Field Scientific Report

On-farm Participatory Assessment of Elite Yam Clones for Yield and Food Quality in Nigeria

Gender Equitable Positioning, Promotion and Performance, WP5

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Ethics: The activities, which led to the production of this document, were assessed and approved by the CIRAD Ethics Committee (H2020 ethics self-assessment procedure). When relevant, samples were prepared according to good hygiene and manufacturing practices. When external participants were involved in an activity, they were priorly informed about the objective of the activity and explained that their participation was entirely voluntary, that they could stop the interview at any point and that their responses would be anonymous and securely stored by the research team for research purposes. Written consent (signature) was systematically sought from sensory panelists and from consumers participating in activities.

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ABSTRACT

The overall agronomic and food quality assessment revealed that the elite yam clones advanced to on-farm testing namely TDa1100374, TDr1401220 and TDr1400158 are suitable for official release. The water yam candidate TDa1100374, produced higher yields and performed better than the checks and showed stability across diverse agro ecologies in Nigeria. It also showed highly resistant reaction to yam diseases with an appealing creamy white tuber flesh colour, with slow rate of oxidation. The TDa1100374 showed low peel loss during processing, higher tuber dry matter content and exhibited an excellent boiled and pounding qualities. On the other hand, the white yam candidate, TDr1401220 showed remarkable yield potential and adaptation across locations while TDr1400158 expressed higher yield but showed a specific adaptation to northern Guinea savannah and the rain forest savannah transition zones. Combined with their high yields and high resistance to yam diseases (virus and anthracnose), both candidates reported excellent industrial and nutritional attributes including high flour yields, dry matter and low peel loss. Their tubers exhibited appealing qualities including a creamy white tuber flesh with slow rate of oxidation. Among the 461 farmers participated in the evaluation the candidate yam varieties in comparison to the standard and local check cultivars for the agronomic and food quality attributes, majority preferred TDr1400158 for excellent pounding qualities while TDr1401220 for good boiled yam quality. Incidentally, more of the consumers/farmers preferred the boiled (53%) and pounded yam (62%) from their local varieties more that the products from TDa1100374. However reverse trend was observed for the tuber yield (63%), tuber appearance (61%) and tuber shape (60%) where they preferred the test genotype over their local varieties.

Keywords: white yam, water yam, boiled yam quality, pounded yam quality, PVS

1 AN OVERVIEW

Yam (*Dioscorea* spp) is a tuber crop, with wide global distribution, that contributes significantly to food security, medicine and income for millions of people, especially in developing countries (Obidiegwu et al., 2020). According to the Food and Agricultural Organization's (FAO) current estimates, Africa accounts for over 93% of global yam production and Nigeria is the largest producer with over 50 million metric tons (FAO, 2020). The *D. rotundata* with its origins from West Africa and *D. alata* with its origins from Asia, are the most popular of the edible yams (Nwankwo et al., 2017). In many yam belt regions across West African countries, cultivation of this starchy tuber crop goes beyond its health benefits, economic or nutritious values. Yams are used in determining social status, prepared for cultural ceremonies and used as religious symbols (Obidiegwu and Akpabio, 2017). Importantly, the linguistic differences across West Africa has very little influence on the beliefs, social values and religious practices attached to the yam crop (Obidiegwu et al., 2020).

Yam crop improvement programs have made rigorous evaluation testing to develop and deploy improved yam variety with well-defined product profiles that meet market targets. The newly bred variety, selected through such rigorous testing for suitability to cultivation and consumer acceptability will enhance the crops potential as a food security and income generating crop in the country.

Furtherance to the fulfilment of the mandate of releasing superior varieties of yam that are better than existing varieties in Nigeria, the yam breeding program through RTBfoods and the AfricaYam project established on-farm elite yam varieties assessment trials in 15 locations across 8 states in Nigeria in collaboration with National Root Crop Research Institute (NRCRI), Umudike (Table1). The trial established following the Yam On farm variety verification SOP constituted of two test genotypes of *D. rotundata* and one for *D. alata* along standard and local check varieties. Both check variety types are top performing varieties with high end-user values. In each location, the trials were planted and managed by farmers till maturity with farmers best local varieties for respective localities serving as the checks. At the peak of vegetative stage (1st to 8th September, 2022) the trials in 7 locations were inspected by representative of crop variety release committee for appropriateness, conformity to standards as well as elicitation farmers' opinions on the vegetative performances of the candidate genotypes.

At maturity, the trials were harvested by the farmers in a participatory approach and agronomic data were collected. After harvest, evaluation was conducted by farmers to select best genotypes with respect to fresh tubers attributes (tuber yield, tuber appearance and tuber shape) and processed products (**boiled and pounded yam**) quality by comparing nominated yam genotypes with the local and standard check varieties. Thirty to fifty farmers with attributes intersecting across age and gender were involved per the evaluation/selection sites and overall, **461 farmers** participated in the evaluation and selection of candidate yam varieties for agronomic and food quality attributes.

Table 1. Locations of 2022 Yam On-farm trials in Nigeria

SN	State	Trial Management	No. of Locations	Names of Location	Agroecology
1	Oyo	IITA	2	Lanlate, Igboho	Savana Transition
2	Osun	IITA	2	Iwo, Ede	Rain forest
3	Edo	IITA	1	Auchi	Rain forest
4	Akwaibom	NRCRI	3	Essien Udim (Nsasak), Afan Ebak, Mkpatak	Mangroove forest
5	Nasarawa	IITA	2	Obi, Dedere	Guinea savana
6	Niger	IITA	2	Bosso, Paiko	Guinea savana
7	Abuja	IITA	1	Kwali	Guinea savana
8	Anambra	NRCRI	2		Rain forest

2 YIELD PERFORMANCE OF GENOTYPES IN THE ON-FARM TRIALS

2.1 Yield performance for *D. rotundata* genotypes

The agronomic data on tuber yield from all locations aggregated from weights of tubers harvested were analyzed to reveal the comparative performances of the test genotypes and checks as well as the yield performances in different locations. The result as shown in Table 2 reveals that for *D. rotundata*, highest average tuber yield (12.6 tons/ha) was obtained from the test genotype TDr1401220 with the yield ranging from 4 to 26 tons/ha but did not show any statistical difference from the test genotype TDr1400158 (9.8 tons/ha) with yield range of 1.4 to 23.7tons/ha (Figure 1). Though the test genotypes did not differ statistically from the average yield performances of standard checks (8.9 tons/ha) and local checks (7.6 tons/ha), TDr1401220 showed a 138.7 and 64.5% yield advantage over the local and standard checks respectively (Table 3). Similarly yield advantage of 21.3 and 18.3% over the local and standard checks were observed respectively (Table 4).

2.2 Yield performance for *D. alata* genotypes

For *D. alata,* similar trend was observed. The test genotype TDa1100374 had the highest tuber yield of 19.4 tons/ha with a range of 4.2 to 61.6 tons/ha (Table 2). Though this did not show any statistical different but the test genotype showed 52.3 and 25.7% yield advantage over local and standard checks respectively (Table 5)

The result further indicated that the overall tuber yield across locations were significantly ($p<0.001$) different for *D. rotundata* and *D. alata* genotypes (Figures 1 and 2)

Table2. Mean yield performance of genotypes across on-farm verification trials

Genotype	Yield(ton/Ha)	min	max
TDrLoc_check	7.6	0.6	21.1
TDr_stand_check	8.9	1.3	23
TDr1400158	9.8	1.4	23.7
TDr1401220	12.6	4.3	26.3
TDa_Loc_check	15.6	0.6	41.7
TDa_stand_check	15.1	1.8	35.9
TDa1100374	19.4	4.2	61.6

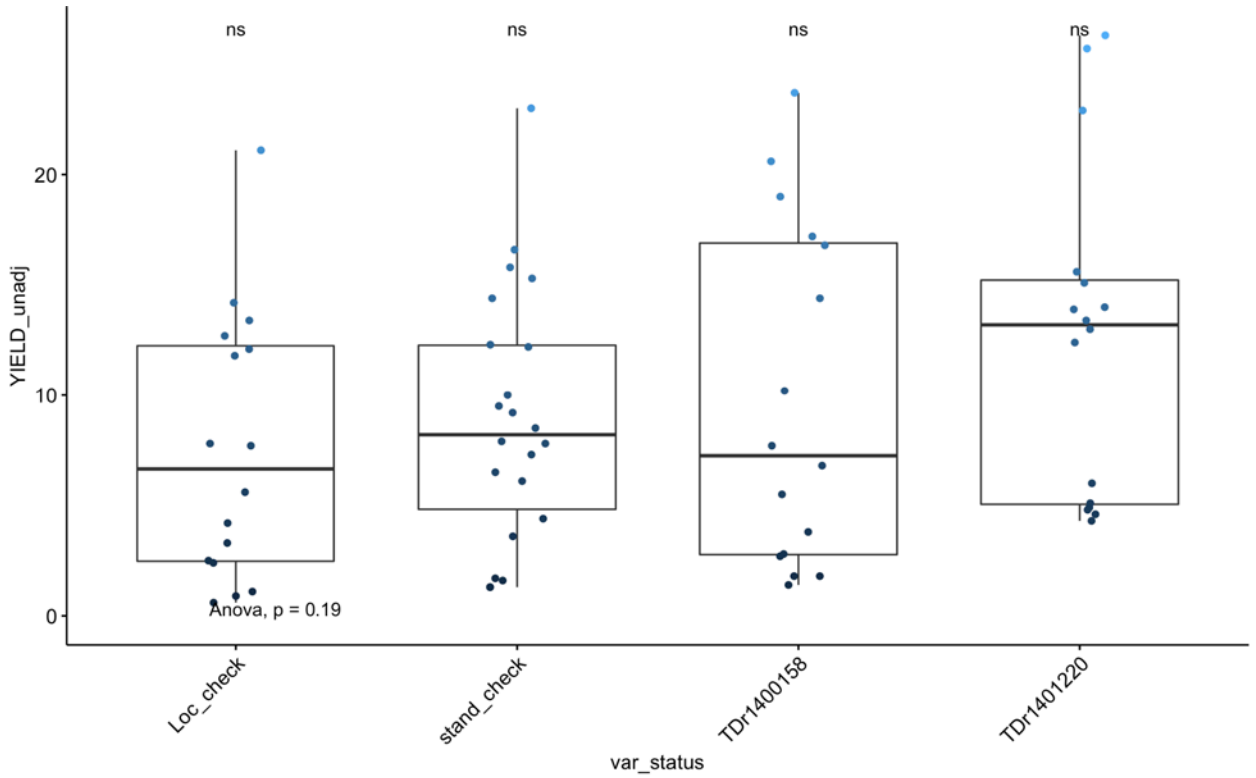


Figure 1. Yield performance of D. rotundata genotypes in on-farm verification trials

Table 3. Yield advantage of TDr1401220 over local and standard check varieties

State	Test Genotype Yield(ton/Ha)	Local check Yield (ton/Ha)	Increase over Local check (%)	Standard check Yield (ton/Ha)	Increase over standard check (%)
Abuja	15.1	7.7	96.1	9.8	54.1
Akwaibom	14	12.6	11.1	14.1	-0.7
Edo	4.9	0.9	444.4	4.6	6.5
Nasarawa	24.6	17.6	39.8	10.7	129.9
Niger	9.9	4.1	141.5	8.2	20.7
Osun	13.2	5.6	135.7	6.5	103.1
Oyo	15.4	7.3	111.0	16.1	-4.3
Anambra	4.6	2	130.0	1.5	206.7
Mean	**12.7**	**7.2**	**138.7**	**8.9**	**64.5**

Table 4. Yield advantage of TDr1400158 over local and standard check varieties

State	Test Genotype Yield(ton/ha)	Local check Yield (ton/Ha)	Increase over Local check (%)	Standard check Yield (ton/Ha)	Increase over standard check (%)
Abuja	1.8	7.7	-76.6	9.5	-81.1
Akwaibom	7.8	12.6	-38.1	14.1	-44.7
Edo	6.8	0.9	655.6	4.6	47.8
Nasarawa	17	17.6	-3.4	10.7	58.9

State	Test Genotype Yield(ton/ha)	Local check Yield (ton/Ha)	Increase over Local check (%)	Standard check Yield (ton/Ha)	Increase over standard check (%)
Niger	2.6	4	-35.0	8.2	-68.3
Osun	16.7	5.6	198.2	6.5	156.9
Oyo	22.2	7.3	204.1	16.1	37.9
Anambra	2.4	2	20.0	1.5	60.0
Mean	**9.7**	**7.2**	**115.6**	**8.9**	**20.9**

Table 5. Yield advantage of TDa1100374 over local and standard checks varieties

State	Test Genotype Yield(ton/Ha)	Local check Yield (ton/Ha)	Increase over Local check (%)	Standard check Yield (ton/Ha)	Increase over standard check (%)
Abuja	8.1	16.1	-49.7	11.6	-30.2
Akwaibom	28.6	13.9	105.8	17.5	63.4
Edo	7.6	8.2	-7.3	10.2	-25.5
Nasarawa	26.1	31.1	-16.1	23.7	10.1
Niger	7.6	6.9	10.1	12.4	-38.7
Osun	21.5	23.2	-7.3	15.9	35.2
Oyo	37.4	28.1	33.1	20.4	83.3
Anambra	8.1	1.8	350.0	3.9	107.7
Mean	**18.1**	**16.2**	**52.3**	**14.5**	**25.7**

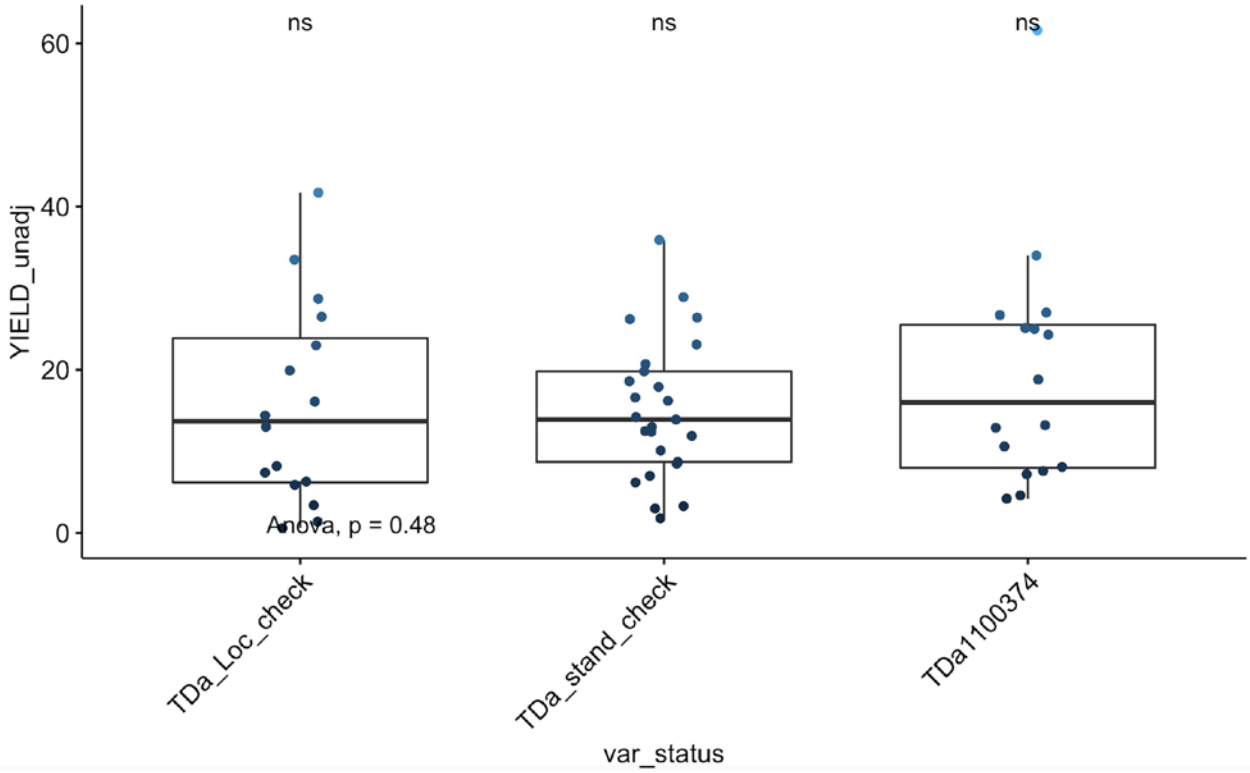


Figure 2. Yield performance of D. alata genotypes in on-farm verification trials

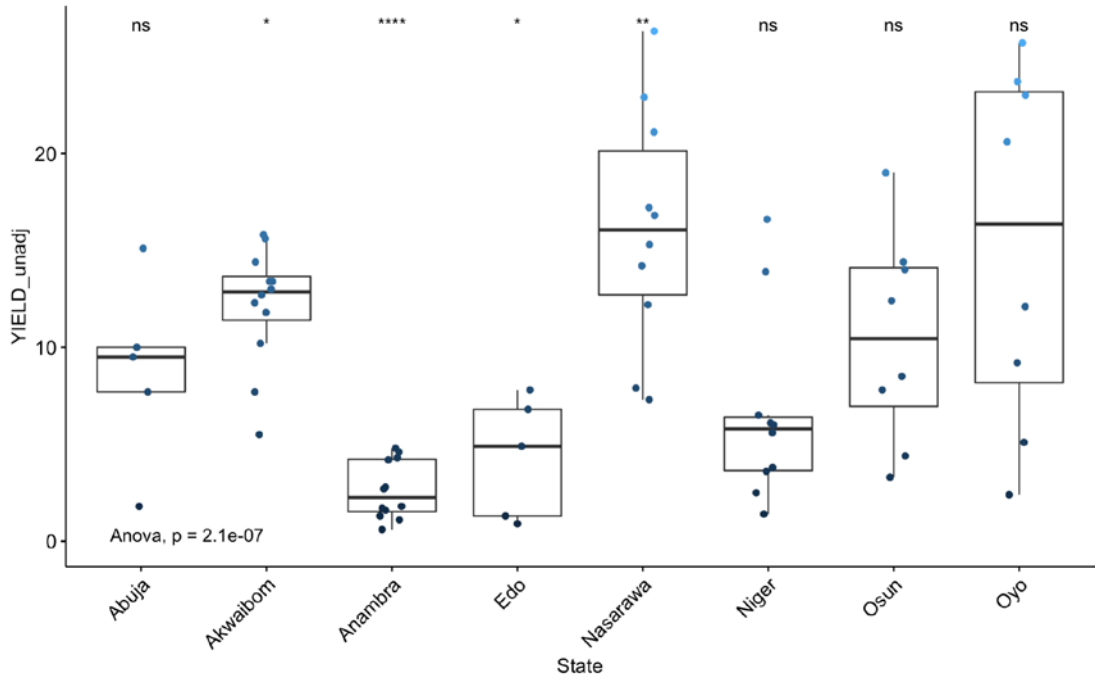
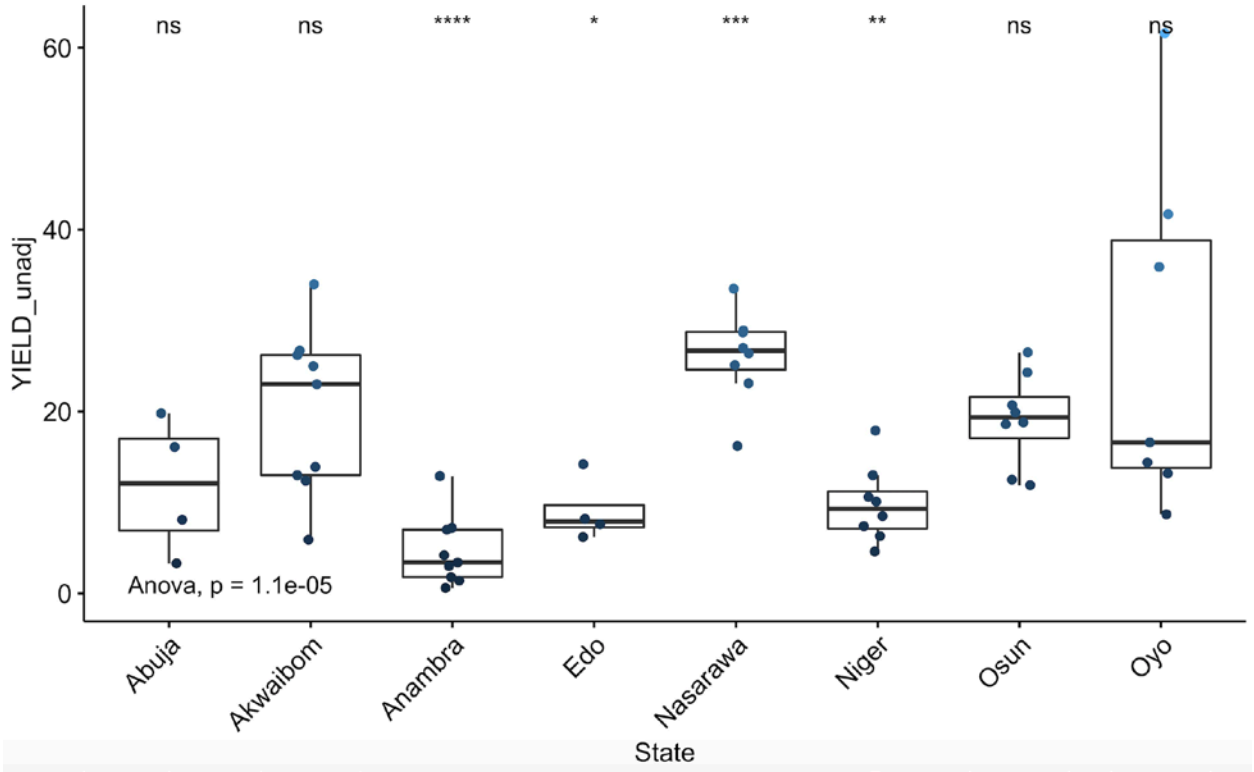


Figure 3. Yield performance of locations of D. rotundata on-farm



3 FARMERS' PREFERENCE FOR AGRONOMIC AND PRODUCT QUALITIES OF TEST GENOTYPES OVER LOCAL AND STANDARD CHECKS

The responses of farmers on their preference for the agronomic (tuber yield, appearance and shape) and products (boiled and pounded yam) as shown in Table 6 below indicate that out of the 461 farmers who evaluated the genotypes, 57 and 54% preferred boiled and pounded yam from TDr1401220 over their local checks while 6 and 11% respectively affirmed that the genotype has same product qualities as their local varieties. Only 36 and 34% believe that the boiled and pounded yam respectively from their local varieties are better than the products from the test genotype. With respect to the tuber yield, appearance and shape, 78, 72 and 69 percent of the farmers accepted that TDr1401220 is better than their local varieties while 4, 8 and 7 percent believe that both the test genotype and their local varieties perform the same with respect to the assessed agronomic traits.

Also 50 and 56 percent of the farmers/consumers respectively like the boiled and pounded yam prepared from TD1400158 more than the products from their local varieties while 8 percent of them believe that the products from both set of genotypes are same.

Incidentally, more of the consumers/farmers preferred the boiled (53%) and pounded yam (62%) from their local varieties more that the products from TDa1100374. However reverse trend was observed for the tuber yield (63%), tuber appearance (61%) and tuber shape (60%) where they preferred the test genotype over their local varieties.

Table 6. Farmers preference for agronomic and product qualities of test genotypes over local check

Test variety	Parameter	More/better than check	Same as check	Less/poor than check
TDr1401220	Boiled yam	266(57.7)	29(6.3)	166(36)
	Pounded yam	240(54.5)	50(11.4)	150(34.1)
	Tuber yield	374(78.4)	17(3.7)	71(15.4)
	Tuber appearance	337 (72.9)	35(7.6)	90(19.5)
	Tuber shape	320(69.3)	31(6.7)	111(24.0)
TDr1400158	Boiled yam	231(50.2)	37(8.0)	192(41.7)
	Pounded yam	245(55.9)	33(7.5)	160(36.5)
	Tuber yield	230(49.8)	28(6.1)	204(44.2)
	Tuber appearance	190(41.1)	33(7.1)	239(51.7)
	Tuber shape	214(46.3)	40(8.7)	208(45.0)
TDa1100374	Boiled yam	186(40.3)	30(6.5)	245(53.1)
	Pounded yam	151(33.3)	22(4.9)	280(61.8)
	Tuber yield	290(62.8)	11(2.4)	161(34.8)
	Tuber appearance	282(61.0)	25(5.4)	155(33.5)
	Tuber shape	276(59.7)	33(7.1)	153(33.1)

The assessment of farmers/consumers' preferences test genotypes over standard check varieties used in the on-farm verification trials shows that higher proportion of the respondents preferred boiled yam (63%) and pounded yam (57%) produced from test genotype TDr1401220 to the products from standard checks while also preferring tuber agronomic qualities: yield (78%), appearance (73%) and shape (72%) to those of the standard checks (Table 7). The test genotype TDr1400158 was also preferred more than the standard checks by the farmers/consumers for boiled yam (59%) and pounded yam (66%) while 9 percent of them believe the standard checks have same product qualities as the test genotype. The *D. alata* test genotype was also assessed be better than the standard checks for boiled yam (56%) and pounded yam (47%) while 61, 61 and 66 percent of the farmers respectively preferred the tuber yield, tuber appearance and tuber shape of TDa1100374 to the agronomic attributes of the standard checks.

Table 7. Farmers preference for agronomic and product qualities of test genotypes over standard checks

Test variety	Parameter	More/better than check	Same as check	Less/poor than check
TDr1401220	Boiled yam	292(63.2)	32(6.9)	138(29.9)
	Pounded yam	254(56.7)	47(10.5)	147(32.8)
	Tuber yield	363(78.4)	18(3.9)	82(17.7)
	Tuber appearance	339(73.2)	23(5.0)	101(21.8)
	Tuber shape	337(72.8)	34(7.3)	92(19.9)
TDr1400158	Boiled yam	270(58.8)	41(8.9)	148(32.2)
	Pounded yam	293(65.7)	41(9.2)	112(25.1)
	Tuber yield	228(49.5)	32(6.9)	201(43.6)
	Tuber appearance	219(47.5)	31(6.7)	211(45.8)
	Tuber shape	227(49.2)	28(6.1)	206(44.7)
TDa1100374	Boiled yam	257(56.1)	50(10.9)	151(33.0)
	Pounded yam	215(47.4)	59(13.0)	180(39.6)
	Tuber yield	283(61.4)	15(3.3)	163(35.4)
	Tuber appearance	279(60.5)	27(5.9)	155(33.6)
	Tuber shape	305(66.2)	22(4.8)	134(29.1)

Farmers assessing the yam tubers genotypes from on-farm trials for agronomic attributes in Abuja

Farmers assessing the yam tubers genotypes from on-farm trials for boiled and pounded yam preferrence in Abuja

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