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Full Length Research Paper

Analyses of hybrid yam (*Dioscorea rotundata* Poir) on-farm trials in southwestern Nigeria

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Hybrid yam variety TDr 89/02665 was compared with a local cultivar Igbakumo in on-farm trials in southwestern Nigeria in 2006 and 2007. The trials were to determine the productivity of the hybrid yam with and without staking of vines in the rainforest and savanna areas respectively. The local cultivar was staked in all the trials. A total of twenty and thirty farmers were used for the trials in the rain forest and savanna respectively. In the forest area, tuber yield was low in both varieties due to late planting in 2006 and yield was similar between the treatments within farms and across the farms. However, early planting in 2007 resulted in higher tuber yield of hybrid yam in all the farms. Hybrid yam tried without staking gave higher yields in 44 to 50% of the farms in the two savanna locations in 2006. The other farms recorded similar yields between the two treatments. In 2007, yield was low and hybrid yams had similar yield with Igbakumo cultivar. Rainfall was scanty during germination and growth in 2007 and this affected yam productivity. In both experiments, hybrid yam TDr 89/02665 was more responsive to environmental changes than the local cultivar using the stability analysis regression equation. Thus, the application of improved agronomic practices will increase tuber yield of hybrid yam above the local cultivar by 50%. It is suggested that cultivating the hybrid yam as early crop in rain forest will improve yield and income of farmers. In the savanna, cultivating TDr 89/02665 without staking is feasible and further selection and breeding of lines for none staking is desirable for economic and environmental reasons.

Key words: Hybrid, local cultivar, on-farm, savanna, rainforest, staking.

INTRODUCTION

Yam is the most important crop in the farming systems of South-western Nigeria with more than 2.8 million hectares of land under cultivation annually (IITA, 2002). The development of improved varieties and the reduction in production cost are the major priorities in root tuber research in Nigeria. This is based on the fact that production cost is high and tuber yield is low, with less than 10 tonnes per hectare. Apart from the cost of planting materials additional cost of about 120 man days are required to procure and establish yam stakes per hectare (Jansens, 2001; Agbaje et al., 2005).

Efforts to improve yam genetically started in Nigeria as far back as 1983 and the first set of hybrid yam varieties produced were released in 2001 (Asiedu, 1992; NACGRAB, 2004). These hybrid lines were found to perform better than local cultivars in on-station trials.

Results of the various trials consistently identified TDr 89/02565 and TDr 89/02665 as superior in tuber yield to other cultivars in south western Nigeria. TDr 89/02665 was noted for its field tolerance to *Meloidogyne incognita* nematode infection and resistance to yam potymosaic virus (Agbaje et al., 2002, 2003).

To discourage the use of stakes in yam production due to its effect on deforestation, hybrid yam lines were evaluated without the use of stakes. The results showed the commercial viability and profitability of TDr 89/02565 and TDr 89/02665 hybrid yam varieties without staking in Nigeria and variety TDr 95/19177 in Ghana (Agbaje and Adegbite, 2006; Otoo et al., 2008).

There is need to confirm these on-station results under the farmer's practices so as to affirm its feasibility. Since farmer's' practices are influenced by access to inputs and variability in soil fertility levels. Yield performances are subject to a complex and significant farm x treatments in-

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teraction in on-farm trials. The performance of the hybrid yam variety on each farmer's field will depend on the use of appropriate management practices by the farmer's'. This research therefore, evaluates whether the new technologies (hybrid yams staked and without staking) are better than the existing technology (staking of local yam) in each farm site. TDr 89/02665 released in 2003 is the test hybrid yam, while Igbakumo relished for its pound ability and high dry matter was the local cultivar.

MATERIALS AND METHODS

On-farm trials were established in Ikole (7° 40' N 5° 15' E), Ilora (7° 48' N 3° 54' E) and Igbope 8° 50' N 3° 47' E areas of south western Nigeria between 2006 and 2007 to validate the on-station performance of hybrid yam TDr 89/02665 under staking and non-staking option. The elevation of all the experimental sites was between 400 to 450 m above sea level and the temperature range during the cultivation period was between 26 and 30°C.

Experiment 1: Comparison of staked hybrid and local (Igbakumo cultivar) yams in rainforest area

The hybrid yam TDr 89/02665 was compared with the local cultivar in the forest ecology of Ekiti state in southwestern Nigeria in 2006 and 2007. The yam vines were staked to conform to the tradition of the farmers. In the rain forest zone, farmers practice staking to mitigate the effects of forest shades. Farmers open virgin lands to plant yam as the first crop and obtain stakes from the surrounding natural forest. The ecology is dominated by forest trees and shrubs which cast shade on crop fields. The soil of the area is clay loam with deep sub-soil. The soil acidity is low with medium N, low P, high K and high organic carbon. A total of twenty farmers were used for the trials. Planting of yam setts were carried out in April, 2006 and in November, 2006 for the repeat trial. Tubers were harvested in November, 2006 and 2007 respectively for the first and second trials respectively.

Experiment 2: Comparison of unstaked hybrid and staked local (Igbakumo cultivar) yams in savanna areas

The trials were carried out at Ilora, a derived savanna zone and Igbope, a guinea savanna ecology without staking the vines of the hybrid yam. The farmers traditionally depend on harvested sorghum stalks to support the crawling yam vines. The area is dominated by shrubs and tall grasses which are easily cleared during land preparation, thus crops are exposed to enough sunshine during growth. The soils are mostly sandy loam soil and low in nitrogen.

A total of thirty farmers were used in Ilora and Igbope for the trials. In 2006, ten farmers were selected each from the two locations and another ten from Ilora only for the repeat trial in 2007. Planting of yam setts were carried out in March, 2006 and 2007 and tubers were harvested by mid-November in the same year. The tuber yield was expressed in ton/hectare.

Experimental design

The experimental design was randomize complete block design with two treatments representing the conventional and the new technologies which were replicated three times in each farm site. The conventional technology is staking of Igbakumo cultivar while the new technologies are the introduction of hybrid yam variety TDr 89/2665 under staking and without staking to the forest and savanna areas respectively. The size of each treatment plot was 20 m^2 and all agronomic operations were carried out by farmers without supervision.

Statistical analysis

In each year tuber yield from eight farms were analysed for each location using the SAS mixed model proceeding. The components of variation in the model for analysis are farm effects, treatment effects, block effects nested within farms and treatment x farm interaction. All the components of the model are considered as random variables except the treatment effects. The test of the treatment effects and estimation of variance components contribution were computed using the restricted maximum likelihood. The treatment x farm effects, though a random variable, appeared as a covariance parameter and was tested using a likelihood ratio test statistic and the best linear unbiased predictor for the treatment means on each farm was calculated. These gave the estimates on which treatment comparisons for a given farm was based (Schabenberger and Pierce, 2002).

Stability analysis of the impact of farmer's environment on yield of the two technologies was assessed using the modified stability analysis. A linear regression equation was derived from technologies mean yield and environmental index from each site according to Hilderbrand (1984).

RESULTS

Hybrid yam performance in rain forest area

Seventy-eight percent (78%) of yield variation in 2006 was due to differences between farms. The mean yield varied between 3.45 and 14 t/ha in farms. Yield differences between the local and hybrid (TDr 89/02665) yam varieties were not significant across the farms and within each farm (Table 1).

For 2007, eighty percent (80%) of yield variation was caused by differences between farms and yield varied from 14 to 28 t/ha. The mean yields across the farms and within farms were significantly higher for hybrid yam (Table 2).

The impact of environmental changes on yield of hybrid yam was compared with the local cultivar using the modified stability analysis (Figure 1). ANOVA for the linear regression of Environmental Index on yield was significant for both treatments. However, the hybrid was more sensitive to environmental changes than the local cultivar. A unit change in the environment increased the yield by 0.72 and 1.28 t/ha in the local and hybrid yam varieties respectively (Figure 1).

Hybrid yam performance without staking in savanna areas

In 2006, farm effects accounted for 74 and 64 % of variation in yield at Ilora and Igbope respectively. The farms mean yield ranged between 15 and 33 t/ha in Igbope and 17 to 22 t/ha in Ilora. In Igbope, three farmers had a significantly higher yield from hybrid yam while fifty percent of the farms in Ilora had significantly higher yields

Table 1. Mean tuber yield (t/ha) of staked local cultivar (Igbakumo) and hybrid variety (TDr89/2665) at Ikole in 2006.

Farm	Tuber yield t/ha		Differences between varieties Pr < t
	Igbakumo	TDr 89/2665	
1	8.4	10.13	0.27
2	10.36	9.33	0.76
3	12.73	15.13	0.16
4	9.75	9.73	0.80
5	7.43	6.63	0.85
6	5.63	6.03	0.63
7	3.40	3.53	0.74
8	7.73	7.16	0.95
Mean	8.12	8.40	0.53

Table 2. Mean tuber yield (t/ha) of staked local cultivar (Igbakumo) and hybrid variety (TDr89/2665) at Ikole in 2008.

Farm	Tuber yield t/ha		Differences between varieties Pr < t
	Igbakumo	TDr 89/2665	
1	18.31	26.60	0.0001*
2	22.89	33.00	0.0001*
3	13.10	17.00	0.0003*
4	27.36	38.73	0.0001*
5	17.4	32.94	0.0001*
6	21.33	34.60	0.0001*
7	14.70	21.60	0.0001*
8	11.80	17.03	0.001*
Mean	18.35	27.68	0.003*

*Mean tuber yields of treatments are significantly different within the farms and across the farms.

from the hybrid yam. Across the farm sites, yields were similar in Igbope ($p > 0.12$) while hybrid yam had a significantly higher yield ($p < 0.01$) in Ilora (Tables 3 and 4).

In 2007, differences between farms in Ilora accounted for 78% of the yield variation. The lowest farm mean yield was 4.5 t/ha while 29.5 t/ha was the highest. However, differences between the two treatments were not significant ($p < 0.05$) within farms and across the farm sites (Table 5).

The stability analysis showed that the staked local cultivar was more stable across the farm sites than the non staked hybrid yam variety. A unit change in environment increased tuber yield by 0.86 and 1.11 t/ha in local and hybrid yams respectively (Figure 2.).

DISCUSSION

The delayed planting in 2006 inhibited the expression of the yield potential in hybrid and local yam varieties in the forest area. The reduction in yield was attributed to shorter growth cycle and reduced tuber growth duration that is associated with late planting (Akoroda, 1993; Orwor and Ekanakaye, 1998). However, early planted hybrid yam cultivated under the traditional staking system in the forest area had higher yield than the local cultivar by 51% in 2007. Yield from this early planting was 69% higher than that of 2006. The superior yield of early planted hybrid yam suggests that economic traits can be exploited from the wide genetic base available in *Dioscorea rotundata* across the forest and savanna areas in the sub-Saharan West Africa.

The stability analysis suggests that yield of hybrids can be increased by improved management practices as observed in its higher response to changes in the environment. Planting early, good farm hygiene, control of pests and diseases and the application of fertilizer will improve hybrid yam tuber yield (Agbaje et al., 2004, 2005).

The yield from staked local yam cultivar was not better

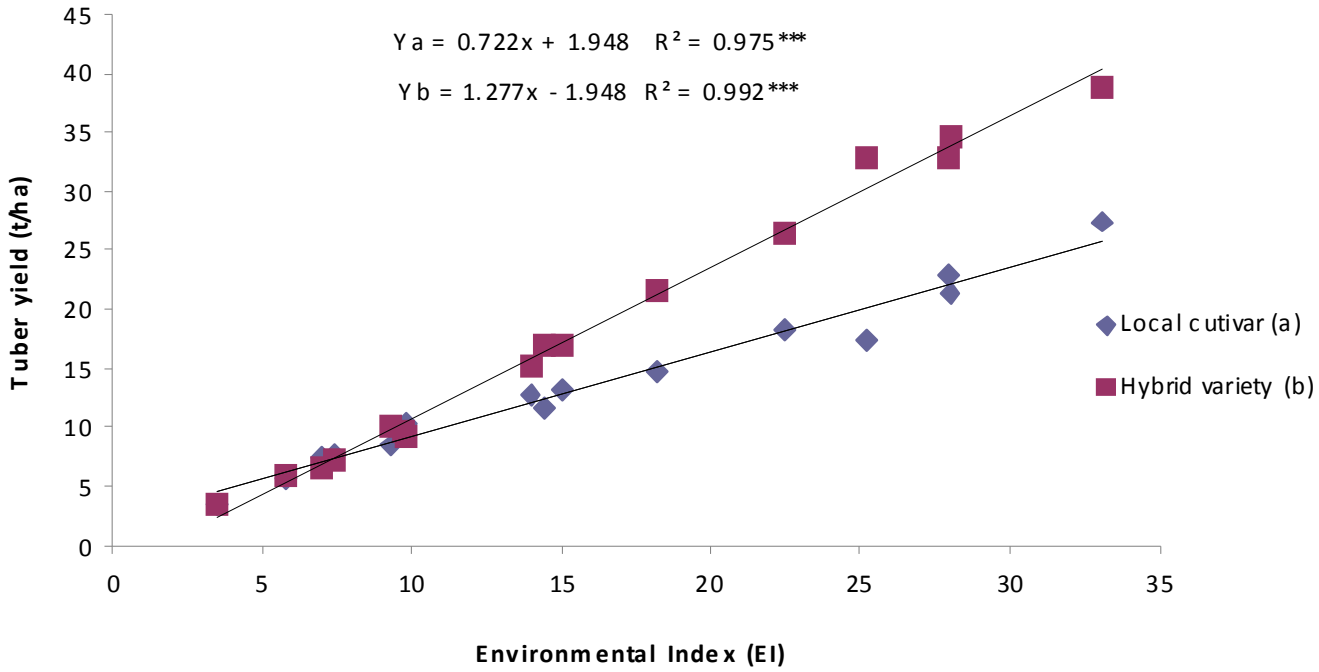

Figure 1. Linear response of yield in staked hybrid and local yam cultivar to environmental changes.

Table 3. Mean tuber yield (t/ha) of staked local cultivar (Igbakumo) and unstaked hybrid variety (TDr89/2665) at Igbope in 2006.

Farm	Tuber yield t/ha		Differences between varieties Pr< t
	Igbakumo (Staked)	TDr 89/2665 (Not staked)	
1	15.56	26.86	0.04*
2	17.75	20.86	0.26
3	13.74	22.86	0.02*
4	18.41	13.64	0.44
5	31.88	33.82	0.39
6	27.08	31.79	0.14
7	23.17	35.41	0.003*
8	17.46	13.35	0.5
Mean	20.63	24.82	0.12

*Mean tuber yields of treatments are significantly different within the farm.

than the unstaked hybrid in any farmer site in 2006. This showed that the cultivating hybrid yam TDr 89/02665 without staking had economic advantages from the elimination of the cost of staking and also from higher tuber yield due to its genetic improvement. Although, yield was low in 2007 at Ilora due to scanty rains in the first two months of the late planting season (Table 6), the hybrid still had the advantage of zero cost on staking despite its similar yield with the local cultivar. Earlier studies on staking had confirmed the superior yield potential of TDr 89/02665 to most local cultivars and cultivating it without staking had economic advantage of 36% over the staked (Agbaje and Adegbite, 2006).

From the studies, it can be concluded that farmer's income will increase significantly by early season planting of hybrid yam (TDr 89/02665) in the forest area. Also, hybrid yam cultivation without staking in the savanna will eliminate deforestation and reduce yam production cost. It will facilitate mechanization and the expansion of the land put to yam cultivation since farmers are relieved from the burden of sourcing and establishment of stakes and training the vines later.

All these advantages of hybrid yam TDr 89/02665 cultivation either staked or not will increase food security

Table 4. Mean tuber yield (t/ha) of staked local cultivar (Igbakumo) and unstaked hybrid variety (TDr89/2665) at Ilora in 2006.

Farm	Tuber yield t/ha		Differences between varieties P < t
	Igbakumo (Staked)	TDr 89/2665 (Not staked)	
1	26.86	33.82	0.03*
2	27.08	31.79	0.08
3	19.27	26.51	0.03*
4	23.17	35.40	0.01*
5	17.46	13.35	0.82
6	27.10	35.81	0.001*
7	25.42	30.06	0.08
8	18.84	24.75	0.05
Mean	23.15	28.93	0.01*

*Mean tuber yields of treatments are significantly different within the farm.

Table 5. Mean tuber yield (T/HA) of staked local cultivar (IGBAKUMO) and unstaked hybrid variety (TDr89/2665) at Ilora in 2007.

Farm	Tuber yield t/ha		Differences between varieties Pr< t
	Igbakumo(Staked)	TDr 89/2665(Not staked)	
1	7.63	10.80	0.31
2	9.44	13.19	0.28
3	10.98	8.14	0.89
4	31.19	27.89	0.97
5	3.86	5.22	0.44
6	7.82	13.93	0.19
7	13.59	15.14	0.42
8	13.06	15.43	0.36
Mean	12.19	13.71	0.21

Table 6. Rainfall (mm) in Ikole and Ilora in 2006 and 2007.

Months	Ikole Ekiti		Ilora	
	2006	2007	2006	2007
January	30.5	0	0	0
February	48.4	36.8	30	0
March	48.4	10.6	98.5	23
April	87.2	130.2	110.4	66.5
May	133.7	126.5	97.8	196.2
June	100.7	141.5	113.1	159.6
July	188	115.6	61.1	274
August	212.7	122.1	152.6	217.5
September	188.2	220.8	335.2	239.1
October	156.3	154	70.3	112.2
November	3.8	65.1	42	63.5
December		0	0	11.8

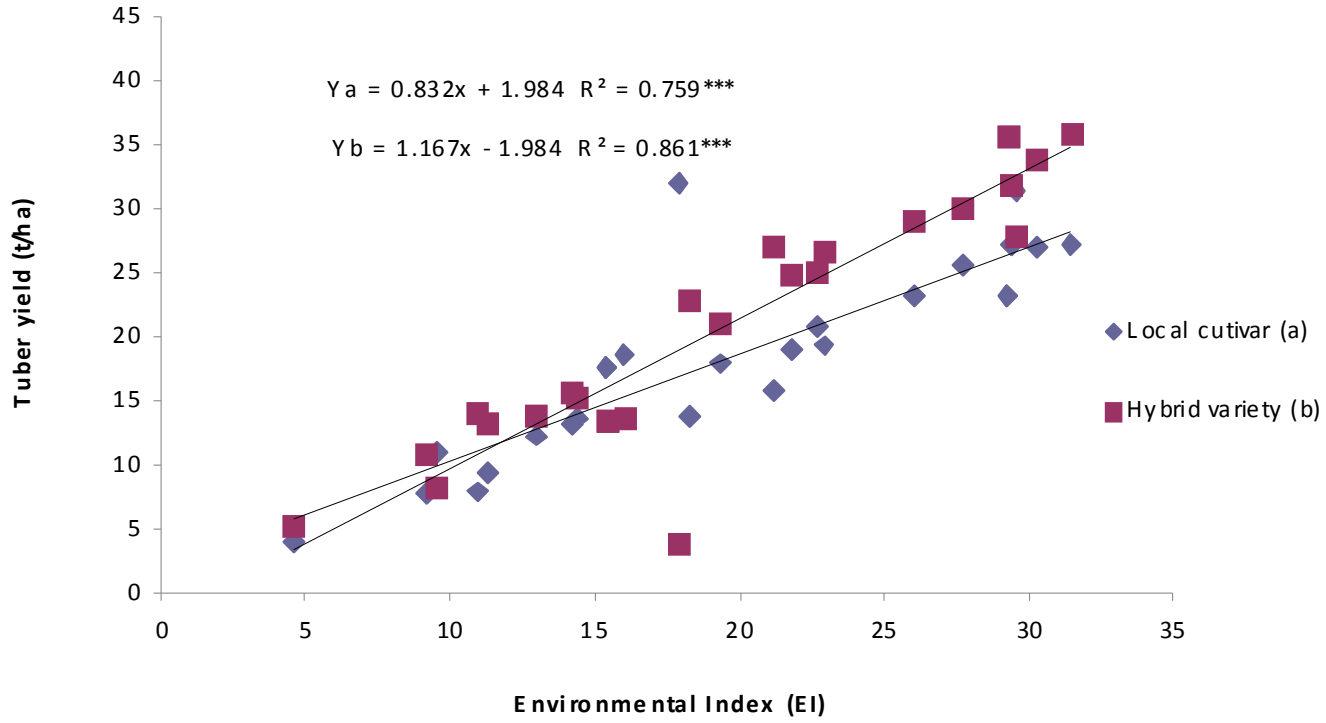

Figure 2. Linear response of yield in staked hybrid and local yam cultivars to environmental changes.

and increase the income of yam farmers. It is suggested that research should be intensified to select and specifically develop yam varieties that are tolerant and adaptable to non-staking because of its economic and environmental implications.

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