EVALUATION OF 64 CLONES SELECTED FROM ADVANCED YIELD TRIALS ESTABLISHED BETWEEN 2005/06 AND 2009/10 IN MAPUTO, GAZA, ZAMBÉZIA, AND TETE

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Table of contents

List of Tables

List of Figures

List of Annexes

SUMMARY

The present report describes the selection of the final best 15 clones from the multi-location trials of 64 clones conducted in Umbelúzi, Chókwè, Gurué, and Angónia for release. The primary objective of these trials was to select clones with deep orange flesh storage roots, good dry matter content/taste, tolerance to drought, good yield, and disease and pest tolerance with potential to be used across different sites/regions in Mozambique.

Two methods to screen for the potential clones were used: The first one was the so called ranking elimination which consisted on the elimination of clones with low performance or with values of the attributes below the average for the characteristics for both combined and single locations. The first characteristic taken into account was the total yield, followed by beta-carotene contends, dry matter, taste, vine vigor, vine survived, root rot, and symptoms of virus. For the total yield, all clones with values of yield greater than the total average yield for the trial per location were selected. The same procedure was used for the remaining attributes aforementioned that were used in the process of selection; the second method was an *index selection which* consisted on weights attributed to each of the 8 variables conventionally considered important in this case for selection of clones. Also, and to make sure that the characteristics used in the selection process accounts for the majority of the variance in the data set, a principal component analysis (PCA) was conducted. Twenty three clones were selected by the two methods and these clones were submitted to GXE analysis using AMMI models, with the objective to determine the degree of stability and adaptability of these 23 clones across the 4 breeding sites. Also to complement these methods a cluster analysis was conducted to determine the similarities among these clones.

After screening the 23 genotypes, there were selected 15 potential clones across the four sites. In general, the results of the analysis on the combined data showed that there were 5 clones with consistent stability (GxE analysis) in all the 4 locations. These clones are 51- MUSG 0616-18, 26-UW119 06-175, 23- UW119 06-79, 27- UW119 06-140, 38- Tacna-2 and 43-Kakamega with wide yield stability (value of *the regression coefficient* around 1).

Apart from these 6 genotypes with broad yield stability across the 4 sites, 6 genotypes were selected for local adaptation in Umbelúzi (13- UW119 06-284, 41-105369-4, 49-W119-15, 47-Mafutha-1,and 50- Ejumula -25), 4 clones in Chókwè (10- MUSG 0603-02, 34- UW119 06-289, 49-w119-15, and 50- Ejumula -25), 5 genotypes in Gurué (13- UW119 06-284, 34- UW119 06-289, 37-LO323-1, 41-105369-4, and 47- Mafutha-1), and 4 clones in Angónia (13- UW119 06-284, 37-LO323-1, 47- Mafutha-1, and 59- Ejumula). Note that the genotypes 13- UW119 06-284 and 47-Mafutha-1 were selected for 3 locations (Umbelúzi, Gurué, and Angónia), while the clones 41-105369-4 (Umbelúzi and Gurué), 49-w119-15 and 50-Ejumula-25 (Umbelúzi and Chókwè), 34-UW119 06-289 (Gurué and Chókwè), were selected for 2 locations.

To validate the results of on-station trials, 60 on-farm trials, 15 in each of the four sites were established. Each individual on-farm trials had 5 clones being four from the 64 clones tested on-station and one from the farmer, as the local check. On the day of the evaluation, the farmer in collaboration with CIP organized and invited other non-participating farmers to evaluate the clones under on-farm in the field. The data in this report were pooled from Umbelúzi and Chókwè, and there were harvested, 9 trials in Umbelúzi and 10 trials in Chókwè. All 15 clones selected as the best under on-station trials were included in the harvested on-farm trials. Overall, there were involved 79 farmers in Chókwè (69 women and 10 men) and 67 farmers in Umbelúzi (48 women and 19 men), totaling 146 participants in the evaluation of the on-farm trials. The parameters evaluated under the vines were the quantity of leaves, greenness of leaves, habit of growth, vigor of the vine

and the volume of the canopy, while the parameters on the roots were the total yield, color of the storage root flesh, size of the roots, taste, and dry matter content.

Finally, and as expected, the results of the on-farm trial were in line with the findings from the ranking and index selection. All 15 selected genotypes under the ranking and index selection were better than the local varieties for root attributes and for the vine attribute under on-farm.

In parallel with the evaluations conducted in the field to select the clones for agronomic traits, a conservation test on the 64 clones were carried out, and among the 15 selected clones to be released, the most important clones in terms of weight conservation were 49 (W119-15) and 26 (UW119 06-175) with only 9.63 % and 13.11 % of weight lost 35 day after harvesting. In general, most of the clones in the trial presented good results, as the lost of weight 35 days after harvesting did not go beyond 50%. The worst clones among those selected for release were the clones 13 (UW119 06-284), and 59 (Ejumula) with weight losses 35 day after harvesting around 80% and 90% respectively.

BACKGROUND

In Mozambique, sweetpotato is the third most important food crop after corn and cassava (INIA-IITA/SARRNET, 2003). Due to its tolerance to drought, nutritional value (Vitamin A), and commercial potential, Mozambique has been investing in sweetpotato research such as comprehensive breeding since 2006 and adaptive trials since 1997.

As result of adaptive trials conducted from 1997 to 2000, eight orange fleshed sweetpotato clones (OFSP) were released in 2001. The adoption of these clones was extensively in many areas of the country; however, some of them were selected for more favorable environments, and their ability to perform in conditions of drought like in many regions of southern Mozambique was in jeopardy. Because of the intensive drought conditions in 2005 CIP-Mozambique funded by Rockefeller Foundation/Harvest Plus/USAID initiated a sweetpotato breeding program to come out with varieties that could tolerate drought conditions by maintaining reasonable levels of production of both roots and vines. From August 2005 to December 2009, several trials (**430**, from seedlings to multi-location were established at Umbelúzi, Chókwè, Angónia, and Gurué involving the evaluation of **198,592** genotypes (Table 1)

Table 1. Summary of all Trials Established from August 2005 to December 2009 at Umbelúzi Research Station, Chókwè, Angónia, Gurué, and Chókwè

Location	Type of Sweetpotato Trial	Nr. Trials	Number Genotypes/ Seeds	Experimental Design	Preceding Trials
Umbelúzi[1] Chókwè[4] Angónia[3] Gurué[2]	Seedling Nurseries	22	198,500	Evaluation on a single plant basis	Seeds from crossing block and introduced
	Clonal	16	14,907	RCBD with 2 replications (reps) Each row with 5 plants	Clones selected in the seedling nurseries
		1	382		
		1	1,575		
		1	1,015		
		1	1,019		
		1	7,251		
	Preliminary Yield Trial (PYT)	21	3,112	RCBD with 2 and 4 reps, each row with 25 plants	Clones selected from the clonal evaluation
		1	206		
	Advance Yield Trial (AYT)	59	1,258*	RCBD with 4 reps, each row with 25 plants at 4 locations	Clones selected from the PYT. Some trials are in the third evaluation
	Multi-location Trial	34	344	RCBD with 4 replications, each plot with 5 rows, total number of plants/ plot=80	Clones from the AYT. Some trials are also in the third evaluation
		4	64		
	Drought Trial (DT)	3	58	RCBD with 6 replications, with 2 rows plot, 24 plants/ plot	Selected clones from previous AYT and multi-location trials
	On-Farm	**205**	**9**	RCBD with 1 replication, each plot with 5 rows, total number of plants/ plot=80	**Clones released in 2001**
	On-farm	**60**	**64**	RCBD with 1 replication, each plot with 5 rows, total number of plants/ plot=80	64 clones from multi-location trials
Total	**6**	**430**	**198,592**	—	—

In collaboration with [2,5,1] USAID Regional [2,5], HarvestPlus breeding [3,41], USAID Mission Maputo & [2,1,5]AGRA.

From these, 59 established Advanced Yield Trials 64 clones emerged as potential to be released. These clones were selected for deep orange flesh, dry matter content/taste, drought tolerance, yield, and disease and pest resistance/tolerance. With these 64 clones 4 trials were established in October 2009 and harvested in March 2010. The characteristics of the 64 clones evaluated under the 4 locations are presented in Tables 2 and 3. The results on the clones are for the dry season 2009/09.

Table 2. List of Best Clones Selected from all the AYT Planted in Umbelúzi, Chókwè, Angónia, and Gurué Planted in October 2009

Name of Clone	IStand (%)	Vigor	CY (t/ha)	Total Yield (t/ha)	Biomass (t/ha)	DM (%)	Taste	B-Carotene (mg/100g)
				Umbelúzi				
W119 06-39	80.43	7.25	15.55	18.37	39.02	26.29	2.00	10.50
AUXiphone 06-1	72.82	7.75	12.94	14.60	38.15	28.01	2.25	1.80
UW119 06-296	59.78	8.00	10.36	14.06	44.85	26,0	1.44	12.04
UW119 06-32	71.74	8.75	22.10	23.44	64.75	21.77	1.91	7.80
MUSG 0703-37	70.67	7.75	18.33	21.03	43.73	23.57	1.40	1.50
UW119 06 290	66.31	7.25	12.83	16.34	35.72	27.11	1.50	10.50
MUSG 0702-17	66.67	8.75	13.00	13.70	44.77	37.05	1.63	1.40
105 101 G 07-07	80.00	2.76	8.80	16.16	42.00	29.90	3.10	1.80
105249 G 07-05	40.00	6.76	14.10	20.33	43.00	32.20	3.00	12.40
105274 G 07-01	90.00	5.00	10.30	20.83	26.33	38.40	3.00	1.00
105260 G 07-08	60.00	6.76	13.21	15.00	63.33	30.40	3.90	1.80
UW119 06-284	60.87	7.75	24.09	25.76	44.38	25.63	1.50	6.10
U1998-12-3-06-3	65.22	8.50	14.82	21.89	47.97	27.43	1.91	1.80
UW119 06-277	77.18	8.75	21.86	23.37	70.11	27.49	2.32	11.00
UW119 06-207	68.48	8.50	13.41	15.32	63.69	25.22	2.00	3.80
MUSG 0704-16	45.33	6.75	13.00	15.00	28.17	28.99	1.75	4.20
MUSG 0705-35	56.00	8.50	12.97	14.30	44.47	29.28	1.96	3.00
UCOL 1806-4	69.57	7.25	13.37	14.24	30.55	21.63	2.00	7.00
MUSG 0608-61	68.00	6.33	12.74	14.44	41.80	26,79	3.00	1.80
105 196 G 07-06	45.00	4.00	18.43	15.00	43.67	31.50	0.00	
105 143 G 07-04	55.00	3.00	15.01	13.33	24.83	31.80	0.03	
				Chókwè				
UW119 06-79	33.26	9.00	9.11	8.67	53.88	25.98	4.00	14.37
MUSG 0606-07	32.22	9.00	12.85	9.00	79.87	23.56	2.75	0.69
UJonathan 06-23	30.31	8.25	16.40	8.33	61.51	22.59	4.50	4.71
UW119 06-175	29.84	9.00	8.14	8.67	73.94	25.38	3.00	4.71
UW119 06-140	25.63	8.87	13.82	7.67	44.97	25.77	4.50	5.48
UW119 06-198	25.16	8.75	5.36	8.00	35.75	25.51	4.50	12.39
UWamazam 06-01	23.73	8.75	13.63	8.00	43.85	24.95	4.50	1.76
UNASPOT 5-06-02	22.94	7.75	7.74	7.00	62.83	30.01	5.00	5.49
MUSG 0608 33	22.31	9.00	6.40	9.00	41.31	26.64	3.75	5.49
UW119 06-80	22.30	8.75	9.59	8.33	36.44	23.85	4.00	0.00

Name of Clone	IStand (%)	Vigor	CY (t/ha)	Total Yield (t/ha)	Biomass (t/ha)	DM (%)	Taste	B-Carotene (mg/100g)
UW119 06-204	22.30	8.75	3.24	7.67	64.35	31.99	3.50	1.38
UW119 06-289	22.26	9.00	17.69	7.29	110.31	35.45	3.50	6.12
UW119 06-322	22.22	8.00	10.91	8.33	108.26	25.01	3.50	6.12
MUSG 0603-02	20.76	8.10	4.06	9.00	65.37	28.97	3.15	3.76
Gurué								
LO323-1	98.57	3.00	3.97	8.60	10.47	27.49	*	4.61
Tacna-2	100.00	4.00	2.40	6.75	9.10	26.16	*	6.12
105 257-3	100.00	4.00	11.40	29.51	34.53	28.36	3.33	3.96
105 268-1	100.00	6.00	6.86	19.56	37.80	30.59	3.67	1.04
105279-1	100.00	4.00	18.36	34.54	54.83	30.12	3.67	4.92
Ejumula -9	100.00	5.00	5.21	9.96	15.20	29.70	*	6.12
Kakamega-7	97.10	5.00	4.66	11.40	12.80	29.02	*	10.50
105413-4	94.20	4.00	16.99	28.55	37.50	29.16	3.00	1.65
MUSG 0619-16	95.67	5.00	1.79	8.10	13.51	30.88	3.25	14.37
MUSG0606-15	96.75	5.00	1.37	6.60	12.05	28.62	2.75	3.96
Angónia								
Mafutha-1	98.67	4.33	1.04	2.03	5.80	20.25	3.40	1.76
W119-12	97.33	4.33	2.49	4.31	10.35	20.31	2.80	5.46
W119-15	100	6	1.28	3.7	11.67	23.42	3.20	6.12
Ejumula -25	100	4.33	1.9	19.17	9.25	27.17	3.80	1.50
MUSG 0603-18	100	3	8.7	13.41	27.07	30.07	3.40	12.39
MUSG 0608-22	98	3.25	10.43	12.28	22.02	29.02	3.00	7.76
MUSG 0609-47	100	3.75	4.89	13.8	17.79	29.87	2.80	7.76
MUSG 0610-39	99	3	8.01	11.74	22.44	29.44	3.00	7.76
MUSG 0603-12	98.67	4	0.55	1.3	7.09	21.2	2.60	6.12
MUSG 0602-19	98.67	4	0.81	1.83	8.74	25.74	2.60	0.00
MUSG 0613-23	89.33	2	0.33	0.92	4.69	22.63	3.80	0.00
MUSG 0613-18	97.33	2.67	0.41	0.87	5.94	21.57	2.20	7.76

IStand = % of Initial Stand; CY = Weight of Commercial Roots; TY = Total Yield in Ton/ha; DM= % of Dry Matter Content
Vigor= 1, Not Vigorous; 5, Moderate; 9, Very Vigorous Taste = 1, Very bad; 2, Bad; 3, Average; 4, Good; 5, Excellent

Table 3. Habit of Growth, Color of the Leaf of the Clones Selected for the Multi-location Trial of 64 Clones Established in October 2009

Trial	Family	Name of Clone	Growth Habit	Color of Leaf
		Umbelúzi		
AYT55	W119	W119 06-39	Erect	Dark Green
AYT55	Xiphone	AUXiphones 06-1	Erect	Greenish Gray
AYT55	W119	UW119 06-296	Prostrate	Dark Green
AYT55	W119A	UW119 06-32	Prostrate	Greenish Gray
AYT40	Ejumula	MUSG 0703-37	Prostrate	Greenish Gray
AYT55	W119	UW119 06 290	Prostrate	Light Green

Trial	Family	Name of Clone	Growth Habit	Color of Leaf
AYT40	Unguija	MUSG 0702-17	Prostrate	Light Green
AYT111	105101	105 101 G 07-07	Prostrate	Green
AYT111	105249	105249 G 07-05	Prostrate	Light Green
AYT111	105274	105274 G 07-01	Erect	Green
AYT111	105260	105260 G 07-08	Prostrate	Dark Green
AYT55	W119	UW119 06-284	Prostrate	Light Green
AYT55	1998-12-3 06-3	U1998-12-3-06-3	Prostrate	Light Green
AYT55	W119	UW119 06-277	Prostrate	Light Green
AYT55	W119	UW119 06-207	Prostrate	Grayish Green
AYT40	Kakamega	MUSG 0704-16	Prostrate	Green
AYT40	Tainung 64	MUSG 0705-35	Prostrate	Green
AYT55	COL 18	UCOL 1806-4	Erect	Green
AYT30	Cordner	MUSG 0608-61	Prostrate	Dark Green
AYT111	108196	108 196 G 07-06	Erect	Light Green
AYT111	105143	105 143 G 07-04	Prostrate	Green
		Chókwè		
AYT48	W 119	UW119 06-79	Prostrate	Light Green
AYT 30	CN 1448-50	MUSG 0606-07	Prostrate	Green
AYT48	Jonathan	UJonathan 06-23	Prostrate	Light Green
AYT48	W 119	UW119 06-175	Prostrate	Green
AYT48	W 119	UW119 06-140	Prostrate	Light Green
AYT48	W 119	UW119 06-198	Prostrate	Light Green
AYT48	Nwamazambe	Uwamazam 06-01	Erect	Light Green
AYT48	NASPOT 5	UNASPOT 5- 06-02	Prostrate	Greenish Gray
AYT 30	Cordner	MUSG 0608 33	Erect	Light Green
AYT48	W 119	UW119 06-80	Prostrate	Light Green
AYT48	W 119	UW119 06-204	Prostrate	Light Green
AYT48	W 119	UW119 06-289	Prostrate	Light Green
AYT48	W 119	UW119 06-322	Erect	Greenish Gray
AYT 30	Bengal	MUSG 0603-02	Prostrate	Light Green
		Gurué		
AYT 37	LO 323	LO323-1	Prostrate	Light Green
AYT 37	Tacna	Tacna-2	Prostrate	Greenish Gray
AYT 111	105 257	105 257-3	Prostrate	Light Green
AYT 111	105 268	105 268-1	Prostrate	Greenish Gray
AYT 111	105 279	105279-1	Prostrate	Greenish Gray
AYT 37	Ejumula	Ejumula -9	Prostrate	Light Green
AYT 37	Kakamega	Kakamega-7	Prostrate	Greenish Gray
AYT 111	105 413	105413-4	Prostrate	Greenish Gray
AYT 30	NC 00-677	MUSG 0619-16	Prostrate	Greenish Gray
AYT 30	CN 1448-49	MUSG0606-15	Prostrate	Greenish Gray
		Angónia		

Trial	Family	Name of Clone	Growth Habit	Color of Leaf
AYT 40	Mafutha	Maphuta-1	Erect	Light Green
AYT 40	W 119	W119-12	Erect	Light Green
AYT 40	W 119	W119-15	Prostrate	Light Green
AYT 40	Ejumula	Ejumula -25	Prostrate	Dark Green
AYT 22	Bengal	MUSG 0603-18	Erect	Light Green
AYT 30	Cordner	MUSG 0608-22	Erect	Green dark
AYT 30	W 250	MUSG 0609-47	Erect	Light Green
AYT 30	NC 9350 A	MUSG 0610-39	Erect	Light Green
AYT 30	Bengal	MUSG 0603-12	Erect	Light Green
AYT 22	Hernandez	MUSG 0602-19	Prostrate	Dark Green
AYT 22	NC 99088	MUSG 0613-23	Erect	Light Green
AYT 22	NC 99088	MUSG 0613-18	Prostrate	Dark Green

As demonstrated in Table 2, most of these clones were selected taking into account their high yield performance in one of the four locations under evaluation. However, in order to verify their yield stability and adaptation in these four locations (Umbelúzi, Chókwè, Angónia, and Gurué), a Multi-location Trial with all 64 clones selected from the Advanced Yield Trial was established at each of the 4 location.

Characteristics of the breeding sites

CIP-Mozambique has been working and establishing sweetpotato trials in 4 agricultural stations that are under the mandate of the local Agrarian Research Institute of Mozambique (IIAM) (Figure 1). According to the IIAM agro-ecological categorization of 2002, these locations were classified as unique in terms of their agro-ecological characteristics. Overall, Mozambique has potentially 10 agro-ecological regions, designated R1 to R10 (Figure 2). Umbelúzi Research Station is located in Maputo province and is under R1 agro-ecological region, Chókwè Research Station in R1/R2, Angónia and Gurué Research Station are located under agro-ecological zone R10, but Gurué has relatively high levels of precipitation, as the average annual rainfall is 1,995.7 mm, and the wet period is from October through July/August, while Angónia has the mean annual rainfall varying from 725 mm to 1149 mm, and the wet season is from November to March.

Figure 1. Map of Mozambique with the areas of intervention

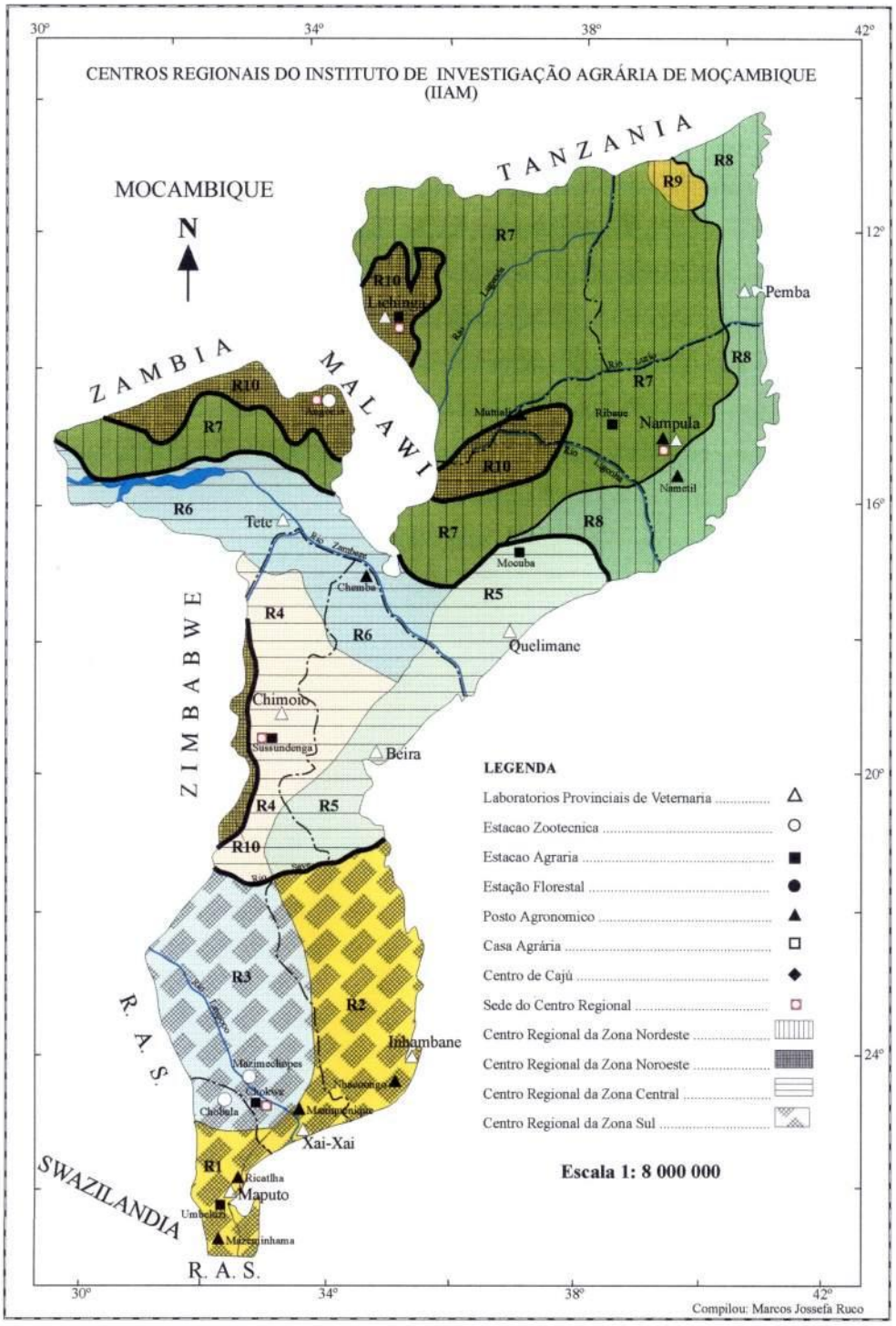

Figure 2. Map of Mozambique with the agro-ecological zones established in 2002 by IIAM

Table 4 summarizes the main characteristics of the 4 environments where the multi-location trial was conducted from October 2009 to March 2010. Accordingly, the southern provinces of Maputo (Umbelúzi) and Gaza (Chókwè) are more prone to drought conditions than the central provinces of Tete (Angónia) and Zambézia (Gurué).

Table 4. Average Annual Rainfall, Altitude, Variation of Dry Season of the 4 Environment where the Multi-location Trial of 64 Clones were conducted, October 2009 to March 2010

Environment	Province	Average Annual Rainfall (mm)	Altitude (m)	Variation of Dry Season
Umbelúzi	Maputo	679.00	12.00	May-September
Chókwè	Gaza	623.00	33.00	April-November
Angónia	Tete	929.00	1300.00	April-October
Gurué	Zambézia	1995.70	1000.00	July-September

Umbelúzi

Umbelúzi (26.03 S, 32.23 E) is 12 m above sea level (masl), located in Boane District in Maputo Province of Mozambique. It has rain season temperatures of 23–26˚C and dry season temperatures of 17–23˚C, with 2.8–7.2 mm/day of evaporation, about 1,857 mm per year with a mean rainfall of 679 mm. It has an alluvial stratified soil with soil texture ranging from sandy loam in the top soil to sandy at 1.75 m depth, and an available water capacity of 200 mm at the 1.75 m deep soil profile (Gomes 1996). The site is semi-arid agro-ecologies in class R1 in the map of Mozambique (Fig 2)

Water balance for sweetpotato cropping: information on the water status of Umbelúzi (Table 5) provides evidence that it is a perfect site for testing the tolerance of sweetpotato genotypes to drought in Mozambique.

Table 5. Available Water in Soil (mm) [total precipitation minus total evapo-transpiration at Umbelúzi of Maputo Province of Mozambique between 1997 to 2007

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
29 yrs*	–98	–70	–79	–67	–88	–66	–75	–111	–114	–133	–133	–142	–1,178
1997[a]	98	–44	9	–72	–91	–90	–55	–51	–24	–21	–30	17	–354
1998[a]	161	–32	–13	–89	–121	–112	–109	–129	–110	3	48	4	–499
1999[a]	83	161	–21	–27	–68	–90	–103	–89	–82	–1	47	–32	–222
2000[a]	22	359	161	–29	–62	–46	–79	–92	–62	–60	125	–29	208
2001[a]	16	131	–63	–48	–74	–76	–92	–103	–118	–66	232	66	–195
2002[a]	–36	–62	–83	–100	–105	–92	–104	–115	–121	–74	–86	–36	–1,014
2003[a]	–121	–22	–91	–98	–84	–17	–91	–139	–80	–132	–107	–138	–1,120
2004[a]	85	7	32	–26	–64	–75	6	–69	–73	–74	31	–37	–257
2005[a]	76	–39	43	–44	–87	–96	–104	–120	–152	–153	–101	–108	–885
2006	–17	–65	25	–13	–142	–121	–129	–132	–118	–91	–13	4	–812
2007	–134	–114	–95	47	–124	–109	–124	—	—	—	—	—	—
Mean	22	25	–9	–45	–93	–84	–90	–104	–94	–67	15	–29	–515
CV (%)	436	543	868	96	29	36	42	28	39	77	732	205	83

** Mean for 29 years before 1975 (from Kassam et al. 1981).*
[a] Computed from data of Instituto Nacional de Meteorologia, Maputo (18 October 2007).

The long-term available soil water data for both the 29 years and the 9 years (1997–2005) in Table 5 assures us that the genotypes were subjected to as dry an environment as can be in any usual drought year. Beyond that level of dryness, a crop failure would result. Of the 120 months of 1997–2006, 26 months had positive water balance.

Chókwè

The site's semi-arid agro-ecologies are classified as class R1 on the map of Mozambique. The mean annual rainfall is 623 mm, the altitude is 30 m, and the soil texture is silty clay loam. Water balance for sweetpotato cropping: information on the water status of Chokwe (Table 6) provides evidence that it is a perfect site for testing the tolerance of sweetpotato genotypes to drought in Mozambique. Table 6 shows the available water in soil at Chókwè for 15 years until 2006.

Table 6. Available Water in mm in Soil at Chókwè for 15 Years up to 2006

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1992[a]	–89	–131	–134	–134	–105	–65	–102	–121	–140	–162	–43	33	–1,192
1993[a]	–111	52	7	–19	–87	–87	–63	–100	–147	–94	–45	–64	–758
1994[a]	–18	–111	–93	–105	–92	–110	–79	–88	–114	–73	–128	–84	–1,094
1995[a]	–155	–83	–109	–74	–34	–85	–115	–62	–135	–129	–116	–37	–1,134
1996[a]	150	–3	–73	–20	22	–61	–61	–69	–127	–157	–92	–56	–547
1997[a]	49	42	–26	–83	–69	–91	–0	0	0	–82	0	0	–260
1998[a]	0	0	–125	–99	–106	–104	–56	–46	–105	–70	–30	222	–519
1999[a]	31	144	–43	–32	–62	–75	0	–95	–126	–110	26	–129	–471
2000[a]	–66	168	0	–41	–29	–30	–24	–76	–46	–108	214	–84	–123
2001[a]	–48	97	4	–28	–72	–88	–102	0	–145	–37	48	171	–200
2002[a]	–71	–88	–60	–94	–73	–42	–89	–91	–64	–53	–30	–106	–859
2003[a]	–152	–53	–92	–93	–89	66	–26	–116	–89	–15	–97	–84	–840
2004[a]	9	–32	210	–15	–78	199	–7	–85	–122	–101	0	0	–21
2005[a]	–96	–109	–101	–114	–117	–120	0	–138	–151	–176	–76	–28	–1,226
2006	37	–107	208	–68	–51	–37	–85	–149	–99	–137	–1	–59	–550
Mean	–35	–14	–28	–70	–69	–49	–54	–82	–107	–100	–25	–20	–653
CV (%)	–236	–681	–376	–58	–51	–168	–76	–53	–40	–47	–340	–485	–61

** Mean for 29 years before 1975 (from Kassam et al. 1981).*
[a] Computed from data of Instituto Nacional de Meteorologia, Maputo (18 October 2007).

The two sites (Umbelúzi and Chókwè) are similar when the available water in soil is averaged for the 1997-2006 periods are compared as shown in Table 7.

Table 7. Comparison of Water Availability (m^3) for Umbelúzi and Chókwè, Averaged for 1997–2006

Site	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Chókwè	–31	6	–3	–67	–75	–32	–39	–80	–95	–89	5	–10	–507
Umbelúzi	37	39	0	–55	–90	–82	–86	104	–94	–67	15	–29	–515

Angónia

Angónia is characterized by two seasons: the rainy season, which starts in December, and the dry season, in April. Annual temperature is 20.9˚C and the mean annual rainfall varies from 725 mm to 1,149 mm. The climate is humid temperate of altitude. The average altitude is 1,300 m, and most soil is heavy in texture and deep (ACNUR/PNUD 1997). This is the site to test for cold (low temperature tolerance).

Gurué

Gurué is located in the north of the province of Zambézia. The climate is humid; the annual rainfall is 1,995.7 mm, the wet period is from October through July/August. The least precipitation is registered during the month of September. The mean temperature is 21.9˚C, with the highest temperature registered in November (32.5˚C) and the lowest temperature registered in July (12.3˚C). The altitude varies from 500 to 1,000 m. The soils are characterized as red to dark brown with the texture of clay loam, deep, well drained, and good natural fertility. This is the site to test for virus disease in sweetpotato, as the pressure is very high.

METHODOS

The design and measured attributes

As aforementioned, the trial consisted of 64 clones selected from Advanced Yield Trials established from 2005/6 to 2008/9 in Umbelúzi (Maputo province), Chókwè (Gaza province), Angónia (Tete province), and Gurué (Zambézia province).

The experimental design was a randomized complete block with four replications. The experimental net plots had one row with 23 plants. The planting density was 0.9 m between rows and 0.3 m between plants. The trial was established without any fertilization. The attributes that were measured and determined were:

1. PBROT = Percentage of sprouting; 2. SHI=Percentage of vine survived 3. Vir2 =Symptoms of virus at early and late stages of growing respectively (1, without symptoms; 5, Moderate; 9, extremely severe) 4. VV1=plant Vigor (Not vigorous; 5, Moderate; 9, Very vigorous) 5. RYC=Commercial Root Yield in tones per hectare 6. RYT=Total Root Yield in tones per hectare 7. RVY=Total Vine Yield in tones per hectare 8. Bio=Biomass in tones per hectare 9. DM=Percentage of Dry Matter Content 10. BC=Levels of Beta-carotene in mg/100g of fresh root 11. COOT1= Taste (Very bad; 2, Bad; 3, Average; 4, Good; 5, Excellent) 12. Wed1=Weevil = Losses due to weevil (1, extremely severe; 2, Severe; 3, Moderate; 4, Light; 5, None) 13. DMAR=other injuries or damages on the roots (1, extremely severe; 2, Severe; 3, Moderate; 4, Light; 5, None)

For each genotype, three roots were randomly collected and sent to the laboratory for dry matter determination. Dry matter was calculated based on fresh grated root sample of about 100g which was oven dried for 72 hours until constant dry weight. For beta-carotene determination 2 fresh roots were used and color comparison was taken with the *Guide for Using the RHS Color Chart for Selecting for High Beta-carotene Sweetpotato*, illustrated by Burgos et al, 2009.

Data analysis

Two methods were combined to screen for the potential varieties. The first method was the elimination (ranking elimination) of all clones with bad performance or with values below the average total yield for both the combined and single location. The first characteristic taken into account in the process of elimination was the total root yield, followed by the content of beta-carotene, dry matter, taste, vine vigor, vine survival, root rot, and symptoms of virus. For the total yield, all clones with values of yield greater than the total average yield of trial per location were selected. To avoid discarding clones with root yield (10 ton/ha or above) but located below the

total average root yield, the statistic LSD at 5% was employed, that is, all clones that were not significantly different from the average total root yield were considered by using this dual comparison statistic test. The same procedure was used for the remaining attributes aforementioned that were employed in the process of selection.

Another important criteria of selection of the best clones across the four locations was the use of an *index selection* consisted of weights attributed to each of the 8 variables conventionally considered important in the process of evaluation and selection of sweetpotatoes varieties.
The formula for the index selection was:

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

The balanced weights for the root yield (RYTHa), beta-carotene (BC), and dry matter is justified for their importance based not only on the farmer's perception on what is a good sweetpotato but also is in line with the balanced variance found in the principal components analysis for the components 1, 2, and 3 that generated eingenvalues greater than 1.

Twenty three clones resultant from the elimination procedure and the index selection were selected from these 64 and submitted to GXE analysis using AMMI models with the objective to determine the degree of stability of these clones across the 4 environments. To complement the present analysis, a cluster analysis was conducted to find out the similarities of the clones.

According to the results on Table 8, the variability associated with the traits used to select these clones is not very significant as none of the principal clones presented proportions of variances greater than 50%. The first principal component explains 43.5 % of the variability in the data set, while the second and third 22.5 % and 14.7% respectively. These 3 principal components together explain 80.5 % of the variance associated with the 12 traits used to evaluate this trial.

Table 8. Eigenvalues for the correlation matrix for the 12 variables used for the PCA analysis in the Multi-location trial of 64 Clones, October2009 to March 2010

Principal Component	*Eigenvalue*	*Difference*	*Proportion*	*Cumulative*
1	5.225123	2.557091	0.4354	0.4354
2	2.668033	0.898543	0.2223	0.6578
3	1.76949	1.079229	0.1475	0.8052
4	0.69026	0.163859	0.0575	0.8627
5	0.52640		0.0439	0.9066

Thus, taking together all 12 variables used in the process of selection the best genotypes across the environments, none of them will generate variances of more than 50% for the data set, and it is predictable that no variable is significantly and exclusively determinant in the process of selection or grouping of the 64 genotypes in the trial, and this suggests a balanced distribution of the weight of the variables when considering the selection. This result can be reinforced by analyzing the results of the eigenvectors for each of the principal components depicted in Table 9.

According to the eigenvectors presented in Table 9, for the first principal component that accounts for 43.5% of the variance associated with the genotypes, there is fairly equilibrium in terms of the weight and influence of the main factors such as SHI, RYTHa, Biomass, RVY, COOT1, and WED1,

with values of eigenvectors ranging from 0.25 to 0.36 approximately. The variables that seem to be significant in this principal component are the PBROT. The factor BC has very little influence in the principal component 1, but with huge power in the principal component 3 that explains 14.7% of the variability of the genotypes. We chose to start to select for the root yield because of the significant influence of this factor in principal component 2, and this choice can be easily justified by the influence of the root yield in the selection of the variables in general.

Table 9. Eigenvectors for the 12 variables used for the PCA analysis in the Multi-location trial of 64 Clones, October2009 to March 2010

Variables	*Principal Comp 1*	*Principal Comp 2*	*Principal Comp 3*	*Principal Comp 4*	*Principal Comp 5*
PBROT	0.396173	-0.11974	0.172236	0.062404	0.062839
SHI	0.366924	0.094423	0.120546	0.048797	-0.11148
Vir2	0.126869	0.136489	0.476339	0.79656	-0.07713
VV1	0.348323	-0.16639	-0.17041	0.131755	0.242914
RYCHa	0.177410	0.49227	0.108802	-0.262	-0.39758
RYTHa	0.250961	0.469013	-0.07634	-0.10972	-0.13531
RVY	0.247225	0.11575	-0.50069	0.206981	0.4705
Bioma	0.305186	0.368641	-0.255	-0.00279	0.075578
DM	0.342041	-0.33262	-0.08236	-0.0603	-0.16425
BC	0.062484	0.170378	0.569202	-0.34836	0.67179
COOT1	0.324610	-0.32331	0.088924	-0.10744	-0.17953
WED1	0.30985	-0.27321	0.16673	-0.28599	-0.06851

1. PBROT = Percentage of sprouting;
2. SHI=Percentage of vine survived
3. Vir2 =Symptoms of virus at early and late stages of growing respectively (1, without symptoms; 5, Moderate; 9, extremely severe)
4. VV1=Vigor (Not vigorous; 5, Moderate; 9, Very vigorous)
5. RYC=Commercial Root Yield in tones per hectare
6. RYT=Total Root Yield in tones per hectare
7. RVY=Total Vine Yield in tones per hectare
8. Bio=Biomass in tones per hectare
9. DM=Percentage of Dry Matter Content
10. BC=Levels of Beta-carotene in mg/100g of fresh root
11. COOT1= Taste (Very bad; 2, Bad; 3, Average; 4, Good; 5, Excellent)
12. Wed1=Weevil = Losses due to weevil (1, extremely severe; 2, Severe; 3, Moderate; 4, Light; 5, None)

RESULTS AND DISCUSSION

The analysis of variance for the measured attributes

The analysis of variance (ANOVA) of the combined data for the 12 variables used in the process of selection in all environment tested in the trials (Tables 10-21) showed significant means squares for both main effects environment (E) and genotype (G) and interaction effects (GxE). Although high significance of genotype main effects, the influence of the environment in the interactions seems to be stronger than from the genotypes, and this can be confirmed by relative high mean

squares of the environment main effects in the majority of the variables. This is internal evidence that the 4 environments had different influences on the performance of the genotypes.

Table 10. Means Squares of ANOVA for the Genotype and Environment Main Effects and GxE interactions of the Percentage of Sprouting (PBROT) for the Pooled Data, Multi-location trials of 64 Clones, October 2009 to March 2010

Source of Variability	DF	Type III SS	Mean Square	F Value	Pr > F
Genotype (G)	63	29366.88	466.141	6.87	<.0001
Environment (E)	3	152658.8	50886.26	750.06	<.0001
R	3	1894.727	631.5756	9.31	<.0001
G*E	189	57863.98	306.1586	4.51	<.0001

Table 11. Means Squares of ANOVA for the Genotype and Environment Main Effects and GxE interaction of the Percentage of Vine Survived (SHI) for the Pooled Data, Multi-location trials of 64 Clones, October 2009 to March 2010

Source of Variability	DF	Type III SS	Mean Square	F Value	Pr > F
Genotype (G)	63	57359.14	910.4626	3.67	<.0001
Environment (E)	3	57207.03	19069.01	76.79	<.0001
R	3	25112.07	8370.689	33.71	<.0001
G*E	189	133661.1	707.2016	2.85	<.0001

Table 12. Means Squares of ANOVA for the Genotype and Environment Main Effects and GxE interaction of the Symptoms of Virus at Late Stage of Growth (VIR2) for the Pooled Data, Multi-location trials of 64 Clones, October 2009 to March 2010

Source of Variability	DF	Type III SS	Mean Square	F Value	Pr > F
Genotype (G)	63	142.0291	2.25443	1.95	<.0001
Environment (E)	3	167.2782	55.75941	48.13	<.0001
R	3	3.51686	1.172287	1.01	0.3868
G*E	189	303.8453	1.607647	1.39	0.0015

Table 13. Means Squares of ANOVA for the Genotype and Environment Main Effects and GxE interaction of Vines Vigor (VV1) 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	431.705	6.85246	3.58	<.0001
Environment (E)	3	1556.59	518.8634	271.2	<.0001
R	3	8.919623	2.973208	1.55	0.1992
G*E	189	601.7628	3.18393	1.66	<.0001

Table 14. Means Squares of ANOVA for the Genotype and Environment Main Effects and GxE interaction of Commercial Root Yield (RYCHa) for the Pooled Data, Multi-location trial of 64 Clones, October2009 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

Table 15. Means Squares of ANOVA for the Genotype and Environment Main Effects and GxE interaction of Total Root Yield (RYTHa) for the Pooled Data, Multi-location trials of 64 Clones, October 2009 to March 2010

Source of Variability	DF	Type III SS	Mean Square	F Value	Pr > F
Genotype (G)	63	30788.05	488.6992	6.05	<.0001
Environment (E)	3	25529.45	8509.818	105.27	<.0001
R	3	4412.241	1470.747	18.19	<.0001
G*E	189	56358.92	298.1953	3.69	<.0001

Table 16. Means Squares of ANOVA for the Genotype and Environment Main Effects and GxE interaction of Total Vine Yield (RVY) for the Pooled Data, Multi-location trials of 64 Clones, October 2009 to March 2010

Source of Variability	DF	Type III SS	Mean Square	F Value	Pr > F
Genotype (G)	63	57422.09	911.4617	7.24	<.0001
Environment (E)	3	10085.13	3361.71	26.7	<.0001
R	3	676.4659	225.4886	1.79	0.1474
G*E	189	75350.3	398.6788	3.17	<.0001

Table 17. Means Squares of ANOVA for the Genotype and Environment Main Effects and GxE interaction of Biomass (Bio) for the Pooled Data, Multi-location trials of 64 Clones, October 2009 to March 2010

Source of Variability	DF	Type III SS	Mean Square	F Value	Pr > F
Genotype (G)	63	96061.74	1524.79	6.09	<.0001
Environment (E)	3	33212.08	11070.69	44.23	<.0001
R	3	7115.779	2371.926	9.48	<.0001
G*E	189	134787	713.1589	2.85	<.0001

Table 18. Means Squares of ANOVA for the Genotype and Environment Main Effects and GxE interaction of Dry Matter Content (DM) for the Pooled Data, Multi-location trials of 64 Clones, October 2009 to March 2010

Source of Variability	DF	Type III SS	Mean Square	F Value	Pr > F
Genotype (G)	63	7731.679	122.7251	14.02	<.0001
Environment (E)	3	1959.755	653.2515	74.64	<.0001
R	3	2.833173	0.944391	0.11	0.9555
G*E	189	2783.863	14.80778	1.69	<.0001

Table 19. Means Squares of ANOVA for the Genotype and Environment Main Effects and GxE interaction of Beta-Carotene Content (BC) for the Pooled Data, Multi-location trials of 64 Clones, October 2009 to March 2010

Source of Variability	DF	Type III SS	Mean Square	F Value	Pr > F
Genotype (G)	63	6050.659	96.0422	14.03	<.0001
Environment (E)	3	267.8085	89.26949	13.04	<.0001
R	3	69.27466	23.09155	3.37	0.0181
G*E	189	3865.543	20.67135	3.02	<.0001

Table 20. Means Squares of ANOVA for the Genotype and Environment Main Effects and GxE interaction of Taste (COOT1) for the Pooled Data, Multi-location trials of 64 Clones, October 2009 to March 2010

Source of Variability	DF	Type III SS	Mean Square	F Value	Pr > F
Genotype (G)	63	78.3537906	1.243711	3.4	<.0001
Environment (E)	3	422.5249886	140.8417	385.31	<.0001
R	3	3.197698	1.065899	2.92	0.0335
G*E	189	169.9683534	0.899304	2.46	<.0001

Table 21. Means Squares of ANOVA for the Genotype and Environment Main Effects and GxE interaction of Weevil Attack (Wed1) for the Pooled Data, Multi-location trials of 64 Clones, October 2009 to March 2010

Source of Variability	DF	Type III SS	Mean Square	F Value	Pr > F
Genotype (G)	63	118.414	1.879588	2.78	<.0001
Environment (E)	3	453.1551	151.0517	223.19	<.0001
R	3	2.808088	0.936029	1.38	0.2467
G*E	189	305.3036	1.615363	2.39	<.0001

In general, the best environment for the total root yield (RYTHa) was Angónia with 20.9 ton/ha, but Umbelúzi was the environment that showed the best results in terms of commercial root yields with 12.35 ton/ha. In terms of the yield of the vines, Gurué was the best with 23.3 ton/ha and the worst were both Chókwè and Umbelúzi. These results are in line with the previous knowledge about these locations, in particular on the vine production, as Gurué is well branded as the best in terms of vine production, and the southern locations known as with poor performance due the prevalence of drought conditions.

Angónia and Gurué are the most important places in terms of virus attack, and the results in Table 22 confirm this. However, in general all varieties in terms of virus had relatively good performance.

Table 22. Means for the Environment Main Effects and GxE interaction for the Pooled Data, Multi-location trial of 64 Clones, October 2009 to March 2010

	Variables											
Environment	**PBROT**	**SHI**	**Vir2**	**VV1**	**RYCHa**	**RYTHa**	**RVY**	**Bioma**	**DM**	**BC**	**COOT1**	**WED1**
Chókwè	99.21	64.7	1.2	6.98	4.79	6.36	15.2	21.6	26.65	5.57	3.87	3.93
Gurué	88.23	80.04	1.71	4.85	9.22	14.72	23.3	37.47	29.84	6.84	4.50	3.00
Umbelúzi	99.85	64.79	1.24	5.67	12.35	16.52	16.7	33.25	26.41	5.9	3.74	4.21
Angónia	69.98	61.12	2.22	3.6	8.45	20.93	20.9	32.29	28.98	5.77	2.69	5.00
Mean	89.32	67.66	1.59	5.28	8.70	14.63	19.04	31.15	27.97	6.02	3.70	4.04
LSD	1.45	2.75	0.19	0.24	1.26	1.57	1.96	2.77	0.53	0.46	0.11	0.15
CV %	9.21	23.27	67.7	26.2	81.6	61.23	58.9	50.66	10.58	43.4	16.33	20.41

1. PBROT = Percentage of sprouting;
2. SHI=Percentage of vine survived
3. Vir2 =Symptoms of virus at early and late stages of growing respectively (1, without symptoms; 5, Moderate; 9, extremely severe)
4. VV1=Vigor (Not vigorous; 5, Moderate; 9, Very vigorous)
5. RYC=Commercial Root Yield in tones per hectare
6. RYT=Total Root Yield in tones per hectare
7. RVY=Total Vine Yield in tones per hectare
8. Bio=Biomass in tones per hectare
9. DM=Percentage of Dry Matter Content
10. BC=Levels of Beta-carotene in mg/100g of fresh root
11. COOT1= Taste (Very bad; 2, Bad; 3, Average; 4, Good; 5, Excellent)
12. Wed1=Weevil = Losses due to weevil (1, extremely severe; 2, Severe; 3, Moderate; 4, Light; 5, None)
13. DMAR=other injuries or damages on the roots (1, extremely severe; 2, Severe; 3, Moderate; 4, Light; 5, None)

Total root yield

In general, the results of the trial indicated good storage root yield of the clones under evaluation. The average root total root yield for all 64 clones over the 4 environments was 14.59 ton/ha. The top three best clones in terms of root production were: clone 48 (W119-12) with 29.63 ton/ha, clone 49 (W119-15) with 27.09 ton/ha, and 26 (UW119 06-175) with 25.94 ton/ha. The worst clones in the trial were 21 (108 196 G 07-06) with 4.48 ton/ha, 2 (UXIPHONE 06-1) with 4.65 ton/ha, and 19 (UCOL 1806-4) with 5.19 ton/ha (Tables 23 and 32).

Beta-carotene

The average beta-carotene content of all 64 clones over the 4 sites was 6.01 mg/100g of fresh roots, and the best clones in terms of beta-carotene were clones 13 (UW119 06-80), 3 (UW119 06-296), 53 (MUSG 0609-47), 51 (MUSG 0616-18), 13 (UW119 06-284) all of them with levels of beta-carotene greater than 10mg/100g (Tables 24 and 34). The worst clones were 22 (105 143 G 07-04), 8 (105 101 G 07-07), 62 (Wagabolige),, 11 (105274 G 07-01), 57 (MUSG 0613-23), 39 (105 257-3), 44 (105413-4), 12 (105260 G 07-08), and 61 (Huambachero), all of them with levels of beta-carotene less than 3.0 mg/100g (Tables 24 and 32).

Dry matter content

The average dry matter content of the trial was 27.94 %. Most of the clones in the trial presented levels of dry matter content over the average and greater than 25%. The clones with negligible levels of dry matter content were 48 (W119-12), 25 (UJONATH 06-23), 32 (UW119 06-80), 49 (W119-15), 5 (MUSG 0703-37), and 56 (MUSG 0602-19) all with levels of dry matter less than 24% (Table 24 and 32).

Table 23. Total and Commercial Root Yield (ton/ha) of 64 Genotypes (G) grown in Umbelúzi (Umb), Chókwè (Cho), Gurué (Gur), and Angónia (Ang), Multi-location trials of 64 Clones, October 2009 to March 2010

G		*Total Root Yield (ton/ha)*					*Commercial Root Yield (ton/ha)*				
	Name	Umb	Cho	Gur	Ang	Mean	Umb	Cho	Gur	Ang	Mean
1	W119 06-39	18.24	4.55	7.68	7.32	9.45	14.77	3.05	4.46	2.27	6.14
2	UXIPHONE 06-1	8.41	5.03	2.64	2.52	4.65	6.80	2.91	-1.33	3.48	2.97
3	UW119 06-296	16.50	6.68	2.03	17.68	10.72	9.46	4.63	-3.22	2.18	3.26
4	UW119 06-32	24.96	7.53	14.96	16.31	15.94	17.71	6.28	13.79	17.39	13.79
5	MUSG 0703-37	25.24	9.30	2.79	7.10	11.11	19.49	5.55	-3.16	3.99	6.47
6	UW119 06 290	18.08	5.80	18.95	15.55	14.60	18.53	5.44	6.30	5.43	8.93
7	MUSG 0702-17	12.52	2.78	9.82	52.43	19.39	10.87	1.89	6.26	11.05	7.52
8	105 101 G 07-07	9.26	7.23	8.77	4.13	7.35	6.84	5.60	7.73	4.85	6.26
9	105249 G 07-05	20.85	4.47	1.96	18.33	11.40	13.53	2.86	-0.15	0.87	4.28
10	MUSG 0603-02	3.30	18.60	6.52	3.44	7.97	1.44	14.56	3.73	3.94	5.92
11	105274 G 07-01	10.31	5.11	3.62	25.43	11.12	7.89	2.25	-0.90	5.26	3.63
12	105260 G 07-08	7.25	3.62	6.74	13.52	7.78	5.23	2.65	7.99	9.06	6.23
13	UW119 06-284	31.93	7.77	23.18	15.33	19.55	27.46	6.72	18.99	15.76	17.23
14	U1998-12-3-06-3	14.29	3.99	11.41	28.66	14.59	10.47	2.69	6.59	11.60	7.84
15	UW119 06-277	13.65	5.11	1.24	20.11	10.03	9.98	3.83	0.27	7.07	5.29
16	UW119 06-207	19.60	3.98	10.46	12.97	11.75	13.81	2.29	0.00	4.06	5.04
17	MUSG 0704-16	25.76	9.98	15.12	15.22	16.52	19.81	7.81	20.11	7.07	13.70
18	MUSG 0705-35	27.66	4.59	2.54	36.16	17.74	20.93	3.58	-1.33	7.51	7.67
19	UCOL 1806-4	7.93	2.62	0.94	9.26	5.19	4.63	1.73	-4.83	2.90	1.11
20	MUSG 0608-61	18.36	2.20	3.15	16.81	10.13	15.70	1.32	-3.67	3.28	4.16
21	108 196 G 07-06	2.26	1.53	10.65	3.49	4.48	2.09	1.21	6.78	3.43	3.38
22	105 143 G 07-04	9.86	6.16	12.14	6.12	8.57	7.45	5.94	6.56	15.39	8.84
23	UW119 06-79	20.61	10.83	28.19	30.33	22.49	17.71	10.16	21.81	16.67	16.59
24	MUSG 0606-07	8.53	3.50	17.83	9.06	9.73	5.72	1.81	9.96	2.75	5.06
25	UJONATH 06-23	14.90	7.13	20.98	4.60	11.90	12.97	5.68	14.90	8.88	10.61
26	UW119 06-175	23.51	14.65	35.73	29.85	25.94	20.57	10.14	19.75	15.94	16.60
27	UW119 06-140	26.93	5.32	19.56	21.45	18.32	22.66	3.99	14.68	13.40	13.68
28	UW119 06-198	16.67	2.70	19.67	8.98	12.01	13.08	2.13	9.25	7.25	7.93
29	UNWAMAZ 06-01	8.69	6.33	2.32	39.91	14.31	6.40	5.54	-1.92	2.54	3.14
30	UNASPOT5 06-02	11.64	5.07	10.40	53.55	20.17	7.16	3.82	7.65	5.43	6.02
31	MUSG 0608 33	12.08	2.62	11.30	7.14	8.29	6.64	1.81	0.65	3.30	3.10
32	UW119 06-80	18.96	8.45	20.43	18.41	16.56	11.43	6.60	18.58	7.61	11.06
33	UW119 06-204	9.12	0.48	11.52	38.99	15.03	7.31	0.20	9.30	5.61	5.61
34	UW119 06-289	33.54	13.12	35.80	3.84	21.58	29.18	10.02	22.10	3.81	16.28
35	UW119 06-322	12.24	5.27	4.02	7.54	7.27	9.06	4.22	2.75	3.48	4.88
36	Jonathan	7.97	6.04	18.88	17.75	12.66	4.59	4.75	5.68	4.35	4.84
37	LO323-1	9.70	5.65	23.58	31.19	17.53	6.60	4.10	16.20	11.59	9.62
38	Tacna-2	29.27	9.90	19.57	29.89	22.16	21.62	7.36	10.50	12.14	12.91
39	105 257-3	12.72	7.41	25.44	29.35	18.73	9.94	7.01	13.11	12.86	10.73
40	105 268-1	13.65	1.85	14.89	31.27	15.42	14.40	1.04	10.65	7.24	8.33
41	105369-4	24.35	9.98	40.76	18.44	23.38	20.57	8.45	30.07	8.69	16.95
42	Ejumula-9	11.88	4.27	17.65	49.82	20.91	8.41	4.26	13.19	14.86	10.18
43	Kakamega-7	17.47	14.73	23.52	22.79	19.63	12.64	12.48	17.75	9.42	13.07

G		Total Root Yield (ton/ha)					Commercial Root Yield (ton/ha)				
	Name	Umb	Cho	Gur	Ang	Mean	Umb	Cho	Gur	Ang	Mean
44	105413-4	18.36	6.52	23.01	9.71	14.40	13.33	4.87	13.69	9.27	10.29
45	MUSG 0619-16	16.26	7.94	10.26	16.89	12.84	12.40	6.58	5.63	1.92	6.63
46	MUSG0606-15	15.46	2.06	6.59	20.10	11.05	12.36	1.05	-2.15	4.35	3.90
47	Mafutha-1	18.80	3.82	18.59	28.01	17.31	15.22	2.42	13.66	6.34	9.41
48	W119-12	24.80	18.78	45.72	29.20	29.63	15.46	15.09	26.81	26.45	20.95
49	W119-15	32.57	13.45	31.78	30.57	27.09	22.99	11.36	20.53	29.35	21.06
50	Ejumula -25	28.99	18.19	6.56	21.56	18.83	25.32	16.18	4.71	23.37	17.40
51	MUSG 0616-18	24.72	9.78	23.33	23.04	20.22	21.51	7.89	17.39	7.97	13.69
52	MUSG 0608-22	27.30	6.76	34.24	11.27	19.89	22.14	6.00	31.52	13.05	18.18
53	MUSG 0609-47	16.31	6.40	13.70	16.45	13.22	9.50	5.23	8.37	8.52	7.91
54	MUSG 0610-39	12.20	6.00	11.95	5.69	8.96	8.86	5.01	8.48	5.61	6.99
55	MUSG 0603-12	25.08	3.74	17.47	18.62	16.23	21.50	3.83	5.72	8.33	9.85
56	MUSG 0602-19	30.23	3.31	34.49	19.45	21.87	22.94	2.90	22.86	8.34	14.26
57	MUSG 0613-23	23.95	6.60	15.26	17.14	15.74	20.25	5.72	10.94	3.08	10.00
58	MUSG 0613-18	14.89	2.66	8.44	15.69	10.42	9.98	2.21	5.76	6.89	6.21
59	Ejumula	6.53	1.28	18.05	33.73	14.90	4.63	2.02	12.54	8.69	6.97
60	Mayai	4.03	0.61	7.21	34.10	11.49	5.07	0.36	3.99	17.21	6.66
61	Huambachero	6.60	5.07	14.17	25.07	12.73	3.39	3.42	5.72	3.81	4.09
62	Wagabolige	0.00	0.73	-5.65	46.72	10.45	0.00	0.32	0.00	0.62	0.24
63	Gaba-Gaba	14.21	3.70	6.52	25.55	12.50	9.66	2.93	0.84	6.70	5.03
64	Local-2	10.18	4.36	3.12	24.09	10.44	8.30	2.92	-0.90	5.98	4.08
LSD5		12.32	6.16	10.57	14.64	-	11.49	5.20	0.00	8.53	-
MEAN		16.86	6.34	14.75	20.70	-	12.99	4.98	9.25	8.30	-

Table 24. Dry Matter (%) and Beta-carotene (mg/100g) content of 64 Genotypes (G) grown in Umbelúzi (Umb), Chókwè (Cho), Gurué (Gur), and Angónia (Ang), Multi-location trials of 64 Clones, October 2009 to March 2010

G		Dry Matter Content (%)					Beta-carotene (mg/100g of fresh root)				
	Name	Umb	Cho	Gur	Ang	Mean	Umb	Cho	Gur	Ang	Mean
1	W119 06-39	25.50	29.49	30.00	28.09	28.27	6.67	6.35	6.80	3.75	5.89
2	UXIPHONE 06-1	24.50	31.73	31.50	29.15	29.22	7.83	1.31	4.23	1.65	3.76
3	UW119 06-296	23.50	25.21	28.91	25.41	25.76	6.53	12.57	12.89	13.38	11.34
4	UW119 06-32	21.50	23.00	27.50	26.00	24.50	8.62	9.60	9.73	7.98	8.98
5	MUSG 0703-37	21.50	21.00	26.34	27.00	23.96	7.28	10.42	9.13	6.04	8.22
6	UW119 06 290	22.50	24.00	27.58	25.60	24.92	6.55	8.00	9.60	4.70	7.21
7	MUSG 0702-17	34.00	31.33	33.00	35.62	33.49	5.16	4.81	4.44	3.29	4.43
8	105 101 G 07-07	31.50	29.04	29.00	26.27	28.95	4.39	1.24			
9	105249 G 07-05	26.50	33.09	30.99	29.98	30.14	8.31	6.14	9.82	4.18	7.11
10	MUSG 0603-02	26.25	29.61	30.00	32.05	29.48	9.39	4.72	5.18	11.45	7.69
11	105274 G 07-01	32.00	34.50	34.50	31.50	33.13	2.76	2.31	0.85	2.52	2.11
12	105260 G 07-08	27.50	29.82	30.50	31.50	29.83	4.37	3.10	2.41	1.71	2.90
13	UW119 06-284	24.00	24.50	27.50	26.50	25.63	6.57	12.39	12.55	9.13	10.16
14	U1998-12-3-06-3	29.00	29.88	33.50	32.10	31.12	5.08	3.93	2.02	1.27	3.08
15	UW119 06-277	25.50	27.27	31.51	24.25	27.13	4.18	4.45	3.45	11.45	5.88
16	UW119 06-207	25.00	23.00	23.75	24.50	24.06	7.45	9.26	14.55	7.49	9.69
17	MUSG 0704-16	25.00	29.00	30.50	32.00	29.13	5.54	5.44	8.44	4.61	6.01
18	MUSG 0705-35	27.00	25.50	30.50	31.50	28.63	5.72	3.39	7.87	4.18	5.29
19	UCOL 1806-4	27.00	28.14	28.00	32.00	28.79	6.66	4.18	9.26	6.36	6.62
20	MUSG 0608-61	28.25	28.49	31.00	24.50	28.06	7.22	4.57	2.29	2.92	4.25
21	108 196 G 07-06	28.25	25.75	31.00	29.55	28.64	6.56	5.05	0.77	0.00	3.10
22	105 143 G 07-04	27.00	27.78	29.00	29.55	28.33	4.33	0.08	0.15	0.45	1.25
23	UW119 06-79	26.00	24.50	30.50	29.00	27.50	5.83	8.78	11.71	7.23	8.39
24	MUSG 0606-07	24.25	22.50	26.50	26.48	24.93	4.67	7.56	12.89	7.23	8.09
25	UJONATH 06-23	20.00	20.97	27.00	24.01	23.00	6.16	12.39	10.42	9.39	9.59
26	UW119 06-175	24.50	25.50	29.00	29.00	27.00	5.06	8.95	10.68	8.86	8.39
27	UW119 06-140	26.00	24.50	26.00	26.50	25.75	10.04	8.95	11.92	8.86	9.94
28	UW119 06-198	23.00	25.39	29.50	25.50	25.85	8.58	4.83	7.63	10.77	7.95
29	UNWAMAZ 06-01	29.00	30.66	34.43	26.94	30.26	8.89	4.80	4.99	4.18	5.72
30	UNASPOT 06-02	27.00	30.00	32.00	26.50	28.88	4.75	4.72	6.49	6.80	5.69
31	MUSG 0608 33	23.00	23.50	26.92	26.95	25.09	6.26	9.73	8.14	9.81	8.49
32	UW119 06-80	25.50	19.71	24.00	23.50	23.18	6.23	12.07	13.88	14.37	11.64
33	UW119 06-204	30.56	33.80	32.45	34.00	32.70	3.23	2.22	1.42	0.60	1.87
34	UW119 06-289	22.50	24.00	26.00	28.50	25.25	4.26	6.74	13.04	6.76	7.70
35	UW119 06-322	25.50	31.00	33.00	32.16	30.42	2.22	3.97	3.05	4.38	3.41
36	Jonathan	28.00	27.50	26.50	27.50	27.38	3.56	4.85	3.56	4.49	4.12
37	LO323-1	28.50	27.87	29.00	31.50	29.22	7.29	4.49	5.66	4.92	5.59
38	Tacna-2	27.00	29.00	31.00	30.29	29.32	7.03	4.19	6.51	3.49	5.31
39	105 257-3	28.50	29.75	32.00	33.00	30.81	0.71	3.03	4.52	1.28	2.39
40	105 268-1	34.00	28.52	35.00	29.50	31.76	10.35	1.38	3.80	0.93	4.12
41	105369-4	30.50	31.50	35.50	33.84	32.84	6.94	4.63	4.49	6.08	5.54
42	Ejumula-9	29.00	26.90	29.50	32.27	29.42	7.70	7.00	6.17	3.82	6.17
43	Kakamega-7	25.00	28.50	30.00	31.62	28.78	4.88	4.88	6.79	7.67	6.06

G		Dry Matter Content (%)					Beta-carotene (mg/100g of fresh root)				
	Name	Umb	Cho	Gur	Ang	Mean	Umb	Cho	Gur	Ang	Mean
44	105413-4	31.00	28.64	32.00	32.67	31.08	4.13	0.22	5.46	0.83	2.66
45	MUSG 0619-16	25.00	30.27	28.50	31.34	28.78	6.35	0.02	11.86	10.77	7.25
46	MUSG0606-15	26.50	26.50	30.00	30.50	28.38	7.34	7.18	6.67	6.11	6.83
47	Mafutha-1	31.00	30.56	33.50	33.45	32.13	5.43	5.13	4.74	4.70	5.00
48	W119-12	20.50	19.65	23.00	20.50	20.91	5.51	5.26	7.09	4.70	5.64
49	W119-15	21.00	23.50	24.50	25.25	23.56	5.26	4.69	6.80	6.08	5.71
50	Ejumula -25	26.00	23.00	30.00	28.00	26.75	8.06	6.18	5.22	4.57	6.01
51	MUSG 0616-18	25.00	21.75	28.51	31.50	26.69	6.19	7.82	13.88	13.38	10.32
52	MUSG 0608-22	24.50	25.00	27.00	28.00	26.13	6.20	5.05	8.05	6.08	6.35
53	MUSG 0609-47	23.00	24.00	26.00	26.50	24.88	8.03	8.34	13.04	12.39	10.45
54	MUSG 0610-39	22.50	21.56	26.50	27.00	24.39	4.91	7.74	10.29	10.77	8.43
55	MUSG 0603-12	27.00	25.79	31.00	28.94	28.18	9.26	4.43	6.58	6.36	6.66
56	MUSG 0602-19	24.00	22.00	24.50	25.50	24.00	6.79	4.83	8.06	4.34	6.01
57	MUSG 0613-23	26.50	31.50	35.50	31.60	31.28	7.09	1.25	0.52	-0.30	2.14
58	MUSG 0613-18	29.50	27.00	28.50	25.50	27.63	5.40	4.90	9.66	7.23	6.80
59	Ejumula	31.50	33.32	35.00	34.27	33.52	7.60	1.85	6.92	5.13	5.38
60	Mayai	27.75	20.75	32.50	34.00	28.75	4.57	4.78	5.86	3.98	4.80
61	Huambachero	30.00	28.88	32.00	32.01	30.72	3.13	1.21	4.34	3.11	2.95
62	Wagabolige	0.00	25.82	35.51	33.83	31.71	5.57	1.33	-0.10	0.03	1.71
63	Gaba-Gaba	26.50	28.00	25.25	29.50	27.31	4.21	4.49	7.96	9.13	6.45
64	Local-2	25.96	20.04	34.76	33.50	28.57	7.20	10.50	0.03	0.45	4.55
LSD5		4.48	4.05	3.90	3.76	-	5.57	2.79	2.93	2.03	-
MEAN		26.43	26.78	29.78	29.17	-	6.09	5.48	6.94	5.81	-

Vine yield

The average vine yield of all 64 clones over the 4 locations in trial was 19.01 ton/ha. The best clones in terms of vine production were genotypes 7 (MUSG 0702-17) with 44.02 ton/ha, 29 (UNWAMAZ 06-01) with 34.55 ton/ha, 42 (Ejumula-9) with 43.33 ton/ha, 33 (UW119 06-204) with 31.88, and 35 (UW119 06-322) with 31.45. The clones that did not perform well in terms of vine production were 24 (MUSG 0606-07) with 5.02 ton/ha, 28 (UW119 06-198) with 6.63 ton/ha, and 25 (UJONATH 06-23) with 6.75 ton/ha (Tables 25 and 32).

Vine vigor

The average vine vigor of all 64 clones over the 4 tested locations was 5.26 points in the scale of 1 to 9 (1- Not vigorous; 5-Moderate; 9-Very vigorous). So in general, most of the genotypes in the trial tended to have average or moderate vine vigor. The best clones in terms of vine vigor were 42 (Ejumula-9) with 6.63 points, 29 (UNWAMAZ 06-01) with 6.63 points, and 33 (UW119 06-204) with 6.56 points. The clones that presented very low levels of vine vigor were 2 (UXIPHONE 06-1) with 3.91 points, 25 (UJONATH 06-23) with 4.25 points, and 22 (105 143 G 07-04) with 4.29 points (Tables 25 and 32).

Table 25. Vine Yield (ton/ha) and Vigor (scale 1-9) of 64 Genotypes (G) grown in Umbelúzi (Umb), Chókwè (Cho), Gurué (Gur), and Angónia (Ang), Multi-location trials of 64 Clones, October 2009 to March 2010

G		*Vine Yield (ton/ha)*					*Vigor (Scale 1-weak; 9-very vigorous)*				
	Name	Umb	Cho	Gur	Ang	Mean	Umb	Cho	Gur	Ang	Mean
1	W119 06-39	43.88	7.33	28.01	7.32	21.64	5.50	6.25	5.50	2.75	5.00
2	UXIPHONE 06-1	6.38	20.11	2.39	2.52	7.85	4.75	5.50	2.75	2.62	3.91
3	UW119 06-296	14.25	13.68	4.60	17.68	12.55	6.25	6.25	2.75	2.25	4.38
4	UW119 06-32	27.05	13.09	35.98	16.31	23.11	6.25	7.50	5.25	2.75	5.44
5	MUSG 0703-37	20.13	15.70	1.89	7.10	11.21	4.75	6.25	3.25	4.50	4.69
6	UW119 06 290	11.88	11.03	22.46	15.55	15.23	4.00	7.00	4.75	3.50	4.81
7	MUSG 0702-17	49.92	33.42	40.29	52.43	44.02	6.50	7.25	5.75	4.00	5.88
8	105 101 G 07-07	12.07	17.69	10.14	4.13	11.01	6.00	7.00	4.25	4.00	5.31
9	105249 G 07-05	30.19	10.14	10.00	18.33	17.17	6.25	6.25	4.00	4.25	5.19
10	MUSG 0603-02	2.38	15.79	10.83	3.44	8.11	4.00	7.75	4.00	1.62	4.34
11	105274 G 07-01	19.73	22.14	17.68	25.43	21.25	6.00	7.50	4.75	5.25	5.88
12	105260 G 07-08	13.69	7.24	28.95	13.52	15.85	6.00	6.25	6.75	5.50	6.13
13	UW119 06-284	16.91	16.91	15.14	15.33	16.07	5.00	7.25	4.50	3.75	5.13
14	U1998-12-3-06-3	16.91	17.39	7.87	28.66	17.71	4.75	8.00	4.75	4.00	5.38
15	UW119 06-277	20.53	12.08	1.81	20.11	13.63	5.00	6.25	3.00	3.00	4.31
16	UW119 06-207	24.96	16.10	0.24	12.97	13.57	5.25	6.75	1.87	3.50	4.34
17	MUSG 0704-16	16.59	8.45	21.26	15.22	15.38	5.75	7.75	5.25	3.25	5.50
18	MUSG 0705-35	27.98	15.30	2.68	36.16	20.53	5.00	8.25	3.00	4.00	5.06
19	UCOL 1806-4	10.87	12.80	0.04	9.26	8.24	6.75	7.50	2.58	2.50	4.83
20	MUSG 0608-61	22.87	13.45	18.26	16.81	17.85	6.25	6.75	4.25	3.25	5.13
21	108 196 G 07-06	12.68	12.88	16.27	3.49	11.33	5.75	5.75	4.50	1.62	4.41
22	105 143 G 07-04	5.72	14.49	8.23	6.12	8.64	4.50	6.00	3.50	3.14	4.29
23	UW119 06-79	13.00	16.10	32.39	30.33	22.96	5.25	7.75	5.50	3.25	5.44
24	MUSG 0606-07	2.50	2.42	6.09	9.06	5.02	6.75	5.50	3.75	1.75	4.44
25	UJONATH 06-23	4.47	12.80	5.11	4.60	6.75	4.75	7.00	3.50	1.75	4.25
26	UW119 06-175	9.74	16.91	20.83	29.85	19.33	6.50	7.50	5.00	3.25	5.56
27	UW119 06-140	16.91	16.50	11.20	21.45	16.52	7.00	7.00	4.00	2.75	5.19
28	UW119 06-198	3.54	7.65	6.34	8.98	6.63	4.00	6.25	4.25	3.00	4.38
29	UNWAMAZ 06-01	32.77	22.78	42.75	39.91	34.55	8.50	8.00	5.25	4.75	6.63
30	UNASPOT5 06-02	21.90	16.91	27.90	53.55	30.07	6.00	7.50	5.25	5.00	5.94
31	MUSG 0608 33	5.96	9.50	44.93	7.14	16.88	5.50	5.50	6.25	2.25	4.88
32	UW119 06-80	6.92	16.10	20.87	18.41	15.58	4.00	7.00	4.50	2.00	4.38
33	UW119 06-204	21.22	16.02	51.27	38.99	31.88	7.25	8.00	6.50	4.50	6.56
34	UW119 06-289	12.88	16.91	25.94	3.84	14.89	6.50	8.00	5.25	3.25	5.75
35	UW119 06-322	36.63	24.16	57.47	7.54	31.45	6.25	8.75	6.25	2.36	5.90
36	Jonathan	7.89	10.91	15.18	17.75	12.93	4.00	6.25	4.25	3.75	4.56
37	LO323-1	10.95	16.50	26.08	31.19	21.18	6.50	7.25	5.00	4.00	5.69
38	Tacna-2	19.72	18.92	33.04	29.89	25.39	5.00	7.25	6.25	4.25	5.69
39	105 257-3	9.98	10.06	26.63	29.35	19.01	4.25	7.25	6.50	6.75	6.19
40	105 268-1	19.89	22.78	30.29	31.27	26.06	5.75	7.00	5.75	4.75	5.81
41	105369-4	17.63	15.30	41.30	18.44	23.17	5.75	8.50	5.75	3.00	5.75
42	Ejumula-9	27.38	17.31	42.79	49.82	34.33	6.00	8.25	6.50	5.75	6.63
43	Kakamega-7	16.91	19.00	22.57	22.79	20.32	6.50	8.00	4.75	4.25	5.88

G		Vine Yield (ton/ha)					Vigor (Scale 1-weak; 9-very vigorous)				
	Name	Umb	Cho	Gur	Ang	Mean	Umb	Cho	Gur	Ang	Mean
44	105413-4	8.33	18.92	87.43	9.71	31.10	5.75	7.75	6.00	3.50	5.75
45	MUSG 0619-16	22.95	12.16	22.65	16.89	18.66	6.00	5.50	5.25	2.50	4.81
46	MUSG0606-15	17.71	10.55	32.46	20.10	20.21	5.00	6.75	4.75	2.50	4.75
47	Mafutha-1	25.81	17.15	53.15	28.01	31.03	6.50	8.25	6.25	4.75	6.44
48	W119-12	4.18	9.26	18.77	29.20	15.35	5.75	8.25	5.00	3.00	5.50
49	W119-15	18.72	23.95	22.64	30.57	23.97	5.75	7.75	4.75	3.00	5.31
50	Ejumula -25	14.29	22.63	9.28	21.56	16.94	6.25	8.00	4.00	3.50	5.44
51	MUSG 0616-18	16.99	16.50	11.92	23.04	17.11	5.50	6.50	4.75	3.50	5.06
52	MUSG 0608-22	18.92	17.31	17.72	11.27	16.31	5.50	7.75	4.75	2.75	5.19
53	MUSG 0609-47	15.30	16.50	12.97	16.45	15.31	5.75	7.00	4.25	4.00	5.25
54	MUSG 0610-39	6.04	14.89	5.04	5.69	7.92	6.50	5.75	4.00	3.00	4.81
55	MUSG 0603-12	22.30	6.76	27.03	18.62	18.68	5.00	6.75	5.50	3.25	5.13
56	MUSG 0602-19	26.17	14.89	23.91	19.45	21.11	5.25	7.75	4.75	2.75	5.13
57	MUSG 0613-23	20.21	17.31	27.36	17.14	20.51	4.75	7.50	5.00	3.00	5.06
58	MUSG 0613-18	14.49	18.11	19.49	15.69	16.95	6.00	5.25	4.75	3.00	4.75
59	Ejumula	15.70	8.86	48.91	33.73	26.80	7.00	5.50	5.75	3.75	5.50
60	Mayai	14.61	12.05	41.34	34.10	25.53	7.50	5.00	5.75	3.75	5.50
61	Huambachero	5.51	20.53	16.52	25.07	16.91	6.50	6.25	5.00	5.50	5.81
62	Wagabolige	10.63	15.26	25.36	46.72	24.49	3.25	5.25	5.00	4.25	4.44
63	Gaba-Gaba	18.11	17.07	28.08	25.55	22.20	6.75	6.50	6.25	6.25	6.44
64	Local-2	7.77	17.40	42.28	24.09	22.89	4.50	7.50	6.00	5.25	5.81
LSD5		13.90	13.24	18.47	14.64	-	2.43	1.81	1.23	1.58	-
MEAN		16.74	15.32	23.29	20.70	-	5.67	6.98	4.82	3.56	-

Virus symptoms

In general, the level of virus symptoms in the trial was insignificant. The average level of virus attack in the trial was 1.59 on the scale 1 to 9 (1, without symptoms; 5, Moderate; 9, extremely severe). However, 31 (MUSG 0608 33) had 6.5 in Angónia (Table 26). Overall, the worst clones were 50 (Ejumula-25) with 3.25, and 31 (MUSG 0608 33) with 2.75 points (Tables 26 and 32).

Weevil attack

As with the virus, the level of weevil attack was in general negligible. The average level of weevil presence in the trial was 4.06 on the scale 1-5, where 1 is severe attack and 5 is without any weevil symptoms. The worst clones in the trial were 28 (UW119 06-198) and 39 (105 257-3) both with 3.3 (Tables 26 and 32).

Table 26. Virus (Scale 1-9) and Weevil (scale 1-5) of 64 Genotypes (G) grown in Umbelúzi (Umb), Chókwè (Cho), Gurué (Gur), and Angónia (Ang), Multi-location trials of 64 Clones, October2009 to March 2010

G		*Virus (1- none; 9-severe)*					*Weevil (1-severe; 5-none)*				
	Name	Umb	Cho	Gur	Ang	Mean	Umb	Cho	Gur	Ang	Mean
1	W119 06-39	1.00	1.00	1.50	1.75	1.31	4.25	4.43	3.50	5	4.30
2	UXIPHONE 06-1	1.00	1.00	1.50	1.32	1.21	3.75	2.67	4.25	5	3.92
3	UW119 06-296	1.50	2.00	1.75	3.25	2.13	4.50	3.75	4.50	5	4.44
4	UW119 06-32	1.00	1.00	2.00	4.75	2.19	4.00	5.00	2.25	5	4.06
5	MUSG 0703-37	1.25	1.50	1.75	1.75	1.56	4.00	2.25	4.75	5	4.00
6	UW119 06 290	1.00	1.00	1.75	3.00	1.69	4.50	3.50	2.00	5	3.75
7	MUSG 0702-17	1.00	1.25	1.00	1.75	1.25	4.25	4.25	4.00	5	4.38
8	105 101 G 07-07	1.00	1.00	1.50	1.50	1.25	4.25	4.01	4.00	5	4.32
9	105249 G 07-05	1.50	1.00	1.25	1.00	1.19	4.50	3.50	4.75	5	4.44
10	MUSG 0603-02	1.00	1.25	1.00	2.99	1.56	4.50	3.64	4.00	5	4.29
11	105274 G 07-01	1.25	1.00	1.75	2.75	1.69	4.00	4.50	4.25	5	4.44
12	105260 G 07-08	1.25	1.00	1.50	1.75	1.38	4.35	3.50	4.50	5	4.34
13	UW119 06-284	1.25	1.50	1.50	1.25	1.38	3.75	5.00	3.25	5	4.25
14	U1998-12-3-06-3	1.50	1.00	1.50	1.25	1.31	3.50	4.50	4.75	5	4.44
15	UW119 06-277	1.00	1.50	1.25	2.25	1.50	4.50	3.25	4.27	5	4.26
16	UW119 06-207	1.00	1.00	1.52	1.75	1.32	3.75	4.00	5.18	5	4.48
17	MUSG 0704-16	1.00	1.00	2.25	1.50	1.44	4.25	4.50	4.00	5	4.44
18	MUSG 0705-35	1.00	1.50	1.25	1.75	1.38	4.25	3.50	4.50	5	4.31
19	UCOL 1806-4	1.00	1.25	1.37	3.75	1.84	4.25	4.75	4.25	5	4.56
20	MUSG 0608-61	1.00	1.25	1.25	1.25	1.19	4.75	4.10	3.25	5	4.28
21	108 196 G 07-06	1.00	1.25	2.00	1.32	1.39	4.50	4.00	3.25	5	4.19
22	105 143 G 07-04	1.75	1.25	2.00	1.27	1.57	4.50	3.50	3.50	5	4.13
23	UW119 06-79	1.00	1.00	1.50	2.50	1.50	4.25	3.00	2.00	5	3.56
24	MUSG 0606-07	1.50	1.00	1.75	2.75	1.75	4.25	3.50	1.50	5	3.56
25	UJONATH 06-23	1.00	1.25	1.50	3.25	1.75	4.75	3.00	2.25	5	3.75
26	UW119 06-175	1.00	1.25	1.25	2.50	1.50	4.50	3.75	2.50	5	3.94
27	UW119 06-140	1.00	1.00	2.75	2.75	1.88	4.50	4.50	1.75	5	3.94
28	UW119 06-198	1.00	1.00	3.00	1.50	1.63	3.68	3.25	1.25	5	3.30
29	UNWAMAZ 06-01	1.00	1.25	1.75	1.00	1.25	4.50	4.85	4.75	5	4.78
30	UNASPOT 06-02	1.25	1.50	1.50	1.75	1.50	4.50	4.00	3.00	5	4.13
31	MUSG 0608 33	1.00	2.25	1.25	6.50	2.75	4.00	3.50	2.00	5	3.63
32	UW119 06-80	1.00	1.00	2.00	4.00	2.00	4.07	3.75	2.00	5	3.71
33	UW119 06-204	1.75	1.00	1.75	1.75	1.56	4.75	3.43	4.50	5	4.42
34	UW119 06-289	1.00	1.00	2.50	3.00	1.88	4.25	4.00	1.50	5	3.69
35	UW119 06-322	1.00	1.00	1.75	1.95	1.43	4.25	4.75	3.00	5	4.25
36	Jonathan	1.00	1.00	2.25	2.50	1.69	4.00	4.00	1.50	5	3.63
37	LO323-1	1.25	1.25	2.50	2.00	1.75	3.75	4.30	1.75	5	3.70
38	Tacna-2	1.00	1.00	1.25	2.25	1.38	4.00	4.75	1.75	5	3.88
39	105 257-3	1.25	1.25	2.75	2.25	1.88	4.07	2.75	1.50	5	3.33
40	105 268-1	1.25	1.00	1.50	1.75	1.38	4.35	3.50	2.25	5	3.78
41	105369-4	1.00	1.00	1.25	1.25	1.13	4.50	4.75	2.50	5	4.19
42	Ejumula-9	1.25	1.00	2.00	1.00	1.31	4.25	4.50	3.00	5	4.19
43	Kakamega-7	1.75	1.00	1.50	1.25	1.38	4.00	4.50	3.50	5	4.25

G	Virus (1- none; 9-severe)						Weevil (1-severe; 5-none)				
	Name	Umb	Cho	Gur	Ang	Mean	Umb	Cho	Gur	Ang	Mean
44	105413-4	1.50	1.00	2.00	1.00	1.38	4.50	3.75	3.50	5	4.19
45	MUSG 0619-16	1.00	1.00	1.75	1.50	1.31	4.00	5.10	3.25	5	4.34
46	MUSG0606-15	1.25	1.00	1.00	1.00	1.06	4.50	3.75	1.75	5	3.75
47	Mafutha-1	2.00	1.00	2.00	3.50	2.13	4.00	4.75	3.00	5	4.19
48	W119-12	1.25	1.00	2.00	2.50	1.69	4.25	4.00	1.25	5	3.63
49	W119-15	1.00	1.25	2.00	2.00	1.56	4.00	3.75	1.50	5	3.56
50	Ejumula -25	6.00	1.50	1.50	4.00	3.25	4.50	4.50	3.75	5	4.44
51	MUSG 0616-18	1.50	1.50	2.00	2.25	1.81	4.50	3.50	3.50	5	4.13
52	MUSG 0608-22	1.00	1.50	2.25	4.25	2.25	4.50	3.75	2.50	5	3.94
53	MUSG 0609-47	1.00	1.25	2.00	2.50	1.69	4.50	4.00	4.25	5	4.44
54	MUSG 0610-39	1.75	1.00	1.75	2.75	1.81	4.25	3.25	3.00	5	3.88
55	MUSG 0603-12	1.00	1.50	1.50	2.00	1.50	4.00	3.75	1.50	5	3.56
56	MUSG 0602-19	1.00	1.50	1.75	4.00	2.06	4.00	3.50	1.50	5	3.50
57	MUSG 0613-23	1.00	1.25	1.50	1.75	1.38	4.00	4.50	2.50	5	4.00
58	MUSG 0613-18	1.25	1.50	1.75	2.50	1.75	4.00	4.75	3.00	5	4.19
59	Ejumula	1.00	1.00	1.75	1.75	1.38	4.25	3.76	2.25	5	3.82
60	Mayai	1.00	1.75	1.50	1.50	1.44	4.25	4.00	3.25	5	4.13
61	Huambachero	1.00	1.00	1.50	1.25	1.19	4.00	3.50	1.25	5	3.44
62	Wagabolige	1.50	1.00	1.50	1.50	1.38	4.24	4.50	4.78	5	4.63
63	Gaba-Gaba	1.25	1.50	1.25	1.75	1.44	4.50	3.50	3.75	5	4.19
64	Local-2	1.00	1.00	2.00	1.50	1.38	3.75	4.30	3.25	5	4.08
LSD5		1.92	0.78	0.98	1.90	-	0.92	1.63	1.17	0	-
MEAN		1.25	1.20	1.71	2.20	-	4.23	3.95	3.05	5	-

Palatability (taste)

In general, majority of the clones had good performance in terms of taste. The average taste in the trial across locations was 3.7 on the scale 1 to 5 (1, Very bad; 2, Bad; 3, Average; 4, Good; 5, Excellent). The clones with poor performance were 24 (MUSG 0606-07), 48 (W119-12) and 54 (MUSG 0610-39), all with 3.13 for the taste (Table 27 and 32). These results are in agreement with dry matter content, as for example, the clone 48 was considered one of the poorest in terms of dry matter content and happened to be one with the poorest taste.

Table 27. Percentage of Vine Survived and results from the palatability test (1-5) of 64 Genotypes (G) grown in Umbelúzi (Umb), Chókwè (Cho), Gurué (Gur), and Angónia (Ang), Multi-location trials of 64 Clones, October 2009 to March 2010

G		*Percentage of Vine Survived*					*Taste (1-very bad; 5-excellent)*				
	Name	Umb	Cho	Gur	Ang	Mean	Umb	Cho	Gur	Ang	Mean
1	W119 06-39	71.74	77.17	71.74	57.00	69.41	3.75	3.36	4.50	2.50	3.53
2	UXIPHONE 06-1	50.00	65.94	85.87	22.02	55.96	3.75	3.71	4.25	3.00	3.68
3	UW119 06-296	82.61	71.74	73.91	39.00	66.82	4.00	4.25	4.50	3.00	3.94
4	UW119 06-32	68.48	70.65	82.61	78.00	74.94	3.75	3.00	4.25	2.50	3.38
5	MUSG 0703-37	68.48	67.40	51.09	62.00	62.24	3.75	4.00	4.25	2.50	3.63
6	UW119 06 290	57.61	69.57	70.65	54.00	62.96	3.75	3.50	4.00	3.00	3.56
7	MUSG 0702-17	75.00	81.52	69.57	71.00	74.27	3.75	4.25	4.75	4.50	4.31
8	105 101 G 07-07	66.31	83.33	81.52	38.91	67.52	3.50	3.71	5.00	2.50	3.68
9	105249 G 07-05	77.18	57.61	60.87	69.00	66.17	4.00	3.50	4.50	3.00	3.75
10	MUSG 0603-02	39.13	83.52	86.96	21.20	57.70	3.25	3.93	5.00	2.50	3.67
11	105274 G 07-01	68.48	60.87	69.57	64.00	65.73	4.00	2.75	4.75	3.00	3.63
12	105260 G 07-08	67.39	49.35	88.04	58.00	65.70	3.32	4.25	5.00	2.00	3.64
13	UW119 06-284	75.00	73.92	81.52	68.00	74.61	3.75	4.00	4.75	2.00	3.63
14	U1998-12-3-06-3	61.96	75.00	79.35	72.00	72.08	3.50	4.50	5.00	3.00	4.00
15	UW119 06-277	59.78	50.00	78.26	70.00	64.51	4.00	4.00	5.00	2.00	3.75
16	UW119 06-207	76.08	68.48	10.55	53.00	52.03	4.25	4.00	4.07	2.50	3.71
17	MUSG 0704-16	85.87	86.05	92.39	56.00	80.08	3.50	4.00	4.75	3.50	3.94
18	MUSG 0705-35	80.43	56.52	39.13	74.00	62.52	3.50	4.25	4.00	4.00	3.94
19	UCOL 1806-4	70.65	55.44	10.78	59.00	48.97	4.00	3.50	4.75	2.50	3.69
20	MUSG 0608-61	67.39	66.31	78.26	54.00	66.49	3.50	3.69	4.25	2.50	3.49
21	108 196 G 07-06	38.05	43.81	81.52	26.91	47.57	4.25	4.50	5.00	3.50	4.31
22	105 143 G 07-04	52.17	36.96	88.04	43.20	55.09	4.75	3.50	5.00	3.00	4.06
23	UW119 06-79	57.61	72.83	83.69	69.00	70.78	4.25	3.75	4.00	2.50	3.63
24	MUSG 0606-07	58.69	65.22	81.52	43.00	62.11	3.00	3.50	3.50	2.50	3.13
25	UJONATH 06-23	57.61	69.57	69.56	49.00	61.44	3.25	3.50	3.75	2.50	3.25
26	UW119 06-175	57.61	76.09	96.74	72.00	75.61	3.50	4.00	4.00	2.00	3.38
27	UW119 06-140	75.00	60.87	80.43	63.00	69.83	3.50	4.25	4.25	3.00	3.75
28	UW119 06-198	61.96	57.61	91.30	57.00	66.97	3.67	4.25	4.25	2.50	3.67
29	UNWAMAZ 06-01	70.65	51.09	82.61	76.00	70.09	3.25	3.90	4.25	2.50	3.48
30	UNASPOT5 06-02	69.57	84.78	92.39	73.00	79.94	3.50	4.00	5.00	2.00	3.63
31	MUSG 0608 33	59.78	58.69	86.96	52.00	64.36	4.00	4.00	4.25	2.00	3.56
32	UW119 06-80	70.65	73.92	70.65	56.00	67.81	4.25	4.00	4.00	1.50	3.44
33	UW119 06-204	53.26	64.13	88.04	66.00	67.86	4.00	3.36	5.00	3.50	3.97
34	UW119 06-289	79.35	73.92	93.48	50.00	74.19	3.50	4.00	3.75	2.50	3.44
35	UW119 06-322	68.48	78.26	91.30	39.22	69.32	3.75	3.75	5.00	2.09	3.65
36	Jonathan	43.47	66.31	83.70	72.00	66.37	3.25	4.25	4.25	2.00	3.44
37	LO323-1	48.91	60.87	94.56	72.00	69.09	4.75	3.93	5.00	2.50	4.05
38	Tacna-2	72.83	58.70	90.22	67.00	72.19	3.00	3.50	4.50	2.50	3.38
39	105 257-3	50.00	54.35	86.96	73.00	66.08	4.00	4.25	4.75	2.00	3.75
40	105 268-1	58.70	58.69	92.39	66.00	68.95	3.32	3.50	5.00	4.50	4.08
41	105369-4	78.26	66.30	93.48	57.00	73.76	3.00	3.50	4.75	2.50	3.44
42	Ejumula-9	69.57	64.13	95.65	70.00	74.84	3.50	3.75	5.00	3.00	3.81
43	Kakamega-7	76.09	73.91	76.09	65.00	72.77	4.00	3.25	4.75	3.00	3.75

G		Percentage of Vine Survived					Taste (1-very bad; 5-excellent)				
	Name	Umb	Cho	Gur	Ang	Mean	Umb	Cho	Gur	Ang	Mean
44	105413-4	68.48	58.10	90.22	51.00	66.95	3.75	4.25	5.00	3.00	4.00
45	MUSG 0619-16	64.13	48.91	93.48	62.00	67.13	3.25	3.69	4.75	2.00	3.42
46	MUSG0606-15	84.78	78.26	85.87	83.00	82.98	4.25	3.75	4.75	2.50	3.81
47	Mafutha-1	75.00	58.69	91.30	62.00	71.75	4.00	3.50	5.00	4.00	4.13
48	W119-12	67.39	92.39	91.31	69.00	80.02	3.75	4.25	3.00	1.50	3.13
49	W119-15	70.65	76.08	86.96	68.00	75.42	3.50	4.00	3.75	2.50	3.44
50	Ejumula -25	63.04	84.78	64.13	74.00	71.49	4.00	4.00	4.50	2.00	3.63
51	MUSG 0616-18	79.35	71.74	80.43	61.00	73.13	3.75	4.00	4.50	3.00	3.81
52	MUSG 0608-22	72.83	80.43	88.04	67.00	77.08	4.00	4.00	4.25	2.50	3.69
53	MUSG 0609-47	82.61	63.04	78.26	64.00	71.98	4.00	3.50	4.25	2.50	3.56
54	MUSG 0610-39	54.35	64.13	68.48	55.00	60.49	3.75	3.75	4.00	1.00	3.13
55	MUSG 0603-12	60.87	45.65	63.04	66.00	58.89	3.75	3.75	4.00	2.50	3.50
56	MUSG 0602-19	67.39	61.96	91.31	70.00	72.67	3.75	4.25	3.75	2.50	3.56
57	MUSG 0613-23	61.96	70.65	76.09	56.00	66.18	3.25	4.00	4.75	3.00	3.75
58	MUSG 0613-18	58.69	48.91	77.17	60.00	61.19	3.50	4.25	4.50	2.00	3.56
59	Ejumula	58.69	73.11	96.74	69.00	74.39	3.50	3.36	4.75	4.50	4.03
60	Mayai	56.52	35.58	94.56	75.00	65.42	4.25	4.00	4.75	4.50	4.38
61	Huambachero	66.30	52.17	91.31	65.00	68.70	3.75	4.25	4.75	2.00	3.69
62	Wagabolige	30.43	48.91	94.57	66.00	59.98	4.00	4.25	5.03	3.00	4.07
63	Gaba-Gaba	56.52	44.56	82.61	55.00	59.67	3.75	4.50	5.00	3.00	4.06
64	Local-2	48.91	70.65	91.30	54.00	66.22	4.00	3.93	5.00	3.00	3.98
LSD5		21.27	27.38	16.67	17.35	-	0.89	0.75	0.76	0.94	-
MEAN		64.79	65.16	80.17	60.46	-	3.74	3.87	4.51	2.69	-

Selection of the best genotypes by using simultaneously all variables

The best clones in the trial were selected taking into account all collected attributes/traits. The first screen was done by the method of ranking each variable using the mean and LSD statistics to eliminate the clone with low performance for the trait under evaluation. In the elimination root total yield was the first attribute to be considered, and this was done for each location, then for all the locations combined/pooled. As criteria, all clones with root yield over 10 ton/ha were selected or taken to next stage of screen, which was considering the mean and LSD of the dry matter content. After eliminating the clones with low dry matter then the next elimination took into account the average and LSD of the beta-carotene content, taste, vine vigor, vine yield, percentage of vine survived, symptoms of virus and weevil The elimination method was combined with the index selection, where all the variables were attributed weights according to their influence (variance) in the data set, and their importance by sweetpotato consumers.

Accordingly, the best clones for each of the 4 locations are presented in Tables 28-31. For Umbelúzi 19 clones were selected, 10 of them matching for both ranking and index selection (Table 28). For Chókwè, 16 clones were selected, 11 of them appearing in the two methods (Table 29). For Gurué, 20 clones were selected as best, 11 of them coinciding in the two methods of selection (Table 30). For Angónia 14 clones were selected, 6 of them selected in both ranking and index methods (Table 31). All clones selected from the ranking and index selection and that performed well in more than one environment were taken for GxE and cluster analysis. In total there were 23 clones (Table 32) selected for more than one of the 4 environment.

Table 28. List of Clones that Showed Simultaneous Good Root Yield, Acceptable Levels of Dry Matter, Beta-carotene, Vine Vigor, Vine Yield, Percentage of Survived Plants, Tolerance to Virus, Weevil Attack, and Taste, Using both Ranking and Index Selection, *UMBELÚZI*, Multi-location Trial of 64 clones, 2009/10 Cropping Season

G	Name	UMBELÚZI														
		PBROT	SHI	Vir1	Vir2	VV1	RYCHa	RYTHa	RVY	Bioma	DM	BC	COOT1	WED1	DAMR	INDEX
1	W119 06-39	100.00	71.74	1.00	1.00	5.50	14.77	18.24	43.88	62.12	25.50	6.67	3.75	4.25	4.00	15.66
4	UW119 06-32	100.00	68.48	1.00	1.00	6.25	17.71	24.96	27.05	52.01	21.50	8.62	3.75	4.00	3.75	14.97
7	MUSG 0702-17	100.00	75.00	1.50	1.00	6.50	10.87	12.52	49.92	62.44	34.00	5.16	3.75	4.25	4.00	16.61
9	105249 G 07-05	100.00	77.18	1.00	1.50	6.25	13.53	20.85	30.19	51.05	26.50	8.31	4.00	4.50	4.75	15.48
13	UW119 06-284	100.00	75.00	1.50	1.25	5.00	27.46	31.93	16.91	48.83	24.00	6.57	3.75	3.75	4.00	15.31
18	MUSG 0705-35	100.00	80.43	1.25	1.00	5.00	20.93	27.66	27.98	55.63	27.00	5.72	3.50	4.25	3.75	15.98
27	UW119 06-140	98.91	75.00	1.00	1.00	7.00	22.66	26.93	16.91	43.84	26.00	10.04	3.50	4.50	4.00	15.07
30	UNASPOT 06-02	100.00	69.57	1.50	1.25	6.00	7.16	11.64	21.90	33.53	27.00	4.75	3.50	4.50	4.25	12.10
38	Tacna-2	100.00	72.83	1.50	1.00	5.00	21.62	29.27	19.72	48.99	27.00	7.03	3.00	4.00	4.00	15.68
40	105 268-1	100.00	58.70	1.00	1.25	5.75	14.40	13.65	19.89	33.53	34.00	10.35	3.32	4.35	4.03	15.94
41	105369-4	100.00	78.26	1.00	1.00	5.75	20.57	24.35	17.63	41.99	30.50	6.94	3.00	4.50	4.00	15.27
43	Kakamega-7	100.00	76.09	1.50	1.75	6.50	12.64	17.47	16.91	34.38	25.00	4.88	4.00	4.00	4.25	12.50
47	Mafutha-1	100.00	75.00	2.00	2.00	6.50	15.22	18.80	25.81	44.60	31.00	5.43	4.00	4.00	3.75	14.98
49	W119-15	98.91	70.65	1.25	1.00	5.75	22.99	32.57	18.72	51.29	21.00	5.26	3.50	4.00	3.50	14.81
50	Ejumula -25	100.00	63.04	1.00	6.00	6.25	25.32	28.99	14.29	43.28	26.00	8.06	4.00	4.50	4.25	15.59
51	MUSG 0616-18	100.00	79.35	2.00	1.50	5.50	21.51	24.72	16.99	41.70	25.00	6.19	3.75	4.50	4.25	14.11
52	MUSG 0608-22	100.00	72.83	1.25	1.00	5.50	22.14	27.30	18.92	46.22	24.50	6.20	4.00	4.50	4.25	14.72
55	MUSG 0603-12	100.00	60.87	1.00	1.00	5.00	21.50	25.08	22.30	47.39	27.00	9.26	3.75	4.00	4.25	15.62
56	MUSG 0602-19	100.00	67.39	1.00	1.00	5.25	22.94	30.23	26.17	56.40	24.00	6.79	3.75	4.00	3.75	15.97
LSD5%		1.19	21.27	0.95	1.92	2.43	11.49	12.32	13.90	23.17	4.48	5.57	0.89	0.92	0.83	3.84
MEAN		99.85	64.79	1.29	1.25	5.67	12.99	16.86	16.74	33.25	26.43	6.09	3.74	4.23	4.09	12.77

Note: The bolded genotypes are those selected in both Index and ranking selection. The ones not bolded are selected using the index selection

1. PBROT = Percentage of sprouting;
2. SHI=Percentage of vine survived
3. Vir2 =Symptoms of virus at early and late stages of growing respectively (1, without symptoms; 5, Moderate; 9, extremely severe)
4. VV1=Vigor (Not vigorous; 5, Moderate; 9, Very vigorous)
5. RYC=Commercial Root Yield in tones per hectare
6. RYT=Total Root Yield in tones per hectare
7. RVY=Total Vine Yield in tones per hectare
8. Bio=Biomass in tones per hectare
9. DM=Percentage of Dry Matter Content
10. BC=Levels of Beta-carotene in mg/100g of fresh root
11. COOT1= Taste (Very bad; 2, Bad; 3, Average; 4, Good; 5, Excellent)
12. Wed1=Weevil = Losses due to weevil (1, extremely severe; 2, Severe; 3, Moderate; 4, Light; 5, None); 13. DMAR=other injuries or damages on the roots (1, extremely severe; 2, Severe; 3, Moderate; 4, Light; 5, None)

Table 29. List of Clones that Showed Simultaneous Good Root Yield , Acceptable Levels of Dry Matter, Beta-carotene, Vine Vigor, Vine Yield, Percentage of Survived Plants, Tolerance to Virus and Weevil Attack, and Taste, Using both Ranking and Index Selection, *CHÓKWÈ*, Multi-location Trial of 64 clones, 2009/10 Cropping Season

G	Name	CHÓKWÈ														
		PBROT	SHI	Vir1	Vir2	VV1	RYCHa	RYTHa	RVY	Bioma	DM	BC	COOT1	WED1	DAMR	INDEX
3	UW119 06-296	100	71.74	1	2	6.25	4.63	6.68	13.68	20.37	25.21	12.57	4.25	3.75	3.5	11.87
10	MUSG 0603-02	58.88	83.52	1.75	1.25	7.75	14.56	18.60	15.79	29.89	29.61	4.72	3.93	3.64	3.61	13.58
13	UW119 06-284	100.00	73.92	1.25	1.50	7.25	6.72	7.77	16.91	24.68	24.50	12.39	4.00	5.00	5.00	12.07
17	MUSG 0704-16	98.64	86.05	1.00	1.00	7.75	7.81	9.98	8.45	18.44	29.00	5.44	4.00	4.50	4.75	11.18
23	UW119 06-79	100.00	72.83	2.00	1.00	7.75	10.16	10.83	16.10	26.93	24.50	8.78	3.75	3.00	3.00	11.78
26	UW119 06-175	100.00	76.09	1.00	1.25	7.50	10.14	14.65	16.91	31.56	25.50	8.95	4.00	3.75	4.25	12.91
29	UNWAMAZ 06-01	100.00	51.09	1.00	1.25	8.00	5.54	6.33	22.78	26.79	30.66	4.80	3.90	4.85	4.86	11.89
34	UW119 06-289	100.00	73.92	1.00	1.00	8.00	10.02	13.12	16.91	30.03	24.00	6.74	4.00	4.00	4.00	11.91
35	UW119 06-322	100.00	78.26	1.00	1.00	8.75	4.22	5.27	24.16	29.43	31.00	3.97	3.75	4.75	4.75	12.00
38	Tacna-2	100.00	58.70	2.00	1.00	7.25	7.36	9.90	18.92	28.82	29.00	4.19	3.50	4.75	4.75	12.87
41	105369-4	100.00	66.30	1.00	1.00	8.50	8.45	9.98	15.30	25.28	31.50	4.63	3.50	4.75	4.75	12.24
43	Kakamega-7	100.00	73.91	1.00	1.00	8.00	12.48	14.73	19.00	33.74	28.50	4.88	3.25	4.50	4.50	12.92
49	W119-15	100.00	76.08	1.00	1.25	7.75	11.36	13.45	23.95	42.67	23.50	4.69	4.00	3.75	4.50	12.15
50	Ejumula -25	100.00	84.78	1.00	1.50	8.00	16.18	18.19	22.63	40.82	23.00	6.18	4.00	4.50	4.75	13.24
52	MUSG 0608-22	100.00	80.43	1.00	1.50	7.75	6.00	6.76	17.31	24.07	25.00	5.05	4.00	3.75	3.25	10.53
53	MUSG 0609-47	100.00	63.04	1.00	1.25	7.00	5.23	6.40	16.50	22.91	24.00	8.34	3.50	4.00	4.00	10.71
LSD5		2.48	27.38	0.69	0.78	1.81	5.20	6.16	13.24	16.43	4.05	2.79	0.75	1.63	1.60	2.36
MEAN		99.06	65.16	1.35	1.20	6.98	4.98	6.34	15.32	21.61	26.78	5.48	3.87	3.95	3.95	10.62

Note: The bolded genotypes are those selected in both Index and ranking selection. The ones not bolded are selected using the index selection

1. PBROT = Percentage of sprouting;
2. SHI=Percentage of vine survived
3. Vir2 =Symptoms of virus at early and late stages of growing respectively (1, without symptoms; 5, Moderate; 9, extremely severe)
4. VV1=Vigor (Not vigorous; 5, Moderate; 9, Very vigorous)
5. RYC=Commercial Root Yield in tones per hectare
6. RYT=Total Root Yield in tones per hectare
7. RVY=Total Vine Yield in tones per hectare
8. Bio=Biomass in tones per hectare
9. DM=Percentage of Dry Matter Content
10. BC=Levels of Beta-carotene in mg/100g of fresh root
11. COOT1= Taste (Very bad; 2, Bad; 3, Average; 4, Good; 5, Excellent)
12. Wed1=Weevil = Losses due to weevil (1, extremely severe; 2, Severe; 3, Moderate; 4, Light; 5, None);
13. DMAR=other injuries or damages on the roots (1, extremely severe; 2, Severe; 3, Moderate; 4, Light; 5, None)

Table 30. List of Clones that Showed Simultaneous Good Root Yield, Acceptable Levels of Dry Matter, Beta-carotene, Vine Vigor, Vine Yield, Percentage of Survived Plants, Tolerance to Virus and Weevil Attack, and Taste, Using both Ranking and Index Selection, GURUÉ, Multi-location Trial of 64 clones, 2009/10 Cropping Season

G	Name	GURUÉ														
		PBROT	SHI	Vir1	Vir2	VV1	RYCHa	RYTHa	RVY	Bioma	DM	BC	COOT1	WED1	DAMR	INDEX
4	UW119 06-32	85.87	82.61	1.00	2.00	5.25	13.79	14.96	35.98	50.94	27.50	9.73	4.25	2.25	2.75	15.20
13	UW119 06-284	92.39	81.52	1.00	1.50	4.50	18.99	23.18	15.14	38.33	27.50	12.55	4.75	3.25	3.75	15.32
23	UW119 06-79	93.48	83.69	1.00	1.50	5.50	21.81	28.19	32.39	60.58	30.50	11.71	4.00	2.00	2.25	18.44
26	UW119 06-175	95.65	96.74	1.00	1.25	5.00	19.75	35.73	20.83	56.56	29.00	10.68	4.00	2.50	3.50	18.25
32	UW119 06-80	92.39	70.65	1.00	2.00	4.50	18.58	20.43	20.87	17.39	24.00	13.88	4.00	2.00	3.75	14.80
34	UW119 06-289	93.48	93.48	1.00	2.50	5.25	22.10	35.80	25.94	61.74	26.00	13.04	3.75	1.50	3.00	18.66
37	LO323-1	91.31	94.56	1.00	2.50	5.00	16.20	23.58	26.08	49.67	29.00	5.66	5.00	1.75	2.50	15.47
38	Tacna-2	92.39	90.22	1.00	1.25	6.25	10.50	19.57	33.04	52.61	31.00	6.51	4.50	1.75	3.50	15.94
39	105 257-3	92.39	86.96	1.00	2.75	6.50	13.11	25.44	26.63	52.07	32.00	4.52	4.75	1.50	3.25	16.39
40	105 268-1	95.65	92.39	1.00	1.50	5.75	10.65	14.89	30.29	45.18	35.00	3.80	5.00	2.25	3.50	15.03
41	105369-4	98.91	93.48	1.00	1.25	5.75	30.07	40.76	41.30	82.07	35.50	4.49	4.75	2.50	2.25	21.52
42	Ejumula-9	91.30	95.65	1.00	2.00	6.50	13.19	17.65	42.79	60.44	29.50	6.17	5.00	3.00	4.50	16.34
43	Kakamega-7	91.31	76.09	1.00	1.50	4.75	17.75	23.52	22.57	46.09	30.00	6.79	4.75	3.50	4.00	15.52
44	105413-4	91.31	90.22	1.00	2.00	6.00	13.69	23.01	87.43	108.40	32.00	5.46	5.00	3.50	4.25	22.21
47	Mafutha-1	95.65	91.30	1.00	2.00	6.25	13.66	18.59	53.15	71.74	33.50	4.74	5.00	3.00	4.00	18.05
48	W119-12	93.48	91.31	1.00	2.00	5.00	26.81	45.72	18.77	64.49	23.00	7.09	3.00	1.25	1.50	18.00
51	MUSG 0616-18	85.87	80.43	1.00	2.00	4.75	17.39	23.33	11.92	35.25	28.51	13.88	4.50	3.50	4.25	16.77
52	MUSG 0608-22	88.04	88.04	1.00	2.25	4.75	31.52	34.24	17.72	51.96	27.00	8.05	4.25	2.50	4.25	17.14
56	MUSG 0602-19	89.13	91.31	1.00	1.75	4.75	22.86	34.49	23.91	58.40	24.50	8.06	3.75	1.50	2.50	16.82
59	Ejumula	93.48	96.74	1.00	1.75	5.75	12.54	18.05	48.91	66.96	35.00	6.92	4.75	2.25	4.25	18.13
LSD5		10.88	16.67	0.10	0.98	1.23	0.00	10.57	18.47	21.21	3.90	2.93	0.76	1.17	1.03	3.21
MEAN		88.23	80.17	1.02	1.71	4.82	9.25	14.75	23.29	37.53	29.78	6.94	4.51	3.05	3.82	13.89

Note: The bolded genotypes are those selected in both Index and ranking selection. The ones not bolded are selected using the index selection

1. PBROT = Percentage of sprouting;
2. SHI=Percentage of vine survived
3. Vir2 =Symptoms of virus at early and late stages of growing respectively (1, without symptoms; 5, Moderate; 9, extremely severe)
4. VV1=Vigor (Not vigorous; 5, Moderate; 9, Very vigorous)
5. RYC=Commercial Root Yield in tones per hectare
6. RYT=Total Root Yield in tones per hectare
7. RVY=Total Vine Yield in tones per hectare
8. Bio=Biomass in tones per hectare
9. DM=Percentage of Dry Matter Content
10. BC=Levels of Beta-carotene in mg/100g of fresh root; 11. COOT1= Taste (Very bad; 2, Bad; 3, Average; 4, Good; 5, Excellent) 12. Wed1=Weevil = Losses due to weevil (1, extremely severe; 2, Severe; 3, Moderate; 4, Light; 5, None); 13. DMAR=other injuries or damages on the roots (1, extremely severe; 2, Severe; 3, Moderate; 4, Light; 5, None)

Table 31. List of Clones that Showed Simultaneous Good Root Yield , Acceptable Levels of dry Matter, Beta-carotene, Vine Vigor, Vine Yield, Percentage of Survived Plants, Tolerance to Virus and Weevil Attack, and Taste, Using both Ranking and Index Selection, ANGÓNIA, Multi-location Trials of 64 clones, 2009/10 Cropping Season

G	Name	ANGÓNIA														
		PBROT	SHI	Vir1	Vir2	VV1	RYCHa	RYTHa	RVY	Bioma	DM	BC	COOT1	WED1	DAMR	INDEX
17	MUSG 0704-16	58.00	56.00	1.25	1.50	3.25	7.07	15.22	15.22	23.91	32.00	4.61	3.50	5.00	5.00	12.89
18	MUSG 0705-35	77.00	74.00	2.50	1.75	4.00	7.51	36.16	36.16	41.17	31.50	4.18	4.00	5.00	5.00	19.12
23	UW119 06-79	78.00	69.00	1.75	2.50	3.25	16.67	30.33	30.33	49.17	29.00	7.23	2.50	5.00	5.00	17.29
26	UW119 06-175	80.00	72.00	1.75	2.50	3.25	15.94	29.85	29.85	48.15	29.00	8.86	2.00	5.00	5.00	17.43
27	UW119 06-140	80.00	63.00	1.75	2.75	2.75	13.40	21.45	21.45	37.94	26.50	8.86	3.00	5.00	5.00	14.47
30	UNASPOT 06-02	88.00	73.00	1.00	1.75	5.00	5.43	53.55	53.55	60.44	26.50	6.80	2.00	5.00	5.00	23.76
37	LO323-1	76.00	72.00	1.00	2.00	4.00	11.59	31.19	31.19	45.33	31.50	4.92	2.50	5.00	5.00	17.64
38	Tacna-2	76.00	67.00	2.25	2.25	4.25	12.14	29.89	29.89	44.56	30.29	3.49	2.50	5.00	5.00	17.99
42	Ejumula-9	78.00	70.00	1.25	1.00	5.75	14.86	49.82	49.82	67.75	32.27	3.82	3.00	5.00	5.00	24.72
43	Kakamega-7	76.00	65.00	1.50	1.25	4.25	9.42	22.79	22.79	35.83	31.62	7.67	3.00	5.00	5.00	15.97
47	Mafutha-1	75.00	62.00	3.25	3.50	4.75	6.34	28.01	28.01	36.88	33.45	4.70	4.00	5.00	5.00	18.64
51	MUSG 0616-18	72.00	61.00	2.50	2.25	3.50	7.97	23.04	23.04	32.68	31.50	13.38	3.00	5.00	5.00	16.90
59	Ejumula	81.00	69.00	1.75	1.75	3.75	8.69	33.73	33.73	44.78	34.27	5.13	4.50	5.00	5.00	19.89
60	Mayai	84.00	75.00	1.25	1.50	3.75	17.21	34.10	34.10	54.75	34.00	3.98	4.50	5.00	5.00	18.97
LSD5		18.49	17.35	1.23	1.90	1.58	8.53	14.64	14.64	21.55	3.76	2.03	0.94	0.00	0.31	0.00
MEAN		68.88	60.46	1.89	2.20	3.56	8.30	20.70	20.70	31.20	29.17	5.81	2.69	5.00	4.94	14.41

Note: The bolded genotypes are those selected in both Index and ranking selection. The ones not bolded are selected using the index selection

1. PBROT = Percentage of sprouting;
2. SHI=Percentage of vine survived
3. Vir2 =Symptoms of virus at early and late stages of growing respectively (1, without symptoms; 5, Moderate; 9, extremely severe)
4. VV1=Vigor (Not vigorous; 5, Moderate; 9, Very vigorous)
5. RYC=Commercial Root Yield in tones per hectare
6. RYT=Total Root Yield in tones per hectare
7. RVY=Total Vine Yield in tones per hectare
8. Bio=Biomass in tones per hectare
9. DM=Percentage of Dry Matter Content
10. BC=Levels of Beta-carotene in mg/100g of fresh root;
11. COOT1= Taste (Very bad; 2, Bad; 3, Average; 4, Good; 5, Excellent)
12. Wed1=Weevil = Losses due to weevil (1, extremely severe; 2, Severe; 3, Moderate; 4, Light; 5, None);
13. DMAR=other injuries or damages on the roots (1, extremely severe; 2, Severe; 3, Moderate; 4, Light; 5, None)

Table 32. List of Clones Selected from more than one Environment (Umbelúzi, Chókwè, Gurué, Angónia), Multi-location Trials of 64 clones, 2009/10 Cropping Season

G	Name	PBROT	SHI	Vir1	Vir2	VV1	RYCHa	RYTHa	RVY	Bioma	DM	BC	COOT1	WED1	DAMR	INDEX
4	UW119 06-32	91.97	74.94	1.50	2.19	5.44	13.79	15.94	23.11	40.13	24.50	8.98	3.38	4.06	3.94	13.39
13	UW119 06-284	91.60	74.61	1.44	1.38	5.13	17.23	19.55	16.07	36.37	25.63	10.16	3.63	4.25	4.44	13.83
17	MUSG 0704-16	86.44	80.08	1.06	1.44	5.50	13.70	16.52	15.38	31.75	29.13	6.01	3.94	4.44	4.56	13.11
18	MUSG 0705-35	89.09	62.52	1.69	1.38	5.06	7.67	17.74	20.53	30.48	28.63	5.29	3.94	4.31	4.19	13.57
23	UW119 06-79	92.60	70.78	1.44	1.50	5.44	16.59	22.49	22.96	42.57	27.50	8.39	3.63	3.56	3.69	15.05
26	UW119 06-175	93.91	75.61	1.19	1.50	5.56	16.60	25.94	19.33	42.38	27.00	8.39	3.38	3.94	4.19	15.36
27	UW119 06-140	93.37	69.83	1.31	1.88	5.19	13.68	18.32	16.52	33.59	25.75	9.94	3.75	3.94	4.19	13.50
29	UNWAMAZ 06-01	96.08	70.09	1.25	1.25	6.63	3.14	14.31	34.55	36.71	30.26	5.72	3.48	4.78	4.78	13.49
30	UNASPOT5 06-02	93.74	79.94	1.13	1.50	5.94	6.02	20.17	30.07	38.56	28.88	5.69	3.63	4.13	4.31	15.19
34	UW119 06-289	89.37	74.19	1.38	1.88	5.75	16.28	21.58	14.89	36.78	25.25	7.70	3.44	3.69	3.94	13.59
37	LO323-1	91.83	69.09	2.44	1.75	5.69	9.62	17.53	21.18	35.08	29.22	5.59	4.05	3.70	3.97	13.89
38	Tacna-2	92.10	72.19	1.69	1.38	5.69	12.91	22.16	25.39	43.75	29.32	5.31	3.38	3.88	4.31	15.62
40	105 268-1	91.41	68.95	1.13	1.38	5.81	8.33	15.42	26.06	35.94	31.76	4.12	4.08	3.78	4.13	14.40
41	105369-4	90.98	73.76	1.06	1.13	5.75	16.95	23.38	23.17	45.20	32.84	5.54	3.44	4.19	4.00	16.10
42	Ejumula-9	92.33	74.84	1.25	1.31	6.63	10.18	20.91	34.33	47.26	29.42	6.17	3.81	4.19	4.56	16.40
43	Kakamega-7	91.83	72.77	1.25	1.38	5.88	13.07	19.63	20.32	37.51	28.78	6.06	3.75	4.25	4.44	14.23
47	Mafutha-1	92.66	71.75	1.94	2.13	6.44	9.41	17.31	31.03	43.55	32.13	5.00	4.13	4.19	4.31	15.69
49	W119-15	94.33	75.42	1.31	1.56	5.31	21.06	27.09	23.97	54.36	23.56	5.71	3.44	3.56	3.94	14.80
50	Ejumula -25	93.03	71.49	1.50	3.25	5.44	17.40	18.83	16.94	36.90	26.75	6.01	3.63	4.44	4.56	13.30
51	MUSG 0616-18	89.47	73.13	1.63	1.81	5.06	13.69	20.22	17.11	33.98	26.69	10.32	3.81	4.13	4.25	14.65
52	MUSG 0608-22	91.26	77.08	1.44	2.25	5.19	18.18	19.89	16.31	37.19	26.13	6.35	3.69	3.94	4.19	13.39
56	MUSG 0602-19	91.53	72.67	1.44	2.06	5.13	14.26	21.87	21.11	40.79	24.00	6.01	3.56	3.50	3.56	13.64
59	Ejumula	92.72	74.39	1.25	1.38	5.50	6.97	14.90	26.80	36.30	33.52	5.38	4.03	3.82	4.17	14.88
LSD5		9.82	15.14	0.74	0.82	1.28	6.69	9.75	11.66	20.59	2.65	2.29	0.53	0.83	0.94	2.35
MEAN*		89.00	67.65	1.39	1.59	5.26	8.76	14.60	19.01	30.90	27.94	6.01	3.70	4.06	4.20	12.92

*Means and values are from the pooled data of the 4 locations

1. PBROT = Percentage of sprouting;
2. SHI=Percentage of vine survived
3. Vir2 =Symptoms of virus at early and late stages of growing respectively (1, without symptoms; 5, Moderate; 9, extremely severe)
4. VV1=Vigor (Not vigorous; 5, Moderate; 9, Very vigorous)
5. RYC=Commercial Root Yield in tones per hectare
6. RYT=Total Root Yield in tones per hectare; 7. RVY=Total Vine Yield in tones per hectare
8. Bio=Biomass in tones per hectare; 9. DM=Percentage of Dry Matter Content
10. BC=Levels of Beta-carotene in mg/100g of fresh root; 11. COOT1= Taste (Very bad; 2, Bad; 3, Average; 4, Good; 5, Excellent)
12. Wed1=Weevil = Losses due to weevil (1, extremely severe; 2, Severe; 3, Moderate; 4, Light; 5, None);
13. DMAR=other injuries or damages on the roots (1, extremely severe; 2, Severe; 3, Moderate; 4, Light; 5, None)

Analysis of Genotype by Environment (GxE)

The GxE analysis was conducted using the additive main effects and multiplicative interaction (AMMI) method in parallel with the cluster analysis. The ANOVA for these clones (Table 10) showed significant means squares for both main effects environment (E) and genotype (G) and interaction effects (GxE).

For the AMMI analysis of these 23 clones, the first PC has a contribution of 72.21% and the second PC a contribution of 22.19%. Both together have a contribution of 94.4% to the explanation of the interaction. Genotypes with slope (b) around 1 have average stability over all environments. Genotypes with slope (b) greater than 1 have below average stability (they are very sensitive to changes in the environments), and hence are suitable for high-yielding environments. Genotypes with slope less than 1 have above average stability (they are very insensitive to changes in the environments), and hence, they could be suitable for low-yielding environments.

Stability analysis for the genotypes

According to Table 33, the clones that showed to be stable over the tested environments were: 51 (MUSG 0616-18), 26 (UW119 06-175), 23 (UW119 06-175), 27 (UW119 06-140), 49 (W119-15), and 38 (Tacna-2), all of them with values of the regression coefficient (b) very close to 1 and low values for MSdev and MSinteraction. Genotype 51 was selected for Umbelúzi, Gurué, and Angónia, and demonstrated good yield stability for these 3 environments, while genotypes 23 and 26 were selected for Chókwè, Angónia, and Gurué, showing also good yield stability in those environments. Actually, the clone 23 is the most stable in the trial (Table 33).

Table 33. Estimates obtained for the 23 Genotypes Selected from more than one Environment (Umbelúzi, Chókwè, Gurué, Angónia) using AMMI analysis for GxE Interaction for Root Total Yield of Clones, Multi-location Trials of 64 clones, 2009/10 Cropping Season

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	UNASPOT5 06-02	20.17	1.94	416.10	330.37	-3.83	0.35

Coef Regr (b) = Coefficient of regression for stability analysis (Clones with values close to 1 have widely adapted)

Msdev and Msint= Mean Square Deviations or deviation from the regression line (smaller is better)

Msint= Mean Square Interaction or the ecovalence (smaller is better)

Stability analysis for the environments

According to the plots in the Figure 3, the most important clone in terms of root yield was 49, with 27.09 ton/ha, and this clone was selected for Umbelúzi and Chókwè. However, its level of dry matter contend is relatively low compared to other clones in the trial. Despite of some similarities between the environment Umbelúzi/Chókwè, and Gurué/Angónia, the data from this trial have perfectly demonstrated that neither environment is stable compared to each other in terms of agro-ecological conditions.

According to the data in Table 34, genotypes selected in Angónia are not very sensitive to changes in environment, which means that those clones that perform well in Angónia have greater chance to perform in similar worse conditions (value of the regression coefficient *b* very low), while clones selected for Gurué are those with chances to perform well in high yielding environment, that is, they are very sensitive to changes in the environments. The clones selected in Umbelúzi are more

likely to perform in all environments, but with tendency to do well in those with relatively good planting conditions (value of b close to 1) (Table 34).

Table 34. Estimates obtained for the 4 Environment (Umbelúzi, Chókwè, Gurué, Angónia) using AMMI analysis for GxE Interaction for Root Total Yield of Clones, Multi-location Trials of 64 clones, 2009/10 Cropping Season

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	-	-	-	-	-

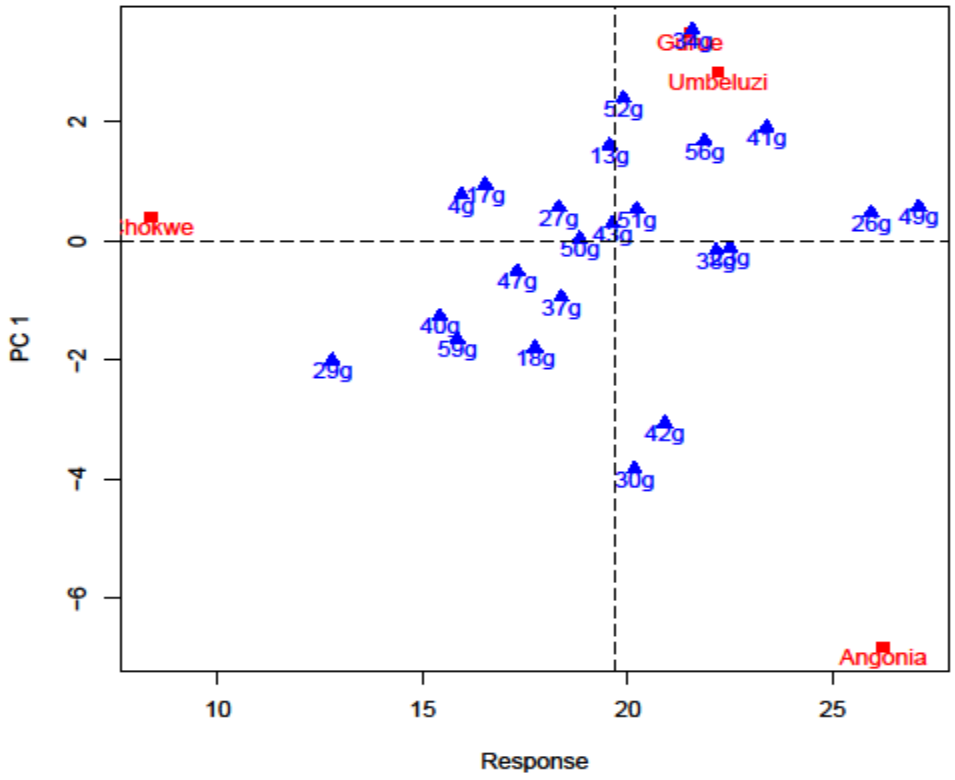

Figure. 3. The AMMI biplot of the 23 genotypes evaluated for root yield in Umbelúzi, Chókwè, Gurué, and Angónia, Multi-location Trials of 64 clones, 2009/10 Cropping Season

A very succinct analysis of the graphic of the two principal components (Figs 3-5) that explain more than 90% of the variability of the data indicate that Umbelúzi and Chókwè are relatively close

environment compared to Gurué and Umbelúzi. Thus, clones that performed well in Umbelúzi are more likely to perform in Chókwè, this are for examples the cases of genotypes13, 27, and 49. Once gain, the clones with the tendency to be more stable are those concentrated in the middle of the plot, and those are 51, 49, 27, 23, and 26. It is perfectly visible that the clones 23, 26, and 43 are in the middle distance among the environments Gurué, Angónia, and Umbelúzi, and in a relative close distance to Chókwè, which means that the clones are widely stable but more adapted to Chókwè. The Genotype 50 is in between of the environments Chókwè and Umbelúzi, showing relatively high adaptation for those environments. Other clones that are more suitable for Chókwè are the 17, 49 and 13. Genotype 41 is much more adapted to Gurué, while clones 30, 42, and 29 to Angónia.

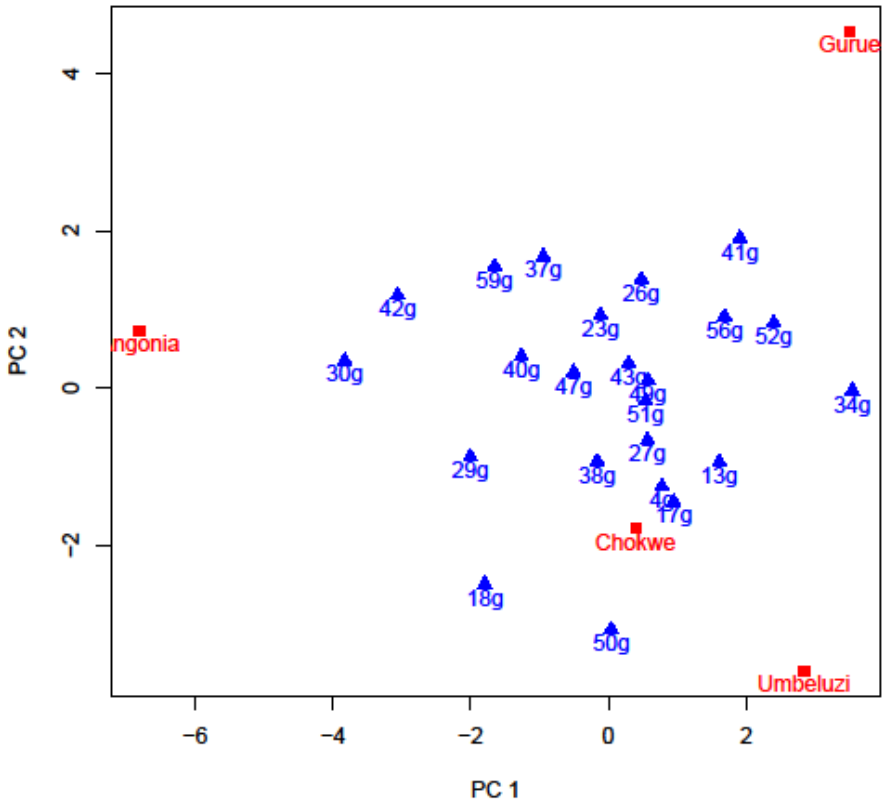

Figure. 4. The AMMI biplot of the 23 genotypes evaluated for root yield in Umbelúzi, Chókwè, Gurué, and Angónia using the results from the PC1 and PC2, Multi-location Trials of 64 clones, 2009/10 Cropping Season

The analyses of the results in Figure 5 confirm that clone 50 is well adapted for the low yielding environment such as Chókwè and Umbelúzi, and had even performed better than the local clones.

And it is evident that the genotype 51 was very stable for the environment Gurué, Umbelúzi, and Angónia. The cluster analysis in Figure 6 shows that apart from the genotype 51, the clones 17 and 27 can be very well suited for Gurué, Umbelúzi, and Angónia. Other clones that showed relative close distance to each other were 23 and 26 (Figure 6). In general, the best of the best clones were gathered in Table 35. The morphological characterization and the images of these 15 selected clones are presented in the Annexes 1 and 2, and the characterization was made according to the *Descriptors for Sweetpotato* from CIP, AVRDC, IBPGR (1991).

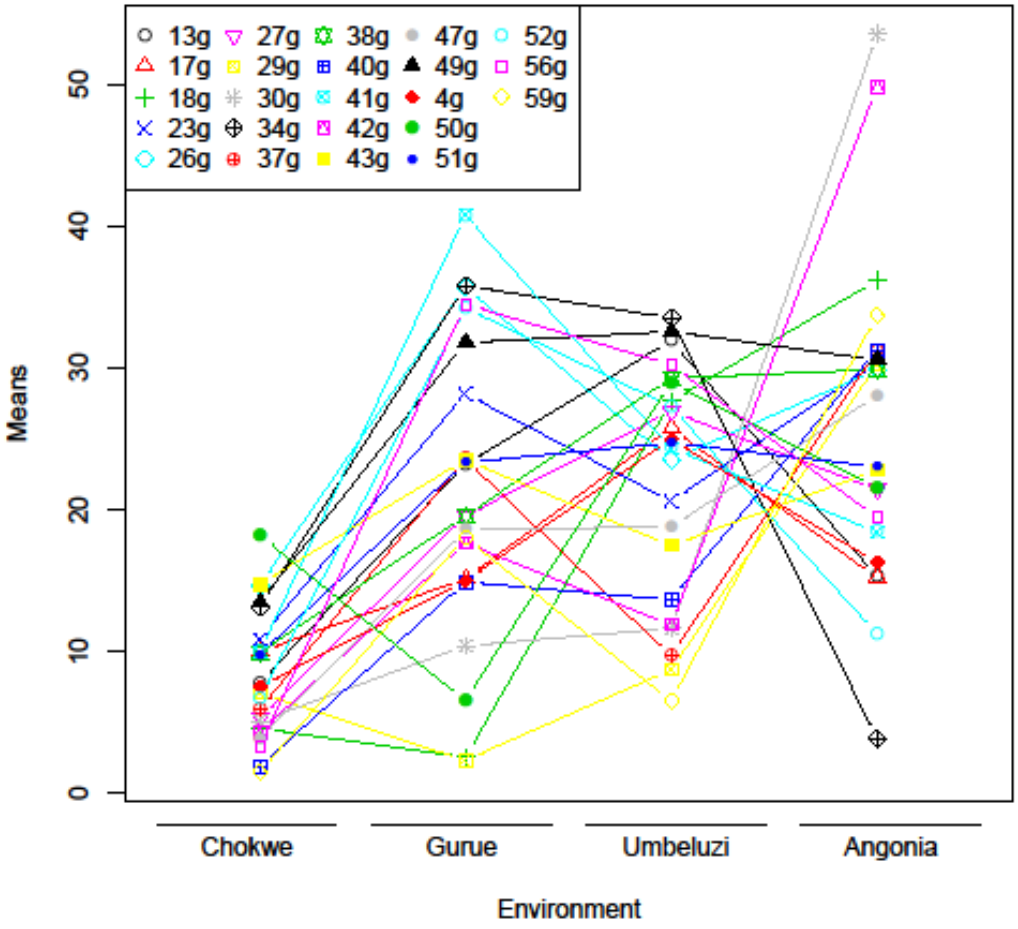

Figure 5. The AMMI Interaction graph of the 23 genotypes evaluated for root yield in Umbelúzi, Chókwè, Gurué, and Angónia, Multi-location Trial of 64 clones, 2009/10 Cropping Season

Figure 6: Cluster Analysis of 23 Clones Selected from more than one Environment (Umbelúzi, Chókwè, Gurué, Angónia), Multi-location Trials of 64 clones, 2009/10 Cropping Season

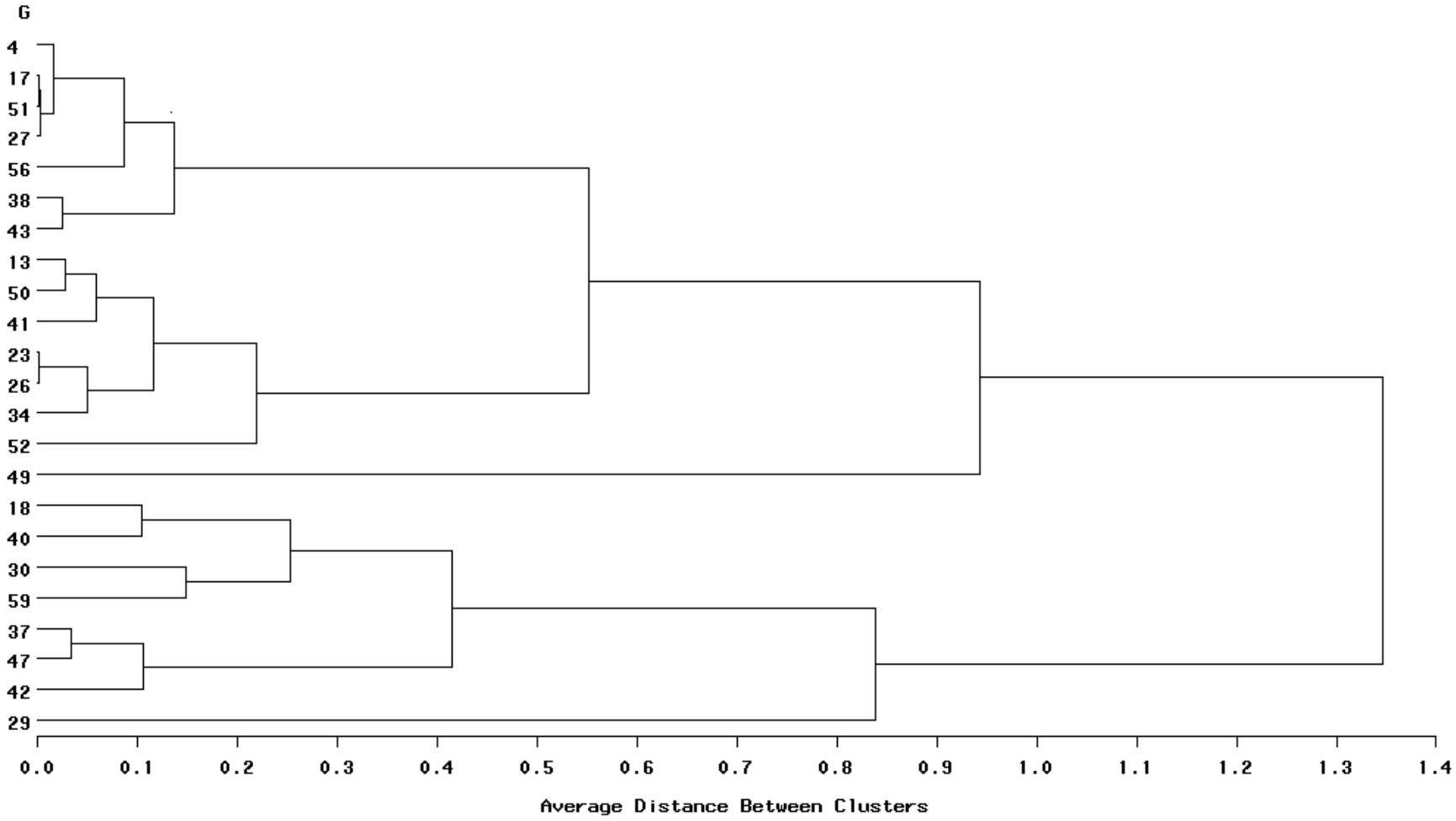

Table 35. Genotypes selected from the 4 Environment (Umbelúzi, Chókwè, Gurué, Angónia) using the Ranking, Index and AMMI analysis, Multi-location Trials of 64 clones, 2009/10 Cropping Season

G	Name	Location	Regression Coefficient(b)	Ms dev	MS interact	SHI	Vir2	VV1	RYCHa	RYTHa	RVY	DM	BC	COOT1	WED1	DAMR	INDEX
50	Ejumula -25	Umbelúzi Chókwè	0.16	128.61	128.61	71.49	3.25	5.44	17.40	18.83	16.94	26.75	6.01	3.63	4.44	4.56	13.30
34	UW119 06-289	Chókwè Gurué	0.2	362.09	280.15	74.19	1.88	5.75	16.28	21.58	14.89	25.25	7.70	3.44	3.69	3.94	13.59
43	Kakamega-7	All	0.43	10.11	26.26	72.77	1.38	5.88	13.07	19.63	20.32	28.78	6.06	3.75	4.25	4.44	14.23
13	UW119 06-284	Umbelúzi Gurué Angónia	0.79	104.47	72.19	74.61	1.38	5.13	17.23	19.55	16.07	25.63	10.16	3.63	4.25	4.44	13.83
41	105369-4	Umbelúzi Gurué	0.85	188.17	126.8	73.76	1.13	5.75	16.95	23.38	23.17	32.84	5.54	3.44	4.19	4.00	16.10
51	MUSG 0616-18	All	0.85	8.07	6.72	73.13	1.81	5.06	13.69	20.22	17.11	26.69	10.32	3.81	4.13	4.25	14.65
26	UW119 06-175	All	0.91	46.67	31.55	75.61	1.50	5.56	16.60	25.94	19.33	27.00	8.39	3.38	3.94	4.19	15.36
23	UW119 06-79	All	1.05	17.83	12.01	70.78	1.50	5.44	16.59	22.49	22.96	27.50	8.39	3.63	3.56	3.69	15.05
27	UW119 06-140	All	1.06	25.64	17.32	69.83	1.88	5.19	13.68	18.32	16.52	25.75	9.94	3.75	3.94	4.19	13.50
49	W119-15	Umbelúzi Chókwè	1.1	14.85	10.56	75.42	1.56	5.31	21.06	27.09	23.97	23.56	5.71	3.44	3.56	3.94	14.80
38	Tacna-2	All	1.12	20.11	14.29	72.19	1.38	5.69	12.91	22.16	25.39	29.32	5.31	3.38	3.88	4.31	15.62
37	LO323-1	Gurué Angónia	1.18	84.99	58.53	69.09	1.75	5.69	9.62	17.53	21.18	29.22	5.59	4.05	3.70	3.97	13.89
47	Mafutha-1	Umbelúzi Gurué Angónia	1.27	5.21	7.75	71.75	2.13	6.44	9.41	17.31	31.03	32.13	5.00	4.13	4.19	4.31	15.69
10	MUSG 0603-02	Chókwè	1.31	598.17	429.11	83.52	1.25	7.75	14.56	18.60	15.79	29.61	4.72	3.93	3.64	3.61	13.58
59	Ejumula	Angónia	1.44	120.56	91.88	74.39	1.38	5.50	6.97	14.90	26.80	33.52	5.38	4.03	3.82	4.17	14.88
LSD (0.05)						15.14	0.82	1.28	6.69	9.75	11.66	2.65	2.29	0.53	0.83	0.94	2.35
MEAN*						67.65	1.59	5.26	8.76	14.60	19.01	27.94	6.01	3.70	4.06	4.20	12.92

*Means and values are from the pooled data of the 4 locations

Coef Regr (b)= Coefficient of regression for stability analysis (Clones with values close to 1 have widely adaptation), Msdev = Mean Square Deviations or deviation from the regression line (smaller is better), Msint= Mean Square Interaction or the ecovalence (smaller is better), 1. PBROT = Percentage of sprouting; 2. SHI=Percentage of vine survived, 3. Vir2 =Symptoms of virus at early and late stages of growing respectively (1, without symptoms; 5, Moderate; 9, extremely severe), 4. VV1=Vigor (Not vigorous; 5, Moderate; 9, Very vigorous), 5. RYC=Commercial Root Yield in tones per hectare, 6. RYT=Total Root Yield in tones per hectare; 7. RVY=Total Vine Yield in tones per hectare, 8. Bio=Biomass in tones per hectare; 9. DM=Percentage of Dry Matter Content, 10. BC=Levels of Beta-carotene in mg/100g of fresh root; 11. COOT1= Taste (Very bad; 2, Bad; 3, Average; 4, Good; 5, Excellent), 12. Wed1=Weevil = Losses due to weevil (1, extremely severe; 2, Severe; 3, Moderate; 4, Light; 5, None); 13. DMAR=other injuries or damages on the roots (1, extremely severe; 2, Severe; 3, Moderate; 4, Light; 5, None)

Characterization of the fifteen selected clones

The characterization of the fifteen selected clones and the photos are in Annex 1 and Annex 2 respectively

Storage/Conservation test on the multi-location trial of 64 clones

All clones from the multi-location trial of 64 clones conducted in Umbelúzi, Chókwè, Angónia, and Gurué were submitted to a conservation test that started on April 12 and ended on May 17. The samples were conserved at normal room temperature and the objective of the test was to identify the clones that can be conserved on the shelf for a period after harvest. The results of the conservation test are presented in terms of weight lost weekly up to 35 days after harvesting the storage roots (Table 36).

Among the selected clones to be released (Table 35), the most important clones in terms of weight conservation were 57 and 49 with only 9.63 % and 11.08 % of weight lost 35 day after harvesting. In general, most of the clones in the trial did present good results, as the lost of weight 35 days after harvesting (dah) did not go beyond the 50% (Table 36) The worst clones among those selected for release were the clones 13 (UW119 06-284), 59 (Ejumula) with losses of weight 35 dah around the 80% and 90% respectively.

Table 36: Weight (grams) and Percentage of Loss of the Weight of Clones from the Multi-location Trials of 64 clones 35 days after harvesting, April-June 2010

Date	*April 12*	*April 19*	*April 27*	*May 3*	*May 10*	*May 17*	*% of lost weight 35 days after harvesting*
Genotype	Initial Weight	Weight (2)	Weight (3)	Weight (4)	Weight (5)	Weight (6)	
57	620.7	593.73	588.84	587.74	567.89	560.92	9.63
49	1439.6	1384	1348.7	1336.8	1294.4	1280.1	11.08
14	2091.1	2033.8	1980.1	1963.1	1858.7	1831.2	12.43
26	1451.3	1387.6	1347.7	1332.6	1287.4	1261.1	13.11
28	2068.2	1996.7	1928.4	1912	1856.7	1735.4	16.09
54	536.1	501.45	491.5	470.88	455.69	444.43	17.10
61	665.7	623.5	582	576.47	550.95	541.17	18.71
31	1620.6	1539.3	1488.9	1470.9	1415.5	1285	20.71
24	1607.9	1539.1	1387.1	1369.6	1316.4	1271.7	20.91
10	1243.9	1194.8	1043.7	1020.3	942	981.5	21.09
50	2241.4	2054.2	1960.5	1947.4	1729.6	1719.6	23.28
16	1777.5	1519.3	1512.8	1479.1	1412.3	1319.2	25.78
11	1465.2	1402.2	1361.8	1229.8	1188.6	1044.6	28.71
6	969.8	904.8	739.5	720.5	702.7	686.6	29.20
30	2135.8	2045.2	1941.1	1567	1622.7	1414.2	33.79
9	2191.1	2121	1634.8	1626.2	1457.6	1450.6	33.80
23	2115.4	1958.1	1903.6	1435.6	1401.8	1387.3	34.42
53	764.7	718.4	535.84	519.11	504.59	492.76	35.56

2	512.45	360.31	356.81	352.31	332.22	324.17	36.74
37	1076.2	1017.1	709.5	690.3	674.7	661.3	38.55
43	2291.6	2171.2	1776.2	1606.6	1531.8	1404.8	38.70
22	2787.5	2710.6	2304.9	2255.6	1656.8	1629.1	41.56
55	1596.9	1517.6	1208	960.5	930.3	904.7	43.35

Date	April 12	April 19	April 27	May 3	May 10	May 17	% of lost weight 35 days after harvesting
Genotype	Initial Weight	Weight (2)	Weight (3)	Weight (4)	Weight (5)	Weight (6)	
51	1784.6	1538.6	1219.7	1161.5	1039.5	1003.3	43.78
4	1412.8	1358.8	829.5	815	801.6	791	44.01
17	4222.57	3410.8	2980.2	2392.8	2324.1	2252.6	46.65
60	830.3	712	742.5	482.24	456.24	441.77	46.79
34	1381.2	970.7	767.8	750.1	732.7	716.3	48.14
27	1080.7	1008.9	805.5	684.5	574.83	558.61	48.31
45	414.97	382.97	372.23	353.4	338.67	212.08	48.89
38	2643.2	2485.6	1992.8	1695.8	1613.1	1335.9	49.46
41	1944.7	1666.5	1131.6	1023.3	988.9	971.7	50.03
12	1607.2	1520.7	1355.4	1081	955.5	797.9	50.35
33	1925	1832.5	1760.1	1728.1	1285	943.9	50.97
1	1224	1019.2	663.2	640.6	618.4	597.31	51.20
44	2188.8	2114.6	1586.9	1378.3	1229.5	1042.7	52.36
52	2193.1	1513.5	1098.3	1072.1	1047.1	1015.1	53.71
46	2061.7	2004	1752.5	1421	1371.9	943.3	54.25
47	1804.7	1729.9	1272.7	1254.3	1018.2	816.4	54.76
42	2163.4	2050.2	1608.8	1164.5	1113.4	892.4	58.75
7	1131	1053.2	886.5	526.31	494.29	459.7	59.35
58	1604.5	1375.3	833.9	807.8	697.7	624.4	61.08
64	896.5	836.2	519.94	498.5	350.58	342.74	61.77
15	2095.4	1503.6	1251.4	1212.4	766.4	752.7	64.08
3	1794.5	1365.9	689	672.5	658.4	643.7	64.13
36	2156.4	1948.8	1866.9	1676.5	1470.6	772.3	64.19
25	1552.1	1275.7	835	807	710.1	514.19	66.87
56	853.7	815.8	795.4	781.9	736.2	274.94	67.79
63	1545.1	1255.8	1212.6	1195.8	827.8	496.49	67.87
5	1056.9	890.1	508.57	451.26	339.47	334.75	68.33
8	925.6	690.1	455.84	380.4	292.75	283.89	69.33
13	3152.4	2760.8	1631.2	458.3	956.8	663.8	78.94
32	987.1	596.95	562.43	313.65	294.23	129.08	86.92
40	1627.9	1180.3	1028.7	483.11	228.62	209.6	87.12
59	751.2	686.7	190.67	92	89.85	87.82	88.31

The results of the evaluations conducted with the farmers (on-farm trials)

Fifteen on-farm trials in each of the four areas where the multi-location trials of 64 clones were established. Each individual on-farm trial was composed of 5 varieties, being one of them a local variety and 4 from the set of 64 clones Farmers in collaboration with CIP organized and invited other farmers to assist with the selection of the varieties in their field. The data in this report were pooled from Umbelúzi and Chókwè, where 9 trials (Umbelúzi) and 10 trials (Chókwè) were harvested with success. All the 15 clones previously selected under on station as the best for release were included under on-farm mentioned above. Overall, 79 farmers in Chókwè (69 women and 10 men) and 67 in Umbelúzi (48 women and 19 men), totaling 146 participants farmers were involved in the evaluation.

The selection was made according to point attributions by using maize seed for women and beans seed for men, on a scale 1-10, where 1 was the minimum punctuation and 10 the maximum for category under evaluation (vines and roots). The parameters evaluated under the vines were the quantity of leaves, greenness of leaves, habit of growth, vigor of the vine and the volume of the canopy, while the parameters under the roots were total yield, color of the storage root flesh, size of the roots, taste, and dry matter content.

In general, most of the genotypes selected as the best with the ranking and index criteria were also considered the best by the farmers, which is an indication of the internal validity of the collected data. Table 36 shows the classification of the genotypes among the groups where there were evaluated. As depicted in Table 37, each group of evaluation was composed by 5 genotypes, one of them the local used for comparison. For the group I for example, the best genotype among the 5 in evaluation was Kakamega-7 with 27% of the points attributed for the vines and 31% of the points attributed to the roots. Overall, there are 12 groups, each one with 1 or 2 genotypes selected as the best in the previous classifications. A more simplistic evaluation which only brings the percentage of the punctuations for the selected genotypes compared to the average percentage of the punctuation for the local varieties is presented in the Figure 7 below.

According to the results (Figure 7), the varieties that present percentages of the punctuation greater than 20% provide an indication that the genotypes in evaluation are at least comparable to or better than the local or other genotypes in the trial. Therefore, 10 out of the 15 selected genotypes (43-Kakamega, 26-UW11906-175, 50-Ejumula-25, 27-UW11906-140, 51-MUSG 0616-18, 41-105369-4, 37-LO 323-1, 47-Mafutha-1, 49-W119-15, and 38-Tacna-2) were found to be among the best genotypes in their groups and also the best among the 15 selected genotypes for root attributes which include the total yield, color of the storage root flesh, size of the roots, taste, and dry matter content. Regarding to the vine attributes, 7 out of the 15 selected genotypes (43-Kakamega, 26-UW11906-175, 50-Ejumula-25, 51-MUSG 0616-18, 37-LO323-1, 47-Mafutha 1, and 38-Tacna-2) were punctuated as the best among the genotypes under evaluation.

In general, the results in Figure 7 are in support that most of the 15 selected genotypes under the ranking and index selection were better than the local varieties for root and vine attribute.

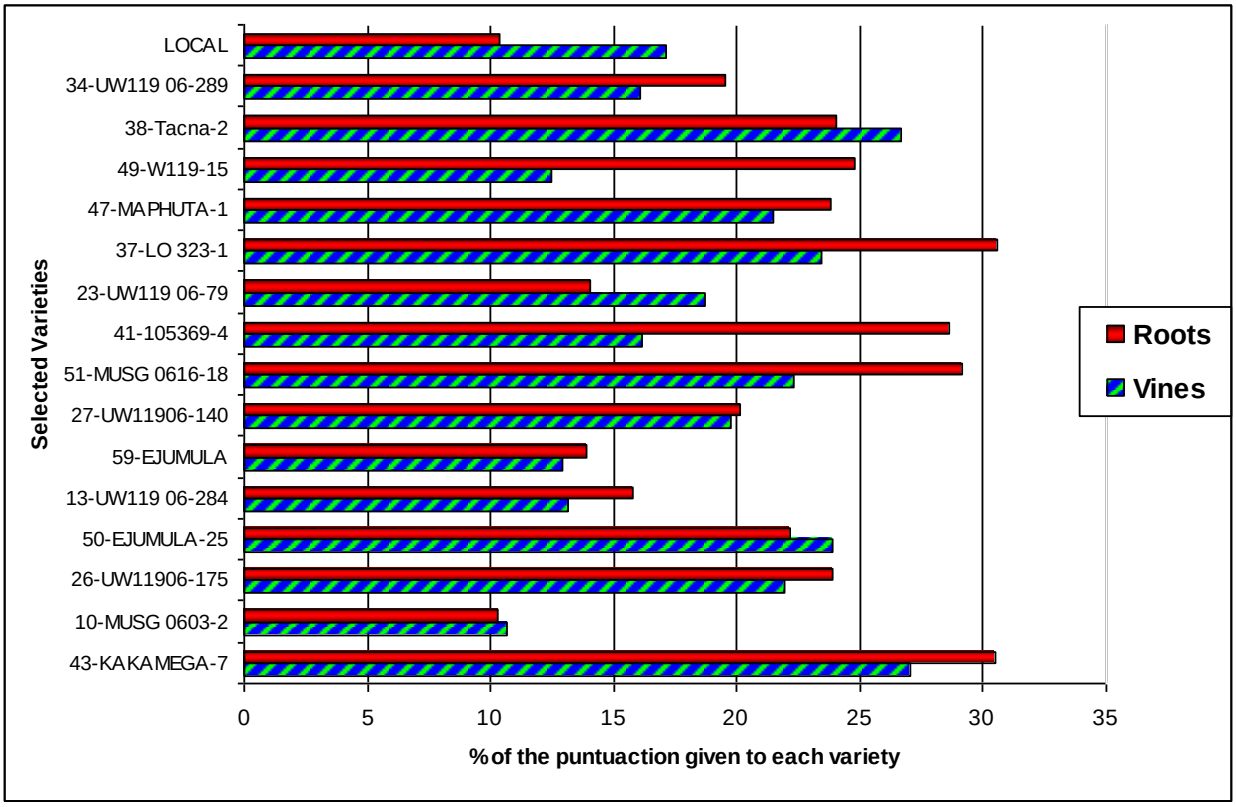

Figure 7. Percentage of the punctuation given to each of the 15 selected genotypes by the 146 participants in the evaluation of the on-farm trials in Umbelúzi and Chókwé, first season 2009/2010

Table 37. Results of the on-farm aggregated Evaluation for the vines (Quantity of the vines, vigor of the vine, habit of growth) and the Roots (Total yield, color of root flesh, size of roots, taste, and dry matter content) Discriminated by Gender and Express as Percentage of the Punctuations

Groups	Variety	Vines					Roots			
		Men	Women	Total Points	%		Men	Women	Total Points	%
Group I	MUSG 0603-2	15	72	87	10.64		9	63	72	10.27
	MUSG 0608-33	59	131	190	23.23		11	192	203	28.96
	KAKAMEGA-7	48	173	221	27.02		19	195	214	30.53
	MUSG0602-19	56	134	190	23.23		11	139	150	21.40
	LOCAL	34	96	130	15.89		0	62	62	8.84
	Total	-	-	-	100.00		-	-	-	100.00
Group II	UW11906-32	28	96	124	12.44		23	128	151	21.57
	105143G07-4	92	191	283	28.39		25	128	153	21.86
	UW11906-175	81	138	219	21.97		22	145	167	23.86
	Ejumula-25	81	157	238	23.87		23	132	155	22.14
	LOCAL	27	106	133	13.34		7	67	74	10.57
	Total	-	-	-	100.00		-	-	-	100.00
Group III	105249G07-5	67	137	204	23.37		6	26	32	4.33
	UCOL 1806-4	68	128	196	22.45		24	133	157	21.24
	U NASPOT5 06-2	42	99	141	16.15		49	180	229	30.99
	MUSG0603-12	53	114	167	19.13		56	224	280	37.89
	LOCAL	43	122	165	18.90		15	26	41	5.55
	Total	-	-	-	100.00		-	-	-	100.00
Group IV	UW119 06-284	0	46	46	13.18		0	54	54	15.74
	MUSG 0704-16	0	82	82	23.50		0	87	87	25.36
	UW119 06-289	0	56	56	16.05		0	67	67	19.53
	MUSG 0613-18	0	61	61	17.48		0	53	53	15.45
	LOCAL	0	104	104	29.80		0	82	82	23.91
	Total	-	-	-	100.00		-	-	-	100.00
Group V	U1998-12-3-06-3	13	87	100	24.88		9	81	90	22.28
	UW119-06-332	10	87	97	24.13		9	84	93	23.02
	MUSG 0606-15	8	56	64	15.92		10	67	77	19.06
	EJUMULA	8	44	52	12.94		9	47	56	13.86
	LOCAL	11	78	89	22.14		13	75	88	21.78
	Total	-	-	-	100.00		-	-	-	100.00
Group VI	105101G07-07	62	146	208	21.49		39	125	164	21.90
	MUSG 068-61	59	122	181	18.70		53	125	178	23.77
	Ejumula-9	80	151	231	23.86		51	159	210	28.04
	MUSG 0610-39	80	82	162	16.74		33	33	66	8.81
	LOCAL	49	137	186	19.21		23	108	131	17.49
	Total	-	-	-	100.00		-	-	-	100.00

Groups	Variety	Vines					Roots			
		Men	Women	Total Points			Men	Women	Total Points	
Group VII	MUSG 0703-37	41	115	156	15.97		40	145	185	22.84
	UW11906-140	59	134	193	19.75		26	137	163	20.12
	105268-1	74	150	224	22.93		34	110	144	17.78
	MUSG 0616-18	100	118	218	22.31		39	197	236	29.14
	LOCAL	47	139	186	19.04		16	66	82	10.12
	Total	-	-	-	100.00		-	-	-	100.00
Group VIII	MUSG 0702-17	105	117	222	24.18		62	138	200	24.91
	UNWMAZ 06-01	78	143	221	24.07		35	78	113	14.07
	105369-4	57	91	148	16.12		105	125	230	28.64
	MUSG 0609-47	63	74	137	14.92		70	114	184	22.91
	LOCAL	75	115	190	20.70		32	44	76	9.46
	Total	-	-	-	100.00		-	-	-	100.00
Group IX	W119 06-39	83	116	199	21.92		67	133	200	22.25
	UW119 06-79	71	99	170	18.72		23	103	126	14.02
	LO 323-1	64	149	213	23.46		69	206	275	30.59
	MAFUTHA-1	70	125	195	21.48		70	144	214	23.80
	LOCAL	42	89	131	14.43		21	63	84	9.34
	Total	-	-	-	100.00		-	-	-	100.00
Group X	105260G07-8	0	97	97	27.64		0	90	90	26.47
	UW119-06-204	0	82	82	23.36		0	72	72	21.18
	MUSG0610-16	0	70	70	19.94		0	92	92	27.06
	MUSG0613-23	0	101	101	28.77		0	86	86	25.29
	LOCAL	0	1	1	0.28		0	0	0	0.00
	Total	-	-	-	100.00		-	-	-	100.00
Group XI	UW11906-296	21	39	60	12.50		26	84	110	27.50
	Ujonathan0623	35	42	77	16.04		27	77	104	26.00
	105257-3	105	111	216	45.00		23	63	86	21.50
	W119-15	24	36	60	12.50		24	75	99	24.75
	LOCAL	35	32	67	13.96		0	1	1	0.25
	Total	-	-	-	100.00		-	-	-	100.00
Group XII	W119-12	31	47	78	16.25		26	63	89	22.25
	Tacna-2	52	76	128	26.67		27	69	96	24.00
	Musg0606-07	43	35	78	16.25		30	93	123	30.75
	Uxiphone06-1	47	64	111	23.13		13	48	61	15.25
	LOCAL	47	38	85	17.71		4	27	31	7.75
	Total	-	-	-	100.00		-	-	-	100.00

CONCLUSIONS

Sixty four clones from all sweetpotatoes advanced yield trial established from 2005/06 to 2009/10 were evaluated by IIAM in collaboration with the International Potato Center in Umbelúzi (Maputo province), Chókwè (Gaza province), Gurué (Zambezia province), and Angónia (Tete province). Although the secondary information showed some similarities between the environment Umbelúzi/Chókwè, and Gurué/Angónia, the results on the GxE analysis for the total root yield have perfectly demonstrated that neither environment is stable compared to each other in terms of agro-ecological conditions. Genotypes selected in Angónia are not very sensitive to changes in environment, which means that those clones that perform well in Angónia have greater chance to perform in similar worse conditions (value of *the regression coefficient* very low), while clones selected for Gurué are those with chances to perform well in high yielding environment, that is they are very sensitive to changes in the environments. Clones selected in Umbelúzi are more likely to perform in all environments, but with tendency do well in those with relatively good planting conditions (value of *the regression coefficient* close and greater than 1).

Clones with good performance in each one of the locations were selected. Those clones which performed well in more than one location, 23 clones, were submitted to GxE analysis. From this analysis 15 clones were selected, being 6 (51- MUSG 0616-18, 26- UW119 06-175, 23- UW119 06-79, 27- UW119 06-140, 38- Tacna-2 and 43-Kakamega-7) with broad yield stability (value of *the regression coefficient* around 1).

Apart from these 6 genotypes with broad yield stability across the 4 environments under description, 5 genotypes were selected for local adaptation in Umbelúzi (13- UW119 06-284, 41-105369-4, 49-w119-15, 47- Mafutha-1,and 50- Ejumula -25), 4 clones in Chókwè (10- MUSG 0603-02, 34- UW119 06-289, 49-w119-15, and 50- Ejumula -25), 5 genotypes in Gurué (13- UW119 06-284, 34- UW119 06-289, 37- LO323-1, 41-105369-4, and 47- Mafutha-1), and 4 clones in Angónia (13- UW119 06-284, 37- LO323-1, 47- Mafutha-1, and 59- Ejumula). Note that the genotypes 13-UW119 06-284 and 47- Mafutha-1 were selected for 3 locations (Umbelúzi, Gurué, and Angónia), while the clones 41-105369-4 (Umbelúzi and Gurué), 49-w119-15 and 50-Ejumula-25 (Umbelúzi and Chókwè), 34- UW119 06-289 (Gurué and Chókwè), were selected for 2 locations.

In summary, over the initial 64 clones in the trial, 15 were selected for all 4 environments in study. Among them, 6 had broad stability, 3 were found to be stable for Umbelúzi, Gurué, and Angónia, while 4 clones performed well in at least 2 environments.

A conservation test of the 64 clones was carried out, and among the 15 selected clones to be released in general, most of the clones in the trial have presented good results, as the lost of weight 35 days after harvesting did not go beyond the 50%. The worst clones among those selected for release were the clones 13 (UW119 06-284), 59 (Ejumula) with losses of weight 35 day after harvesting around the 80% and 90% respectively.

The results of the on-farm trials of the 64 clones evaluated by 146 farmers indicated that with exception to 3 clones out of the 64 clones, all of them were classified as better than the local clones in the four areas where the trial was established and therefore, all 15 selected clones under the ranking and index selection were better than the local varieties for root and vine attributes. One of the most important results of these on-farm trails was the strong indication of a goodness fit of the data (internal validity) collected over the years to lead the final potential 64 clones that were consensually evaluated as better than the local varieties.

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Annex 1. Morphological Characterization of the Vines and Roots of the 15 Selected Clones, Multi-location Trial of 64 Clones, 2009/10 Cropping Season

Genotype	Plant Type	Ground cover	Vine inter-node length	Vine inter-node diameter	Predominant vine color	Second vine color
10 MUSGO603-02	Semi-erect	Medium	Very short	Thin	Green	Green base/Green tip
38 Tacna-2	Semi-erect	Medium	Very short	Thin	Green with few purple spots	Green base/Green tip
34 UW119 06-289	Semi-erect	Medium	Very short	Thin	Green with few purple spots	Green base/Green tip
41 105369-4	Erect	High	Very short	Thin	Green with few purple spots	Green purple tip
23 UW119 06-79	Semi-erect	Medium	Very short	Thin	Green	Green base/Green tip
13 UW119 06-284	Semi-erect	High	Short	Thin	Green	Green base/Green tip
59 Ejumula	Erect	Low	Very short	Very thin	Green	Green base/Green tip
26 UW119 06-175	Semi-erect	Medium	Very short	Very thin	Green	Green base/Green tip
50 Ejumula-25	Erect	Low	Very short	Thin	Green	Green base/Green tip
43 Kakamega-7	Semi-erect	High	Very short	Thin	Totally purple	Purple base
49 W119 – 15	Semi-erect	Medium	Very short	Very thin	Totally purple	Purple base/purple nodes
51 MUSG 0616-18	Semi-erect	High	Intermediate	Intermediate	Green	Green base/Green tip
27 UW119 06- 140	Semi-erect	High	Very short	Thin	Green	Absent
37 LO323-1	Erect	Medium	Very short	Thin	Totally purple	Purple base
47 Mafutha -1	Semi-erect	High	Short	Thin	Green	Purple base/purple tip

Genotype	Vine tip pubescence	General outline of the leaf	Leaf lobes type	Leaf lobe number	Shape of central leaf lobe	Mature leaf size
10 MUSGO603-02	Absent	Hastate	Moderate	5	Elliptic	Medium
38 Tacna-2	Absent	Lobed	Moderate	5	Semi-elliptic	Medium
34 UW119 06-289	Sparse	Lobed	Moderate	5	Semi-elliptic	Medium
41 105369-4	Absent	Lobed	Deep	5	Elliptic	Medium
23 UW119 06-79	Absent	Triangular	Slight	5	Semi-elliptic	Small
13 UW119 06-284	Absent	Lobed	Deep	5	Semi-elliptic	Medium
59 Ejumula	Absent	Lobed	Moderate	5	Triangular	Small
26 UW119 06-175	Absent	Lobed	Moderate	5	Semi-elliptic	Small
50 Ejumula-25	Absent	Lobed	Moderate	7	Semi-elliptic	Medium
43 Kakamega-7	Absent	Hastate	Deep	5	Oblanceolate	Medium

Genotype	Vine tip pubescence	General outline of the leaf	Leaf lobes type	Leaf lobe number	Shape of central leaf lobe	Mature leaf size
49 W119 – 15	Absent	Lobed	Moderate	5	Lanceolate	Small
51 MUSG 0616-18	Sparse	Cordate	No lobes	1	Thoothed	Medium
27 UW119 06- 140	Sparse	Lobed	Deep	5	Oblanceolate	Medium
37 LO323-1	Absent	Almost divided	Very deep	5	Linear	Medium
47 Mafutha -1	Absent	Hastate	Slight	3	Semi-elliptic	Medium

Genotype	Abaxial leaf vein pigmentation	Mature leaf color	Immature leaf color	Petiole length	Petiole pigmentation	Storage root shape
10 MUSGO603-02	Green	Green	Green with purple edge	Short	Green	Obovate
38 Tacna -2	All veins mostly or totally purple	Green	Slightly purple	Short	Some petioles purple, others green	Obovate
34 UW119 06-289	Green	Green	Green with purple edge	Short	Green	Obovate
41 105369-4	All veins partially purple	Green	Green with purple edge	Short	Green with near leaf	Round elliptic
23 UW119 06-79	Green	Green	Green with purple edge	Short	Green	Elliptic
13 UW119 06-284	Green	Green	Green with purple edge	Short	Green	Round elliptic
59 Ejumula	Green	Green	Green with purple edge	Very short	Green	Obovate
26 UW119 06-175	Green	Green	Green with purple edge	Very short	Green	Elliptic
50 Ejumula-25	Green	Green	Green with purple edge	Short	Green	Obovate
43 Kakamega-7	All veins totally purple	Green	Green with purple edge	Short	Totally or mostly purple	Obovate
49 W119 – 15	Green	Green with purple veins on upper surface	Green with purple edge	Short	Totally or mostly purple	Round elliptic

Genotype	Abaxial leaf vein pigmentation	Mature leaf color	Immature leaf color	Petiole length	Petiole pigmentation	Storage root shape
51 MUSG 0616-18	Green	Slightly purple	Green with purple edge	Short	Green	Long elliptic
27 UW119 06- 140	Green	Green	Green with purple edge	Short	Green	Elliptic
37 LO323-1	Main rib partially purple	Green	Green with purple edge	Short	Totally or mostly purple	Long elliptic
47 Mafutha -1	Green	Green	Green	Short	Green	Long oblong

Genotype	Storage root surface defects	Storage root cortex thickness	Predominant skin color	Intensity of predominant skin color	Secondary skin color	Predominant flesh color
10 MUSGO603-02	Absent	intermediate	Brownish orange	Intermediate	Absent	Intermediate orange
38 Tacna-2	Absent	Thin	Purple-red	Intermediate	Absent	Strongly pigmented with anthocyanins
34 UW119 06-289	Absent	Intermediate	Brownish orange	Pale	Absent	Intermediate orange
41 105369-4	Absent	Intermediate	Purple-red	Pale	Purple-red	Pale orange
23 UW119 06-79	Absent	Thin	Purple-red	Dark	Red	Pale orange
13 UW119 06-284	Shallow longitudinal grooves	Thick	Brownish orange	Pale	Absent	Intermediate orange
59 Ejumula	Shallow longitudinal grooves	Very thick	Purple-red	Intermediate	Red	Intermediate orange
26 UW119 06-175	Shallow horizontal constrictions	Intermediate	Brownish orange	Pale	Absent	Pale orange
50 Ejumula-25	Absent	Thin	Brownish orange	Pale	Absent	Pale orange
43 Kakamega-7	Shallow longitudinal grooves	Thin	Purple-red	Intermediate	Purple-red	Pale orange

Genotype	Storage root surface defects	Storage root cortex thickness	Predominant skin color	Intensity of predominant skin color	Secondary skin color	Predominant flesh color
49 W119 – 15	Deep longitudinal grooves	Intermediate	Brownish orange	Intermediate	Brownish orange	Intermediate orange
51 MUSG 0616-18	Absent	Thick	Brownish orange	Intermediate	Absent	Dark orange
27 UW119 06- 140	Absent	Thin	Brownish orange	Pale	Absent	Intermediate orange
37 LO323-1	Absent	Thin	Brownish orange	Pale	Absent	Intermediate orange
47 Mafutha -1	Absent	Thin	Brownish orange	Pale	Absent	Intermediate orange

Genotype	Secondary flesh color	Distribution of secondary flesh color	Frequency of roots per plant	Roots medium weight	Flowering habit	Flower color
10 MUSGO603-02	Yellow	Scattered spots in flesh	15	0.21Kg	Sparse	White limb with purple throat
38 Tacna-2	Orange	Scattered spots in flesh	5	0.48Kg	Profuse	Pale purple limb with purple throat
34 UW119 06-289	Orange	Scattered spots in flesh	5	0.45Kg	Sparse	
41 105369-4	Orange	Covering most of the flesh	4	0.51Kg	Moderate	Pale purple limb with purple throat
23 UW119 06-79	Yellow	Ring and other areas in flesh	4	0.49Kg	Sparse	Pale purple limb with purple throat
13 UW119 06-284	Orange	Covering most of the flesh	5	0.32Kg	Sparse	
59 Ejumula	Orange	Broad ring in flesh	4	0.32Kg	Sparse	Pale purple limb with purple throat

Genotype	Secondary flesh color	Distribution of secondary flesh color	Frequency of roots per plant	Roots medium weight	Flowering habit	Flower color
26 UW119 06-175	Yellow	Covering most of the flesh	6	0.41Kg	Sparse	Pale purple limb with purple throat
50 Ejumula-25	Yellow	Covering most of the flesh	6	0.41Kg	Sparse	Pale purple limb with purple throat
43 Kakamega-7	Yellow	Ring and other areas in flesh	7	0.30Kg	Sparse	Pale purple limb with purple throat
49 W119 – 15	Orange	Covering all flesh	6	0.56Kg	Moderate	Pale purple limb with purple throat
51 MUSG 0616-18	Orange	Scattered spots in flesh	5	0.36Kg	Moderate	Pale purple limb with purple throat
27 UW119 06- 140	Orange	Scattered spots in flesh	5	0.34Kg	Sparse	Pale purple limb with purple throat
37 LO323-1	Orange	Covering most of the flesh	4	0.53Kg	Sparse	Pale purple limb with purple throat
47 Mafutha -1	Orange	Scattered spots in flesh	5	0.4Kg	Sparse	Pale purple limb with purple throat

Genotype	Shape of limp	Sepal shape	Color of stigma	Nematode	Weevil big	Weevil small
10 MUSGO603-02	Rounded	Ovate	White	Absent		
38 Tacna-2	Rounded	Obovate	White	Absent	Present but insignificant	Absent
34 UW119 06-289				Absent	Present but in low scale	Absent
41 105369-4	Pentagonal	Obovate	White	Absent	Present but insignificant	Absent
23 UW119 06-79	Semi-stellate	Obovate	White	Absent	Presente mas com danos ligeiros	Absent
13 UW119 06-284				Absent	Present but insignificant	Absent
59 Ejumula	Pentagonal	Obovate	White	Absent	Present but insignificant	Absent
26 UW119 06-175	Pentagonal	Lanceolate	White	Absent	Present but insignificant	Absent
50 Ejumula -25	Pentagonal	Obovate	White	Absent	Absent	Absent
43 Kakamega -7	Pentagonal	Elliptic	White	Absent	Absent	Absent

Genotype	Shape of limp	Sepal shape	Color of stigma	Nematode	Weevil big	Weevil small
49 W119 – 15	Pentagonal	Obovate	White	Absent	Present but insignificant	Absent
51 MUSG 0616-18	Semi-stellate	Ovate	White	Absent	Absent	Absent
27 UW119 06- 140	Pentagonal	Obovate	White	Absent	Present but insignificant	Absent
37 LO323-1	Pentagonal	Lanceolate	White	Absent	Present but insignificant	
47 Mafutha -1	Pentagonal	Obovate	White	Absent	Absent	Absent

Genotype	Root rot	Mal do pe	Dwarfism	Streptomyces ipomoea	Erwinia chrysanthemi	Mosaic
10 MUSGO603-02	Absent	Absent				Absent
38 Tacna-2	Absent	Absent	Absent	Absent	Absent	Absent
34 UW119 06-289	Absent	Absent	Absent	Absent	Absent	Absent
41 105369-4	Absent	Absent	Absent	Absent	Absent	Absent
23 UW119 06-79	Present	Absent	Absent	Absent	Absent	Present
13 UW119 06-284	Absent	Absent	Absent	Absent	Absent	Absent
59 Ejumula	Absent	Absent	Absent	Absent	Absent	Present
26 UW119 06-175	Absent	Absent	Absent	Absent	Absent	Present
50 Ejumula-25	Absent	Absent	Absent	Absent	Absent	Absent
43 Kakamega-7	Present	Absent	Absent	Absent	Absent	Absent
49 W119 – 15	Absent	Absent	Absent	Absent	Absent	Absent
51 MUSG 0616-18	Absent	Absent	Absent	Absent	Absent	Absent
27 UW119 06- 140	Absent	Absent	Absent	Absent	Absent	Absent
37 LO323-1	Absent	Absent	Absent	Absent	Absent	Absent
47 Mafutha -1	Absent	Absent	Absent	Absent	Absent	Absent

Annex 2. Images of the Vines and Roots of the 15 Selected Clones, Multi-location Trial of 64 Clones, 2009/10 Cropping Season

Figure 8. Leaves, flower, and storage root of the genotype *10-MUSGO603-02*

Figure 9. Leaves, flower, and storage root of the genotype *38-TACNA-2*

Figure 10. Leaves and storage root of the genotype *34-UW119 06-289*

Figure 11. Leaves, flower, and storage root of the genotype *41-105369-4*

Figure 12. Leaves and storage root of the genotype *59-EJUMULA*

Figure 13. Leaves and storage root of the genotype *23-UW119 06-79*

Figure 14. Leaves and storage root of the genotype *50-EJUMULA-25*

Figure 15. Leaves and storage root of the genotype *26-UW119 06-175*

Figure 16. Leaves and storage root of the genotype *43-KAKAMEGA*

Figure 17. Leaves, flower, and storage root of the genotype *49-W119-15*

Figure 18. Leaves, flower, and storage root of the genotype *51-MUSG 0616-18*

Figure 19. Leaves, flower, and storage root of the genotype *27-UW119 06-140*

Figure 20. Leaves, flower, and storage root of the genotype *37-LO323-1*

Figure 21. Leaves and storage root of the genotype *47-MAFUTHA-1*

Figure 22. Leaves of the genotype *13-UW119 06-284*