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# POTENTIAL FOR CASSAVA PRODUCTION IN THE BATHURST REGION OF THE EASTERN CAPE PROVINCE OF SOUTH AFRICA

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## ABSTRACT

Cassava *(Manihot esculenta)* is a minor crop in South Africa that has had periodic rises in interest since it was first cultivated in the country. Interest in the crop has waned over the years, but the crop is now being used as a source of high quality starch, which has again stimulated interest in its use as a commercial crop. No cassava is cultivated in the Bathurst area despite the apparently suitable climatic conditions. This study was conducted in order to evaluate the potential of this area for dryland cassava production. Eight varieties (I92/0326, I90/00330, I93/0170, TMS60444, TMS90853, ThaiI, Aunty Alice and Tokunbo) were planted at a density of 8 300 plants $ha^{-1}$ using tissue cultured plants. Harvesting took place at 6, 15 and 21 months after planting (MAP), with each harvest date being established as a separate block. Tuber yields 6 MAP ranged from 8 to 22 t $ha^{-1}$, with I93/0170 producing the highest yield. After 15 months, the highest yield was around 34 t $ha^{-1}$ produced by TMS90853, although no significant ($P>0.05$) differences were noted between varieties at this stage. TMS60444 produced a yield of 76 t $ha^{-1}$ 21 MAP. Only three varieties showed significant ($P<0.05$) increases in yields from 6 to 15 months, while yields of seven varieties increased significantly ($P<0.05$) between 15 and 21 months. This was attributed to the cold winter period falling between the 6 and 15 month harvest period. The Bathurst region is suitable for cassava production, but variety selection should be based upon the growing period envisaged.

*Key Words*: *Manihot esculenta*, storage roots, winter

## RÉSUMÉ

Le manioc *(Manihot esculenta)* est une plante mineure qui a eu des peaks d'intérêts périodiques depuis qu'il a été cultivé pour la première fois en Afrique du sud. Les intérêts pour la plante ont décru au fur des années, mais elle est aujourd'hui utilisée comme source d'amidon de qualité élevée qui stimulera encore l'utilisation de la plante pour le but commercial. Le manioc est cultivé en Bathusrt en dépit des conditions climatiques plus ou moins adéquate. Cette étude a été conduite pour évaluer le potentiel de la région pour la production du manioc en région sèche. Huit variétés (I92/0326, I90/00330, I930170, TMS60444, TMS90853, ThaiI, Aunty Alice et Tokundo) étaient plantées à la densité de 8300 plantes $ha^{-1}$ utilisant (bio-culture des tissus). La récolte à eu lieu a 6, 15 et 21 mois après semence (MAS). Les dates de récolte ont été considérées comme des blocs séparés. Les rendements en tubercules étaient de 34 t $ha^{-1}$ produits par TMS 90853, même si aucune différence significative était observée entre les variétés à ce niveau ($P<0.05$). TMS 60444 a produit le rendement de 76t $ha^{-1}$ après 21 MAS. Seulement trois variétés ont montré de différences significatives entre 15 et 21 mois ($P<0.05$). Ceci était attribué à la période froide d'hiver entre le sixième et 15eme mois entre la période de récolte. La région Bathurst est très propice à la production du manioc, mais la sélection des variétés doit être basée sur la période de culture envisagée.

*Mots Clés*: *Manihot esculenta*, stockage des racines, hiver

## INTRODUCTION

Cassava is a starchy root crop that has been cultivated in tropical America for more than 5000 years. Introduced to Africa and Asia by the Portuguese during the 16th century, it is now cultivated in more than 90 countries, and provides food for more than 500 million people world-wide (CIAT, 2001). Cassava is a particularly valuable crop in many areas of Africa, where it is the staple food. Today, it is the second most important food in the African diets (Neker *et al.*, 2002). In South Africa, however, this plant is of minor importance as a subsistence crop, having had limited commercial success, and its major potential has been viewed as a raw material for industrial purposes.

The crop was possibly introduced into the country during the early part of the 19th century (CIAT, 1980), and is well known by elders in rural areas. Interest in commercial exploitation of this crop was first stimulated in 1948 due to its potential source of starch (Daphne, 1980). The interest subsequently waned due to the unfavourable economic climate in the aftermath of the Second World War and a major change in the politics of the country (Allemann, 1996a). A drop in the sugar price in the 1960s led to a brief resurgence in interest in cassava (Daphne, 1980).

Interest in cassava was again stimulated during 1974 when the Anglo American Corporation forecast a possibility of major shortage in basic energy foods in South Africa by the end of the 20th century. During the 70s, it was established that commercial production in South Africa was not significantly affected by production factors throughout the sub-tropical areas of the country. It was concluded that the crop could be successfully cultivated in the warmer areas of the country. Larger areas were planted, a number of varieties imported, and yield trials conducted (Daphne, 1980). Research into the etiology and control of African cassava mosaic disease and cassava bacterial blight was conducted in northern KwaZulu-Natal (Daphne, 1980; Trench *et al.*, 1985).

The earliest recorded research on cassava in South Africa took place at the Makhatini research station in northern KwaZulu-Natal, and at the Bathurst research station in the Eastern Cape (Velleich and Smith, 1939). This research concluded that the crop could be cultivated successfully in these areas.

Bathurst lies outside the area in which cassava is cultivated and, as such, there is no danger of virulent cassava pests and diseases such as ACMV and mealybug infesting the plantings. These are major problems in the lowveld areas and in the cassava producing areas of KwaZulu-Natal (Trench *et al.*, 1985). This area also lies in the chicory producing area of the Eastern Cape, and the local chicory production and marketing company expressed interest in looking for an alternative crop for use in this area.

The objective of this study was to confirm earlier reports that cassava could be successfully cultivated in the Albany region of the eastern Cape Province, and to evaluate its potential as an alternative crop for chicory.

## MATERIAL AND METHODS

The study was conducted at the Bathurst Agricultural Centre (33°31'S and 26°48'E) of the Eastern Cape Province Department of Agriculture and Nature Conservation. This site is approximately midway between Port Elizabeth and East London, and 12 km inland from the coast, at an altitude of 200m. It is located in a frost-free area that receives an annual rainfall of 670 mm that falls mainly in the summer months of September to April.

The site has sandy clay loam soil of the Oakleaf form (Soil Classification Working Group, 1991) containing approximately 25% clay. The land was ploughed and disked to prepare a fine seedbed. Fertiliser at a rate of 800 kg 2:3:2(22) $ha^{-1}$ was broadcast and incorporated into the soil prior to beds being prepared with a pineapple bedmaker. These beds were 1 m wide across the crown and 0.2 m apart.

Eight varieties of cassava (I92/0326, I90/00330, I93/0170, TMS60444, TMS90853, Thai I, Aunty Alice and Tokunbo) were planted in a randomised complete block design, with eight replicates. Planting was at a spacing of 1.2 m x 1.0 m, resulting in a population density of 8 300 plants $ha^{-1}$. Hardened tissue culture plants were used to establish this trial due to inadequate quantities of cuttings. After planting, the plots were watered

until they established. Thereafter, the trial continued under rainfed conditions. Weed control was carried out by hand bi-weekly.

Plants were harvested at 6, 15 and 21 months after planting (MAP). Each harvest date was established as a separate trial. Data on plant height, yield (plant and total), number of roots and the roots mass were collected. This data were analysed using the Genstat statistical analysis package. All results showing significant treatment means were seperated using the Least Significant Difference test as described by Steel and Torrie (1980).

## RESULTS

Highly significant ($P<0.01$) differences were recorded for plant height, total yield, yield and number of roots produced per plant (Table 1). Storage root mass was also significantly affected by variety.The best yield was produced by I93/0170 (22.9 t $ha^{-1}$) and was significantly better that that of all other varieties. The lowest yield (8.3 t $ha^{-1}$) was by Thai I, but this did not differ significantly from the yields of TMS90853 (10.8 t $ha^{-1}$), Aunty Alice (9.76 t $ha^{-1}$) and I90/00330 (8.96 t $ha^{-1}$). Total yield also gave a good indication of the number of storage roots produced by the different varieties, with the most (16.3) being produced by I93/0170, and the least by Aunty Alice (6.0), although the latter did not differ significantly from Tokunbo, TMS60444, TMS90853, I90/00330 and Thai I.

The variety with the highest total yield (I93/0170) produced individual storage roots of a mass (0.172 kg) that did not differ significantly from those of the variety with the heaviest storage roots (Tokunbo-0.2 kg). I92/0326 (0.146 kg) and TMS90853 (0.148 kg) produced the lightest individual storage roots. Storage roots produced by all plants at this stage were fairly long and narrow, with no sign of fibrousness.

Although plant height differed significantly between varieties, it had a limited bearing on total yield. This was true inspite of the fact that the variety with the tallest plants also produced the highest yield (I93/0170).

Significant differences were noted for plant height and individual storage root mass after 15 months of growth (Table 2). Data for the number of storage roots per plant, as well as yield showed no significant differences after 15 months of growth. From the data, it is clear that individual storage roots from Aunty Alice (0.508 kg), Thai I (0.477 kg) and TMS90853 (0.432 kg) were significantly ($P<0.05$) heavier than these of other varieties. There appeared to be no correlation between plant height and mass of roots produced, either in terms of total mass or individual roots mass.

Changes in plant height and mass of individual roots were determined as a percentage of the results obtained after six months (Table 2). The greatest percentage increase in plant height was by I92/0326, which increased in height by 85.6%.

TABLE 1. Cassava varieties, plant height and tuber yield parameters6 MAP in South Africa

| Variety | Plant height (cm) | Number of roots | Yields | | Root mass (kg $root^{-1}$) |
|---|---|---|---|---|---|
| | | | Total (kg $ha^{-1}$) | Average (kg $plant^{-1}$) | |
| I93/0170 | 106 | 16.3 | 22 916 | 2.75 | 0.172 |
| Tokunbo | 92.5 | 10.0 | 16 666 | 2.00 | 0.200 |
| I92/0326 | 69.2 | 11.3 | 13 958 | 1.68 | 0.148 |
| TMS60444 | 91.3 | 9.0 | 13 958 | 1.68 | 0.186 |
| TMS90853 | 87.5 | 8.8 | 10 833 | 1.30 | 0.148 |
| Aunty Alice | 87.8 | 6.0 | 9 758 | 1.18 | 0.185 |
| I90/00330 | 100 | 7.0 | 8 958 | 1.08 | 0.154 |
| Thai I | 89.5 | 6.5 | 8 333 | 1.00 | 0.163 |
| $LSD_{T(0.05)}$ | 12.3 | 4.1 | 5 451.4 | 0.65 | 0.036 |

The increase in the mass of individual roots ranged from 20.3% (I93/0170) to 192.6% for Thai I. Four varieties (I90/00330, I93/0170, TMS60444 and Tokunbo) registered increases in individual root mass of less than 100% between 6 and 15 MAP harvest.

Significant differences ($P<0.05$) in yield and highly significant differences ($P<0.01$) in plant height, number of storage roots and mass of individual storage roots were recorded at 21 MAP harvest period (Table 3). However, yield of roots per plant showed no significant differences. TMS60444 was the highest yielding variety, producing more than 76 t $ha^{-1}$. This was significantly better than the yields of Thai I (53 t $ha^{-1}$), I93/0170 (47 t $ha^{-1}$) and TMS90853 (44 t $ha^{-1}$). The yields from the other varieties were intermediate to these. TMS60444 produced the highest number of storage roots per plant (13.24) and Thai I the lowest (7.38).

The masses of individual storage roots of Thai I and Aunty Alice was significantly greater than those produced by TMS60444, I90/00330, TMS90853 and I93/0170. This appeared not to be correlated to the number of storage roots produced by each variety, or the height of the plants; it was probably related to the total size of the plant. As the diameter of the plant canopy, or leaf area, were not measured this could not be confirmed. However, it has been shown that decreasing the leaf area of cassava plants results in decreased yields (Dahniya, 1981; Dahniya *et al.*, 1981), so this would appear to be a valid observation.

Highly significant ($P<0.01$) varietal differences were realised for number of storage roots produced by each plant and the plant height. Variety x

TABLE 2. Cassava varieties, plant height and tuber yield parameters15 MAP in South Africa

| Variety | Plant height | | Root mass | |
|---|---|---|---|---|
| | (cm) | % increase | Average (kg $root^{-1}$) | % increase |
| Thai I | 151.0 | 68.7 | 0.477 | 192.6 |
| I90/00330 | 138.9 | 38.9 | 0.250 | 62.3 |
| I92/0326 | 128.4 | 85.6 | 0.315 | 112.8 |
| Aunty Alice | 125.2 | 42.6 | 0.508 | 174.6 |
| I93/0170 | 122.5 | 15.6 | 0.318 | 20.3 |
| TMS90853 | 118.9 | 35.9 | 0.432 | 191.9 |
| TMS60444 | 108.5 | 18.8 | 0.252 | 35.48 |
| Tokunbo | 108.0 | 16.8 | 0.339 | 69.5 |
| $LSD_{T(0.05)}$ | 23.94 | ns | 0.165 | ns |

TABLE 3 Cassava varieties, plant height and tuber yield parameters 21 MAP in South Africa

| Variety | Plant height | | Number of roots | Total yield (kg $ha^{-1}$) | Root mass | |
|---|---|---|---|---|---|---|
| | (cm) | % increase | | | Average (kg $root^{-1}$) | % increase |
| I90/00330 | 186.0 | 33.9 | 9.05 | 57 919 | 0.581 | 132.4 |
| Aunty Alice | 181.7 | 45.1 | 9.07 | 64 079 | 0.915 | 80.1 |
| I92/0326 | 175.5 | 36.7 | 10.38 | 61 768 | 0.804 | 155.2 |
| Tokunbo | 170.4 | 57.8 | 9.64 | 67 115 | 0.851 | 151.03 |
| Thai I | 168.0 | 11.3 | 7.38 | 53 748 | 0.918 | 92.5 |
| TMS60444 | 167.7 | 54.6 | 13.24 | 76 702 | 0.663 | 163.1 |
| I93/0170 | 160.7 | 31.2 | 10.13 | 47 186 | 0.544 | 71.1 |
| TMS90853 | 147.0 | 23.6 | 9.25 | 44 269 | 0.581 | 34.5 |
| $LSD_{T(0.05)}$ | 22.35 | ns | 2.85 | 20 881 | 0.236 | ns |

ns = not significant

growth period interaction also significantly influenced these factors. Total yield was significantly affected by the variety and growth period interaction. In all cases, this indicates that the varieties reacted differently at the different growth periods.

All varieties, with the exception of TMS90853, showed significant increases in yield from 15 to 21 MAP (Table 4). Only three varieties (Aunty Alice, Thai I and TMS90853) showed significant increases between 6 and 15 MAP. Over the entire growing period, no significant varietal effect was realised

## DISCUSSION

It was observed that all varieties experienced defoliation during the cooler months of the year. This was also found during previous cassava trials carried out in other areas of the country, as well as elsewhere in the world (AAC, 1978; Daphne, 1979; Manrique, 1997). This resulted in loss of leaf area, hence, affecting bulking of storage roots as illustrated by Dahniya *et al.*, 1981). Differences in yields at 6 MAP harvest could, therefore, be due to growth differences between varieties, with some varieties starting vigorous growth earlier than others, hence, being able to acquire a larger leaf area prior to harvest. Many researchers have indicated that LAI of cassava is a function of the branching characteristics, leaf size, leaf formation rate, and individual leaf life (Cock *et al.*, 1979; Ramanujam, 1985; Manrique, 1997), all of which can be affected by the genotype. There appeared no differences between varieties in terms of levels of branching. Therefore, it appears that leaf size or duration could be the major factor playing a role here.

The yields obtained suggest that a growing season of six months does not permit full realisation of variety yield potentials, particularly if planting is delayed. This is in agreement with other results in the country (Daphne, 1979). However, temperature studies indicate that planting could be as early as August, giving a growing season of 10 months.

The fact that no differences in yield were found at the 15 MAP harvest, while there were significant differences earlier (6 MAP harvest), indicates one of two possibilities. Firstly, as there was a cool winter period between these two harvests, it could suggest that some of the varieties are better adapted to cold than others, so resulting in a longer period of growth before leaf senescence. Secondly, it could be that some of the varieties started growing actively earlier at the onset of warmer temperatures in the spring, so putting on leaf area faster than the other varieties. In both cases, this would indicate some level of genetic adaptation to cooler weather, and would enable these varieties to have a longer period of root bulking than those that either lost their leaves earlier, or started growing later. This is an aspect for greater detailed studies in future.

Yield increase from 15 MAP to the 21 MAP exceeded 90% in all varieties tested, with the exception of TMS90853 (29.6%). This indicated that this is a two season crop under the conditions experienced at the trial site. This is in agreement with earlier cassava studies conducted between

TABLE 4. Effect of variety and growing period on cassava yields at Bathurst, South Africa

| Variety | Yield (kg ha$^{-1}$) | | | Average yield (kg ha$^{-1}$) |
|---|---|---|---|---|
| | 6 MAP | 15 MAP | 21 MAP | |
| TMS60444 | 13 958 | 25 693 | 76 715 | 43 755 |
| Aunty Alice | 9 791 | 29 940 | 64 085 | 39 568 |
| Tokunbo | 16 666 | 21 609 | 67 121 | 38 825 |
| I92/0326 | 13 958 | 22 395 | 61 768 | 36 457 |
| Thai I | 8 333 | 27 988 | 53 748 | 34 361 |
| TMS90853 | 10 833 | 34 107 | 44 269 | 33 517 |
| I93/0170 | 22 916 | 23 645 | 47 186 | 32 915 |
| I90/00330 | 8 958 | 19 525 | 57 927 | 32 773 |
| $LSD_{T(0.05)}$ | 6MAP = 2 154.5 | 6 vs 15,21MAP = 18 745.6 | 15,21MAP = 15 305.7 | |

22° and 30°S (Daphne, 1979). These findings also substantiate the statement that cassava can be cultivated at higher latitudes than 30°S provided warmer sites in low-lying coastal areas are used. It, therefore, appears as that cassava can be used as an alternative for chicory in the coastal regions of the eastern Cape province, substantiating an earlier study conducted for this area (Allemann, 1996b). However, the fact that winter temperatures limit the growth period of the crop to around 9 - 10 months in any single year, it would be necessary to grow the crop for two seasons in order to fully realise its yield potential. This would also be necessary if the crop is cultivated for industrial purposes. In this respect, research world-wide has indicated that the highest starch content in the roots is attained after a growth period of 18 months (Daphne, 1979; IITA, 1990). A careful study of the economic implications of cassava production for this area should be made prior to concrete recommendations being made.

## CONCLUSIONS

The Bathurst area is suitable for dryland cassava production, and variety selection should be based on the growing period envisaged. I93/0170 gives the best yields after a six-month growing period. All varieties are suitable for a 15 month growing period, while TMS60444 should be used if a 21 month growing period is envisaged.

Acceptable yields are obtained from the crop after a six-month growing period. The climatic conditions in this area are suitable for viable cassava production from August until May/June (9 - 10 months). However, it would be necessary to grow the crop for two seasons to realise its yield potential. This is particularly important if cultivating the crop for industrial applications. More research is required on this crop before concrete recommendations can be made.

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