Evaluation of 64 Advanced Orange Fleshed Sweetpotato Clones in 4 Sites in Mozambique and Release of 15 Drought Tolerant Varieties

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Background

In Mozambique, the first nine OFSP varieties from the introduced OFSP material were released in 2000. The promotion of these varieties was throughout the country; however, some of them were selected for favorable environments, and their ability to perform in conditions of drought was limited. The Rockefeller Foundation/Harvest Plus/AGRA and USAID funded a sweetpotato breeding program to come out with drought tolerant and high level beta-carotene varieties using ABS (Accelerated Breeding Scheme).

From August 2005 to December 2009, several trials (161), from seedlings to multi-location trials involving 198,592 genotypes were established at Umbelúzi, Chókwè, Angónia, and Gurué (Fig. 1).

Figure 1. Map of Mozambique with the breeding sites highlighted

Methods

The design and measured attributes: The experimental design was a RCBD with 0.9x0.3m planting density. The trial was established without any fertilization. The measured attributes were:

1. PBROT = Percentage of sprouting
2. SHI=Percentage of vine survived
3. Vir2 =Symptoms of virus (1-without symptoms; 5-moderate; 9-extremely severe)
4. VV1=Vigor (1-Not vigorous; 5-Moderate; 9-Very vigorous)
5. RYC=Commercial Root Yield in t/ha
6. RYT=Total Root Yield in t/ha
7. RVY=Total Vine Yield in t/ha
8. Bio=Biomass in t/ha
9. DM=Percentage of Dry Matter Content
10. BC=Beta-carotene in mg/100g of fresh root (CIP color c
11. COOT1= Taste (1-Very bad; 3- Average; 5-Excellent)
12. Wed1=Losses due to weevil (1-ext. severe; 2-Severe; 3-Mod; 4-Light; 5-None)
13. DMAR=other damages on roots (1-ext. severe; 2-Severe; 3-Mod; 4-Light; 5-None)

Sixteen (16) on-farm trial were established in all four evaluation sites. Additionally, all 64 clones were submitted to a 35 days conservation test.

Data Analysis: The varieties were screened using the *ranking elimination* and *index selection*. For the *ranking elimination*, the attributes RYT, RVY, BC, VV1, COOT1, and Virus were considered. The LSD test at 5% was employed, that is, all clones that were not significantly different from the average total root yield were considered.

The *index selection* consisted of weights attributed to the variables in study. The formula for the index selection was:

INDEX= 20% RYT+ 20%BC + 20%DM + 10%VV1 + 10%RVY + 10%C00T1 + 5%VIR + 5%WED

To certify that the attributes used in the process of selection accounts for the majority of the variance in the data set, a principal component analysis (PCA) was conducted. To determine the degree of stability and adaptability of the 23 clones pre-selected, the GXE analysis using AMMI models was conducted.

Results

The analysis of variance (ANOVA) of the pooled data for the 12 variables used in the trial showed significant means squares for both main effects environment (E) and genotype (G) and interaction effects for GxE. Table 1 shows the means squares of ANOVA for RYT in the pooled data.

Table 1. Means squares for the main effects and GxE interaction of RYT for the pooled data, multi-location trial of 64 clones, October 2009 to March 2010

Source of Variability	DF	Type III SS	Mean Square	F Value	Pr > F
Genotype (G)	63	21908.81	347.7589	6.82	<.0001
Environment (E)	3	7248.396	2416.132	47.36	<.0001
R	3	2810.642	936.8807	18.36	<.0001
G*E	189	15159.35	80.20819	1.57	<.0001

In total, 23 clones were pre-selected as they matched using both ranking and index selection in all 4 environment. These genotypes were them submitted to GxE and cluster analysis. Table 2 present the result of the GxE analysis for the 23 clones.

Table 2. Estimates for the 23 genotypes selected in Umbelúzi, Chókwè, Gurué, and Angónia using AMMI analysis for GxE interaction for total root yield

G	Name	Average Total Yield (ton/ha)	Regression Coefficient (b)	Msdev	MSinteract	PC1	PC2
50	Ejumula -25	18.83	0.16	128.61	128.61	0.04	-3.06
34	UW119 06-289	21.58	0.20	362.09	280.15	3.54	-0.03
43	Kakamega-7	19.63	0.43	10.11	26.26	0.29	0.31
17	MUSG 0704-16	16.52	0.48	45.36	46.70	0.95	-1.44
4	UW119 06-32	15.94	0.66	37.71	32.25	0.78	-1.25
52	MUSG 0608-22	19.89	0.76	201.70	137.97	2.40	0.83
13	UW119 06-284	19.55	0.79	104.47	72.19	1.61	-0.94
29	UNWAMAZ 06-01	14.31	0.82	168.96	114.50	-2.01	-0.87
41	105369-4	23.38	0.85	188.17	126.80	1.91	1.91
51	MUSG 0616-18	20.22	0.85	8.07	6.72	0.54	-0.16
26	UW119 06-175	25.94	0.91	46.67	31.55	0.48	1.38
23	UW119 06-79	22.49	1.05	17.83	12.01	-0.12	0.93
27	UW119 06-140	18.32	1.06	25.64	17.32	0.57	-0.66
49	W119-15	27.09	1.10	14.85	10.56	0.58	0.10
38	Tacna-2	22.16	1.12	20.11	14.29	-0.16	-0.93
37	LO323-1	17.53	1.18	84.99	58.53	-0.94	1.67
47	Mafutha-1	17.31	1.27	5.21	7.75	-0.51	0.20
56	MUSG 0602-19	21.87	1.32	132.44	94.48	1.68	0.91
40	105 268-1	15.42	1.39	43.70	38.51	-1.26	0.40
59	Ejumula	14.90	1.44	120.56	91.88	-1.65	1.55
18	MUSG 0705-35	17.74	1.48	224.11	163.05	-1.80	-2.49
42	Ejumula-9	20.91	1.93	265.52	229.27	-3.06	1.18
30	UNASPOT 06-02	20.17	1.94	416.10	330.37	-3.83	0.35

According to results in Table 2 and Figure 2, the genotypes (G) 51, 26, 23 (Fig.3), 27, 49, and 38 (Tacna-2), were more stable across the environments, as they showed values of the regression coefficient (b) very close to 1 and very low levels of MSdev and MSinteraction.

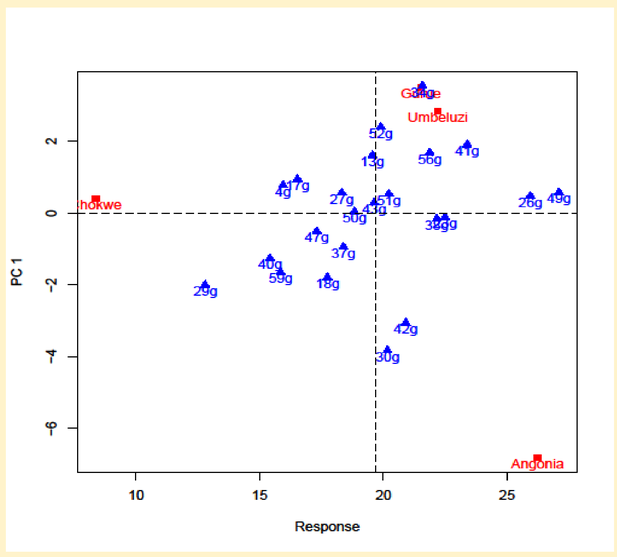

Figure 2. The AMMI biplot of the 23 genotypes

Figure 3. View of the genotype 23, named variety *Bela*

In relation to the environments, in general, genotypes selected in Angónia were not very sensitive to changes in environment, which means clones performing well in Angónia have better chance to grow in similar or worse conditions (regression coefficient *b* very low), while clones from Gurué tended to perform well in high yielding environment. The clones selected in Umbelúzi were more likely to perform in all environments, but with tendency to good yielding conditions (value of *b* close to 1) (Table 3).

Table 3. Estimates for the 4 environments (Umbelúzi, Chókwè, Gurué, and Angónia) using AMMI analysis for GxE interaction for total root yield

Environment	Average Total Yield (ton/ha)	Regression Coefficient (b)	Msdev	MSinteract	PC1	PC2
Umbelúzi	16.62	1.19	55.18	53.09	2.84	-3.59
Chókwè	6.36	0.65	15.83	16.49	0.40	-1.78
Gurué	14.72	2.29	57.21	73.64	3.50	4.53
Angónia	20.93	0.01	134.57	139.58	-6.81	0.73
Mean	14.63	-	-	-	-	-
LSD	1.57	-	-	-	-	-
CV %	61.23	-	-	-	-	-

The selection of the best clones

According to the results of ranking elimination, index selection, and AMMI analysis, 15 out of the 23 pre-selected clones matched in all attributes in study. The best of the best clones are presented in Table 4.

Table 4. Distribution of the new improved varieties according to specific adaptation to different locations in Mozambique

Region/Location	Official Name	Given Name	Regression Coefficient	Vir2	RYTHa	RVY	DM	BC	COOT1
Varieties with wide adaptation in Mozambique	51–IIAM–CIPBD001	Tio Joe	0.85	1.81	20.22	17.11	26.69	10.32	3.81
	26–IIA M-CIPBD002	Namanga	0.91	1.50	25.94	19.33	27.00	8.39	3.38
	23–IIAM–CIPBD004	Bela	1.05	1.50	22.49	22.96	27.50	8.39	3.63
	27–IIAM–CIPBD009	Lourdes	1.06	1.88	18.32	16.52	25.75	9.94	3.75
	38–IIAM–CIPBD003	Ininda	1.12	1.38	22.16	25.39	29.32	5.31	3.38
	43–IIAM–CIPBD005	Irene	0.43	1.38	19.63	20.32	28.78	6.06	3.75
Umbelúzi (South of Mozambique)	50-IIAM-CIP BD007	Cecilia	0.16	3.25	18.83	16.94	26.75	6.01	3.63
	13–IIAM–CIPBD011	Erica	0.79	1.38	19.55	16.07	25.63	10.16	3.63
	41–IIAM–CIPBD012	Delvia	0.85	1.13	23.38	23.17	32.84	5.54	3.44
	49–IIAM–CIPBD006	Melinda	1.10	1.56	27.09	23.97	23.56	5.71	3.44
	47–IIAM–CIPBD013	Amélia	1.27	2.13	17.31	31.03	32.13	5.00	4.13
Chókwè (South/Central of Mozambique)	50-IIAM-CIP BD007	Cecilia	0.16	3.25	18.83	16.94	26.75	6.01	3.63
	34–IIAM–CIPBD010	Sumaia	0.20	1.88	21.58	14.89	25.25	7.70	3.44
	49–IIAM–CIPBD006	Melinda	1.10	1.56	27.09	23.97	23.56	5.71	3.44
	10–IIAM–CIPBD015	Esther	1.31	1.25	18.60	15.79	29.61	4.72	3.93
Gurué (Central/North of Mozambique)	34–IIAM–CIPBD010	Sumaia	0.20	1.88	21.58	14.89	25.25	7.70	3.44
	13–IIAM–CIPBD011	Erica	0.79	1.38	19.55	16.07	25.63	10.16	3.63
	41–IIAM–CIPBD012	Delvia	0.85	1.13	23.38	23.17	32.84	5.54	3.44
	37–IIAM–CIPBD008	Jane	1.18	1.75	17.53	21.18	29.22	5.59	4.05
	47–IIAM–CIPBD013	Amélia	1.27	2.13	17.31	31.03	32.13	5.00	4.13
Angónia (Central of Mozambique and South of Malawi)	13–IIAM–CIPBD011	Erica	0.79	1.38	19.55	16.07	25.63	10.16	3.63
	37–IIAM–CIPBD008	Jane	1.18	1.75	17.53	21.18	29.22	5.59	4.05
	47–IIAM–CIPBD013	Amélia	1.27	2.13	17.31	31.03	32.13	5.00	4.13
	59–IIAM–CIPBD014	Glória	1.44	1.38	14.90	26.80	33.52	5.38	4.03
LSD (0.05)				0.82	9.75	11.66	2.65	2.29	0.53
MEAN*				1.59	14.60	19.01	27.94	6.01	3.70

In general, the results of the on-farm trial showed that all 15 selected clones over performed the local varieties (Fig. 4)

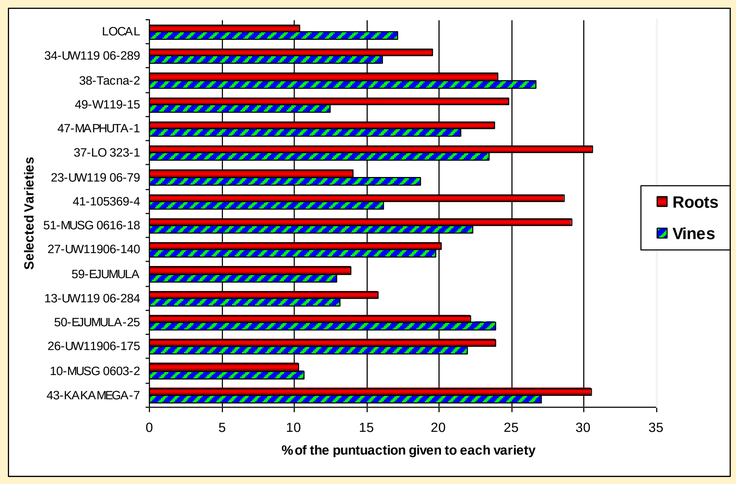

Figure 4. Percentage of the punctuation given to each of the 15 selected genotypes by the 146 participants of the on-farm trials in Umbelúzi and Chókwé

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