African Journal of Agricultural Research Vol. 3 (10), pp. 672-676, October, 2008
Available online at http://www.academicjournals.org/AJAR
ISSN 1991- 637X © 2008 Academic Journals

Full Length Research Paper

Evaluation and release of new sweet potato varieties through farmer participatory selection

Laurie, S.M.* and Magoro, M.D.

Agricultural Research Council (ARC) - Vegetable and Ornamental Plant, Pretoria, South Africa.

Accepted 24 September, 2008

Low yields and yield instability due to the use of old land races were limiting sweet potato production by resource-poor farmers in South Africa. Participatory Varietal Selection (PVS) is considered an appropriate method to develop varieties for low input agricultural systems. The aim of this study was to evaluate advanced sweet potato genotypes, using PVS, to determine their adaptability and acceptability in targeted production areas. Advanced sweet potato lines and varieties were tested in multi-location trials, maintained collaboratively by resource-poor farmers, agricultural extension officers and research technicians at six sites across the period 2000/2001 to 2002/2003. This study resulted in varietal recommendations for six areas, the release of seven cream-fleshed varieties and one new orange-fleshed variety for alleviation of vitamin A deficiency. Farmer participation proved useful, though a number of shortcomings were identified and recommendations have been made to improve the procedure.

Key words: Multi-location trials, participatory varietal selection, sweet potato.

INTRODUCTION

Prior to 1980, the formal breeding sector had been of limited benefit to resource-poor farmers in agro-ecological and socio-economically marginal and variable environments, because the focus was on cash crops produced under favorable high input conditions (Bänzinger and Cooper, 2001). Farmer participation was initiated in the 1980's to encourage resource-poor farmer adoption of higher yielding varieties. Selection was based on released or near-release varieties (Witcombe, 1996), thus, Participatory Varietal Selection (PVS). PVS is a logical step before Participatory Plant Breeding (PPB), and is considered the most appropriate method to develop varieties for marginal, high stress environments, together with low input systems (Dawson et al., 2007). PVS can rapidly provide farmers with improved germplasm and the selected germplasm can flow into PPB. Farmer participation in the advanced stages of sweet potato varietal selection has been reported to be successful in Ethiopia, Kenya and Uganda (Shamebo and Belehu, 2000; Ndolo et al., 2001; Abidin, 2004).

In South Africa, sweet potato is a popular crop amongst resource-poor farmers. In a survey on the production and use of sweet potato during 1996/1997 and 1997/1998 in 14 areas, low yields and yield instability, as a result of using old landraces, were found to be some of the main factors hindering sweet potato production (Thompson et al., 1999). The most important traits used by farmers to select sweet potato varieties were a sweet taste, dry texture and good yield (Domola, 2003). Breeding aimed at these traits commenced in 1992 in South Africa.

The aim of this study was to test advanced sweet potato lines, including imported genotypes, using PVS to determine their adaptability and acceptability, and recommend varieties for production in targeted areas. It is believed that the availability of varieties with improved yield, taste and adaptation to low input conditions will facilitate sustainable sweet potato production in South Africa, thereby contributing to food security.

MATERIALS AND METHODS

Across 2000/2001 to 2002/2003, multi-location trials were established at six sites, in four provinces of South Africa. The Provincial Departments of Agriculture assisted with selection of sites where resource-poor farmer groups could participate, mostly communal gardens. Trials were conducted with one growing season per annum for two growing seasons at each site. The sites were

i.) Ditshilo and Disaneng community, Mafikeng (North West Province).

*Corresponding author. E-mail: slaurie@arc.agric.za.

Table 1. Marketable yield and taste results of 2001/2002 sweet potato trials at Mafikeng, Tompi Seleka and Venda, South Africa

Mafikeng	Yield	Cooked	Tompi Seleka	Yield	Cooked	Venda	Yield	Cooked
Variety/Line	**t/ha**	**Taste**	**Variety/Line**	**t/ha**	**Taste**	**Variety/Line**	**t/ha**	**taste**
Ndou ~	14.2	Good	W-119 ~	48.2	Avg-Poor	Natal Red	9.5	Excellent
Blesbok	11.1	Poor	**Mokone ~**	34.6	Good	Mokone	9.4	Poor
Letlhabula ~	10.0	Avg – Poor	Phala	31.1	Poor	**Phala ~**	9.3	Avg-Good
W-119 ~	9.0	Good	1989-23-1	29.6	Poor	**Ndou ~**	9.0	Good
Monate ~	8.3	Good	**Excel ~**	29.6	Excellent	**Excel ~**	8.5	Good
Kenia	8.1	Avg	A45	27.2	Avg-Good	Kenya	8.1	Avg
1986-12-2	7.8	Very poor	**Mamphenyane~**	26.1	Good	Atacama	5.8	Poor
1989-23-1	6.9	Poor	Bosbok	25.7	Excellent	Mafutha	5.6	Excellent
Mafutha	6.9	Good	Natal Red	24.9	Excellent	Resisto	2.9	-
Bosbok	5.6	Good	Mafutha	22.8	Excellent	1997-18-1	2.8	-
Yan Shu 1	5.6	Excellent	Xushu 18	21.1	-	1987-17-3	1.8	-
1997-18-1	5.5	Avg	A2	20.9	-	Bosbok	1.5	-
CN1656-97	5.2	Poor	Ndou	18.2	-	ST87.030	1.4	-
1994-11-3	4.6	Avg – Poor	ST87.030	12.5	-	Amasi	0.9	-
A15	3.9	Good	1987-17-3	6.3	-	A59	0.7	-
Mean	7.51			25.26			5.14	
CV%	36.0			47.4			60.71	
LSD (P = 0.05)	4.52			16.64			5.23	

~ recommended varieties .

ii.) Vulindlela community, Pietermaritzburg (KwaZulu-Natal Province).
iii.) Thembalethu community, KwaMhlanga (Mpumalanga Province).
iv.) Tshiombo experimental site near Thohoyandou, Venda. (Limpopo Province).
v.) Dingleydale community, Bushbuckridge (Limpopo Province).
vi.) Tompi Seleka College of Agriculture, Marble Hall area (Limpopo Province).

A total of 22 ARC lines, two land races, four local cultivars and eight imported varieties, were identified from the breeding program of the Agricultural Research Council (ARC) (Laurie and Van den Berg, 2002) and three lines from the program of the University of KwaZulu-Natal. The control cultivars were Mafutha (preferred by resource-poor farmers) and Blesbok or Bosbok (popular commercial cultivars). The varieties and lines tested varied at the different localities as determined by the availability of planting material, as well as preference. Cuttings were propagated, from a virus-tested source, in the field at the ARC for establishment of the trials during November - December.

Each trial had 15 entries planted with three replicates of 30 plants in a randomized block design. A between-row spacing of 1 m and in-row spacing of 0.3 m were used. Fertilization amounted to 500 kg/ha fertilizer mix at planting and two top dressings of 150 kg/ha ammonium nitrate. Cultivation was done by tractor or hand implements, depending on local practices. Weed control was done manually by hand or by hoe. No chemical control was applied. Supplementary irrigation was applied by furrow irrigation, buckets or hoses. Planting and trial maintenance was done by ARC research technicians, agricultural extension officers and the farmers.

At harvesting, 4.5 to 6 months after planting, data collected included root colour, shape, defects, yield (marketable and unmarketable roots) and taste. Farmers and agricultural extension officers assisted with this process. Farmers' days were held where the taste of the cooked sweet potatoes of the various genotypes were evaluated. The least significant difference (LSD) and coefficient of variation were calculated using Genstat 7.2 ANOVA. Treatment means were separated using Fishers' protected t-test LSD.

RESULTS

Results from the second season of the trials are presented in Tables 1 and 2, as the final recommendations were made from these results. The mean yields of the trials in communal gardens were low, 3.9 to 9.5 t/ha, compared to 25.2 t/ha at the experimental station at Tompi Seleka. The parameters used for recommending varieties for production in each area were marketable yield and taste. Three to four varieties were recommended at each location and are highlighted in the tables.

At Mafikeng, Ndou produced the highest yield and had good taste (Table 1). Other recommended varieties were W-119, an orange-fleshed variety from USA, and Monate. Letlhabula could be an option for farmers more interested in yield than taste. The Tompi Seleka trial had a number of good performing orange-fleshed varieties, e.g. W-119 and Excel, which were accepted well. In contrast, the orange-fleshed line 1989-23-1, which had a low dry matter content resulting in a watery consistency after cooking, rated poorly in taste. Mokone was the recommended cream-fleshed variety for that area. In Venda, the landrace Natal Red performed well, but had a high percentage cracked roots (data not shown). As the same was observed in earlier years at Roodeplaat, it was not recommended. Instead Phala, Ndou and Excel were recommended for this area.

Table 2. Marketable yield and taste results of sweet potato trials at Vulindlela (2001/2002), Thembalethu (2002/2003) and Bushbuckridge (2002/3), South Africa

Vulindela	Yield	Cooked	Thembalethu	Yield	Cooked	Bushbuckridge	Yield	Cooked
Variety/Line	**t/ha**	**taste**	**Variety/Line**	**t/ha**	**Taste**	**Variety/Line**	**t/ha**	**taste**
W-119 ~	14.4	Avg	Blesbok	9.4	Very poor	**Monate** ~	9.5	Good-Avg
Letlhabula ~	14.4	Avg	**Phala** ~	8.3	Good-Avg	**Excel** ~	6.7	Very poor
Natal Red	14.1	Avg	1994-5-1	8.0	Avg-Poor	Phala	6.1	Good
A56	12.9	Poor	1994-8-1	7.0	Avg-Poor	**Serolane** ~	5.7	Good
Ndou ~	11.8	Excellent	**Ndou** ~	5.7	Excellent	**Ndou** ~	5.4	Avg-Good
A40	10.7	Avg - Good	1986-12-4	5.2	Poor	1994-5-1	5.5	Excellent
1989-23-1	9.8	Very poor	**Serolane** ~	4.8	Excellent	A15	5.2	Avg
Monate	9.8	Avg - Good	**W-119** ~	4.6	Excellent	Mokone	4.3	Avg-Poor
Amasi ~	9.7	Good	Monate	3.9	Good-Avg	W-119	3.7	Good- Excellent
ST87.030	6.9	Avg	Mafutha	3.7	Excellent	Mafutha	3.0	Excellent
Mafutha	6.1	Excellent	Mamphenyane	1.9	Excellent	1986-12-4	2.6	Good-Avg
Tacna	5.8	Avg	A-15	1.1	Excellent	Jewel	2.0	Very poor
Resisto	5.8	Excellent	Jewel	0.7	Avg-Poor	Blesbok	1.0	Avg-Poor
CN1656-97	5.7	Avg	Natal Red	0.0	Avg-Good	Natal Red	0.6	Good
Bosbok	5.3	Good				1994-8-1	0.0	Poor
Mean	9.54			4.6			3.93	
CV%	38.9			47.2			77.9	
LSD (P = 0.05)	6.2			3.65			5.12	

~ Recommended varieties.

At Vulindlela, again W-119 had the highest yield and was recommended together with Ndou and Amasi, with Letlhabula as an additional option (Table 2). The results for Thembalethu showed good performance by Phala and again Ndou. Serolane and W-119 were also recommended due to their excellent taste, despite having a slightly lower yield. At Bushbuckridge, Monate was the top variety, followed by Excel, Serolane and Ndou. The very high coefficient of variation at this location was most likely caused by the zero value for marketable yield of line 1994-8-1, as all the roots were graded in the unmarketable class, since insect damage had occurred (data not shown).

A total of seven cream-fleshed and three orange-fleshed varieties were recommended for the six sites. The flesh colour, skin colour and shape of these are shown in Table 3.

During the course of the trials, training sessions in cultivation practices of sweet potato were presented by ARC technicians. At four of the sites the farmers maintained the trials, resulting in hands-on experience in the cultivation of sweet potato. The farmers also named the recommended ARC lines (Table 3).

DISCUSSION

Through PVS, sweet potato varietal recommendations were made for six targeted areas from the results of the first set of multi-location trials conducted in South Africa to address the needs of resource-poor farmers. It is believed that the release of the new cream-fleshed varieties Ndou, Monate, Mokone, Letlhabula, Phala, Amasi and Mamphenyane will facilitate sustainable sweet potato production, thereby contributing to food security. Ndou was recommended at five locations and, therefore, was the most promising of the new releases. W-119 and Excel, the orange-fleshed varieties introduced from the USA, were recommended at four and three locations, respectively. In addition, the locally bred orange-fleshed variety Serolane was released for production at two locations. These contain high levels of pro-vitamin A and are used in addressing vitamin A deficiency (Low et al., 2007). At all the localities the orange-fleshed genotypes were well accepted, despite it being a new crop.

In these trials, Mafutha scored well with the taste evaluation, confirming its status as the cultivar with a taste preferred by resource-poor farmers, but with mediocre yield. Of the commercial control cultivars, Bosbok generally performed very poorly under these low input conditions. Blesbok produced good yields in all trial areas, except at Thembalethu, but the taste was rated as poor to very poor due to its low dry matter content resulting in a watery consistency after cooking. The new varieties should, therefore, better address the needs of the resource-poor sector. As a follow up of these trials, planting material of the new varieties was established in nurseries in the targeted areas to give farmers access to cuttings of the recommended varieties. Additional trials are to be conducted in other areas to expand varietal recommendations.

Table 3. Information on the naming, skin and flesh colours and root shape of varieties recommended for production by resource-poor farmers in South Africa

Variety name (breeding line nr)	Meaning of name	Indigenous language	Skin colour	Flesh colour	Storage root shape
Amasi (1985-6-3)	Full cream milk resembling the flesh colour of this variety	Zulu	Cream to pale brown	Cream, pale orange spots	Round elliptic to cylindrical
Letlhabula (1995-10-1)	Harvesting time	Tswana	Pale cream	Pale cream	Long elliptic to long obovate
Mamphenyane (1984-10-340)	A type of indigenous pumpkin with the same flesh colour	Pedi/Ndebele	Copper	Cream, slight pale orange	Elliptic to long elliptic
Mokone (1987-16-1)	A tribe in the Nebo area near Tompi Seleka	Pedi/Ndebele	Cream	Dark cream	Cylindrical to ovate
Monate (1989-17-1)	Sweet or nice	Tswana	Cream	Cream	Long elliptic to round elliptic
Ndou (1995-13-2)	The big one or elephant	Venda	Cream	Cream	Long elliptic to obovate
Phala (1984-2-201)	Impala, because of the purple skin like the old cultivar Impala	Venda	Bright purple	Cream, slight pale orange	Cylindrical to long elliptic
Serolane (1998-12-3)	Yellow	Pedi	Pale orange	Orange with yellow ring	Long obovate to long elliptic
Excel (USA)	n/a	n/a	Pale orange	Orange, yellow cortex	Long elliptic to elliptic
W-119 (USA)	n/a	n/a	Orange	Orange	Long elliptic to elliptic

Since the imported genotypes, Xushu 18 and Yan Shu 1 from China, CN1656-97 from Taiwan, Atacama, Tacna and ST87.030 from Peru, performed poorly and subsequently not recommended for production in South Africa, the value of locally bred varieties was emphasized.

The use of PVS proved to be a useful selection method. The strengths were farmer participation and training that resulted in a feeling of ownership (Weltzein et al., 2003), selection at the same low input farming conditions that farmers use, therefore addressing the needs of more marginalized farmers (Dawson et al., 2007), and a rapid and cost effective way to assess and select potential varieties was facilitated by the process (Abidin, 2004).

However, shortcomings were also identified, e.g. lack of uniformity of the trial plots (variation in soil fertility, non-uniform watering) and management of trials (gaps in plots, poor weeding and damage to plants during late weeding). Due to this, although significant differences were found in the marketable yield of varieties and lines in all the trials, the coefficient of variation was mostly high to very high, especially at Bushbuckridge. As a way of improving the scientific efficiency of this selection method, multi-location trials, in which farmers participate to ensure ownership, should first be conducted on experimental stations with transitionally controlled conditions over a period of two years. Thereafter, a small number of entries should progress to on-farm evaluation for final selection. Additionally, the evaluation phase preceding the multi-location trials could be conducted not only at the ARC, but also at two to three experimental stations. This is in agreement with decentralization of breeding as was recommended for low-input production systems (Dawson et al., 2007).

ACKNOWLEDGEMENTS

The ARC biometricians, ARC research technicians involved in the project, assistance of the personnel from the Provincial Departments of Agriculture and commitment of the farmers in the four communities are acknowledged. The project was funded by the ARC and Southern Africa Root Crops Research Network (SARRNET).

REFERENCES

Abidin PE (2004). Sweet potato breeding for northeast Uganda: Farmer varieties, farmer-participatory selection and stability of performance. PhD thesis Wageningen University, The Netherlands, pp. 69-86.

Bänzinger M, Cooper M (2001). Breeding for low input conditions and consequences for participatory breeding: Examples from tropical maize and wheat. Euphytica 122: 503-519.

Dawson JC, Murphy KM, Jones SS (2006). Decentralized selection and participatory approaches in plant breeding for low-input systems. Euphytica 160: 143-154.

Domola MJ (2003). Survey on characterisation of sweet potato viruses in South Africa. M. Inst Agrar (Plant Protection) thesis, University of Pretoria, South Africa, p.54.

Laurie SM, Van Den Berg AA (2002). A review of recent progress in breeding sweetpotato in South Africa for resource-poor farmers. In: Nakatani N, Komaki K (eds) 12th Symposium of International Society of Tropical Root Crops (ISTRC), 10-16 Sept 2000, Tsukuba, Japan.

Cultio Corporation, Ibaraki, Japan, pp. 216-219.
Low JW, Arimond M, Osman N, Cunguara B, Zano F, Tschirley D (2007). A food-based approach introducing orange-fleshed sweet potatoes increased vitamin A intake and serum retinol concentrations in young children in Mozambique. J. Nutr. 137:13209-11327.
Ndolo PJ, Mcharo T, Carey EE, Gichuki ST, Ndinya C, Maling'a J (2001). Participatory on-farm selection of sweetpotato varieties in Western Kenya. Afr. Crop Sci. J. 9:41-48.
Shamebo D, Belehu T (2000). Seven sweet potato varieties released in farmers' participatory assessment in Ethiopia. APA Conf. Proc. 5: 149-152.
Thompson GJ, Van der Mescht A, Naudè SP, Thompson AH, Nuijten E, Lubout P (1999). Sweet potato and cassava in the Kwazulu Natal Province of South Africa: a baseline study. In: Akoroda MO, Teri JM (eds) Proceedings of scientific workshop of SARRNET, 17 - 19 Aug 1998, Lusaka, Zambia. IITA, Ibadan, Nigeria, pp. 40-50.
Weltzein E, Smith ME, Meitzner LS, Sperling L (2003). Technical and institutional issues in participatory plant breeding – From the perspective of formal plant breeding. A global analysis of issues, results and current experience. PPB Monograph No. 1. PRGA, Cali, Columbia, pp. 1-10.
Witcombe JR (1996). Participatory approaches to plant breeding and selection. Biotech. Dev. Monit. 29: 2-6.