Tropical Root Crops

RESEARCH STRATEGIES FOR THE 1980s

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TROPICAL ROOT CROPS:
RESEARCH STRATEGIES FOR THE 1980s


EDITORS: E.R. TERRY, K.A. ODURO, AND F. CAVENESS

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Postal Address: Box 8500, Ottawa, Canada K1G 3H9
Head Office: 60 Queen Street, Ottawa

Terry, E.R.
Oduro, K.A.
Caveness, F.

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**Discussion Summary**

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EVALUATION OF SOME MAJOR SOILS FROM SOUTHERN NIGERIA FOR CASSAVA PRODUCTION

J.E. OKEKE AND B.T. KANG

NATIONAL ROOT CROPS RESEARCH INSTITUTE, UMUDIKE, UMUHIA, NIGERIA, AND INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE, IBADAN, NIGERIA

A pot trial was carried out with cassava and seven benchmark soils commonly used for cassava production in the forest and derived savanna of southern Nigeria. Soils from basement complex rocks from the forest zone (Araromi, Egbeda, and Apomu series) have higher potential for cassava production than those derived from sandy sedimentary rocks (Alagba, Onne, and Nkpologu series) or sandy soil from derived savanna (Shante series). Differential N, P, K, Mg, S responses and Zn deficiency were also observed among the seven soils. The data obtained can be used as a guide for fertilizer experiments.

In the traditional bush fallow system, cassava is usually grown as the last crop because of its ability to produce a reasonable yield on low fertility soils. However, cassava can produce high yields when grown on fertile soils or with judicious fertilization. In minikit trials carried out in East Central State, Nigeria, Ezeilo (1977) reported large and economic root yield increases ranging from 21 to 181% with NPK application. A number of investigators have reported responses to N, P, and K in cassava in various cassava-growing areas in southern Nigeria (Irving 1956; Amon and Adetunji 1973; Obigbesan 1977; Obigbesan and Fayemi 1976; Kang et al. 1980). As part of the Nigerian government’s effort to increase food production in the country, emphasis has been given to the use of fertilizers to increase cassava yield. For this purpose, more and better data are needed about the responses of cassava to the nutrients contained in the soils of the major cassava-growing areas of the country. As one of the initial steps for obtaining the needed information, we carried out a greenhouse trial to assess the nutrient status of seven benchmark soils widely used for cassava production in southern Nigeria.

Table 1. General information on the seven soils used in the experiment.

<table>
<thead>
<tr>
<th>Soil order</th>
<th>Soil series</th>
<th>Location</th>
<th>USDA classification</th>
<th>Vegetation and land use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfisol</td>
<td>Alagba</td>
<td>Ikenne</td>
<td>Oxic paleustalf</td>
<td>Bush regrowth in forest area</td>
</tr>
<tr>
<td>Entisol</td>
<td>Apomu</td>
<td>IITA, Ibadan</td>
<td>Psammentic usthorthent</td>
<td>Grass fallow in forest area</td>
</tr>
<tr>
<td>Alfisol</td>
<td>Egbeda</td>
<td>IITA, Ibadan</td>
<td>Oxic paleustalf</td>
<td>Secondary forest Derived savanna</td>
</tr>
<tr>
<td>Entisol</td>
<td>Shante</td>
<td>Ogbomosho</td>
<td>Psammentic usthorthent</td>
<td>Grass fallow in forest area</td>
</tr>
<tr>
<td>Alfisol</td>
<td>Araromi</td>
<td>Ishoya</td>
<td>Oxic paleustalf</td>
<td>Grass fallow in forest area</td>
</tr>
<tr>
<td>Ultisol</td>
<td>Nkpologu</td>
<td>Umudike</td>
<td>Typic paleudult</td>
<td>Grass fallow in forest area</td>
</tr>
<tr>
<td>Ultisol</td>
<td>Onne</td>
<td>Onne</td>
<td>Typic paleudult</td>
<td>Bush regrowth in forest area</td>
</tr>
</tbody>
</table>
Table 2. Physical and chemical properties of soils used in the experiment.

<table>
<thead>
<tr>
<th>Soil series</th>
<th>Sand (%)</th>
<th>Silt (%)</th>
<th>Clay (%)</th>
<th>pH</th>
<th>Organic C (%)</th>
<th>Total N (%)</th>
<th>Bray-I P (ppm)</th>
<th>K (me/100g)</th>
<th>Mg (ppm)</th>
<th>Ca (ppm)</th>
<th>Zn (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apomu</td>
<td>85</td>
<td>7</td>
<td>8</td>
<td>6.0</td>
<td>1.13</td>
<td>0.18</td>
<td>6.0</td>
<td>0.25</td>
<td>1.07</td>
<td>2.90</td>
<td>3.3</td>
</tr>
<tr>
<td>Alagba</td>
<td>81</td>
<td>10</td>
<td>10</td>
<td>6.0</td>
<td>1.40</td>
<td>0.18</td>
<td>1.8</td>
<td>0.08</td>
<td>2.00</td>
<td>3.20</td>
<td>2.4</td>
</tr>
<tr>
<td>Shante</td>
<td>91</td>
<td>5</td>
<td>4</td>
<td>6.4</td>
<td>1.10</td>
<td>0.08</td>
<td>6.0</td>
<td>0.33</td>
<td>0.07</td>
<td>1.70</td>
<td>0.8</td>
</tr>
<tr>
<td>Egbeda</td>
<td>70</td>
<td>15</td>
<td>15</td>
<td>6.4</td>
<td>1.60</td>
<td>0.29</td>
<td>3.0</td>
<td>0.60</td>
<td>2.40</td>
<td>1.40</td>
<td>6.8</td>
</tr>
<tr>
<td>Araromi</td>
<td>51</td>
<td>19</td>
<td>30</td>
<td>6.0</td>
<td>2.50</td>
<td>0.39</td>
<td>6.3</td>
<td>1.20</td>
<td>2.50</td>
<td>8.70</td>
<td>23.1</td>
</tr>
<tr>
<td>Nkpologu</td>
<td>87</td>
<td>8</td>
<td>12</td>
<td>4.9</td>
<td>1.10</td>
<td>0.14</td>
<td>4.17</td>
<td>0.21</td>
<td>0.23</td>
<td>0.38</td>
<td>1.5</td>
</tr>
<tr>
<td>Onne</td>
<td>81</td>
<td>7</td>
<td>12</td>
<td>4.1</td>
<td>1.03</td>
<td>0.14</td>
<td>4.17</td>
<td>0.21</td>
<td>0.23</td>
<td>0.38</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Table 3. Effect of fertilizer application and soil type on height (cm) of cassava variety TMS 30395 at 5 WAP.\(^a\)

<table>
<thead>
<tr>
<th>Fertilizer treatment</th>
<th>Egbeda</th>
<th>Apomu</th>
<th>Alagba</th>
<th>Araromi</th>
<th>Onne</th>
<th>Nkpologu</th>
<th>Shante</th>
<th>Fertilizer mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>19.8</td>
<td>21.8</td>
<td>13.0</td>
<td>18.8</td>
<td>15.8</td>
<td>17.0</td>
<td>14.0</td>
<td>17.1</td>
</tr>
<tr>
<td>NPKSMg</td>
<td>21.5</td>
<td>19.8</td>
<td>20.8</td>
<td>17.8</td>
<td>17.5</td>
<td>17.3</td>
<td>15.3</td>
<td>18.5</td>
</tr>
<tr>
<td>NPKS</td>
<td>20.0</td>
<td>18.5</td>
<td>21.8</td>
<td>16.0</td>
<td>18.5</td>
<td>14.5</td>
<td>16.0</td>
<td>18.5</td>
</tr>
<tr>
<td>NPKMg</td>
<td>19.8</td>
<td>17.8</td>
<td>23.8</td>
<td>15.5</td>
<td>13.5</td>
<td>17.5</td>
<td>14.0</td>
<td>18.3</td>
</tr>
<tr>
<td>NPSMg</td>
<td>21.5</td>
<td>19.0</td>
<td>19.8</td>
<td>17.3</td>
<td>20.3</td>
<td>16.5</td>
<td>16.3</td>
<td>18.6</td>
</tr>
<tr>
<td>NKSMg</td>
<td>15.8</td>
<td>17.5</td>
<td>14.8</td>
<td>18.0</td>
<td>18.3</td>
<td>14.0</td>
<td>16.0</td>
<td>16.3</td>
</tr>
<tr>
<td>PKSMg</td>
<td>21.5</td>
<td>19.0</td>
<td>18.8</td>
<td>20.3</td>
<td>15.3</td>
<td>13.5</td>
<td>15.0</td>
<td>17.6</td>
</tr>
<tr>
<td>Soil mean</td>
<td>20.0</td>
<td>19.3</td>
<td>18.9</td>
<td>17.9</td>
<td>17.0</td>
<td>15.8</td>
<td>15.5</td>
<td></td>
</tr>
</tbody>
</table>

\(^a\)Soil type: SE ± 0.72; LSD 5% = 2.2; WAP = weeks after planting.

Table 4. Effect of soil type and fertilizer application on plant dry weight (g) at 12 WAP.\(^a\)

<table>
<thead>
<tr>
<th>Fertilizer treatment</th>
<th>Araromi</th>
<th>Egbeda</th>
<th>Apomu</th>
<th>Alagba</th>
<th>Onne</th>
<th>Nkpologu</th>
<th>Shante</th>
<th>Fertilizer mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nil</td>
<td>20.0</td>
<td>16.4</td>
<td>13.8</td>
<td>11.8</td>
<td>15.4</td>
<td>9.6</td>
<td>10.5</td>
<td>13.9</td>
</tr>
<tr>
<td>NPKSMg</td>
<td>23.9</td>
<td>19.7</td>
<td>21.4</td>
<td>20.4</td>
<td>15.7</td>
<td>16.2</td>
<td>14.5</td>
<td>18.8</td>
</tr>
<tr>
<td>NPKS</td>
<td>21.4</td>
<td>18.3</td>
<td>19.9</td>
<td>18.4</td>
<td>16.1</td>
<td>14.0</td>
<td>10.6</td>
<td>17.1</td>
</tr>
<tr>
<td>NPKMg</td>
<td>18.8</td>
<td>15.1</td>
<td>15.7</td>
<td>17.3</td>
<td>14.3</td>
<td>14.5</td>
<td>9.9</td>
<td>15.1</td>
</tr>
<tr>
<td>NPSMg</td>
<td>19.7</td>
<td>22.5</td>
<td>16.0</td>
<td>16.0</td>
<td>12.6</td>
<td>14.5</td>
<td>13.3</td>
<td>16.4</td>
</tr>
<tr>
<td>NKSMg</td>
<td>19.0</td>
<td>13.3</td>
<td>15.1</td>
<td>14.5</td>
<td>13.9</td>
<td>14.6</td>
<td>14.2</td>
<td>14.9</td>
</tr>
<tr>
<td>PKSMg</td>
<td>24.1</td>
<td>16.3</td>
<td>15.9</td>
<td>12.6</td>
<td>12.5</td>
<td>11.9</td>
<td>10.9</td>
<td>14.9</td>
</tr>
<tr>
<td>Soil type mean</td>
<td>21.1</td>
<td>17.4</td>
<td>16.8</td>
<td>15.9</td>
<td>14.4</td>
<td>13.6</td>
<td>12.0</td>
<td>15.9</td>
</tr>
</tbody>
</table>

\(^a\)Soil type: SE ± 0.82; LSD 5% = 2.45; fertilizer: SE ± 0.72; LSD 5% = 2.00; fertilizer treatment within soil type: SE = ± 1.89; LSD 5% = 5.3.

**Materials and Methods**

The list of soil samples used in the experiment is given in Table 1. Soil texture was measured by the hydrometer method; a 1:1 soil:water ratio was used in pH measurements with glass electrode; organic carbon was determined by a modified version of the Allison wet digestion method; total nitrogen was determined by the Kjeldahl method; extractable phosphorus was determined with a Bray no. 1 extractant; exchangeable cations were extracted by 1 N ammonium acetate; and extractable zinc was measured after extraction with 0.1 N hydrochloric acid.

Plant samples were digested in a Tecator model 40 aluminum digestion block; the reagents were nitric, perchloric, and hydrochloric acids. Phosphorus was measured by means of a Technicon...
autoanalyzer; potassium, by means of an EEC flame photometer; and zinc, with a Perkin Elmer model 403 atomic absorption spectrophotometer. Nitrogen was measured by a micro-Kjeldahl distillation method.

The greenhouse trial was a split-plot design with four replications. The seven soil types constituted the main plots; five fertilizer treatments were applied to subplots: NPKSMg, NPKS, NPKMg, NPSMg, NKSMg, PKSMg, and control (no fertilizer). N, P, and K were added at 100 ppm each and Zn and S added at 20 ppm each. Five kilograms of air-dried soil was used in each pot. Fertilizers were thoroughly mixed with soil, and the pots watered to field capacity. Four stakes of cassava variety TMS 30395 were planted in each pot and thinned after 2 weeks to two plants/pot. A top dressing with 25 ppm N was made at 5 WAP (weeks after planting). Plants were harvested at 12 WAP. Index leaf samples were collected at 8 WAP for Zn determination.

**RESULTS AND DISCUSSION**

**SOIL ANALYSIS**

Some of the characteristics of the soils used in the study are shown in Table 2. Except for the Araromi soil, which was sandy clay loam, all the soils were coarse, ranging from loamy sand to sandy loam. The Araromi soil, which is derived from amphibolitic rocks, showed the highest nutrient status; the Onne soil, which is derived from marine sediments, exhibited the lowest. Except for the Onne soil, the soils were low in extractable P; the soils derived from sandy sedimentary materials (Ikenne, Nkpologu, and Onne) were also low in exchangeable K. Also noteworthy is the high acid-

---

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Control</th>
<th>NPKSMg</th>
<th>NPKS</th>
<th>NPKMg</th>
<th>NPSMg</th>
<th>NKSMg</th>
<th>PKSMg</th>
<th>Soil Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egbeda</td>
<td>4.5</td>
<td>5.0</td>
<td>5.2</td>
<td>5.0</td>
<td>5.2</td>
<td>5.8</td>
<td>4.5</td>
<td>5.0</td>
</tr>
<tr>
<td>Alabba</td>
<td>3.5</td>
<td>4.2</td>
<td>3.8</td>
<td>3.8</td>
<td>4.0</td>
<td>3.9</td>
<td>3.6</td>
<td>3.8</td>
</tr>
<tr>
<td>Apomu</td>
<td>3.9</td>
<td>5.4</td>
<td>5.2</td>
<td>5.2</td>
<td>5.0</td>
<td>3.3</td>
<td>4.5</td>
<td>4.6</td>
</tr>
<tr>
<td>N(%)</td>
<td>3.2</td>
<td>4.4</td>
<td>4.9</td>
<td>5.1</td>
<td>4.6</td>
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<th>NKSMg</th>
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<td>1.77</td>
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Table 5. N, P, K concentrations (%) in index leaf blade as affected by fertilizer and soil type (12 WAP).
The data clearly showed some relationship between soils, crop growth, and plant nutrient status. It also appears that soils derived from basement complex rocks in the forest zone (Araromi, Egbeda, and Apomu series) have higher potential for cassava production than those derived from sandy sedimentary rocks (Alagba, Onne, and Nkpologu series) or sandy soil from derived savanna (Shante series).

The nitrogen responses in the Apomu, Shante, Alagba, Onne, and Nkpologu soils (Table 4) were to be expected because of the low N and organic C status of these soils. These responses are a reflection of the vegetative cover (Table 1).

The phosphorus responses observed in this pot trial (Table 4 and 5) may be related to the limited

Table 6. Zn levels (ppm) in cassava leaf blades at 8 and 12 WAP.

<table>
<thead>
<tr>
<th>Fertilizer treatment</th>
<th>Egbeda 8 WAP</th>
<th>Egbeda 12 WAP</th>
<th>Alagba 8 WAP</th>
<th>Alagba 12 WAP</th>
<th>Apomu 8 WAP</th>
<th>Apomu 12 WAP</th>
<th>Shante 8 WAP</th>
<th>Shante 12 WAP</th>
<th>Nkpologu 8 WAP</th>
<th>Nkpologu 12 WAP</th>
<th>Onne 8 WAP</th>
<th>Onne 12 WAP</th>
<th>Araromi 8 WAP</th>
<th>Araromi 12 WAP</th>
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<td>24 54 29 56</td>
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<td>18 16 30 32</td>
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soil volume used. As indicated by Kang et al. (1980), cassava has low external P requirements, and responses for field-grown cassava are not common.

The sandy entisols (Apomu and Shante) and soils derived from sandy sedimentary rocks (Alagba, Onne, and Nkpologu soils) are potentially more subject to potassium deficiency than are the others. The Shante soil from the derived savanna also showed potential for magnesium and sulfur deficiencies.

Though early zinc deficiency on the Shante and Nkpologu soils was expected because of their low zinc levels (Table 2), it was not expected on the Alagba soil, which had adequate zinc levels. The disappearance of zinc deficiency later (12 WAP) may be related to the ability of the older roots to explore the entire soil volume.

Data from this trial may be useful in the planning of field fertilizer trials in the major cassava-growing areas of southern Nigeria.

We express our thanks to the former Director General of IITA, Dr W.K. Gamble, and the former Director of the National Root Crops Research Institute (NRCRI) Dr B.E. Onochie for providing facilities and funds for the work, to Dr S.K. Hahn, Assistant Director, Tuber and Root Improvement Programme, for his valuable assistance, and to the present Director NRCRI, Dr L.S.O. Ene.