parts. The traced areas of the duplicating papers were then cut out and weighed. The ratio of area to weight of complete duplicating papers were used to determine the area of the traced papers and therefore of okra leaves.

## RESULT

### Emergence of subsequent growth

Vine emergence of the minisetts of the yam variety Um 680 started 15 days after planting while those of Obiaoturugo started after 22 days. In Okra, seedling emergence started 5 days after sowing. Flowers of okra started opening 125 days after sowing. At 100 days after planting, yam plants had attained maximum foliation which was sustained until towards plant maturity.

### Leaf area development

Presence of okra and height of stakes had no significant effect on leaf area index (LAI) of yam; however indices for yam varieties (Um 680, 1.48 and Obiaoturugo, 1.21) differed significantly ($P=0.05$) as shown in Table 1. Average leaf size of Um 680 was 0.420 $dm^2$ and of Obiaoturugo 0.318 $dm^2$, the difference being significant ($P=0.05$). In 1990, the average circumference of canopies supported on 1m, 1.5m and 2m stakes were 155.5cm, 105.9cm and 93.5cm respectively for Um 680 and correspondingly 120.0cm, 82.5cm and 77.0cm for Obiaoturugo.

Leaf area index of okra was not significantly affected by yam variety and height of stakes in both years. The average LAI of okra at flowering stage was 0.348 in 1989 and 0.303 in 1990. The LAI for both years were similar. Size of fully expanded leaves varied between 1.4$dm^2$ and

109.4dm² in 1989 and between 2.2dm² and 95.5dm² in 1990. Height of okra plants were not significantly affected by the presence of yam plants and height of stakes. Average height of okra plants at the onset of flowering was 121.1cm ranging between 36cm and 227cm.

Table 1: Effect of height of stakes and intercropping with okra on leaf area index (LAI) of yam: 1990 data.

| Yam Variety | Height of Stakes | | | |
|---|---|---|---|---|
| | 1m | 1.5m | 2m | Mean |
| Obiaoturugo | | | | |
| Okra present | 1.22 | 1.14 | 1.25 | 1.20 |
| Okra absent | 1.26 | 1.08 | 1.30 | 1.21 |
| Mean | 1.24 | 1.11 | 1.28 | 1.21 |
| Um 680 | | | | |
| Okra present | 1.43 | 1.40 | 1.58 | 1.47 |
| Okra absent | 1.49 | 1.47 | 1.50 | 1.49 |
| Mean | 1.46 | 1.44 | 1.54 | 1.48 |
| LSD (0.05) between varieties | | | 0.19 | |

**Yield of yam**

In 1989, the yields of the two yam varieties were similar (Table 2). Presence of okra enhanced tuber yield by 4.2% in Obiaoturugo and 5.6% in Um 680 but these differences were not significant. Height of stakes also had no significant effect on tuber yield. In 1989, Um 680 suffered anthracnose disease of vine while the vines of some of the plants of Obiaoturugo suffered from shoe-string virus attack. In 1990 (Table

2), Um 680 significantly (P=0.05) outyielded Obiaoturugo by 46.1%. Presence of okra enhanced tuber yield by 1.2% in Obiaoturugo but depressed yield by 5.7% in Um 680, but these differences were not significant. Height of stakes also had no effect on tuber yield/ha. Average yield/ha in 1990 was greater than average yield/ha in 1989 by 47.2% (P=0.01). Tuber numbers per plant were similar in the two yam varieties in 1989 but in 1990 Um 680 had 10.8% (P=0.05) more tubers/plant than Obiaoturugo (Table 3). Presence of okra and height of stakes had no significant effect on number of tubers/plant. In 1990 number of tubers/plant was 10.8% (P=0.05) greater in Um 680 than in 1989 whereas with Obiaoturugo the two years were similar. In 1989, tuber size was similar between the two yam varieties whereas in 1990, Um 680 had 46.1% (P=0.01) larger tuber size than Obiaoturugo (Table 4). Average tuber size for 1990 was 89.4% (P=0.01) larger than 1989. Partial correlation of tuber yield per plant with tuber number per plant and tuber size in 1989 and 1990 showed that tuber yield was highly correlated with tuber size (r=0.76, P=0.01) whereas tuber number was not significant (r=0.37. Tuber number and size were not correlated (r=0.17).

**Yield of okra**

Yam variety and height of stakes had no significant effects on the yield of okra fruits in both years (Table 5). However, 59.6% (P=0.01) higher yields were obtained in 1989 than in 1990. In 1990, the average number and weight of okra fruits harvested per plant were 15.1 and 149.9g respectively. At 4-day harvest intervals, the average size of okra fruit was 9.8g.

Table 2. Effect of height of stakes and intercropping with Okra on tuber yield of yam (t/ha) in 1989 and 1990

| Yam Variety | Height of Stakes | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1m | 1.5m | 2m | Mean | 1m | 1.5m | 2m | Mean |
| Obiaoturugo | | | 1989 | | | | 1990 | |
| Okra present | 4.08 | 4.72 | 5.44 | 5.01 | 6.28 | 6.95 | 7.08 | 6.77 |
| Okra absent | 4.60 | 4.82 | 5.02 | 4.81 | 6.76 | 6.55 | 6.90 | 6.74 |
| Mean | 4.74 | 4.77 | 5.23 | 4.91 | 6.52 | 6.75 | 6.99 | 6.75 |
| Um 680 | | | | | | | | |
| Okra present | 5.40 | 5.36 | 5.08 | 5.28 | 9.83 | 11.00 | 10.19 | 10.34 |
| Okra absent | 5.04 | 4.80 | 5.16 | 5.00 | 10.44 | 11.04 | 11.08 | 10.85 |
| Mean | 5.22 | 5.08 | 5.12 | 5.14 | 10.14 | 11.02 | 10.64 | 10.60 |
| LSD (0.05) between varieties | | | | | 1.57 | | | |
| " " " Years | | | | | 1.19 | | | |

Table 3. Effect of height of stakes and intercropping with Okra on number of tubers/plant in 1989 and 1990

| Yam Variety | Height of Stakes 1m | 1.5m | 2m | Mean | 1m | 1.5m | 2m | Mean |
|---|---|---|---|---|---|---|---|---|
| Obiaoturugo | | | 1989 | | | | 1990 | |
| Okra present | 1.08 | 1.05 | 1.08 | 1.07 | 1.02 | 1.09 | 1.18 | 1.10 |
| Okra absent | 1.24 | 1.10 | 1.05 | 1.13 | 1.07 | 1.12 | 1.13 | 1.11 |
| Mean | 1.16 | 1.08 | 1.07 | 1.10 | 1.05 | 1.11 | 1.16 | 1.11 |
| Um 680 | | | | | | | | |
| Okra present | 1.13 | 1.25 | 1.06 | 1.15 | 1.27 | 1.22 | 1.26 | 1.25 |
| Okra absent | 1.12 | 1.04 | 1.04 | 1.07 | 1.18 | 1.18 | 1.25 | 1.23 |
| Mean | 1.13 | 1.15 | 1.05 | 1.11 | 1.23 | 1.20 | 1.25 | 1.23 |
| LSD (0.05) between varieties | | | | | 0.07 | | | |
| " " " Years | | | | | 0.09 | | | |

**Table 4.** Effect of height of stakes and intercropping with Okra on tuber size of yam (g) in 1989 and 1990

| Yam Variety | Height of Stakes | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1m | 1.5m | 2m | Mean | 1m | 1.5m | 2m | Mean |
| | | | 1989 | | | | 1990 | |
| Obiaoturugo | | | | | | | | |
| Okra present | 108.0 | 118.4 | 101.1 | 109.2 | 147.7 | 154.7 | 161.8 | 154.7 |
| Okra absent | 106.5 | 106.1 | 100.5 | 104.4 | 151.8 | 149.8 | 157.0 | 152.9 |
| Mean | 107.3 | 112.3 | 100.8 | 106.8 | 149.8 | 152.3 | 154.4 | 153.8 |
| Um 680 | | | | | | | | |
| Okra present | 34.1 | 104.6 | 87.2 | 92.0 | 216.5 | 221.3 | 216.4 | 218.1 |
| Okra absent | 95.5 | 100.4 | 86.2 | 94.0 | 225.6 | 233.0 | 235.1 | 231.2 |
| Mean | 89.8 | 102.5 | 86.7 | 93.0 | 221.1 | 227.2 | 225.8 | 224.7 |
| LSD (0.05) between varieties | | | | | | 33.0 | | |
| " " " Years | | | | | | | | |
| | | | | | | 17.3 | | |

Table 5. Effect of height of stakes and yam variety on yield of Okra fruits (t/ha) in 1989 and 1990

| Yam Variety | Height of Stakes | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1m | 1.5m | 2m | Mean | 1m | 1.5m | 2m | Mean |
| | | 1989 | | | | 1990 | | |
| Obiaoturugo | 2.60 | 2.55 | 2.36 | 2.50 | 1.60 | 1.53 | 1.46 | 1.53 |
| Um 680 | 2.05 | 2.67 | 2.23 | 2.32 | 1.45 | 1.52 | 1.46 | 1.48 |
| Mean | 2.33 | 2.61 | 2.30 | 2.41 | 1.53 | 1.53 | 1.46 | 1.51 |
| LSD (0.05) for years | | | | | 0.50 | | | |

## DISCUSSION

Any meaningful yam-based intercropping system especially that involving minisetta should be such that does not reduce the tuber yield of yam. The result presented here shows that okra (*Abelmoschus esculentus*) is one of such suitable companion crops. This point is important in selecting suitable intercrops and in evaluating the existing intercropping practices for yam. Tuber yield per plant was highly correlated with tuber size (Tables 2, 3 & 4) and any mixed cropping system which reduces yam tuber size reduces yam tuber yield. It has been suggested that such interferences with yam tuber yield are often mediated through increasing the soil physical impedance to tuber growth (Igwilo, 1994). There is an inverse relationship between soil impedance and tuber yield (Kang and Wilson, 1981).

Intercropping yam minisetts with okra neither reduced the tuber yield of yam nor reduced the fruit yield of okra (Tables 1 & 4) thereby increasing the productivity of the land and ensuring extra income for the yam farmer. The average yield of okra for 2 years was 1.96 t/ha yielding and extra gross receipt of ₦4,900.00/ha at the prevailing market price of ₦2.5/kg for okra.

Yam tuber yield in 1990 was 30.4% greater than in 1989 (Table 2). This difference is attributable to anthracnose disease attack on Um 680 and shoe-string infestation of Obiaoturugo in 1989 when the two yam varieties had similar yields. Normally Um 680 gives higher tuber yield and larger LAI than Obiaoturugo as observed in 1990 (Table 1). Again rainfall amount and sunshine hours were not dramatically different between 1989 and 1990. Indeed, 1989 had 1.7% more sunshine hours than 1990 and sunshine duration has been shown to be positively correlated with crop yields especially in the rainforest zone of Nigeria (Igwilo, 1982). In 1989, rainfall amount and sunshine

duration were 2160.2mm and 1564.3 hours respectively and correspondingly 1929.3mm and 1537.7 hours in 1990.

Stakes of 1m height were as good as the 2m stakes for supporting minisett vines in terms of tuber yield. This agrees with the earlier findings of Enyinnaya *et al.* (1983) using sole crop yam minisetts. Earlier, it has been shown that stakes function mainly to keep the yam vines away from flood water (Igwilo and Udeh, 1987; Igwilo 1989). Yam canopies supported on shorter stakes also had wider girth than those on taller stakes making for efficient distribution of solar radiation (Chapman, 1965). This may explain why height of stakes have no significant effect on tuber yield. Thus, supporting minisett plants on stakes shorter than 2m will combine with intercropping with okra to make seed-yam production even more profitable in the rain forest zone of Nigeria.

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