Tropical Root Crops

RESEARCH STRATEGIES FOR THE 1980s

Proceedings of the First Triennial Root Crops Symposium of the International Society for Tropical Root Crops ~ Africa Branch
Although the editorial chores for these proceedings were the sole responsibility of the editors, the International Society for Tropical Root Crops — Africa Branch has a full Editorial Board comprising E.R. Terry, O.B. Arene, E.V. Doku, K.A. Oduro, W.N. Ezeilo, J. Mabanza, and F. Nweke. This Board serves the Society in various editorial capacities at all times.
The International Development Research Centre is a public corporation created by the Parliament of Canada in 1970 to support research designed to adapt science and technology to the needs of developing countries. The Centre's activity is concentrated in five sectors: agriculture, food and nutrition sciences; health sciences; information sciences; social sciences; and communications. IDRC is financed solely by the Parliament of Canada; its policies, however, are set by an international Board of Governors. The Centre's headquarters are in Ottawa, Canada. Regional offices are located in Africa, Asia, Latin America, and the Middle East.

The International Society for Tropical Root Crops — Africa Branch was created in 1978 to stimulate research, production, and utilization of root and tuber crops in Africa and the adjacent islands. The activities include encouragement of training and extension, organization of workshops and symposia, exchange of genetic materials, and facilitation of contacts between personnel working with root and tuber crops. The Society's headquarters is at the International Institute of Tropical Agriculture in Ibadan, Nigeria, but its executive council comprises eminent root and tuber researchers from national programs throughout the continent.

©1981 International Development Research Centre
Postal Address: Box 8500, Ottawa, Canada K1G 3H9
Head Office: 60 Queen Street, Ottawa

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

International Society for Tropical Root Crops — Africa Branch, Ibadan NG


UDC: 633.4 (213)  ISBN: 0 88936 285 8

Microfiche edition available
Cooperating institutions
CONTENTS

Foreword E.R. Terry .............................................................. 7

Participants ............................................................................. 9

Welcoming Addresses

Bede N. Okigho, President, International Society for Tropical Root Crops —
Africa Branch ................................................................. 15
Alhaji Ibrahim Gusau, Minister of Agriculture, Nigeria ..................... 17
S. Olajuwon Olayide, Vice-Chancellor, University of Ibadan, Nigeria .... 19
E. Hartmans, Director-General, International Institute of Tropical Agricul-
ture, Nigeria .................................................................. 22

Cassava

Cassava Improvement Strategies for Resistance to Major Economic Diseases
Singh ............................................................................. 25
Cassava Improvement in the Programme National Manioc in Zaire: Objectives
and Achievements up to 1978 H.C. Ezumah .................................. 29
Assessment of Cassava Cultivars for Extension Work C. Oyolu .......... 35
Breeding Cassava Resistant to Pests and Diseases in Zaire T.P. Singh .... 37
Selection of Cassava for Disease and Pest Resistance in the Congo Joseph
Mabanza ............................................................................ 40

Cassava: Ecology, Diseases, and Productivity: Strategies for Future
Research E.R. Terry ............................................................ 45
Field Screening of Cassava Clones for Resistance to Cercospora henningsii
J.B.K. Kasirivu, O.F. Esuruoso, and E.R. Terry ............................. 49
Properties of a Severe Strain of Cassava Latent Virus Isolated from Field-
Grown Tobacco in Nigeria E.C.K. Igwegbe ................................ 58
Cassava Bacterial Blight Disease in Uganda G.W. Otim-Nape and T.
Sengooba ............................................................................. 61

Insect Dissemination of Xanthomonas manihotis to Cassava in the People’s
Republic of Congo J.F. Daniel, B. Boher, and N. Nkouka .................. 66
Cassava Root Rot due to Armillariella tabescens in the People’s Republic of
Congo Casimir Makambila ..................................................... 69
Screening for Resistance Against the Green Spider Mite K. Leuschner .... 75
Biological Control of the Cassava Mealybug Hans R. Herren ................ 79
Entomophagous Insects Associated with the Cassava Mealybug in the People’s
Republic of Congo G. Fabres ................................................. 81
Dynamics of Cassava Mealybug Populations in the People’s Republic of
Congo G. Fabres .................................................................... 84
Consumption Patterns and Their Implications for Research and Production in
Tropical Africa Felix I. Nweke ................................................ 88
Problems of Cassava Production in Malawi  R.F. Nembozanga Sauti .......................... 95
Effects of Soil Moisture and Bulk Density on Growth and Development of Two Cassava Cultivars  R. Lal ................................................................. 104
Performance of Cassava in Relation to Time of Planting and Harvesting  F.O.C. Ezedinma, D.G. Ibe, and A.I. Onwuchuruba ................................. 111
The Effects of Previous Cropping on Yields of Yam, Cassava, and Maize S.O. Odurukwe and U.I. Oji ................................................... 116
Intercropping of Plantains, Cocoyams, and Cassava  S.K. Karikari ....................... 120
Weed Control in Maize—Cassava Intercrop  I. Okezie Akobundu ......................... 124
Cassava Leaf Harvesting in Zaire  N.B. Lutaladio and H.C. Ezumah ......................... 134
Effects of Leaf Harvests and Detopping on the Yield of Leaves and Roots of Cassava and Sweet Potato  M.T. Dahniya ................................. 137
Metabolism, Synthetic Site, and Translocation of Cyanogenic Glycosides in Cassava  M.K.B. Bediako, B.A. Tapper, and G.G. Pritchard ...................... 143
Loss of Hydrocyanic Acid and Its Derivatives During Sun Drying of Cassava  Emmanuel N. Maduagwu and Aderemi F. Adewale ......................... 149
The Role of Palm Oil in Cassava-Based Rations  Ruby T. Fomunyam, A.A. Adegbola, and O.L. Oke ............................................................ 152
Comparison of Pressed and Unpressed Cassava Pulp for Gari Making M.A.N. Ejiofor and N. Okafor ................................................. 154
Gari Yield from Cassava: Is it a Function of Root Yield?  D.G. Ibe and F.O.C. Ezedinma .................................................. 159

Yams

Parameters for Selecting Parents for Yam Hybridization  Obinani O. Okoli ................................. 163
Anthracnose of Water Yam in Nigeria  Okechukwu Alphons Nwankiti and E.U. Okpala ................................................................. 166
Strategies for Progress in Yam Research in Africa  I.C. Onwueme ..................... 173
Study of the Variability Created by the Characteristics of the Organ of Vegetative Multiplication in Dioscorea alata  N. Ahoussou and B. Toure ................................................................. 177
Growth Pattern and Growth Analysis of the White Guinea Yam Raised from Seed  C.E. Okezie, S.N.C. Okonkwo, and F.I. Nweke .......................... 180
Artificial Pollination, Pollen Viability, and Storage in White Yam  M.O. Akoroda, J.E. Wilson, and H.R. Chheda ................................. 189
Improving the In-Situ Stem Support System for Yams  G.F. Wilson and K. Akapa ................................................................. 195
The Economics of Yam Cultivation in Cameroon  S.N. Lyonga ...................... 203
Yield and Shelf-Life of White Yam as Influenced by Fertilizer  K.D. Kpeglo, G.O. Obigbesan, and J.E. Wilson ........................................ 198
Weed Interference in White Yam  R.P.A Unamma, I.O. Akobundu, and A.A.A. Fayemi ................................................................. 203
Effect of Traditional Food Processing Methods on the Nutritional Value of Yams in Cameroon  Alice Bell and Jean-Claude Favier .............................................. 214

Cocoyams

Strategies for Progress in Cocoyam Research  E.V. Doku ........................................ 227
Root and Storage-Rot Disease of Cocoyam in Nigeria  G.C. Okeke ......................... 231
Fungal Rotting of Cocoyams in Storage in Nigeria  J.N.C. Maduewesi and Rose C.I. Onyike ............................................................ 235
A Disease of Cocoyam in Nigeria Caused by Corticium rolfsii  O.B. Arene and E.U. Okpala ............................................................. 239
Cocoyam Farming Systems in Nigeria  H.C. Knipscheer and J.E. Wilson ................................................................. 247
Yield and Nitrogen Uptake by Cocoyam as Affected by Nitrogen Application and Spacing  M.C. Igbokwe and J.C. Ogbannaya .............................................. 255

Abstracts
Cassava Research Program in Liberia  Mallik A-As-Saqui .................... 259
Effects of Cassava Mosaic on Yield of Cassava  Godfrey Chapola ............ 259
Effects of Green Manure on Cassava Yield  James S. Squire .................. 260
Alleviating the Labour Problem in Yam Production: Cultivation without Stakes or Manual Weeding  I.C. Onwueme ................................................. 260

Discussion Summary
Strategies for the 1980s ................................................................. 263

References ................................................................. 265
EFFECTS OF SOIL MOISTURE AND BULK DENSITY ON GROWTH AND DEVELOPMENT OF TWO CASSAVA CULTIVARS

R. Lal

INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE, IBADAN, NIGERIA

A study of the effects of soil moisture and soil density on cassava yields was undertaken on a well-drained soil derived from fine-grained biotite gneiss and Schist parent materials. Two soil densities and two soil moisture treatments were used. Two cassava varieties were tested — Isunikakiyar and improved 30211. Water use, plant growth, and dry-matter production were evaluated. The findings showed that soil-moisture stress adversely affects shoot and root growth, water consumption, and water use efficiency, although there are varietal differences to drought stress. The adverse effects of soil-moisture stress are accentuated when the plant’s root system development is inhibited by high soil bulk density or low total porosity.

Étude des effets de la tension de l’humidité et de la densité du sol sur la production de manioc dans les sols irrigués dérivés de gneiss et schiste à biotite microgène. Deux variétés de manioc, Isunikakiyar et la 30211 améliorée ont fait l’objet d’essais dans deux sols de densité différente humidifiés selon deux procédés. L’eau utilisée, la croissance de la plante et la production en matière sèche ont été évaluées. Les résultats ont démontré que la tension de l’humidité a des effets nocifs sur la croissance des racines et des pousses, sur l’efficacité de la consommation et de l’utilisation de l’eau, même si les variétés ne possèdent pas toutes la même tolérance. Les effets nocifs observés sont accentués lorsque le développement du système radiculaire de la plante est retardé par un sol lourd ou à faible porosité.

Although cassava is a relatively drought-tolerant crop that can survive even 4–6 months of dry season, the growth, plant vigour, and yield can be drastically reduced by prolonged periods of drought (Shanmugavelu et al. 1973), and adverse soil conditions may inhibit root development. If the drought stress is slight and of a relatively short duration, cassava can recover from the damage because of its long growth duration.

Among major constraints to cassava production in Africa is the periodic drought stress — a result of a multitude of interacting factors including soil moisture and temperature regimens, root spacing or effective porosity, and methods of seedbed preparation that alter the available soil—water storage capacity. The magnitude of the effects is governed by the amount and distribution of rainfall during the growing season.

Strongly interacting with drought stress is soil temperature, the effects of the two factors often being difficult to separate. The range of optimum root zone temperature is slightly wider for cassava than for the seasonal grain crops such as maize and soybean. Nevertheless, soil temperatures exceeding 35°C in the root zone coupled with low soil moisture availability can result in a significant yield reduction (Okigbo 1979).

The available water-holding capacity of a soil also depends on total porosity and the pore—size distribution. A relatively high proportion of macro-pores may facilitate water and air movement and provide the much-needed space for the development of tuberous roots. High soil bulk density can significantly decrease the tuberous:feeding root ratio (Vine 1980).

The soil’s physical and nutritional properties and the cultural practices can also affect the disease and pest incidence (Hahn et al. 1979). For example, a distinct dry season is necessary for the buildup of the mealybug population.

Although cassava provides more than 50% of the caloric requirements of about 500 million people in the world, this is one of the least-studied crops in terms of its response to a range of soil conditions. The research information concerning the effects of soil conditions on cassava growth and yield is rather scanty. The objective of this investigation, therefore, was to study the effects of soil moisture and soil bulk density on growth and development of cassava.
Fig. 1. Height of two cassava cultivars subjected to different soil treatments.
**MATERIALS AND METHODS**

These experiments were conducted in the greenhouse from June 1977 to February 1978. Cassava was grown in wooden boxes 50 × 75 × 100 cm. These boxes were filled with the soil from Egbeda Association. This is a well-drained soil derived from fine-grained biotite gneiss and Schist parent materials (Moormann et al. 1975) and is classified as Tropudalf (Taxonomy) or Ferric Luvisol (FAO). The soil is medium-to-light-textured near the surface, with sandy clay to clay subsoil, and a layer of angular and subangular quartz gravel immediately below the surface. The gravel concentration in the gravelly horizon ranges from 30 to 60%, and the organic carbon content of the surface layer from 0.8 to 1.5%. The clay fraction is dominated by kaolinitic clay minerals and amorphous iron and aluminum oxides.

The available water-holding capacity of the soil is rather low. At series level, the soil is classified as clayey skeleton, kaolinitic, isohyperthermic, oxic, paleustalf.

The soil was sampled in the field horizon by horizon and packed in boxes in the same order. The subsoil (5–10 cm depth) was packed at two bulk densities: 1.3 and 1.6 g/cm³. Soil compaction was done in a way that avoided stratification among successive horizons in the box. There were two soil-moisture treatments. Soil-moisture suction at 15 cm depth was maintained at 0.1 and 10 bars. The regulation of soil moisture suction was facilitated by the use of tensiometers and gypsum blocks, respectively. A 2-cm perforated irrigation tube was installed at the centre of the box and all along its depth. The open lower end of the tube was imbedded in a 5-cm thick layer of coarse gravel placed at the bottom of the box before the soil was packed into it. When necessary, irrigation was done through this tube for uniform distribution of water in the soil body. Each combination of bulk density and soil moisture was replicated three times. Twelve boxes were arranged in the greenhouse according to a complete randomized design.

There were two cassava varieties — a tall and erect local Isunikakiyan and the improved 30211. Two stakes of each variety were planted in each box, totaling four plants per box. Stakes were planted in mid-June 1977, and cassava plants were harvested in February 1978.

Weekly observations were made for plant height and leaf number. Water requirements for two soil-moisture treatments were also computed on a weekly basis. Root and shoot weights were measured at harvest.

**RESULTS AND DISCUSSION**

**WATER USE**

Water consumption by cassava was different for different soil moisture and bulk density treatments (Fig. 1). The maximum water use in about 7 months of cassava growth was 24, 63, 90, and 102 cm for 10-bar suction at 1.6 bulk density, 10-bar suction at 1.3 bulk density¹, 0.1-bar suction at 1.3 bulk density, and 0.1-bar suction at 1.6 bulk density treatments, respectively. Water consumption was related to the cassava's growth rate. The water regimen in one of the boxes was altered about 12 weeks after the planting date from 10-bar suction to 0.1-bar suction; the water consumption in that treatment changed drastically.

Under optimum soil-moisture conditions, cassava uses about 4–5 mm of water/day in the first 6 months of its growth. Water consumption under greenhouse conditions may be slightly more than that under natural field conditions. It is expected that water consumption is greater in the later rather than the earlier 6 months of cassava growth because of the time required for a full canopy development and bulking that normally occurs after 10 months of growth. Nevertheless, the cumulative water use for the first 6 months exhibited a linear increase with time without exhibiting any specific periods of high water demand.

**PLANT GROWTH**

Plant height and growth were affected by soil moisture and bulk density treatments (Fig. 2), although soil moisture had a more pronounced effect than did bulk density. There were no differences in plant height among two bulk densities for the 0.1-bar suction soil moisture treatment. However, plant height at 1.3 bulk density was superior to that at 1.6 bulk density for the 10-bar suction moisture treatment. In general, variety 30211 is shorter than Isunikakiyan. The difference in plant height of the two varieties increased with increase in soil bulk density and soil moisture suction. For example, differences in plant height among the two varieties at 25 weeks after the planting date were 9 and 4 cm for 0.1- and 10-bar suction at 1.3 g/cm³ bulk density, and 19 and 11 cm for 0.1- and 10-bar suction at 1.6 g/cm³ bulk density, respectively. This differential response implies that variety 30211 is more susceptible to adverse soil-moisture conditions than is Isunikakiyan.

Plant height, in treatments with favourable

---

¹Water treatment was altered 12 weeks after planting date.
Fig. 2. Water consumption of two cassava cultivars subjected to moisture stress at two soil densities.
Fig. 3. Leaf production of two cassava cultivars in different soil treatments.
moisture, increased rapidly and linearly to about 12 weeks after planting date. Then, lateral branching initiated and rate of vertical increase declined. Once again the maximum plant height of 127 cm was observed for the 0.1-bar suction with 1.3 g/cm³ soil bulk density, and the least (41 cm) for the 10-bar suction with 1.6 g/cm³ soil bulk density.

Extreme susceptibility of variety 30211 to adverse soil-moisture conditions is evident from data on leaf numbers (Fig. 3). Isunikakiyan had more leaves than 30211 at all growth stages. Furthermore, variety 30211 dropped its lower leaves about 10–12 weeks after planting. Leaf losses in variety 30211 were observed irrespective of the soil moisture and bulk density treatments.

Leaf numbers in Isunikakiyan were significantly affected by the soil moisture and bulk density treatments. The leaf number at harvest was 102 and 60 for 1.3 g/cm³ bulk density and 122 and 40 for 1.6 g/cm³ bulk density for 0.1- and 10-bar suction moisture treatments respectively. The maximum leaf number in 30211 was observed 12 weeks after planting date and was 52 and 20 for 1.3 g/cm³ bulk density, and 52 and 23 for 1.6 g/cm³ bulk density for 0.1- and 10-bar suction moisture treatments, respectively. The leaf number at harvest for 30211 was 40 and 18 for 1.3 g/cm³ density compared with 34 and 11 for 1.6 g/cm³ bulk density for 0.1- and 10-bar suctions, respectively. For the same moisture regimen, leaf number was adversely affected more at high than at low bulk density. For the same bulk density, the leaf number was adversely affected more at low than at high soil moisture stress (Fig. 3).

**DRY-MATTER PRODUCTION**

Fresh and dry weights of cassava shoots and roots measured about 26 weeks after planting date were significantly affected by the soil moisture bulk density treatments (Table 1). For example, there was a reduction of 14, 20, 16, and 13% in fresh root weight, dry root weight, fresh shoot weight, and dry shoot weight, respectively, at 1.6 g/cm³ compared with 1.3 g/cm³ treatments with 0.1-bar suction. For 10-bar suction, the reduction in growth by increase in bulk density from 1.3 to 1.6 g/cm³ was 38, 24, 21, and 13% in fresh root weight, dry root weight, fresh shoot weight, and dry shoot weight, respectively.

Data in Table 2 indicate that soil moisture had a far greater effect on cassava growth than did soil bulk density. Percent reduction in growth with increase in suction from 0.1- to 10-bars was 94 and 96 in fresh root weight, 93 and 94 in dry root weight, 61 and 64 in fresh shoot weight, and 65 and 65 in dry shoot weight for 1.3 and 1.6 g/cm³ soil bulk density, respectively.

The moisture content in roots and shoots was also affected by the soil moisture and bulk density treatments. The moisture content in roots and shoots at 1.3 g/cm³ bulk density was 212 and 198% at 0.1-bar suction compared with 164 and 230% at 10-bar suction, respectively. Similarly, the moisture content in roots and shoots at 1.6 g/cm³ bulk density was 236 and 188% at 0.1-bar suction compared with 126 and 199% at 10-bar suction, respectively. Irrespective of the soil bulk density, moisture content in roots declined significantly with increase in soil moisture suction from 0.1 to 10 bars. Furthermore, moisture content in the roots and shoots was generally lower at 1.6 than at 1.3 g/cm³ bulk density.

Soil moisture and bulk density also affected root: shoot ratio. For example, the fresh and dry root: shoot ratio for 1.3 g/cm³ bulk density was 1.0 and 0.96, respectively, at 0.1-bar suction compared with 0.15 and 0.19 at 10-bar suction. Similarly, the fresh and dry root: shoot ratio for 1.6 g/cm³ bulk density was 1.03 and 0.88 for 0.1-bar suction compared with 0.13 and 0.17, respectively, for 10-bar suction. Increase in bulk density also adversely affected root: shoot ratio.

The water use efficiency (WUE), compared as weight per cm of water use, ranged widely among treatments. The water use efficiency for 1.3 g/cm³

---

**Table 1. Effects of soil moisture and density on shoot and root yields.**

<table>
<thead>
<tr>
<th></th>
<th>1.3 g/cm³ bulk density</th>
<th>1.6 g/cm³ bulk density</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.1-bar suction</td>
<td>10-bar suction</td>
</tr>
<tr>
<td>Root</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fresh weight (g)</td>
<td>1121</td>
<td>66</td>
</tr>
<tr>
<td>Oven-dry weight (g)</td>
<td>359</td>
<td>25</td>
</tr>
<tr>
<td>Shoot</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fresh weight (g)</td>
<td>1118</td>
<td>433</td>
</tr>
<tr>
<td>Oven-dry weight (g)</td>
<td>375</td>
<td>131</td>
</tr>
</tbody>
</table>
bulk density was 12.5 and 1.05 for the fresh root weight, 4.0 and 0.4 for the dry root weight, 12.4 and 6.9 for the fresh shoot weight, and 4.2 and 2.1 g/cm for the dry shoot weight for 0.1- and 10-bar suction soil moisture regimens, respectively. The water use efficiency for the 1.6 g/cm³ treatments, at 0.1- and 10-bar suctions respectively, was 9.2 and 2.0 for the fresh root weight, 2.8 and 0.9 for the dry root weight, 10.5 and 15.5 for the fresh shoot weight, and 3.2 and 5.2 g/cm for the dry shoot weight. Increase in bulk density decreased the fresh weight WUE, whereas the reverse was the case with the dry weight WUE. The WUE, however, decreased drastically with an increase in soil water suction from 0.1 to 10 bars.

Under the present experimental setup, it was difficult to evaluate the varietal response to soil-moisture deficit in terms of dry-matter production. Soil-moisture stress can adversely affect shoot and root growth, water consumption and, water use efficiency. There are varietal differences to drought stress. Plant height, vigour and, secondary branching of cassava are also affected by soil moisture. At high moisture stress, the moisture content in the roots is decreased more drastically than is that in the shoots. The adverse effects of soil-moisture stress are accentuated when the plant’s root system development is inhibited by high soil bulk density or low total porosity.

There is a need to investigate plant—water requirement of cassava in relation to different cultural practices. The effects of soil moisture on cassava should be evaluated in terms of plant—water potential. The high yield potential of cassava can be realized with proper soil, water, and nutritional management.