# Performance of New Hybrid Yam (*D. rotundata* Poir) Varieties in the Forest Zone of Nigeria

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## Summary

*Four hybrid yam varieties (TDr 89/01438, TDr 89/02665, TDr 95/01924 and TDr 89/01213) and three local cultivars (Danacha, Obiaturugo and 93-2) were evaluated for tuber yield, leaf mosaic virus and nematodes infection at Orin-Ekiti for three years, 1999 to 2001. Varietal differences and relationship between tuber yield, severity of leaf mosaic virus and tuber infection by nematodes were determined. Tuber yields were highest in 89/02665 and 95/01924 with a mean of 16 and 14 t.ha$^{-1}$ respectively. The lowest yielders were Danacha (5 t.ha$^{-1)}$ and a hybrid 89/01438 (6.6 t.ha$^{-1}$). In the two highest yielding varieties, 47 to 53% of yields were contributed by ware yam sizes which contributed 34% of the total number of tubers harvested. Seven percent of the tubers harvested were of ware sizes in Danacha and they contributed 11% to total yield. Reaction to leaf mosaic virus was low in TDr 89/ 02665, mild in 95/01924, and moderate to severe in 89/01438, 93-2 and Danacha. Nematode attack on tubers was mild in all varieties. Positive correlations were found between tuber yield and percent weight of ware yams (r= 0. 53 **) and percent number of ware tubers (r= 0.76***). Correlation was negative and significant between tuber yield and virus infection (r= -0.59***) whereas it was not significant for nematode infection (r= 0.13). Two hybrid varieties 89/02665 and 95/01924 are recommended for on-farm testing by farmers in forest areas of Nigeria.*

## Résumé

**Performance de nouvelles variétés hybrides d'igname (*D. rotundata* Poir) dans une zone forestière du Nigeria**

*Quatre variétés hybrides d'ignames (TDr 89/01438, TDr 89/02665, TDr 95/01924 et TDr 89/01213) et trois variétés locales (Danacha, Obiaturugo et 93/2) ont été plantées entre 1999 et 2001 à Orin- Ekiti et ont été évaluées pour leur rendement en tubercules, leur résistance au virus de la mosaïque de la feuille ainsi que pour la résistance des tubercules à l'infestation par les nématodes. Les plus hauts rendements en tubercules ont été obtenus chez les hybrides TDr 89/02665 et TDr 95/01924 et atteignaient respectivement 16 et 14 t.ha$^{-1}$ alors que les plus faibles rendements ont été obtenus chez la variété locale Danacha (5 t.ha$^{-1}$) ainsi que pour l'hybride TDr 89/01438 (6,6 t.ha$^{-1}$). Pour les deux hybrides les plus productifs, 47 à 53% du rendement était constitué de tubercules de taille commercialisable qui représentaient 34% du nombre total des tubercules récoltés. Pour la variété locale Danacha, seulement 7% des tubercules présentaient une taille suffisante pour être commercialisés. Ces tubercules constituaient 11% du rendement total. L'infection par le virus de la mosaïque de la feuille était faible chez l'hybride TDr 89/02665, moyenne pour la variété 93/2 et forte pour la variété Danacha. Les dégâts causés par les nématodes sur les tubercules étaient moyens pour toutes les variétés. Les corrélations positives ont été obtenues entre le rendement en tubercules et le pourcentage du poids d'ignames commercialisables (r= 0,53**) alors qu'avec le pourcentage du nombre de tubercules commercialisables, cette corrélation était de r= 0,76***. Une corrélation négative et significative a été obtenue entre le rendement en tubercules et l'infestation par le virus (r= -0,59***) et que la corrélation n'était pas significative entre le rendement et l'infestation par les nématodes (r= 0,13). Deux variétés hybrides (TDr 89/02665 et TDr 95/01924) sont à recommander aux agriculteurs pour la réalisation d'essai en champs dans les zones forestières du Nigeria.*


## Introduction

In the middle belt and southern parts of Nigeria, yam is relished and preferred above any other food crop especially when it is cooked and pounded to form paste, "iyan". Due to its importance as a staple food crop, yam commands high market price. However, yam productivity had been low in Nigeria and tuber yield for over twenty years ranged between 10 and 13 t.ha$^{-1}$ (9, 11). Low yield in yam was due to the use of unimproved local cultivars which has low genetic capacity to store starch in their tubers. The initial diffi-

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culty experienced in inducing flowering in most cultivars have inhibited the genetic improvement in yam.

The problem of diseases and pests also contributed to low yield in yam. In southwestern Nigeria, yam mosaic virus infection resulted in drastic reduction in tuber yield, tuber size and weight in *D. rotundata* (10). The virus reduces the leaf area and also destroys the leaf chloroplasts causing a significant reduction in photosynthesis activities in infected plants. Breeding for resistance or tolerance to the disease in yam has been suggested as the only means of controlling its menace (14). Another major cause of low yield is nematode infection. Nematode attack on the yam tuber periderm predisposes it to fungal and bacterial attack, which eventually resulted to yam rot. Most post-harvest losses were due to the invasion of tuber by nematode on the field (4). The possibility of interspecific hybridisation or gene transfer between nematode resistant varieties of *D. alata* and the susceptible *D. rotundata* could be exploited in the nearest future.

Initially, breeding in yam was difficult due to inconsistent or non-flowering genotypes as well as problems of pollination and fertilization, but with the better understanding of new yam reproductive physiology, significant progress has now been made in the development of new yam varieties (1, 2, 7). In Nigeria, hybrid yams developed at IITA were first released to the National Agricultural Research Systems for trial in 1996. This research is a continuation of our efforts to identify newly developed hybrid varieties that are high-yielding and are also resistant to leaf mosaic virus and nematode in the forest agro-ecology of Nigeria.

## Material and methods

Trials were carried out for three years (1999, 2000 and 2001) at Orin-Ekiti, the rain forest experimental substation of Institute of Agricultural Research and Training, Obafemi Awolowo University, Nigeria. The soil type is Kandustalf (USDA) and portions under natural fallow for five to six years were opened each year for yam trials. The nutrient composition of soils between 0-15 cm depth ranged from 2.56-3.25% Organic matter, 0.28-0.35% Nitrogen, 7.44-9.92 mg/kg Phosphorus and 1.71-1.92 cmol/kg Potassium. The major vegetation cover were mainly Elephant grass (*Cynodon* spp.) and Siam weed (*Euphatorium odorata*).

Four hybrid yam varieties (TDr 89/01438, TDr 89/02665, TDr 95/01924, TDr 89/01213) and three local cultivars (Danacha, Obiaturugo and 93-2) obtained from International Institute for Tropical Agriculture were tried in a randomised complete block design experiment with three replications. Plots were five rows wide, with 1 m inter-row spacing and 5 m long. Plantings were done between 12 and 15 April in the three years. Yam setts with an average weight of 250 g were planted. The setts were cut from ware tubers, treated with wood ash and cured overnight before planting at 1 m apart within the row. Fertilizers were not added to the soils. Weeds were controlled by pre-emergence application of atrazine at 5 kg ai.ha$^{-1}$ and subsequently by hand weeding. Staking of vines commenced at 8 weeks after planting (WAP). At five months after planting (MAP), the severity of leaf mosaic virus were visually rated using a scale of 1-5 where 1 indicated no symptom, 2- mild infection, 3- moderate infection, 4- severe infection and 5- very severe infection. Tubers were harvested at 10 MAP from the three internal rows and the tubers were assessed for the severity of nematode infection using a scale of 1-5 as above. The total yield of tubers from each plot were expressed in t.ha$^{-1}$. Small yams and ware yams (> 1 kg) were separated and the weight and number of ware yam were expressed as a percentage of the total tuber yields and total number of harvested tubers respectively. Tuber girth and length were measured from tubers in ten randomly selected stands within the plot. The angularly transformed values in percent weight of ware yam (% WWY) and percent number of ware yam (% NWY), total tuber yield (TTY), tuber girth (TG), tuber length (TL), leaf mosaic virus severity (LMVS) and nematode severity (NS) were subjected to analysis of variance and simple correlations.

## Results and discussion

Varietal differences were significant ($P< 0.05$) in all the variables measured but not for nematode severity (Table 1). Tuber yields were highest in TDr 89/02665 and TDr 95/01924, however Obiaturugo had similar yield with TDr 95/01924. The lowest yielding varieties were Danacha and a hybrid TDr 89/01438. The percentage of ware yam in TDr 89/02665 and TDr 95/01924 and Obiaturugo were the highest whereas that of Danacha and TDr 89/01438 were the lowest. The percent number of ware yams was also significantly higher in the two highest yielding varieties with Danacha having the least value. Tuber girth was wider and tuber length longer in TDr 89/02665 whereas it was lowest in Danacha.

The tolerance of TDr 89/02665 to virus was better than any other variety since the symptoms were hardly noticed on its leaves. Three of the varieties including a local cultivar (TDr 95/01924, TDr 89/01213 and Obiaturugo) had mild infection while Danacha, TDr 89/01438 and 9302 had moderate infection. The severity of nematode infection on tubers was mild on all the varieties and none showed moderate or severe infection.

Positive and significant correlation was found between total yield and % WWY (r= 0.68***),% NWY (r= 0.76***), TG (r= 0.53***) and TL (r= 0.57***). The correlation was highly significant and negative between yield and virus infection (r= - 0.59***) but not significant with nematode scores (r= 0.13). All the agronomic variables were negatively and significantly correlated with virus rating (Table 2).

Variety TDr 89/02665 high tuber yield and tolerance to virus (5) is confirmed in this trial. Tuber yield in yam is dependent on its photosynthetic efficiency and this is correlated with leaf area and leaf area duration (6). The influence of biotic stress especially virus on yam resulted into leaf area reduction and destruction of leaf chloroplast and a 50% reduction in tuber yield, reduction in tuber size and weight in infected yam (*D. rotundata*) had been reported (10, 13).

**Table 1**
**Yam tuber yield and resistance to virus and nematodes infection at Orin-Ekiti**

| Variety | Tuber yield t.ha$^{-1}$ | % weight of ware yams | % number of ware yams | Tuber girth cm+ | Tuber length cm+ | Nematode Severity Ratings 1 - 5 | Virus Severity Ratings 1 - 5 |
|---|---|---|---|---|---|---|---|
| TDr 95/01924 | 13.85ab | 46.76ab | 34.44a | 29.48±6.1ab | 30.84±4.26b | 1.88 | 1.88b |
| Danacha | 5.02d | 11.46d | 6.73c | 22.39±3.93d | 25.51±4.09c | 1.88 | 3.00c |
| TDr 89/02665 | 16.01a | 53.31a | 34.57a | 31.82±4.07a | 36.68±5.01a | 1.88 | 1.22a |
| TDr 89/01438 | 6.67d | 34.63c | 21.24b | 24.17±4.96d | 28.06±3.45b | 1.77 | 3.00c |
| 93-2 | 8.69c | 44.63b | 25.99b | 26.11±4.95c | 28.16±3.78b | 1.88 | 3.33c |
| TDr 89/01213 | 10.89c | 44.25b | 25.97b | 27.38±3.88bc | 30.95±3.35b | 1.88 | 2.22b |
| Obiaturugo | 13.29b | 47.54ab | 28.14b | 24.82±3.12cd | 27.73±4.62b | 2.00 | 2.27b |
| Mean | 10.63 | 40.37 | 25.30 | 26.59±5.43 | 29.71±5.35 | 1.88 | 2.42 |
| Lsd 0.05 | | | | | | | |
| Variety (V) | 2.28 | 8.08 | 5.47 | 3.05 | 3.33 | NS | 0.59 |
| Year (Y) | NS | NS | NS | NS | NS | NS | NS |
| Interaction (V x Y) | NS | NS | NS | NS | NS | NS | NS |
| CV (%) | 22.60 | 21.04 | 22.71 | 12.04 | 11.77 | 15.16 | 25.67 |

NS: Not significant at P< 0.05.
+: Mean ± standard deviation.

**Table 2**
**Correlation between tuber yield, yield components, nematode and virus severity in yam**

| | % WWY | %NWY | TG | TL | NS | LMVS |
|---|---|---|---|---|---|---|
| %WWY | 1 | | | | | |
| %NWY | 0.87*** | 1 | | | | |
| TG | 0.41*** | 0.46*** | 1 | | | |
| TL | 0.42*** | 0.46*** | 0.52*** | 1 | | |
| NS | 0.11 | 0.07 | 0.01 | -0.02 | 1 | |
| LMVS | -0.40*** | -0.45*** | -0.48*** | -0.42*** | 0.05 | 1 |
| TTY | 0.68*** | 0.76*** | 0.53*** | 0.57*** | 0.13 | -0.59 |

*, **, *** Significant at 0.05, 0.01 and 0.001 probability levels respectively.
Abbreviations: %WWY – percent weight of ware yam from total tuber yield; %NWY – percent number of ware yam harvested; TTY-total tuber yield per hectare; TG- Tuber girth; TL- tuber length; NS – nematode severity and LMVS- leaf mosaic virus severity.

Virus severity was significantly correlated to yield and its attributes in this study. The indigenous cultivar Obiaturugo was better than Danacha in tolerance to virus and consequently it ranked next to TDr 89/02665 in yield performance. However, a hybrid that is not tolerant to virus, TDr 89/01438, finally gave low yield. This confirms that breeding of varieties that are tolerant to virus is important for improved yield in yam production (14). The poor performance of an hybrid due to virus shows that the genetic characteristics of varieties used in hybridization were not ascertained before crosses were made or it may be due to difficulties in genetic compatibility in yam, a complex polyploidy species (7).

Nematode attack was low in this trial probably due to the long period of land fallow before cultivation. The inclusion of fallow as cultural control methods for nematodes has been suggested and the presence of some weeds like *Cynodon* spp. and *Euphatorium odorata* in the fallow has been reported to reduce nematode populations significantly (3, 12).

From this study, two varieties, TDr 89/02665 and TDr 95/01924 are recommended for on-farm multilocation testing in the forest areas of Nigeria. Obiaturugo would have performed better but for its low tolerance to virus infection. This indicated the need to improve this local cultivar for virus resistance. There is need for a comprehensive data on indigenous cultivars reaction to local abiotic and biotic stresses prior to breeding programmes. For examples, one of the new hybrids, TDr 89/01438, succumbed to virus infection which indicated that the parent lines used for the hybridization were virus susceptible.

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