Evaluation Of Cassava (**Manihot Esculenta** Crantz) Genotypes In The South Region Of Mozambique

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**Abstract.** This study aimed to evaluate ten cassava genotypes in the south region of Mozambique. The experiment was conducted at the Experimental Station of Umbeluzi- Agronomic Research Institute of Mozambique, situated 30 km from Maputo, 12 m above the sea level, 26° 03' Latitude South and 32° 23’ Longitude East. It was used the randomized block design, 10 cassava genotypes were evaluated with 3 replications, the experiment was implanted on February 19, 2008, no fertilizers were used, the cassava was harvested in July of 2009. The genotypes are as follows: MzUB04107, MzUB04045, MzUB04073, MzUB04596, Chinhembwe, MzUB04211, MzUB 04027, MzUB04030, Munhaça, MzUB04104. For statistical means comparison when necessary, the Tukey’s test was carried out, all the statistical analysis was carried out at 5%. The following variables were evaluated: mean number of marketable and unmarketable roots, mean yield of the shoots, marketable, unmarketable and total mean yield of the roots, harvest index, percentages of starch and dry matter in the roots. Significant differences weren’t found only for unmarketable mean yield, percentages of dry matter and starch. According to the evaluated variables, Chinhembwe, MzUB04104, MzUB04107, MzUB04027 and MzUB04030 are the cassava genotypes with the best performance.

**1 Introduction**

Cassava (**Manihot esculenta** Crantz) belongs to the Euphorbiaceae family, being the unique cultivated species of the Manihot genus among the 128 species already identified, it’s a plant which varies a lot in height and vegetative features, depending on the environmental conditions in which it’s developing [10]. The cassava is the crop that produces a higher energy quantity, followed by corn, rice, cocoyam, sorghum and potato [16]. It is the major staple starch of the people in most parts of the tropics [5]. Its reserve roots are rich in carbohydrates and present different forms and sizes, botanically, cassava is a perenial plant and the reserve roots are the main plant product, being harvested in the 1st or 2nd year after plantation [15]. Cassava is among the energetic crops, one of the easiest production crop for human consumption, for demanding little hand-labour, growing even in poor and acid soils and for being little affected by exchangeable Al³⁺ [8]. For being very cheap to grow this crop and also a drought tolerating crop, cassava is the main roots crop, being cultivated by the familiar sector for food, it’s cultivated almost in intercrop with beans, peanut, maize without use of fertilizers and pesticides [9]. The actual production of cassava is compromised by several factors, such as: pests, virus diseases, low quality of the propagation material, low soil fertility, irregularity of rain and bad cultivation techniques. The diseases have reduced cassava yields and contributing for food insecurity, mainly for the rural population, where this crop is more consumed [2]. The study aimed to evaluate the yield components of cassava roots, ten genotypes were evaluated.

**2 Material and methods**

**2.1 Study area**

The experiment was conducted at the Experimental Station of Umbeluzi- Agronomic Research Institute of Mozambique, situated 30 km from Maputo, 12 m above the sea level, 26° 03’ Latitude South and 32° 23’ Longitude East. This region, is characterized by having soil with elevated clay quantities, high water holding capacity, medium annual precipitation of 679 mm, irregular rain with rainy season from November to March [14]. According to the Thornthwaite’s climatic classification the area is dry and of semi-arid climate, with temperatures ranging from 23 to 26 °C in the rainy season, and from 17 to 23 °C in the dry season. The soils are of alluvial and basalt origin, with good soil fertility, the textural class is clay loam, moderate drainage, depth superior to 100 m [12]. It was used the randomized block design, 10 cassava genotypes were evaluated with 3 replications, the experiment was implanted on February 19, 2008, no fertilizers were used, the cassava was harvested in July of 2009, the distance among the replications was of 2 m and among the plots 1 m, the plants spacing was of 1 x 1 m, in
each plot, the useful area was of 9 m², in each plot, each line had 5 m and 5 plants/line.

2.2 Cassava genotypes description
The used treatments consisted of 2 local cassava genotypes which are Chinhembwe and Munhaça used as controls, the remaining genotypes were cassava genotypes which were being studied by the Agronomic Research Institute of Mozambique.

<table>
<thead>
<tr>
<th>Genotypes names</th>
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</tr>
</thead>
<tbody>
<tr>
<td>MzUB04107</td>
<td>MzUB04211</td>
</tr>
<tr>
<td>MzUB04045</td>
<td>MzUB04027</td>
</tr>
<tr>
<td>Chinhembwe</td>
<td>MzUB04030</td>
</tr>
<tr>
<td>MzUB04073</td>
<td>Munhaça</td>
</tr>
<tr>
<td>MzUB04596</td>
<td>MzUB04104</td>
</tr>
</tbody>
</table>

2.3 Data analysis
The results were submitted to the Bartlett test of homogeneity of variances and Skewness/Kurtosis test for Normality. Afterwards, statistical means comparison when necessary was carried out by the Tukey’s test. All the statistical analysis was carried out at 5%.

2.4 Variables evaluated
Mean number of marketable and unmarketable roots
We considered as marketable roots, the roots with adequate features for trade, weight above 200 g and without pests attack. We considered as unmarketable roots, the roots without adequate features for trade, with weight below 200 g and with pests attack. Both variables were calculated according to the roots number/hectare.

Mean yield of the shoots, marketable, unmarketable and total mean yield of the roots and harvest index
We determined the mean yield of the shoots, mean yield of marketable and unmarketable roots and total (marketable + unmarketable) mean yield. All these variables were calculated in tonnes/hectare. The harvest index was determined according to [6]:

\[
HI = \frac{TWR \times 100\%}{TWR + SW}
\]

\[
TWR = \text{total weight of roots}
\]

\[
SW = \text{shoots weight}
\]

\[
HI = \text{harvest index}
\]

Percentages of starch and dry matter in roots
The percentage of roots dry matter was determined by the specific weight method [11], using the hydrostatic weight. In each plot, we harvested with 3 kg, we cleaned it and then in the laboratory we determined the sample weight in the air and after this, we determined the sample weight in the water, the dry matter percentage was determined by the following formula:

\[
DM = \frac{158.3 \times Wa - Ww}{Wa - Ww} - 142
\]

\[
Wa = \text{weight of the sample determined in the air}
\]

\[
Ww = \text{weight of the sample determined in the water}
\]

\[
DM = \text{dry matter percentage of cassava roots}
\]

The percentage of starch in the roots was determined according to [4]

\[
% \text{Starch} = \frac{DM \times 0.875}{100}
\]

\[
% \text{Starch} = \text{percentage of organic matter in the roots}
\]

\[
0.875 = \text{conversion factor}
\]

3 Results and discussion
Mean yield of the shoots and harvest index
The figure 1 presents the behaviour of precipitation, the maximum and minimum temperatures during the experiment. Significant differences (P<0.05) were obtained for the harvest index (HI) (Table 2) the genotype MzUB04104 presented the highest HI (0.49) in spite of being similar to (P>0.05) MzUB04107, MzUB04045, Chinhembwe, MzUB04073, MzUB04211, MzUB04027, MzUB04030 and Munhaça. Chinhembwe and MzUB04104 are the only ones which had adequate HI as according to [3] a good HI should be above 0.45. In general, there’re many variations on HI among the diverse cassava cultivated genotypes [13], elevated HI are desirable, because they demonstrate the roots capacity to attract and accumulate the carbohydrates under the form of starch produced in the leaves. Elevated HI are of great importance on the choice of cassava genotype to be cultivated for table meal and they’re also related with high roots marketable yield. Significant differences were obtained for the mean yield of the shoots (P<0.05), the genotype MzUB04030 presented the highest value (48.5 tonnes/hectare), in spite of being similar to MzUB04211, MzUB04596, Chinhembwe, MzUB 04045, MzUB04045, Chinhembwe, MzUB04073, MzUB04211, MzUB04027, MzUB04030 and Munhaça. Chinhembwe and MzUB04104 are the only ones which had adequate HI as according to [3] a good HI should be above 0.45. In general, there’re many variations on HI among the diverse cassava cultivated genotypes [13], elevated HI are desirable, because they demonstrate the roots capacity to attract and accumulate the carbohydrates under the form of starch produced in the leaves. Elevated HI are of great importance on the choice of cassava genotype to be cultivated for table meal and they’re also related with high roots marketable yield. Significant differences were obtained for the mean yield of the shoots (P<0.05), the genotype MzUB04030 presented the highest value (48.5 tonnes/hectare), in spite of being similar to MzUB04211, MzUB04596, Chinhembwe, MzUB 04045, MzUB04045, Chinhembwe, MzUB04073, MzUB04211, MzUB04027, MzUB04030 and Munhaça. Chinhembwe and MzUB04104 are the only ones which had adequate HI as according to [3] a good HI should be above 0.45. In general, there’re many variations on HI among the diverse cassava cultivated genotypes [13], elevated HI are desirable, because they demonstrate the roots capacity to attract and accumulate the carbohydrates under the form of starch produced in the leaves. Elevated HI are of great importance on the choice of cassava genotype to be cultivated for table meal and they’re also related with high roots marketable yield. Significant differences were obtained for the mean yield of the shoots (P<0.05), the genotype MzUB04030 presented the highest value (48.5 tonnes/hectare), in spite of being similar to MzUB04211, MzUB04596, Chinhembwe, MzUB 04045, MzUB04045, Chinhembwe, MzUB04073, MzUB04211, MzUB04027, MzUB04030 and Munhaça.
prefer bigger roots because they promote a better 

mean yield is very important, but the industries 

had total mean yield above the yield obtained under 

traditional farming which is under 5 tonnes/hectare 

and minimum (Tmin) temperatures (°C) during 

the experiment

There was a tendency in which the genotypes 

which had higher marketable yields are the same 

ones with higher total yields which is the case of 

MzUB04107, Chinhembwe, MzUB04027, 

MzUB04104, MzUB 0430, this may be because 

MzUB04107, Chinhembwe, MzUB04027, 

MzUB04030 and MzUB 04104. Significant 

differences were also found the mean number of 

marketable roots which had higher total yield above the general mean of the 

experiment are the ones which express better adaptation [18], so, MzUB04107, Chinhembwe and 

MzUB04104 are in this situation, they’ve yields 

above 14.704 96 ton/hectare, which is the general 

mean of the total yield found in this experiment.

Mean number of marketable (NMR) and 

unmarketable roots (NUMR)

Significant differences were found for the mean number of unmarketable roots (Table 4), MzUB 04107 had the highest value, being similar to MzUB 04045, Chinhembwe, MzUB040473, MzUB04596, MzUB04211, MzUB04027, MzUB04030 and MzUB 04104. Significant differences were also found the mean number of marketable roots where Chinhembwe had the highest value, being similar to MzUB04107, MzUB04073, MzUB04027, MzUB 0430 and MzUB04104.

Table 3- Marketable mean yield (MMY), 

unmarketable mean yield (UMMY) and total 

mean yield (TMY) of cassava genotypes

<table>
<thead>
<tr>
<th>Genotypes</th>
<th>MMY (ton/hectare)</th>
<th>UMMY (ton/hectare)</th>
<th>TMY (ton/hectare)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MzUB04107</td>
<td>12.42063 ab</td>
<td>6.441799 ab</td>
<td>18.86243 ab</td>
</tr>
<tr>
<td>MzUB04045</td>
<td>6.283333 bc</td>
<td>3.508333 bc</td>
<td>9.791667 ab</td>
</tr>
<tr>
<td>Chinhembwe</td>
<td>18.67394 ab</td>
<td>16.50463 ab</td>
<td>35.178573 a</td>
</tr>
<tr>
<td>MzUB04073</td>
<td>5.476191 c</td>
<td>3.404762 b</td>
<td>8.880952 b</td>
</tr>
<tr>
<td>MzUB04596</td>
<td>3.566667 c</td>
<td>2.935812 b</td>
<td>6.668481 b</td>
</tr>
<tr>
<td>MzUB04211</td>
<td>6.412037 bc</td>
<td>2.363741 b</td>
<td>8.777778 b</td>
</tr>
<tr>
<td>MzUB04027</td>
<td>7.666667 ab</td>
<td>4.050926 ab</td>
<td>11.717599 ab</td>
</tr>
<tr>
<td>MzUB04030</td>
<td>9.512873 ab</td>
<td>3.408254 ab</td>
<td>12.98413 ab</td>
</tr>
<tr>
<td>Munhaça</td>
<td>5.476191 c</td>
<td>1.429371 b</td>
<td>6.6</td>
</tr>
<tr>
<td>MzUB04104</td>
<td>20 a</td>
<td>6.25</td>
<td>26.25 ab</td>
</tr>
</tbody>
</table>

* Means without significant differences by the Fisher 

at 5%. Means followed by the same letter are not 

significantly different by the Tukey’s test at 5%
Means followed by the same letter are not significantly different by the Tukey’s test at 5%

There was also a tendency in which the genotypes with higher total yields are the same ones with higher number of marketable roots, this is the case of Chinhembwe, MzUB04107, MzUB04027, MzUB 04030 and MzUB04104, this is because the number of marketable roots has more contribution on the total yield.

**Percentages of starch and dry matter**

Significant differences weren’t found for dry matter and starch percentage (P>0.05). About the starch percentage, the ideal is that the cassava roots present at least 30% of starch [7], only Munhaça and MzUB 04211 had lower percentages than 30%, indicating lower starch percentages, the remaining genotypes had higher percentages.

<table>
<thead>
<tr>
<th>Genotypes</th>
<th>Starch (%)</th>
<th>Dry matter (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MzUB04107</td>
<td>30.11867</td>
<td>34.42133</td>
</tr>
<tr>
<td>MzUB04045</td>
<td>32.09775</td>
<td>36.68314</td>
</tr>
<tr>
<td>Chinhembwe</td>
<td>32.69805</td>
<td>37.3692</td>
</tr>
<tr>
<td>MzUB04073</td>
<td>33.86349</td>
<td>38.70113</td>
</tr>
<tr>
<td>MzUB04596</td>
<td>34.92786</td>
<td>39.91755</td>
</tr>
<tr>
<td>MzUB04211</td>
<td>28.84205</td>
<td>32.96235</td>
</tr>
<tr>
<td>MzUB04027</td>
<td>33.786</td>
<td>38.61257</td>
</tr>
<tr>
<td>MzUB04030</td>
<td>31.21322</td>
<td>35.67225</td>
</tr>
<tr>
<td>Munhaça</td>
<td>28.40733</td>
<td>32.46552</td>
</tr>
<tr>
<td>MzUB04104</td>
<td>33.77362</td>
<td>38.59842</td>
</tr>
</tbody>
</table>

According to [15] the quantity of dry matter is an important factor for the determination of cassava yield and also a characteristic for the acceptance of any cassava genotype or variety and it must be between 30-35%, MzUB04107, MzUB04211 and Munhaça are in this interval, the remaining genotypes had dry matter percentages above 35%, indicating high industrial value. According to [17] the quantity of dry matter is a feature which determines the higher or the lower cassava price paid by the industries, being important that the genotypes with high roots yields be the same ones with high dry matter percentages, in this study, the genotypes with this behaviour are MzUB04104, Chinhembwe, MzUB 04045, MzUB04027 and MzUB04030.

**Relationships among the studied variables**

In some genotypes, the number of unmarketable roots was superior to the number of marketable roots but the marketable mean yield was superior to the unmarketable mean yield in all the genotypes (Figure 2), positive correlation was found between the harvest index and the total mean yield (Figure 3), no correlation was found between the harvest index and the shoots yield. Starch and dry matter percentages had positive correlation (Figure 4), similar behaviour was also found by [1]. Absence of correlation was found for dry matter, shoots yield and total mean yield.

**Figure 2-Relationship among mean number of marketable roots (NMR) and unmarketable roots (NUMR), marketable mean yield (MMY) and unmarketable mean yield (UMMY)**

**Figure 3- Relationship among harvest index (HI), total mean yield (TMY) and shoots yield (SY)**

**Figure 4- Relationship among total mean yield (TMY), shoots mean yield (SY), percentages of dry matter (DM) and starch**
Conclusions

The genotypes had different performance, Chinhembwe, MzUB04104, MzUB04107, MzUB04027 and MzUB04030 are the ones with the best performance, according to the evaluated variables.

References