Impact of Two Compound Fertilizer Types on the Performance of Three Cassava Varieties (*Manihot esculenta* Crantz) in Humid Tropics, Port Harcourt, Nigeria

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Authors’ contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

ABSTRACT

The evaluation of the performance of three cassava varieties was studied using two compound fertilizer types at the Teaching and Research Farm, Rivers State University Port Harcourt between March 2021 and February 2022. The treatments were combined in a split plot arrangement in a Randomized Complete Block Design (RCBD) with three replicates. Parameters evaluated were number of branches and canopy diameter at four weekly intervals starting from tenth weeks after planting and ending to fresh/dry pulp weight and fresh/dry peel weight were also taken. Results show that cassava variety TMS 95/0289 interacting with NPK 15-15-15 produced the highest branches per plot (24.7), TMS 96/0523 interacting with NPK 15-15-15 produced the widest canopy diameter per stand (263.1cm), fresh peels weight and dry peels weight (129.7g and 100.3g). TME 419 interacting with NPK 15-15-15 compound fertilizer produced the highest fresh and dry pulp weight with mean values of 722.7 and 487.0. Application of NPK fertilizer especially NPK 15-15-15 enhanced number of branches, dry pulp weight, dry peels weight and canopy diameter. TME 419 had higher fresh/dry pulps and dry peels weight while TMS 96/0523 had high fresh peels weight and canopy width respectively. Whereas cassava variety TMS 95/0289 was high in number of branches. Thus it is recommended that TME 419 be introduced to farmers as it produced highest
pulp weight per stand. Also, fertilizer NPK 15-15-15 is a preferred NPK fertilizer as it has the capability in increasing the number of branches, canopy width, peels weight and pulp weight in comparison with NPK 20-10-10.

**Keywords:** Cassava; varieties; growth; yield; performance; compound fertilizer.

### 1. INTRODUCTION

Cassava is an amphidiploid perennial shrub belonging to the family Euphorbiaceae, phylum Magnoliophyta, order Euphorbiales and is believed to originate from Latin America [1,2]. It is currently the most important food source for carbohydrate, after rice, sugarcane and maize for over 500 million people in the developing countries of the tropics and subtropics [3].

*Manihot esculenta* Crantz has the ability to grow on poor soils, difficult climatic conditions and its root tuber acts as the cheapest source of calories with the leaves highly nutritious in minerals, vitamins and protein so it is a vital food as it provides 500 Kcal per day of food energy for consumption of 70million people in Africa and 100 Kcal for 500 million people in the world [4]. The cropping season and date of harvest is variable due to its dependence on the type of cassava grown and household consumption needs [5]. Though, in Rivers State, planting of cassava commence with the onset of the rainy season from March/April.

Economically, cassava is used in the production of ethanol biofuel, laundry starch, flour for confectioneries, hydrolysates for pharmaceutical industry and syrup concentrate for drink production [6]. Tewe [7] revealed that raw cassava tuber consists of 38.1 g of carbohydrate, 160 kcal of food energy, 1.7 g of sugar, 1.8 g of dietary fibre, 0.3 g of fat, 1.4 g of protein, 0.087 mg of thiamine, 0.048 mg of riboflavin, 0.854 mg of niacin, 0.088 mg of vitamin B6, 27 µg of folate, 20.6 mg of vitamin C, 16 mg of calcium, 0.27 mg of iron, 21 mg of magnesium, 27 mg of phosphorus, 21 mg of potassium, 14 mg of sodium, 0.34 mg of zinc and 60 g of water.

Cassava production is faced with a lot of problem in Nigeria ranging from weeds, climatic conditions, Government policy, poor extension services, low soil fertility to pests and diseases [8]. Macalou [9] stated that the major limiting factor in cassava production in Nigeria is low soil fertility. This statement is in alignment with the reports of Howeler [10] who reported that continuous cropping of cassava on a land leads to fast depletion of major nutrients, like N, P and K and will require fertilizer supplement to give stable yield as cassava removes about 55 kg/ha N, 132 kg/ha P and 112 kg/ha K respectively. As a result of this, the research study is geared towards equipping the public on the effect of two compound fertilizers (NPK 20-10-10 and NPK 15-15-15) on the performance of TMS 95/0289, TMS 96/0523 and TME 419 in the humid tropics, Nigeria.

### 2. MATERIALS AND METHODS

#### 2.1 Study Area

This experiment was carried out at Rivers State University Teaching and Research farm, Port Harcourt. The soils in the experimental site were formed from coastal plain sand and the texture of the soil is sandy-loam [11]. The farm is located in the humid forest zone with temperature ranges of 27°C - 33°C and annual rainfall of about 2400mm.

#### 2.2 Source of Experimental Materials

The studied varieties (TME 419, TMS 96/0523 and TMS 95/0289) were released in 2005 by International Institute of Tropical Agriculture (I.I.T.A). The stems of these improved cassava varieties were procured from International Institute of Tropical Agriculture (I.I.T.A), Onne Station in Rivers State.

The compound fertilizers (NPK 20-10-10 and NPK 15-15-15) were collected from Agricultural Development Programme, Rivers State.

#### 2.3 Land Preparation, Planting, Fertilizer Application and Weed Control

A land area of 648 m² was used and was manually cleared, the land was divided into three blocks with each block comprising of nine (9) sub-plots of 24 m². Cassava cuttings of 20 – 25 cm length were planted per hole at a spacing of 1 m by 1 m. The fertilizer rates used were 300 kg per hectare which was applied in split doses of half at eight weeks after planting and half at twelve weeks after planting. Weeding was done...
manually, first weeding was done at four weeks after planting, second weeding at nine weeks after planting and third weeding was done at thirteen weeks after planting.

2.4 Parameters Assessed

The parameters evaluated are namely; number of branched stands, canopy diameter, fresh pulp weight, dry pulp weight, dry peels weight and fresh peels weight. Data was taken at four weekly interval starting from the tenth week after planting (10 WAP) to thirty–eight weeks after planting (38WAP). Data involving tubers were taken at harvest in February 2022.

2.5 Experimental Design

The experimental design used in this research study is a split plot arrangement fitted into a Randomized Complete Block Design (RCBD). The treatments were replicated thrice.

2.6 Data Analysis

Data collected from the field at four weeks intervals were computed into Microsoft excel spreadsheet and Analysis of variance was done using Minitab statistical software. Treatment means were separated using Tukey’s Pairwise comparison grouping method at 5% probability level.

3. RESULTS

The interactive effect of NPK compound fertilizers and the cassava varieties on the number of branches (Table 1) noted no significant difference (P>0.05) among the treatments at 10WAP and 14WAP but TME 419 was significantly different from TMS 96/0523 and TMS 95/0289 during the study. TMS 96/0523 grown with NPK 20-10-10 fertilizer (V2F1) and TMS 96/0523 grown with NPK15-15-15 fertilizer (V3F2) at 10WAP to 22WAP had the highest mean values. TMS 95/0289 grown with NPK15-15-15 fertilizer (V3F2) at 10WAP to 22WAP recorded the highest mean value of 16.3, 20.0, 21.3, 24.7 in 26WAP, 30WAP, 34WAP and 38WAP while TMS 96/0523 grown with NPK15-15-15 fertilizer (V3F2) (3.7, 5.7, 11.0, 14.0) had the highest mean in 10WAP - 22WAP respectively. The lowest number of branches in the study period was in TME 419 grown with NPK15-15-15 fertilizer (V3F2) (0.3, 0.3, 0.7, 0.7 and 0.7) at 14WAP, 18WAP, 26WAP, 30WAP, 34WAP, 38WAP and TME 419 grown with NPK20-10-10 fertilizer (V2F1) (0, 0 and 0.3) at 10WAP, 14WAP and 22WAP. Although, no significant difference was noted at 38WAP between the studied treatments except in TME 419 grown with NPK15-15-15 fertilizer (V3F2).

The varietal difference in number of branches as shown in Fig 1 recorded significant differences among the varieties (TME 419, TMS 95/0289, TMS 96/0523) during the monitoring period (10WAP – 38WAP) where the highest branch number was in TMS 95/0289 at 26WAP – 38WAP and TMS 96/0523 at 10WAP – 22WAP respectively. Plants grown with control treatment (no fertilizer) plots had the least branch number during the study period (10WAP – 38WAP) but a higher number of branches were observed in plants grown with NPK15-15-15 fertilizer (Fig. 2).

The combined effect in Table 2 shows that TMS 96/0523 cultivated with NPK 15-15-15 fertilizer (V3F2) was significantly higher (138.7, 196.3, 214.3, 222.0, 241.7 and 263.1) in canopy width during the study period followed by TMS 95/0289 cultivated with NPK20-10-10 fertilizer (V2F1) at 18WAP and TMS 96/0523 cultivated with 20-10-10 fertilizer (V2F1) at 22WAP, 26WAP, 30WAP, 34WAP, 38WAP while the least was in TMS 419 cultivated with NPK15-15-15 fertilizer (V3F2) at 18WAP, TMS 419 cultivated with no fertilizer (V3F0) at 22WAP to 38WAP. Significant difference (P<0.05) was noted in the studied varieties with NPK 20-10-10 and NPK 15-15-15 fertilizer over plants cultivated with no fertilizer in the study period. The difference in the three studied varieties as observed in Fig. 3 noted the highest canopy width in TMS 96/0523 followed by TMS 95/0289 then the lowest was in TME 419. In terms of fertilizer effects, the varieties that had NPK 15-15-15 application produced the highest canopy width followed by varieties with NPK 20-10-10 application (Fig. 4).

Table 3 showed that TMS 96/0523 cultivated with NPK 15-15-15 compound fertilizer (V3F2) gave the highest fresh peels weight followed by TMS 95/0289 cultivated with no compound fertilizer (V3F0) but were not significantly different and low in TMS 96/0523 grown with NPK 20-10-10 compound fertilizer (V2F1). For dry peels weight, the maximum mean value of 100.3 was achieved by TMS 96/0523 cultivated with NPK 15-15-15 compound fertilizer (V3F2) and lowest in TMS 96/0523 cultivated with NPK 20-10-10 compound fertilizer (V2F1) (69.0). TME 419 cultivated with NPK 15-15-15 compound fertilizer (V3F2) produced the highest fresh and dry pulp weight.
with mean values of 722.7 and 487.0 followed by TME 419 cultivated with 20-10-10 compound fertilizer ($V_3F_1$) (666.3 and 462.7) and least in TMS 95/0289 cultivated with NPK 15-15-15 compound fertilizer ($V_3F_2$) (417.0 and 305.3) respectively. TME 419 produced the maximum mean weight values in dry peels (83.8), fresh pulp (680.0) and dry pulp (468.8) which was followed by TMS 96/0523 while TMS 96/0523 had the highest mean value of fresh peel weight (115.1). The lowest in dry peels weight, fresh peels weight, fresh pulp and dry pulp weight was recorded in TMS 95/0289 (Fig. 5). Control had the highest mean weights in fresh peels and fresh pulp (116.9 and 596.7) and lowest in dry peel weight. NPK 15-15-15 had high mean number in dry peels and dry pulp weights while the lowest in fresh peel weight and dry pulp weight was NPK 20-10-10, fresh pulp weight was in NPK 15-15-15 respectively (Fig. 6).

Fig. 1. Varietal difference on number of branches

![Fig. 1. Varietal difference on number of branches](image)

Fig. 2. Fertilizer effect on number of branches of three cassava varieties

![Fig. 2. Fertilizer effect on number of branches of three cassava varieties](image)

Fig. 3. Varietal difference on canopy width

![Fig. 3. Varietal difference on canopy width](image)
Fig. 4. Fertilizer effect on canopy width of three cassava varieties

Fig. 5. Varietal difference on Fresh/dry peels weights and Fresh/dry pulp weights

Fig. 6. Fertilizer effect on Fresh/dry peels weights and Fresh/dry pulp weights
Table 1. Interactive effect of two fertilizer types and three varieties on the number of cassava branches

<table>
<thead>
<tr>
<th>Treatments</th>
<th>10WAP</th>
<th>14WAP</th>
<th>18WAP</th>
<th>22WAP</th>
<th>26WAP</th>
<th>30WAP</th>
<th>34WAP</th>
<th>38WAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>V₁F₀</td>
<td>0.7a</td>
<td>2.3ab</td>
<td>5.3b</td>
<td>6.3b</td>
<td>10.7ab</td>
<td>16.3ab</td>
<td>16.7a</td>
<td>19.3a</td>
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<tr>
<td>V₂F₀</td>
<td>2.3a</td>
<td>3.3ab</td>
<td>5.0b</td>
<td>8.0b</td>
<td>10.0ab</td>
<td>11.0b</td>
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<td>14.0a</td>
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<tr>
<td>V₃F₀</td>
<td>0.3b</td>
<td>0.3b</td>
<td>0.3c</td>
<td>0.7d</td>
<td>1.0b</td>
<td>1.3b</td>
<td>1.3b</td>
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<tr>
<td>V₁F₁</td>
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<td>5.0a</td>
<td>7.7ab</td>
<td>10.3ab</td>
<td>13.3a</td>
<td>16.3ab</td>
<td>19.7a</td>
<td>22.3a</td>
</tr>
<tr>
<td>V₂F₁</td>
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<td>6.7ab</td>
<td>7.3b</td>
<td>11.7a</td>
<td>13.7b</td>
<td>15.0ab</td>
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<tr>
<td>V₃F₁</td>
<td>0b</td>
<td>0b</td>
<td>0.3c</td>
<td>0.7d</td>
<td>1.0b</td>
<td>1.0c</td>
<td>1.0b</td>
<td>1.3b</td>
</tr>
<tr>
<td>V₁F₂</td>
<td>1.0b</td>
<td>4.0a</td>
<td>6.3ab</td>
<td>13.3a</td>
<td>16.3a</td>
<td>20.0a</td>
<td>21.3a</td>
<td>24.7a</td>
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<tr>
<td>V₂F₂</td>
<td>3.7a</td>
<td>5.7a</td>
<td>11.0a</td>
<td>14.0a</td>
<td>15.3a</td>
<td>16.3ab</td>
<td>17.3a</td>
<td>18.3a</td>
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<tr>
<td>V₃F₂</td>
<td>0.3a</td>
<td>0.3b</td>
<td>0.3c</td>
<td>0.7d</td>
<td>0.7b</td>
<td>0.7b</td>
<td>0.7b</td>
<td>0.7b</td>
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</table>

*Means that do not share same letter in columns are significantly different (Tukey method at 95% confidence level)


Table 2. Interaction effect of two fertilizer types and three cassava varieties on cassava canopy width (cm)

<table>
<thead>
<tr>
<th>Treatments</th>
<th>18WAP</th>
<th>22WAP</th>
<th>26WAP</th>
<th>30WAP</th>
<th>34WAP</th>
<th>38WAP</th>
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<tbody>
<tr>
<td>V₁F₀</td>
<td>123.3a</td>
<td>110.3c</td>
<td>145.3bc</td>
<td>164.0bc</td>
<td>134.7bc</td>
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<tr>
<td>V₂F₀</td>
<td>108.7b</td>
<td>144.3b</td>
<td>165.7b</td>
<td>179.0b</td>
<td>193.3b</td>
<td>220.7a</td>
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<tr>
<td>V₃F₀</td>
<td>89.3c</td>
<td>91.0c</td>
<td>101.7c</td>
<td>87.0c</td>
<td>69.7c</td>
<td>57.0d</td>
</tr>
<tr>
<td>V₁F₁</td>
<td>131.7a</td>
<td>130.0b</td>
<td>171.7ab</td>
<td>170.0bc</td>
<td>165.3b</td>
<td>167.7c</td>
</tr>
<tr>
<td>V₂F₁</td>
<td>131.0a</td>
<td>145.7a</td>
<td>191.7a</td>
<td>200.7ab</td>
<td>220.7a</td>
<td>247.7a</td>
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<tr>
<td>V₃F₁</td>
<td>112.7b</td>
<td>97.7c</td>
<td>118.3c</td>
<td>118.7c</td>
<td>107.3bc</td>
<td>96.7d</td>
</tr>
<tr>
<td>V₁F₂</td>
<td>120.0a</td>
<td>118.0c</td>
<td>169.3b</td>
<td>178.7b</td>
<td>185.7a</td>
<td>179.3c</td>
</tr>
<tr>
<td>V₂F₂</td>
<td>138.7a</td>
<td>196.3a</td>
<td>214.3a</td>
<td>222.0a</td>
<td>241.7a</td>
<td>263.1a</td>
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<tr>
<td>V₃F₂</td>
<td>87.0c</td>
<td>113.3c</td>
<td>124.3c</td>
<td>106.7b</td>
<td>85.0c</td>
<td>65.0d</td>
</tr>
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</table>

*Means that do not share same letter in columns are significantly different (Tukey method at 95% confidence level)


Table 3. Interaction effect of two fertilizer types and three cassava varieties on the Fresh/dry peels weights and Fresh/dry pulp weights

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Fresh peel weight</th>
<th>Dry peels weight</th>
<th>Fresh pulp weight</th>
<th>Dry pulp weight</th>
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</thead>
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<tr>
<td>V₁F₀</td>
<td>120.3a</td>
<td>87.3ab</td>
<td>612.0a</td>
<td>328.3a</td>
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<tr>
<td>V₂F₀</td>
<td>117.3a</td>
<td>76.0b</td>
<td>527.0b</td>
<td>333.3a</td>
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<tr>
<td>V₃F₀</td>
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<td>80.0ab</td>
<td>651.7a</td>
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<tr>
<td>V₁F₁</td>
<td>105.3a</td>
<td>85.0ab</td>
<td>552.7b</td>
<td>316.7a</td>
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<tr>
<td>V₂F₁</td>
<td>98.3a</td>
<td>69.0b</td>
<td>562.0b</td>
<td>306.7a</td>
</tr>
<tr>
<td>V₃F₁</td>
<td>109.0a</td>
<td>92.0a</td>
<td>666.3a</td>
<td>462.7a</td>
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<td>V₁F₂</td>
<td>101.0a</td>
<td>77.3b</td>
<td>417.0b</td>
<td>305.3a</td>
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<tr>
<td>V₂F₂</td>
<td>129.7a</td>
<td>100.3a</td>
<td>605.3ab</td>
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<td>V₃F₂</td>
<td>112.0a</td>
<td>79.3b</td>
<td>722.7a</td>
<td>487.0a</td>
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</table>

*Means that do not share same letter in columns are significantly different (Tukey method at 95% confidence level)


4. DISCUSSION

The combined effect between fertilizer and cassava varieties in number of branches revealed that TMS 95/0289 variety applied with NPK 15-15-15 fertilizer gave the highest branches. TMS 95/0289 had high number of branches and this is contrary to the result of Ceballos and de la Cruz [12] that stated high branching characteristics of TMS 96/0523 and
TME 419 as they produce planting materials up to their secondary branching. However, the findings on the number of branches of TME 419 and TMS 96/0523 obtained in this study contrast the assertion of Yomeni [13] who reported high branching ability of the varieties (TME 419 and TMS 96/0523) in her research.

Furthermore, TMS 96/0523 variety applied with NPK 15-15-15 fertilizer gave the highest canopy width all through the planting months and this differs from the works of Muojiama and colleagues [14] that observed no significant difference between fertilized and unfertilized plots in canopy diameter. Findings from this work showed that TMS 96/0523 had high canopy width likewise the application of NPK 15-15-15 which is agreed with the works of Cenpukekdee and Fukai [15] that reported increase in canopy size and plant height of fertilized plots. Production of branches, plant height and leaf area were stimulated by application of higher nitrogen [15].

TMS 95/0289 had good number of branches, this may be due to varietal morphology and high branching capability [12]. This experimental study showed that NPK fertilizer greatly influenced cassava growth positively [9,16].

In peels weight and pulp weight, the fresh peels and dry peels was higher in TMS 96/0523 applied with NPK 15-15-15 but TME 419 applied with NPK 15-15-15 was higher in fresh and dry pulp weight. Fresh and dry weight of peels and pulps were higher in fertilized plots than control plots with NPK 15-15-15 having the highest and TME 419 as they produce planting materials up to their secondary branching. However, the findings on the number of branches of TME 419 and TMS 96/0523 obtained in this study contrast the assertion of Yomeni [13] who reported high branching ability of the varieties (TME 419 and TMS 96/0523) in her research.

Also, NPK 15-15-15 produced significantly higher number of branches, dry peels weight, dry pulp weight and canopy width while Control plots had the highest fresh pulp weight and fresh peels weight. Therefore, it is recommended that TME 419 be introduced to farmers as it produced highest pulp weight per stand. Also, fertilizer NPK 15-15-15 is a preferred NPK fertilizer as it has the capability in increasing the number of branches, canopy width, peels weight, pulp weight and pulp weight in comparison with NPK 20-10-10.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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