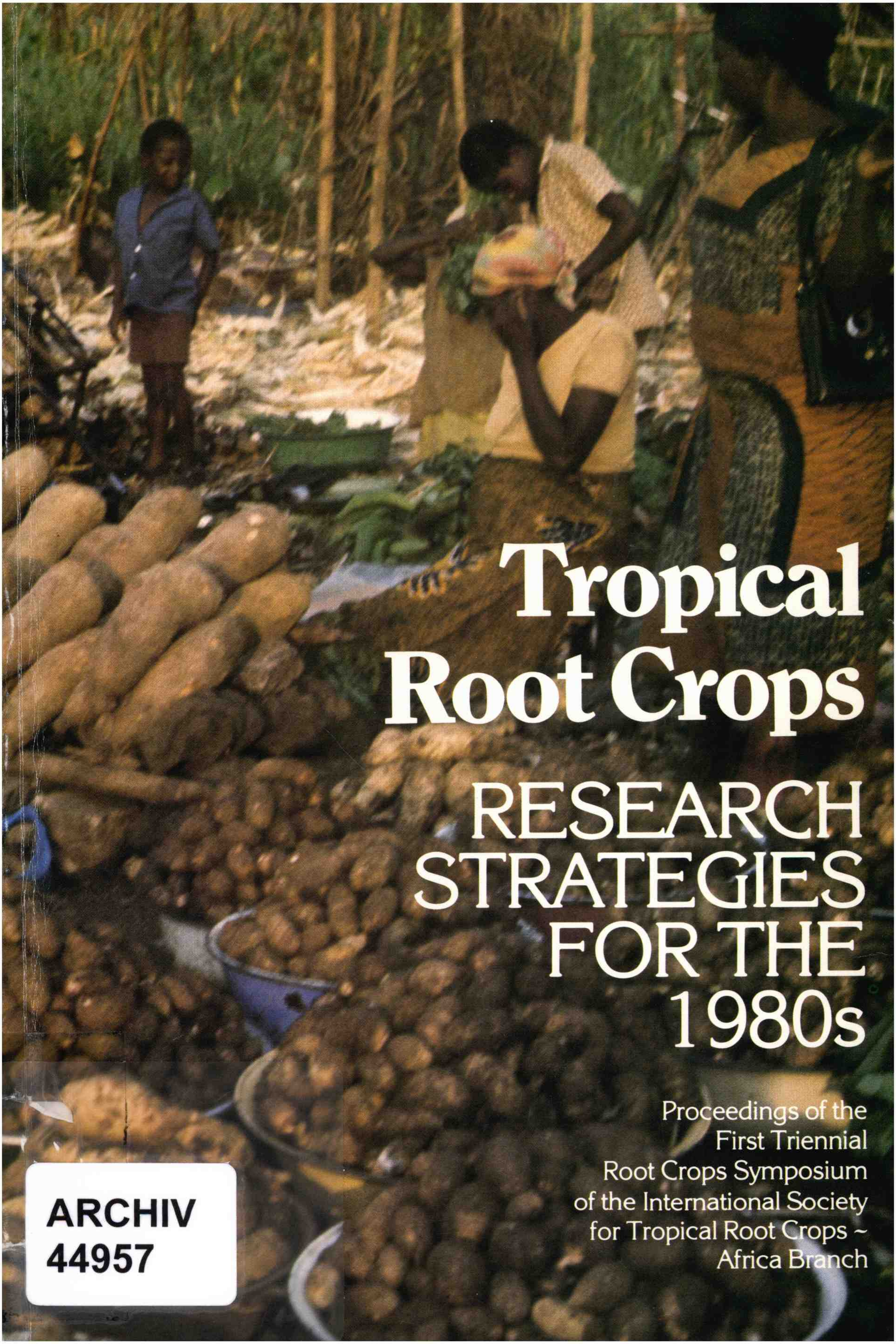

Tropical Root Crops

RESEARCH STRATEGIES FOR THE 1980s

Proceedings of the First Triennial Root Crops Symposium of the International Society for Tropical Root Crops ~ Africa Branch

IDRC-163e

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, 8–12 SEPTEMBER 1980, IBADAN, NIGERIA

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

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.

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

IDRC-163e

Tropical root crops: research strategies for the 1980s. Ottawa, Ont., IDRC, 1981. 279 p. : ill.

/IDRC publication/, /root crops/, /agricultural research/ — /plant breeding/, /plant diseases/, /cassava/, /sweet potatoes/ , /pests of plants/ , /plant production/ , /weed control/ , /intercropping/ , /harvesting/ , /crop yield/ , /conference report/ , /list of participants/ , /agricultural statistics/.

UDC: 633.4 (213)

ISBN: 0 88936 285 8

Microfiche edition available

Cooperating institutions

CANADA

CONTENTS

EVALUATION OF SOME MAJOR SOILS FROM SOUTHERN NIGERIA FOR CASSAVA PRODUCTION

J.E. OKEKE AND B.T. KANG

NATIONAL ROOT CROPS RESEARCH INSTITUTE, UMUDIKE, UMUAHIA, 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.

Expérience de culture du manioc sur sept sols différents qui forment généralement la couche arable des forêts et savanes du sud du Niger où on produit cette plante-racine. Les sols de la zone forestière (Araromi, Egbeda et Apomu) produits par l'altération du socle rocheux ont un potentiel de production plus élevé que les sols de grès (Alagba, Onne et Nkpologu) ou les sols sableux des savanes (Shante). Les sept sols ont réagi différemment à l'apport de N, P, K, Mg et S et on a pu observer des carences en Zn. Ces données peuvent servir de base pour la conduite d'expériences sur les engrais.

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.

Soil order	Soil series	Location	USDA classification	Vegetation and land use
Alfisol	Alagba	Ikenne	Oxic paleustalf	Bush regrowth in forest area
Entisol	Apomu	IITA, Ibadan	Psammentic usthorthent	Grass fallow in forest area
Alfisol	Egbeda	IITA, Ibadan	Oxic paleustalf	Secondary forest
Entisol	Shante	Ogbomosho	Psammentic usthorthent	Derived savanna
Alfisol	Araromi	Ishoya	Oxic paleustalf	Grass fallow in forest area
Ultisol	Nkpologu	Umudike	Typic paleudult	Grass fallow in forest area
Ultisol	Onne	Onne	Typic paleudult	Bush regrowth in forest area

Table 2. Physical and chemical properties of soils used in the experiment.

Soil series	Mechanical analysis (%) Sand	Silt	Clay	pH	Organic C (%)	Total N (%)	Bray-1 P (ppm)	Extractable cations (me/100g) K	Mg	Ca	Extractable Zn (ppm)
Apomu	85	7	8	6.0	1.13	0.18	6.0	0.25	1.07	2.90	3.3
Alagba	81	9	10	6.0	1.40	0.18	1.8	0.08	2.00	3.20	2.4
Shante	91	5	4	6.4	1.10	0.08	6.0	0.33	0.07	1.70	0.8
Egbeda	70	15	15	6.4	1.60	0.29	3.0	0.60	2.40	4.10	6.8
Araromi	51	19	30	6.0	2.50	0.39	6.3	1.20	2.50	8.70	23.1
Nkpologu	87	5	8	4.9	1.40	0.13	6.9	0.08	0.50	1.20	0.7
Onne	81	7	12	4.1	1.03	0.14	41.7	0.21	0.23	0.38	1.5

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

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

[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]

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

[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 5. N, P, K concentrations (%) in index leaf blade as affected by fertilizer and soil type (12 WAP).

	Eg-beda	Alag-ba	Apo-mu	Shante	Nkpo-logu	Onne	Arar-omi	Fertilizer mean
					N(%)			
Control	4.5	3.5	3.9	3.2	3.1	4.4	6.0	4.1
NPKSMg	5.0	4.2	5.4	4.4	4.9	5.3	5.5	5.0
NPKS	5.2	3.8	5.2	4.9	3.4	6.4	5.9	5.0
NPKMg	5.0	3.8	5.2	5.1	4.5	5.6	5.5	5.0
NPSMg	5.2	4.0	5.0	4.6	3.6	5.3	5.7	4.0
NKSMg	5.8	3.9	3.3	4.5	3.4	6.0	5.1	4.6
PKSMg	4.5	3.6	4.5	3.4	3.1	4.9	5.0	4.1
Soil mean	5.0	3.8	4.6	3.8	3.7	5.4	5.5	
					P(%)			
Control	0.14	0.22	0.18	0.25	0.15	0.16	0.17	0.18
NPKSMg	0.30	0.28	0.20	0.32	0.24	0.23	0.20	0.25
NPKS	0.20	0.13	0.30	0.32	0.22	0.24	0.22	0.23
NPKMg	0.23	0.22	0.32	0.32	0.16	0.24	0.21	0.24
NPSMg	0.30	0.20	0.31	0.26	0.24	0.30	0.34	0.28
NKSMg	0.16	0.18	0.19	0.18	0.18	0.16	0.13	0.17
PKSMg	0.32	0.30	0.30	0.39	0.23	0.21	0.28	0.29
Soil mean	0.24	0.22	0.26	0.29	0.20	0.22	0.22	
					K(%)			
Control	2.60	1.10	1.30	1.64	1.30	1.33	2.94	1.74
NPKSMg	2.90	1.39	2.63	3.15	1.50	2.00	3.10	2.38
NPKS	2.90	0.85	2.60	2.46	1.54	3.10	2.60	2.29
NPKMg	2.90	1.30	2.50	2.46	2.86	2.45	2.60	2.44
NPSMg	2.11	0.75	1.77	1.10	1.12	1.35	2.20	1.49
NKSMg	2.97	2.17	2.10	2.33	1.51	2.01	2.90	2.28
PKSMg	1.40	1.41	1.26	1.77	1.60	2.49	2.79	1.82
Soil mean	2.54	1.28	2.03	2.13	1.63	2.10	2.73	

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

Fertilizer treatment	Egbeda 8 WAP	Egbeda 12 WAP	Alagba 8 WAP	Alagba 12 WAP	Apomu 8 WAP	Apomu 12 WAP	Shante 8 WAP	Shante 12 WAP	Nkpologu 8 WAP	Nkpologu 12 WAP	Onne 8 WAP	Onne 12 WAP	Araromi 8 WAP	Araromi 12 WAP
Control	27	62	20	31	23	62	24	54	29	56	30	54	33	64
NPKSMg	32	40	27	38	32	39	18	16	30	32	41	44	41	55
NPKS	35	44	23	40	29	38	20	43	26	29	32	44	32	44
NPKMg	38	32	26	37	39	43	21	22	26	69	38	42	38	45
NPSMg	29	31	29	43	27	54	21	35	24	64	36	39	36	30
NKSMg	39	56	23	44	36	61	26	48	26	67	33	44	33	60
PKSMg	27	38	23	33	23	55	24	57	20	59	34	41	35	49
Mean	32	43	24	38	30	50	22	39	22	54	35	44	35	50

ity of the Onne and Nkpologu soils. In another study, the Onne soil was shown to have high levels of extractable aluminum.

PLANT GROWTH

Plant height, as measured at 5 WAP, varied significantly with soil types (Table 3). The mean plant height was very much affected by soil type. Though there were no significant differences attributable to fertilizer treatment, best growth was observed with complete treatment (NPKSMg).

The plant dry weight determined at 12 WAP probably gives a better indication of the productivity of the soil than does the height of plants (Table 4). The mean dry weight was also very much affected by soil type. The Araromi soil, which had the highest nutrient status, gave the highest dry weight. Yields from control treatments were lower than those from soils that had a complete fertilizer mixture. The treatments without nitrogen and phosphorus gave the lowest yields, averaged over all soils.

A comparison of the effects of fertilizer treatments on the various soils indicates that the plants responded to nitrogen treatment on Alagba, Onne, Nkpologu, and Shante soils; to phosphorus on Araromi, Egbeda, Apomu, and Alagba soils; to potassium on Araromi, Apomu, Alagba, and Onne soils. Also, dry-matter yield increases were observed with sulfur addition on all soils, but particularly on Apomu and Shante soils, and magnesium application significantly increased dry-matter yield from the Shante soil.

PLANT NUTRIENT STATUS

The index leaf blades taken at 12 WAP indicated that the Araromi soil sustained plants with the highest nitrogen status; the amount ranged from 5 to 6% and was not appreciably affected by fertilizer treatment (Table 5). Plants on other soils showed marked increases in leaf nitrogen levels with N addition, although the levels in plants on the Alagba, Shante, and Nkpologu soils were still below the critical N level indicated by Howeler (1978). This may mean that application rates of 125 ppm N are not sufficient for these soils.

Plants grown on all soils showed marked responses in leaf blade phosphorus with P application. In general the blade levels without P application were lower than the 0.2% critical value reported by Howeler (1978).

Potassium was highest in leaves from plants on Egbeda and Araromi soils and lowest for plants on Alagba, Nkpologu, and Onne soils, which showed good responses to K application.

Low zinc levels were observed in leaf blades at 8 WAP (Table 6). Zinc deficiency symptoms were observed on plants grown on Alagba, Nkpologu, and Shante soils. The levels in plants showing deficiency symptoms ranged from 18 ppm to 27 ppm, which are below the critical level of 35 ppm reported by Howeler (1978). Levels improved substantially by the 12th week without any Zn addition, and the deficiency symptoms were scarcely discernible.

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 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.