PERFORMANCE OF SWEETPOTATO VARIETIES IN NORTHERN NAMIBIA

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ABSTRACT

Shortage of drought tolerant sweetpotato varieties was identified as one of the main constraints to the production of this crop in Northern Namibia. The research was carried out to identify varieties that can produce reasonable yield under the rainfall conditions of Northern Namibia. Twelve varieties were planted in a Randomised Complete Block Design with three replications. Data were analysed using one-way ANOVA. The percentage of harvested tubers that were marketable and DM content were significantly different at 5%. The yields (t/ha) of tubers were not significantly different (p=0.013; 0.283) among the varieties at both testing sites, with the exception of Jewel which produced outstanding yield of 56.7t/ha at Mannheim. Centennial, Mafutha and Monate were promising varieties, obtaining marketable yields of 8.8t/ha, 5.2t/ha and 5.0t/ha respectively. In addition, Mafutha obtained 29%, and Centennial and Monate 28% of dry matter. Evaluation of taste and consumer acceptability of the promising varieties was therefore recommended for the next season.

INTRODUCTION

Sweetpotato *Ipomoea batatas* Lam (L) is a dicotyledonous plant belonging to the family *Convolvulaceae* (Onwueme and Charles, 1994). It originated in northern South America and southern parts of Central America (Laurie, 2003; Onwueme and Charles, 1994). Sweetpotato is now grown in many Southern African Development Community (SADC) countries, and is considered as an additional food crop in Malawi, Angola, Mozambique and the Democratic Republic of Congo (Laurie, 2003).

Sweetpotato grows well in all types of soils, although sandy, sandy loam and loam soils are the most suitable for the production of sweetpotato. The best growth is in soil with a pH between 5.6 and 6.6 (Onwueme and Charles, 1994); It requires 450-600mm of water, uniformly distributed over the season (ARC, 2003; Onwueme and Charles, 1994; Horticultural Research Institute, 1975). The first two to eight weeks after planting are the critical stages when sweetpotato needs more water for the formation and enlargement of tubers (ARC, 2003; Onwueme and Charles, 1994). If moisture stress occurs during these stages, the tubers formed do not enlarge but become lignified and turn into pencil roots.

Sweetpotato is regarded as additional food, and is mainly grown for home consumption in Northern Namibia. The average annual rainfall in Northern Namibia varies from 350 to 550mm, with erratic and unequal distribution over the season (Mendelsohn *et al.*, 1997; Cunningham *et al.*, 1992). Most of the soils are sandy and poor in major nutrients.

A baseline survey on the production of sweetpotato in Northern Namibia was carried out during 1996, and the results revealed that sweetpotato is the fourth most important crop after pearl millet, sorghum and maize (Lenhardt and Rusch, 1996; Rusch, 1998, 1999). Local varieties were used. However, due to the frequent occurrence of long dry seasons in Northern Namibia, stocks of planting materials have not survived and varieties have been lost. Therefore the shortage of drought tolerant varieties was identified as one of the main constraints to the expansion of sweetpotato production (Lenhardt and Rusch, 1996; Rusch, 1998, 1999).

Since 1996/97, the Namibian Root Crop Research Project has conducted Variety Evaluation Trials to identify varieties that are suitable for the harsh climatic conditions of Northern Namibia. Varieties Blesbok, Ribbok, Yan shu 1 and Xushu 18 produced good yields during trials from 1996/97 to 1998/1999, and were therefore recommended for production in Northern Namibia (Braun, 2000, 2001; Laurie *et al.*, 2002). However, considering the erratic rainfall in Northern Namibia, the variety evaluation program continued to evaluate more varieties that suit the prevailing environment. The objective of the research was to identify varieties that are adaptable to lower rainfall areas, produce reasonable and marketable yields, and produce tubers with reasonable dry matter content.

MATERIALS AND METHODS

Site selection

The trials were conducted at research stations located across Northern Namibia. During the 2003/04 season, Advanced Variety Trials were conducted at Mannheim Research Station in Oshikoto Region and at Ongwediva Rural Development Centre (ORDC) in Oshana Region. Soil samples were taken two months before planting and analysed in the soil laboratory at the Ministry of Agriculture, Water and Forestry, Windhoek. The results of the soil analysis are presented in Table1.

Trial design

Twelve varieties were tested in the Advanced Variety Evaluation Trials. The experimental set-up followed a Randomised Complete Block Design (Gomez & Gomez, 1976) with three replications. The treatments were represented by varieties; and each treatment consisted of two rows of 4.5 m long, with spacing of 0.30 m within the rows. The space between the ridges was 1m. The entire two rows represent a net plot. Blesbok, one of the pre-released varieties (Braun 2000, 2001) was used as a control. Names, origin and characteristics of the varieties evaluated in the Advanced Variety Trials are presented in Table 4.

Table1. Soil analysis at various research stations

	pH	N%	P ppm	K ppm	Ca ppm	Mg ppm	Na ppm	OM	Texture	Sand%	Clay%	Silt%
ORDC	6.83		0.74	72	248	79	14	0.58	sand	93.2	1.9	5.0
Mannheim	7.89	0.039	52.35	128	3173	512	49	0.61	loamy sand	79.5	13.1	7.4

Table 2. The rainfall recorded at the testing sites during the 2003/04 season, including the rainfall received after planting

Months	2003/04 season	
	Mannheim	Ongwediva (ORDC)
October	13	28
November	57	0
December	37	283.3
January	64	227.2
February	102	80
March	110	0
April	0	0
May	0	0
June	0	0
Total	383	618.5
Rainfall received after planting	276	307.2

Trial management

Tip cuttings were used as planting material and were planted on ridges. The trial was planted on the 7th and 12th January 2004 and harvested on the 7th and 2nd June 2004 at ORDC and Mannheim Research Station respectively. NPK 2:3:2 (22) fertilizer was broadcast immediately before planting at the rate of 300 kg/ha, that can be calculated as 19 kg N, 28 kg P and 19 kg K. The potassium nitrate was applied as side dressing eight weeks after planting at the rate of 200 kg/ha. Weeding was done regularly as weeds appeared. The trial was rain fed at all stations. Rainfall figures are given in Table 2.

Data collection and analysis

Plant counts were done 14 days after planting (DAP) and also during harvest. The percentage of the surviving vines 14 DAP and also at harvest were calculated against the vines that were planted. During harvesting, the harvested tubers were sorted into marketable tubers, very small tubers, damaged tubers, and cracked tubers. Marketable tubers were those that weighed more than 100 g, and were free from cracks, weevil infection, and other damage. The total tubers encompass all the tubers harvested. The percentages of the marketable tubers were calculated against the total tubers. All tuber categories were weighed and the total yield was the sum of the weighed tubers.

The dry matter (DM) content of the tubers was determined at Mannheim Research Station where a drying oven is available. The tubers grouped per variety per replication were peeled and cut into cubes. The sample of cubes weighed approximately 300 g and was dried in the oven at 65°C for 48 hours. Data on the survival yield performance and dry matter percentages were analysed using one-way ANOVA. The calculations used are presented in Table 3.

RESULTS AND DISCUSSION

The varieties were evaluated based on the record of vines that survived 14 DAP and also at harvest, average tubers produced per plant, percentage of marketable tubers, total yield and dry matter content percentage.

Adaptability of the varieties was determined by the survival percentage 14 DAP and at harvest. Survival percentage is the planted vines that were still alive 14 DAP. There was a significant difference of 5% in survival percentages among the varieties tested at both testing sites (Figure 1). Good survival percentage was recorded at ORDC where Mafutha and Kandee recorded 100% establishment, while Centennial, Kemb 10 and Resisto showed 96.3% survival. Monate survived with 94.4%. Blesbok, a pre-released variety that was used as a control, survived poorly at ORDC with 87% compared to Mafutha, Kandee, Kemb 10 and Resisto. However, Blesbok showed a significant improvement with 94.4% survival at Mannheim Research Station. 1992–4–2, had a 97.8% survival, higher than all other varieties tested at Mannheim Research Station. Kemb10, Mafutha and Monate also established well at Mannheim Research Station with 94.5%, 93.4% and 93.3% respectively, while Centennial and Jewel had 88.9%. Kandee and Resisto on the other hand, although surviving well at ORDC, had a significantly lower survival rate at Mannheim Research Station, with 62.2% and 61.1% respectively.

The survival rate at harvest is the planted vines that survived, grew and contributed to the harvest. Figure 2 indicates that harvesting percentages were significantly different at 5% between the varieties at both testing sites. The survival rate at harvest at Mannheim Research Station was slightly lower than at ORDC, and the highest survival rate was recorded from 1992–4–2, with 90.0%, followed by Mafutha, Centennial and Monate with 88.9, 81.1 and 80.0% respectively. However at ORDC, Mafutha and Monate got 92.6 and 87.0% respectively, while Kemb 10 and Centennial obtained 85.2%. Good rainfall received at ORDC during the month of January resulted in good establishment and harvesting percentage at ORDC, in

Table 3. Calculation of different variables

Variable	Formula used
Survival percentage 14 DAP	(number of plant stands 14 DAP/number of vines planted) X 100
Survival percentage at harvest	(number of plant stands during harvest/number of vines planted) X 100
Average tubers per plant	(number of tubers in a net plot/plant stands in the net plot during harvest)
Percentage marketable tubers	(number of tubers that were marketable /total number of tubers harvested) X 100
Yield of marketable tubers (t/ha)	(weight of tubers that were marketable X 10000m^2)/ plot size
Percentage DM	(dry weight/ fresh weight) X 100

Table 4. Names, origins and characteristics of sweetpotato varieties used in the Advanced Variety Trials during 2003/04

Name	Origin	Tuber skin colour	Tuber flesh colour
Blesbok	South Africa	Pale purple	Cream white
Mafutha	South Africa	Intermediate pink	Cream with orange spots
1989–17–1 (Monate)	South Africa	Pale pink	Yellow to cream
Centennial	USA	Orange	Dark orange with yellow ring
Excel	USA	Orange	Orange with yellow ring and yellow spots central
Jewel	USA	Orange	Light orange with milky spots
Kandee	USA	Orange	Orange with yellow spots
Kamb 10	Kenya	Pale yellow	Pale yellow
Resisto	USA	Red	Dark orange
TIS 3290	IITA	Pale yellow	Pale yellow
Virovisky	South Africa	Pale red	Yellow with orange spots
1992–4–2	South Africa	Pale cream	Cream with yellow spots

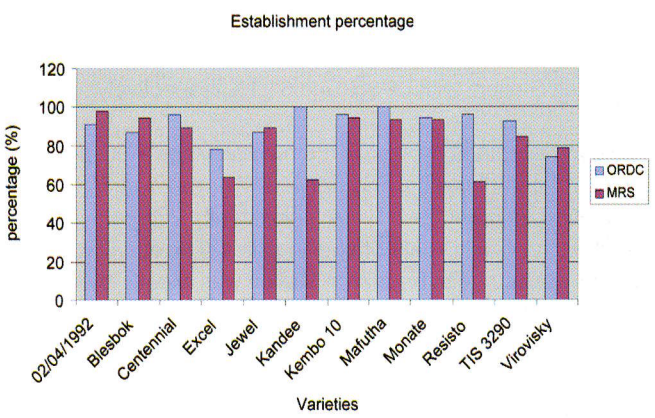

Figure 1. Survival percentage 14 DAP of the sweetpotato varieties evaluated at ORDC and Mannheim Research Station (MRS) 2003/04.

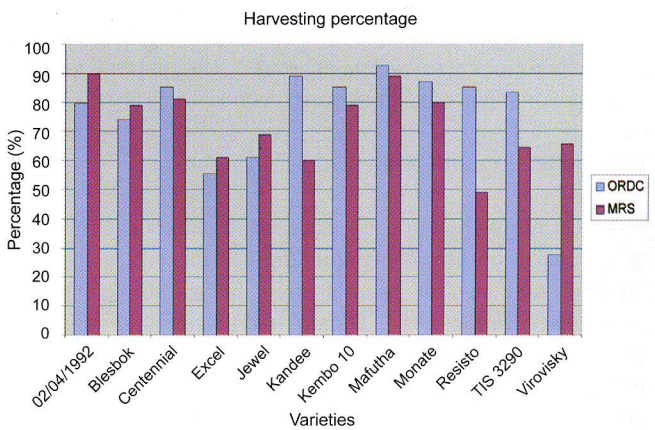

Figure 2. Survival percentage at harvest of the sweetpotato varieties evaluated at ORDC and Mannheim Research Station (MRS) 2003/04.

sharp contrast to Mannheim Research Station where poor rainfall was received.

Yield performance is indicated by the number and the weight of tubers produced. The average number of tubers indicates the yield potential of the varieties. The varieties that produce a large number of tubers tend to have high yields. Figure 3 indicates significant differences at 5% for the average number of tubers per plant at Mannheim Research Station, but there were no significant differences (P=0.014) at ORDC. Variety 1992–4–2 produced the largest number of tubers per plant at both testing sites. It produced 6 and 4.2 average tubers per plant at ORDC and Mannheim Research Station respectively. This was significantly higher than all other varieties with the exception of Jewel, which produced 3.8 at ORDC, and Blesbok (3.5), Kandee (2.7) and Jewel (2.6) at Mannheim Research Station. Excel, Kemb 10 and TIS3290 produced the lowest yield of tubers at both sites. Kemb 10 was observed to have a large number of pencil roots at ORDC. This indicates that with sufficient rainfall, good yield could be obtained from Kemb 10.

The average number of tubers implies yield potential of the variety and the percentage of marketable tubers relates the yield potential to early maturity. Varieties that produce higher portions of marketable tubers are considered to have a short growing period. The short growing varieties are the most suitable varieties for Northern Namibia where a short rainfall season is experienced. The percentage of tubers that were marketable was significantly different in all varieties at 5% at both stations (Figure 4). There were no serious threats from weevils or other damage, and the reduction in the percentage of marketable tubers was mainly due to the large number of small tubers that were less than 100 g. Variety 1992–4–2, produced the largest number of tubers at both sites, but only a few of the tubers were marketable with 18.9% and 56.6% at ORDC and Mannheim Research Station respectively. Jewel, Blesbok, Monate, Centennial and Mafutha, however respectively produced tubers with 85.2, 80.2, 78.5, 73.7 and 70.9% marketable at Mannheim Research Station. Furthermore, there were few marketable tubers at ORDC, where a mean of 28.6% was obtained (Table 5). Monate produced 62.2%.

Table 6. The percentage DM of the sweetpotato varieties evaluated in Advanced Variety Trials at Mannheim Research Station 2003/04

Variety	Percentage DM
02/04/1992	24.9
Blesbok	24.667
Centennial	27.567
Excel	27.333
Jewel	26.133
Kandee	20.533
Kembo 10	21.000
Mafutha	29.333
Monate	27.767
Reisito	25.467
Tis 3290	21.467
Virovisky	24.233

The yield denotes the weight of the tubers that were marketable. The varieties that produced tubers with higher weight implied that individual tubers have a large portion of flesh, which contributes to food in the household. There were no significant differences (5%) in yield of marketable tubers (t/ha) produced by varieties at both stations, (P= 0.020 and P= 0.280 at ORDC and Mannheim Research Station respectively), with the exception of Jewel which was significantly higher than all varieties at Mannheim (Figure 5). The average yield was at 1.2 t/ha and 8.4 t/ha at ORDC and Mannheim Research Station respectively (Table 5), lower than the average yield of 11 t/ha obtained at Omahenene Research Station during 1998 (Rusch, 1999). Considering the optimum soil pH required for sweetpotato which is 5.6 to 6.6 (Onweme and Charles, 1994; Horticultural Research Insititute, 1975), the pH 6.83 and 7.83 for ORDC and Mannheim respectively, is much higher than required. Therefore this could also be one of the contributing factors to the lower yield obtained. In spite of that, the soil pH at Mannheim Research Station is much higher than that of ORDC. However, the soil texture is loamy sand, and contains reasonable amounts of potassium, required for tuber formation and development, unlike the soil texture at ORDC which is sandy and poor in most elements. Thus, the yield at Mannheim is better than at ORDC. Apart from soil pH and poor soil fertility at ORDC, there was also uneven distribution of rainfall throughout the season. The rainfall received at ORDC was good during December and January, but it ended in February. Therefore, soil pH, soil fertility and rainfall distribution all contributed to lower yield.

Some varieties such as Centennial, 1992–4–2 and Kemb 10, produced 8.8, 7.6, and 6.4 t/ha respectively while Mafutha and Monate produced 5t/ha at Mannheim Research Station. Jewel produced outstandingly with 26.7 t/ha. Jewel also recorded

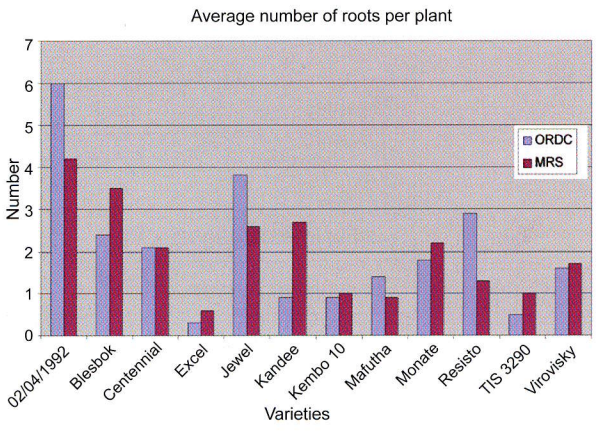

Figure 3. Average number of tubers per plant of the sweetpotato varieties evaluated at ORDC and Mannheim Research Station (MRS) 2003/04.

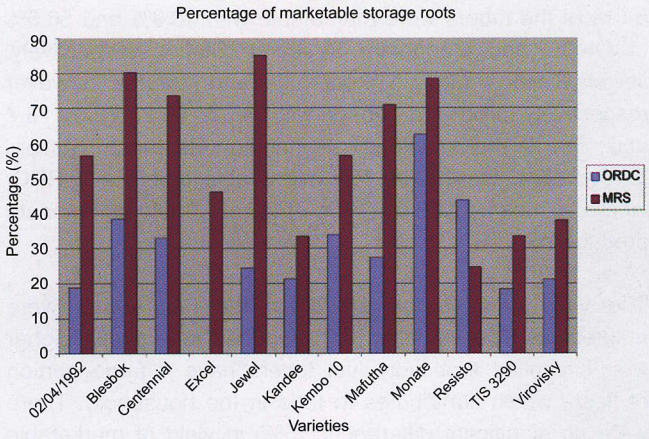

Figure 4. Percentage tubers that were marketable of the sweetpotato varieties evaluated at ORDC and Mannheim Research Station (MRS) 2003/04.

good yield of marketable tubers of 36.7 t/ha during the 1999/00 season (Braun, 2000). The yield of 2.7 t/ha produced by Monate was the highest at ORDC. Blesbok, Jewel and 1992–4–2 produced 2.1, 2.0, and 1.7 t/ha respectively, while all other varieties produced less than 1.5 t/ha. Even though 1992–4-2 produced significantly fewer marketable tubers, the marketable yield was much better than most varieties, and this implies that this variety is high yielding with sufficient moisture content.

The tubers from different varieties contain different dry matter content, and the dry matter percentage indicates the starch content in the tubers. The results indicate significant differences in DM content among the varieties (Table 6). The tubers of Mafutha contain dry matter content of 29.3%, significantly higher by 5% than all other varieties except Centennial and Monate, which obtained 28%, followed by Excel and Jewel with 27.0 and 26.1% respectively. The results in the taste evaluation conducted in the 1998/99 season show positive correlation between the dry matter percentage and good taste (Braun, 1999). Mafutha is a dry and sweet variety. It was also reported as the variety with the highest dry matter content during the 1998/99 season, obtaining 34.6% DM (Braun, 1999), and was reported with 38.4% DM in Northern Province and Mpumalanga, South Africa (Laurie *et al.*, 1999).

CONCLUSION AND RECOMMENDATIONS

Despite low yield obtained at both testing sites, it could be deduced with certainty from these results that a clear direction could be seen, because the best performing varieties such as Jewel, Centennial, Monate and Mafutha, outperformed other varieties in marketable yield and dry matter percentage. However, due to moisture stress conditions experienced during the growing period, low yields were produced across both testing sites. It should be noted that these varieties have high yield potential in a good rainfall season. Therefore, since poor rainfall robbed them of their potential yielding abilities, these varieties need to be re-evaluated during the next cropping season under irrigation to test their potentiality, taste and consumer acceptability, and thus to consolidate the findings.

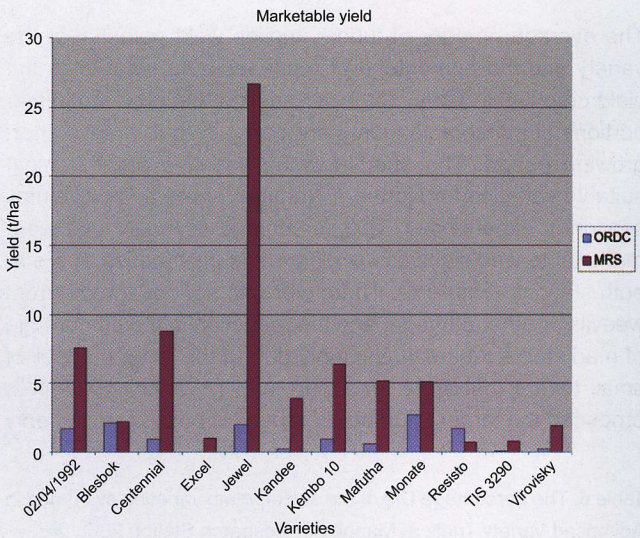

Figure 5. The yield of Marketable tubers of the sweetpotato varieties evaluated at ORDC and Mannheim Research Station (MRS) 2003/04.

Table 5. Mean and standard error of different variables

Variables	Mean		Standard error	
	ORDC	Mannheim RS	ORDC	Mannheim RS
Survival percentage 14DAP	91.0	83.4	1.5	2.5
Survival percentage at harvest	75.5	72.2	3.4	2.4
Average storage roots	2.0	2.0	0.3	0.2
Percentage marketable tubers	28.6	56.4	3.1	3.9
Marketable yields	1.2	8.4	0.2	4.1
Percentage DM	***	25.6	***	0.6

Although variety 1992–4–2 produced low dry matter content and percentage of tubers that were marketable, it produced an outstandingly large number of tubers, more than all other varieties at both sites, and the yield of marketable tubers was much better than most varieties. Therefore, this variety could be recommended for production under irrigation.

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REFERENCES

BRAUN, B., 2001. Performance Evaluation of Sweetpotato Varieties in Northern Namibia. Unpublished data.

BRAUN, B., 1999. Yield Performance and Taste Evaluation of Sweetpotato Varieties in Northern Namibia. Proceedings of the National Annual Agricultural Research Reporting Conference of the Directorate of Agricultural Research and Training held 6-10 September 1999 at the Auditorium of the Ministry of Fisheries and Marine Resources, Swakopmund.

BRAUN, B., 2000. Evaluation of the performance of Sweetpotato Varieties in Northern Namibia. Proceedings of the National Annual Agricultural Research Reporting Conference of the Directorate of Agricultural Research and Training held 25-28 September 2000 at the Auditorium of the Ministry of Fisheries and Marine Resources, Swakopmund.

CUNNINGHAM, T., KINAHAN, J., MARSH, A., STUART-WILLIAMS, V., HUBBARD, D., KREIKE, E. and SEELY, M., 1992. Oshanas Sustaining People, Environment and Development in Central Owambo, Namibia.

GOMEZ, K.A. and GOMEZ, A.A., 1976. Statistical Procedures for Agricultural Research. Second edition. International Rice Research Institute. Philippines.

HARTEMINK, A.E., 2003. Integrated Nutrient Management Research with Sweetpotato in Papua New Guinea. *Outlook on Agriculture* 32 (3) pp.173-182.

Horticultural Research Institute., 1975. The Production of Sweet Potatoes. Series: The Cultivation of Vegetables in South Africa. IV. The Cultivation of Sweet Potatoes. No. A. 1/ 1975 *Farming in South Africa*.

LAURIE, S.M., VAN DEN BERG, A.A. and STORK, P.O., 1999. Progress by the South African Sweetpotato Breeding and Multiplication Program in Support of Resource-poor Farmers. Food Security and Crop Diversification in SADC countries: the role of Cassava and Sweetpotato. Proceedings of the Scientific Workshop of the Southern Root Crop Research Network (SARRNET) held at Pamodzi Hotel, Lusaka, Zambia, 17-19 August 1998.

LAURIE, S.M., MALEMELA, M.L., MAGORO, M.D., BRAUN, B.R., BOK, I. and NXUMALO, M., 2002. Evaluation of Selected Sweetpotato Breeding Lines and Imported Cultivars in the Southern Regions of SADC. *Acta Horticulture* 583:95-101.

LAURIE, S., 2003. Guide to Sweetpotato Production in South Africa. Agricultural Research Council. Roodeplaat Vegetable and Ornamental Plant Institute. May 2003.

LENHARDT, P.J. and RUSCH, B., 1996. The Namibian Root Crop Research Project. Baseline Information on Sweet Potato and Cassava in the Kavango and Caprivi regions. MAWRD DART Annual Progress Report 1995/96.

MENDELSOHN, J., OBEID, S. and ROBERTS, C., 1997. A Profile of North-Cental Namibia. Gamsberg Macmillan Publishers, Namibia.

ONWUEME, I.C. and CHARLES, W. B., 1994. The Tropical Root and Tuber Crops Production, Perspectives and Future Prospects. FAO, Rome.

ONWEME, I.C. and SINHA, T.D., 1991. Field Crop Production in operation, Netherlands.

RUSCH, B., 1999. Sweetpotato production and research in Namibia. Food Security and Crop Diversification in SADC Countries: the role of Cassava and Sweetpotato. Proceedings of the Scientific Workshop of the Southern Root Crop Research Network (SARRNET) held at Pamodzi Hotel, Lusaka, Zambia, 17-19 August 1998.

RUSCH, B.R. 1998. The Maintenance of Sweetpotato Planting Materials in Namibia: Options for the Development of a Vine Production and Distribution system. Submitted in partial fulfilment of the requirements for the degree of M Inst Agar: Plant Genetic Resources Management and Utilisation in the Faculty of Agricultural Science, University of Pretoria. Pretoria.tato varieties evaluated at ORDC and Mannheim Research Station (MRS) 2003/04.