

PRODUCTION POTENTIALS OF MAJOR TROPICAL ROOT AND TUBER CROPS

E.V. DOKU

In comparison with the temperate regions, the tropical environment has lower solar-radiation levels, shorter photoperiods, and hence, a lower potential productivity. Productivity of cassava, yams, sweet potato, and cocoyams, the four most important tropical root and tuber crops, has other constraints as well: inadequate water supply (in arid areas with optimal solar-radiation levels); pests and diseases; long maturation; and difficult-to-harvest roots and tubers with poor keeping quality.

Research so far has been insufficient to break the numerous bottlenecks, although there is great promise from exploration, conservation, identification, evaluation, and breeding of germ plasm and some high-yielding, adaptive, pest- and disease-resistant varieties have already been developed for distribution throughout Africa. Although yields of the highest yielding varieties currently available are only about one-third to one-half of estimated potentials, recent research on the continent is rapidly amassing knowledge with a concomitant crop-improvement achievement in the following order of priority: cassava, sweet potato, yam, and cocoyam. By the end of the decade, yield levels of commercial varieties of the four crops should approach their potential.

POTENTIAL UTILIZATION OF MAJOR ROOT CROPS, WITH SPECIAL EMPHASIS ON HUMAN, ANIMAL, AND INDUSTRIAL USES

D.G. COLRSEY

Root crops in developing countries are mainly used for human food. Most are still grown by small-scale farmers, who operate within the subsistence economy, with only limited off-takes of produce to the market economy supplying the rapidly growing urban centers. With cassava in much of Latin America, yams in West Africa and the Caribbean, and taro in the Pacific, a trend exists, and may be expected to increase with further urbanization, toward semi commercial or commercial production, together with the development of more sophisticated marketing systems. Yams and, in most circumstances, taro, other aroids, and minor root crops command too high a price for significant amounts to be available for uses other than human food, although peelings, waste, etc are used as animal feed within subsistence economies. Cassava is in a completely different category, the costs of equicaloric amounts being only about one-fifth of those of yam. Similarly, sweet potato, with two to four crops per year is productive and like cassava is seldom a preferred food. These two crops can, therefore, supply substantial surpluses beyond food demands; the former, especially, is already being exploited for animal feed, edible and industrial starch, and other derived products. Although alternative uses of tropical root crops will probably increase, their primary role is likely to remain as human food in producing countries.

GENETIC PARAMETERS OF CASSAVA

N.M. MAHUNGU, H.R. CHHEDA, S.K. HAHN, AND C.A. FATOKUN

We investigated six diverse cassava populations grown during 1979-80 and 1980-81 at the International Institute of Tropical Agriculture (IITA), Ibadan, to estimate genetic parameters for 22 traits of cassava. The data, when analyzed, revealed that: considerable variation existed both within and between the populations for most of the characters; the coefficients of variation for phenotype and genotype were largest for root yield (85% and 62%, respectively), quite large for the roots per plant and root size (60% and 40%), moderate for harvest index and total number of branches (45% and 30%, respectively), and low (less than 30% and 15%) for stem girth, canopy width, and plant height at harvest. Heritability estimates as well as expected genetic gain also varied considerably. On average, root yield and number of roots showed moderately high heritability (50%) and high expected response to selection (88% and 64%, respectively). Relatively high heritability values were obtained for harvest index (49%) and dry-matter content (52%), but they were associated with expected genetic gains of only 50% and 29%, respectively. Agronomic traits such as stem girth, canopy width, and plant height at harvest showed moderate-to-low heritability values (32-42%) associated with low expected genetic advance (15-18%).

**EVALUATION OF CASSAVA CLONES FOR LEAF
PRODUCTION IN ZAIRE**

N.B. LUTALADIO

At Mvuazi, Zaire, the tops of 30 cassava clones were harvested periodically, and the production of tender leaves for use as a vegetable was evaluated. The local variety, Mpelongi, had the highest yield (10.2 t/ha) of tasty leaves, but several other varieties proved to be good leaf producers. Staff at Programme national manioc (PRONAM) are studying ways of improving varieties for higher yields of both leaves and roots. Cultural practices and factors influencing leaf production will be analyzed.

CASSAVA SCREENING IN RWANDA

J. MULINDANGABO

In Rwanda, work to improve cassava was begun in earnest in 1979 following serious damage from diseases and pests, especially cassava mosaic, bacteria blight, and the cassava green mite. The purpose of this paper is to describe progress in research by the Institut des sciences agronomiques du Rwanda (ISAR) in conjunction with the International Institute of Tropical Agriculture (IITA) to obtain and screen breeding material for resistance to disease and the green mite. The future prospects of cassava research in Rwanda are also discussed.

**EFFECT OF VARIETY AND PLANTING TIME ON THE YIELD OF CASSAVA
IN MALAWI**

R.F. NEMBOZANGA SAUTI

In trials conducted at Bvumbwe and Baka research stations in Malawi, three cassava varieties Chitembwere, Mbundumali, and Gomani - were planted at monthly intervals in an attempt to determine the effect of different planting dates on yields. At both sites, yields were highest for crops planted in January. At Bvumbwe, there were highly significant differences between varieties whereas time of planting had a marked effect at Baka.

**RESPONSE OF CASSAVA TO FERTILIZERS AND TOWN REFUSE
UNDER CONTINUOUS CROPPING**

S.O. ODURUKWE AND U.I. OJI

We sought to determine whether, and at what levels, NPK fertilizer and compost could be used to sustain continuous cropping with cassava. NPK and compost were each tested at three levels. Experimental design was 3^4 factorial arranged in nine incomplete blocks of nine treatments. The experiment lasted 4 years (1974-76 and 1978). Results showed that only K consistently affects root yield significantly. There was a decline in yield with years of continuous cropping — for 1975, 1976, and 1978, respectively, 33.8%, 45.8%, and 49.1%. The yield decline was attributed to depletion of trace and minor elements, proliferation of pests and diseases, and physical deterioration of the soil. Under the heavy rainfall common in the area, the fertility and productivity of the soil could not be maintained by application of fertilizers and refuse.

RAPID MULTIPLICATION OF CASSAVA BY DIRECT PLANTING

N.T. DAHNIYA AND S.N. KALLON

The possibility of rapidly multiplying cassava by planting short, hardwood stakes and soft-stem tops into the field was investigated. The results suggest 1-, 2-, 3-, and 4-node hardwood stakes could be planted directly into the field under the wet, tropical conditions of Sierra Leone. Young stem tops could also be used, if two tops were planted per stand.

EFFECTS OF SHADE, NITROGEN, AND POTASSIUM ON CASSAVA

I.N. KASELE, S.K. HAHN, C.O. OPUTA, AND P.N. VINE

We studied the effects of shade, nitrogen, and potassium on the formation of tuberous roots in cassava. In pot experiments, shade delayed initiation of bulking by about 40 days and reduced tuberous cell size and number as well as dry-matter diversion to tuberous roots. Tuberous roots were detected in plants treated with potassium earlier than in unfertilized plants. Nitrogen did not affect tuberization but significantly increased numbers of tuberous roots. Root diameter and weight, storage-cell size and number, and dry-matter allocation to roots were significantly greater in plants supplied with potassium, alone or in combination with nitrogen, but were significantly reduced by nitrogen applied without potassium.

WEED INTERFERENCE IN CASSAVA-MAIZE INTERCROP IN THE RAIN FOREST OF NIGERIA

RAY P.A. UNAMMA AND L.S.O. ENE

In 1981-82, we conducted studies of cassava and maize intercropped on sandy loam in the rain-forest zone of Nigeria to determine when and how long the plants had to be kept weed-free. The major weeds present in the control (8 weeks after planting) were mainly annual broadleaves, grasses, and sedges. The broadleaves included *Boerhaavia diffusa*, *Calapogonium mucunoides*, *Cleome ciliata*, *Commelina benghalensis*, *Eupatorium odoratum*, *Euphorbia hirta*, *Talinum triangulare*, and *Trianthema protulacastrum*; the grasses comprised mainly *Andropogon gayanus*, *Brachiaria deflexa*, *Cynodon dactylon*, *Digitaria horizontalis*, *Panicum maximum*, *Paspalum or biculare* and *Setaria barbata*. Uncontrolled weed growth caused a 2-year average loss of \$5607/ha in yield value compared with the mixture kept weed-free from planting to maturity. Average value of yield for 2 years (\$9206/ha) from the cassava-maize intercrop was much higher than that for the sole crops, although yield in grain and roots was lower. The yield of the crop mixture was depressed by weed interference during the first 4 -8 weeks; however weeds emerging after this period did not significantly impair the yield.

CROP PERFORMANCE IN COMPLEX MIXTURES: MELON AND OKRA IN CASSAVA-MAIZE MIXTURE

J.E.G. IKEORGU, T.A.T. WAHUA, AND H.C. EZUMAH

We conducted a 2-year investigation at Ibadan, Nigeria, to determine the economic benefits of including melon and okra in a cassava-maize intercropping system. Fresh-root yields of cassava were reduced by 28% by maize in the mixture but only by 3%, 6%, and 9% by okra, melon, or both, respectively. Intercropping had no adverse effect on the grain yield of maize; rather yield was 19% higher in the maize-cassava intercrop than in monoculture. Fresh-fruit yields of okra were reduced by 72%, 89%, and 56% in mixtures with cassava, cassava-maize, and cassava-maize-melon, respectively. Melon-seed yields were decreased by 56% and 76% in mixtures with cassava and cassava-maize, respectively. The cassava-maize cropping system yielded the highest amount of calories per hectare; however, total productivity per unit area of land was highest in the cassava-maize mixture with both okra and melon.

SOIL-CONSERVING TECHNIQUES IN CASSAVA AND YAM PRODUCTION

P.N. VINE, O.B. AJAYI, D.M. MITCHOZOUNOU, E.J. HOUNKPATIN, AND T. HOUNKPEVI

In the belief that conventional land preparation for root crops accelerates soil erosion unnecessarily, we investigated the potential of some soil-conserving practices in the production of cassava and yam in Nigeria. We studied dry-season planting of cassava to hasten canopy development to protect the soil during the subsequent rainy season and we examined the effects of mulching and tillage on both cassava and yams. Dry-season cassava, when protected by insecticide or acaricide, yielded more than 30 t/ha at 14 months after planting. A certain amount of residual soil moisture at planting time was found necessary for crop establishment. In both the dry and the wet seasons, mulch aided cassava growth in some circumstances but not in others; however, it increased wet-season earthworm activity many fold and reduced splash erosion. In fact, soil splash was reduced more by mulching than by omission of tillage both in the cassava and in the yam studies. In the latter, *Dioscorea alata*, planted in April 1983 with five soil treatments (no tillage; plowing only; plowing plus overall mulch; plowing and ridging; and plowing and building mounds) had best early growth on the flat treatments, and soil splash as well as soil slumping were drastically reduced by the mulch treatment. Other findings in the series of studies were that planting cassava stakes on a slant is suitable for both tilled and untilled plots and that the hardness of the soil does not appreciably affect the ease with which cassava roots can be pulled from the ground.

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**FACTORS LIMITING CASSAVA PRODUCTION AMONG PEASANTS IN
LUKANGU, ZAIRE**

KILUMBA NDAYI

A survey of cassava production was conducted in Lukangu, Zaire in 1982. The study covered the type of land selected for cultivation; planting times; diseases, insects, and pests attacking cassava; the possibility of solving food shortages in the region by intercropping; and lastly, the possibility of enabling the peasants to plant cassava in fertile valleys as a result of introducing improved resistant PRONAM varieties.

EPIDEMIOLOGY OF ANTHRACNOSE IN CASSAVA

C. MAKAMBILA

I studied the symptoms of anthracnose induced by *Colletotrichum manihotis* (*C.gloeosporioides*) on cassava plant stems. The symptoms develop on tissue that has become necrotic because of insect (*Pseudotherapus devastans*) bites and becomes the germination site for conidia from the pathogenic agent. The conidia produce a mycelium that subsequently propagates in the host tissues. I investigated factors, such as relative humidity, the type of insect-caused injury, insect populations, and stem lignification, to determine their effect on disease development. The study was conducted with either stem fragments or whole plants artificially inoculated.

**CASSAVA YIELD LOSSES FROM BROWN LEAF SPOT INDUCED BY
*CERCOSPORIDIUM HENNINGSII***

J.M. TERI, P.W. MTAKWA, AND D. MSHANA

We studied progress of cassava brown leaf spot (BLS) and its effect on yield of five cassava cultivars: Aipin Valenca, F279, Mzungu, Tanga, and T27. Field plots of each cultivar were established in an area where BLS is endemic, and half the plots were sprayed with the fungicide benomyl. We recorded disease progress in the plots by counting the number of lesions per plant and by recording percent defoliation. Disease intensity was highest between 3 and 6 months after planting. In 1981-82, the epiphytotic reached a peak 3 months after planting; in 1982-83, there was a low peak 3 months after planting and a higher peak at 5 months. All variables were subjected to analysis of variance with Duncan's new multiple-range test. The independent t-test showed very highly significant differences between sprayed and unsprayed plots. Root yield from fungicide-sprayed plots was compared with that from corresponding diseased plots, the differences in 1981-82 ranging from 1.7% to 32.3% for the four cultivars and averaging 26.8% for the susceptible cultivars. In 1982-83, the range was from 15.2% to 38.1% for three cultivars and 30% for the two susceptible cultivars.

SUSCEPTIBILITY OF CASSAVA TO *COLLETOTRICHUM MANIHOTIS*

MUIMBA-KANKOLONGO A., M.O. ADENIJI, AND E.R. TERRY

Studies were conducted to determine how inoculum concentration, pathogen virulence, cassava host, insect mediation, planting time, and location influence the susceptibility of cassava to anthracnose. The results indicated that the severity of infection is directly related to inoculum concentration and virulence of the isolate, although no specific races were identified among the isolates. A latent phase of *Colletotrichum manihotis* exists, during which its acervuli can be recovered from tender, symptomless stems. *Pseudotherapus devastans* feeding on cassava mediate the initiation of infection, and the degree of infection varies according to planting season and location.

**BOTRYODIPLODIA STEM ROT OF CASSAVA AND METHODS OF
SELECTING VARIETIES FOR RESISTANCE**

G.W. OTIM-NAPE

After *Botryodiplodia* stem rot of cassava (CSR) was observed for the first time in Africa (in Uganda) in 1981, a series of experiments were initiated to determine the effects of stem maturation on infection; to identify suitable methods of screening for field resistance; and to screen varieties for sources of resistance to the disease. Four cassava varieties were planted in a split-plot experiment, with varieties as the main plots and heights as the subplots. At maturity, the stems were harvested, and the number of *B. theobromae* pustules counted. The number of pustules was directly related to maturity of the stem. Two methods of screening for resistance were compared: scoring for rot severity on a 0-5 scale and counting rot pustules per unit area. Scoring for severity was deemed most suitable for resistance screening, and counting of pustules had advantages for epidemiological and pathogenicity studies. In screening tests of eight families, four: IYT (OP) 1979; PYT (OP) 1980; 30555 (OP) 1979; and 30572 (OP) 1980 exhibited some resistance to the disease.

R. MASSALA

Phytosanitary surveys in the People's Republic of Congo have shown that cassava mosaic disease (CMD) occurs throughout the country although the prevalence and effects of the disease differ with the ecological zone. Under the auspices of PRONAM (Programme national manioc), my colleagues and I are studying the prevalence and rate of natural infection of local and introduced varieties as well as other epidemiological factors. Identification and characterization of the causal agent of CMD are also planned.

THE CASSAVA MEALYBUG FRONT HYPOTHESIS: ROLE OF INDIGENOUS NATURAL ENEMIES

K.M. LEMA, R.D. HENNESSEY, AND H.R. HERREN

Ten years after the discovery of the cassava mealybug, *Phenacoccus manihoti*, in Zaire, reports claim that damage from the pest in Bas-Zaire and Bandundu states has been decreasing since 1978 and reached a minimum in 1983. At the same time, severe outbreaks have been reported in Kivu and Shaba states where the pest has recently been introduced. We believe that cassava mealybug infestations form a "front" that progresses to colonize and destroy new areas, whereas in previously invaded areas, whereas in previously invaded areas the damage is gradually reduced. This phenomenon and the role that might have been played by indigenous natural enemies as well as that of other factors are discussed in this paper.

**COMPARATIVE BIOECOLOGY OF TWO COCCINELLIDS,
PREDATORS OF THE CASSAVA MEALYBUG, IN THE CONGO**

G. FABRES AND A, KIYINDOU

Within the biocenosis of the cassava mealybug (*Phenacoccus manihoti*), two coccinellid species, i.e., *Exochomus flaviventris* and *Hyperaspis senegalensis hottentotta*, stand out because of their large numbers and their constant presence in the ecosystem. The biological parameters of these two predators were studied in the laboratory. The biological cycle, development time of different stages, sex ratio, as well as fertility and longevity of the females were determined. Using the data, we calculated the intrinsic rate of multiplication of each species and compared the control potential of these two local aids to pest control. In the field, population dynamics were studied along with those of the mealybug. The range of variation in population numbers in each species and the time of emergence in the field were recorded. This information allows one to define the role played by the species in regulating mealybug populations. It also should serve to direct the choice of exotic species to be introduced to supplement these insects' predatory activity.

**EFFECTS OF FERTILIZER APPLICATION ON POSTEMBRYONIC
DEVELOPMENT AND REPRODUCTION OF THE CASSAVA MEALYBUG**

K.M. LEMA AND N.M. MAHUNGU

Experiments were conducted with two cassava varieties in the greenhouse to ascertain the effect of NPK, N, and K fertilizer application on the postembryonic development and reproduction of the cassava mealybug, *Phenacoccus manihoti*. Nitrogen and NPK were applied at the rates of 60, 120, and 190kg/ha and potassium (K₂O) at the rates of 15, 30, and 45 kg/ha. The results showed that none of the applications significantly ($P < 0.05$) affected either the development or the fertility of the mealybug on the two cassava varieties.

**FUNCTIONAL RESPONSE OF AMBLYSEIUS FUSTIS TO
INCREASING DENSITY OF ITS PREY *MONONYCHELLUS* TANAJOA**

T.O. EZULIKE AND J.K.U. EMEHUTE

We studied the functional response of *Amblyseius fustis* to increasing density of its prey *Mononychellus tanajoa*. The experiment was conducted in the laboratory at a temperature of 24-29°C and relative humidity of 50-73%. In tests at eight densities of prey (10, 20, 30, 40, 50, 60, 70, and 80 nymphs and adults), the predator increased its consumption of prey up to a maximum at a density of 40. The number of eggs laid by the predator was not influenced by prey density. The functional-response curve is typical of invertebrate predators.

CONTROL OF THE CASSAVA GREEN MITE IN UGANDA

B. ODONGO AND G.W. OTIM-NAPE

Investigations were conducted at Serere Agricultural Research Station (eastern Uganda) to identify and promote resistance of cassava to *Mononychellus tanajoa*, the most destructive arthropod pest of cassava in the country. Six cassava families that were imported from the International Institute of Tropical Agriculture, Nigeria, as seeds and included in the breeding program exhibited different degrees of hairiness of leaf surface. When they were subjected to severe mite attack during the dry season, their resistance correlated with the number of hairs on the leaves. This information helped in selecting cassava varieties with high mite resistance.

**STUDIES ON THE NUTRIENT CONTENT OF YELLOW-PIGMENTED
CASSAVA**

O. SAFO-KANTANKA, P. ABOAGYE, S.A. AMARTEY, AND J.H. OLDHAM

A local cultivar of yellow cassava, Bankye Borode (BB), was found to have begun to acquire pigmentation after 3 months of growth. We extracted the pigment, using petroleum ether in acetone (1: 1) or hexane as solvent. The extract was purified by column chromatography. The absorption spectrum of the pigment corresponded with that of β -carotene, with peak absorption at 450 nm. The extract and β -carotene gave identical Rf values of 0.82 and 0.805, respectively, when chromatographed on silica-gel adsorbent. It was concluded that the yellow pigment is β -carotene, the precursor of vitamin A. A proximate analysis revealed that, apart from its carotenoid content, BB was not much different from Ankra, a local unpigmented cultivar, in nutrient composition.

MICROBIAL BREAKDOWN OF LINAMARIN IN FERMENTING CASSAVA PULP

M.A.N. EJIOFOR AND NDUKA OKAFOR

Linamarin-hydrolyzing microorganisms were inoculated into fresh cassava pulp. The bacteria and yeasts grew well: generation times were 59, 58, 78, and 74 minutes for *Alcaligenes faecalis*, *Leuconostoc mesenteroides*, *Saccharomyces cerevisiae*, and *Rhodotorula minuta*, respectively. They hydrolyzed cassava linamarin, releasing 0.090, 0.094, 0.102 and 0.100 mg HCN/g of pulp, respectively. Alone, the linamarase endogenous to the cassava released only 0.045 mg HCN/g of pulp. We believe, therefore, that the four microorganisms can be used in the commercial detoxification of cassava pulp during the production of gari or other fermented cassava-based meals.

PERFORMANCE OF A CASSAVA PEELING MACHINE

P.M. NWOKEDI

Peeling constitutes a major problem in cassava processing in Nigeria. At present, the method of peeling is usually manual. This paper discusses the development, design, and manufacture of a peeling machine suitable for village use. The machine is an oval chamber that has holes cut along the walls and is lined with sharp wire gauze. Cassava roots are loaded in the chamber, which is mounted on two mild-steel rods, 35 cm in diameter, attached at either end. The rods allow the chamber to rotate clockwise. The left rod is connected to a 5-hp electric motor by means of a v-belt pulley. Thirty balls coated with wire gauze are added to the chamber. The machine is mounted on an angle —33°. The angle permits the sharp edges of the chamber and balls to carry out effective abrasive peeling. The roots are cleaned as they are being peeled, the chamber passing through a water-filled pan underneath it.

AN IMPROVED TECHNIQUE OF PROCESSING CASSAVA FUFU

FESTUS A. NUMFOR

In tropical Africa, the preparation of fufu involves soaking (fermenting) peeled cassava roots for 3-5 days, mashing, sun-drying the pulp for 2-4 days, and milling into flour (2% protein). An attempt was made to improve on this time-consuming process and on the nutritional value of the product. Peeled roots were grated before being soaked, the result being that fermentation proceeded much faster than with the whole roots. When the grated pulp was inoculated with 3-day-old cassava liquor, the fermentation time was further reduced, and a simply designed solar/fire dryer reduced drying time substantially. The nutritional value was improved to 6% protein by the addition of full-fat soybean flour (10% of total weight). The product was not significantly different ($P < 0.05$) organoleptically from the unenriched flour.

CASSAVA-BASED DIETS FOR RABBITS

R.T. FOMUNYAM, A.A. ADEGBOLA, AND O.L. OKE

Rabbits, New Zealand White and Californian breeds, fed corn- or cassava-based diets had comparable reproductive, growth, and carcass traits, although feed intake and average daily gain were significantly ($P < 0.05$) greater for rabbits fed the cassava-based diets. It was more profitable to raise rabbits on cassava-based diets than on corn-based diets.

EFFECTS OF CASSAVA MEAL ON THE HATCHABILITY OF CHICKEN EGGS

D.A. NGOKA, E.C. CHIKE, A.B. AWONIYI, T. ENYINNIA, AND S.O. ODURUKWE

Yaffa hens and Rhode Island Red cocks were fed cassava root meal in maize-based rations at four dietary levels, substituting for maize at 0, 50, 75, and 100%; 800 eggs were collected from the hens and incubated in five replicate batches for all the treatments. The numbers of infertile eggs as well as mortality in the shell, salability, and incubation period were recorded. The eggs from the birds fed the highest level of cassava showed a significantly ($P < 0.05$) higher infertility and lower hatchability than the others. Other differences were not significant. The results suggest that cassava meal can be substituted for maize up to 75% in breeders' rations without deleterious effects on the hatchability of chicken eggs.

IN-VITRO CULTURE OF DIOSCOREA ROTUNDATA EMBRYOS

C.E.A. OKEZIE, F.I.O. NWOKE, AND S.N.C. OKONKWO

Dioscorea rotundata (Obiaoturugo variety) embryos were found to germinate faster in Murashige/Skoog (1962) and Linsmaier/Skoog (1965) media than if left in intact seeds. The ability of the embryos to germinate in the two media increased with time from seed harvest — an indication that recovery of seeds from dormancy is gradual and that the embryos are immature at the time of seed harvest. The latter is further supported by the embryo's gradual increase in size and transformation from globular to fan-shaped during the 3-4 month dormancy. The technique used in this study could enhance breeding programs.

ECONOMIC INDICES FOR CLONAL SELECTION AND BREEDING OF YAMS

0.0. OKOLI, J.U. NWOKOYE, AND C.C. UDUGWU

Edible yams are widely grown under mixed-cropping systems in Nigeria. Sizable portions of food tubers are planted to produce new crops, the yields of which are greatly influenced by the numbers and sizes of seeds planted. Currently, yield data are not reported in such a way as to take this variation into account. Thus, we have developed a system of reporting that will enable a better comparison of results. We also have detailed other indices that make for objective selection of clones in a breeding program and. to exemplify the approach, we have used these indices and other conventional descriptors to describe cultivars belonging to two yam species.

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SEED-YAM PRODUCTION

M.N. ALVAREZ AND S.K. HAHN

We tested several techniques to increase the multiplication ratio in yams, and all showed promise, although the degree varied according to cultivar. Seed-yam production from true seed gave the highest yield per unit area. The use of microsett propagation with the aid of phytohormones increased the multiplication ratio from the traditional 1: 4 to 1: 90, and the minisett technique with plastic mulch showed the greatest potential for rapid multiplication at the farm level. Plastic mulch had no adverse effect on the seed yams produced.

**NATURAL ANTIFUNGAL COMPOUNDS FROM THE PEEL OF
YAM TUBERS**

S.K. OGUNDANA, D.T. COXON, AND C. DENNIS

Two phenolic compounds were isolated from the peel of *Dioscorea rotundata* tubers by thin-layer chromatography. They acted as a fungicide against the bioassay organism *Cladosporium cladosporioides* and the pathogens causing storage rot of yams. The toxic compounds were identified with the aid of ultraviolet and infrared spectroscopy, nuclear magnetic resonance, and mass spectrometry: 2, 5-dihydroxy-4-methoxy-9,10-dihydrophenanthrene and 7-hydroxy-2,4, 6-tri-methoxyphenanthrene. Both compounds were found to be absent in the yam flesh.

OPTIMAL TIME FOR FERTILIZATION OF DIOSCOREA ROTUNDATA

S.C.O. NWINYI

I compared the effects of applying fertilizer at 8, 9, 10, 11, and 12 weeks after planting (WAP) to determine the best time for fertilization of white yam (*Dioscorea rotundata* cv. Nwapoko). In 1981, the differences between treatments were not significant from each other or from the control (no fertilizer); but, in 1982, yields for all treatments were significantly higher than those for the control (ranging between $P < 0.05$ and $P < 0.001$) but not significantly different from one another.

EFFECTS OF STAKING ON TUBER YIELD OF THREE CULTIVARS OF TRIFOLIATE YAM

S.N. LYONGA AND J.T. AMBE

At Ekona, South West Province, Cameroon, in 1979-81, three cultivars of trifoliate yam (Jakiri, Muyuka, and local) was compared for their tuber yields on ridges of staked and unstaked plots. Blocking was done according to treatments and oriented in an east-west direction so that staked plants would not shade unstaked ones. The tuber yields differed significantly among cultivars (main plots). Although staked and unstaked treatments did not differ markedly in yield, the staked plots were easier and cheaper to maintain, had a lower prevalence of fungal disease, and produced more male and female flowers than did the unstaked plots.

EFFECT OF TIME OF STAKING ON THE DEVELOPMENT OF ANTHRACNOSE DISEASE OF WATER YAM

A.O. NWANKITI AND I.U. AHIARA

We studied the effects of staking at four different periods on the development of anthracnose disease of water yam (*Dioscorea alata*) caused by *Colletotrichum gloeosporioides*. Plots staked 63 and 84 days after planting and unstaked plots showed severe anthracnose infections. Disease decreased with earlier staking (21 and 42 days after planting). Yield reductions increased with delay in staking. The peak of leaf production for all the treatments was between 4.5 and 5 months after planting. Serious defoliation of the vines occurred in susceptible cultivars 5 months after planting when staking was delayed.

THERMODYNAMICS APPLIED TO THE STORAGE OF YAM TUBERS

GODSON O. Osuji

The prolonged storage of yam tubers requires the design and construction of an adequate environment. The nature of such an environment can be mathematically conceived from the biological properties of the tubers; the final developmental step is the experimental testing of the environment for its efficiency in the storage of the tubers. The influence of thermodynamic factors on the yam tuber provides the necessary parameters for the mathematical formulation of the adequate storage environment. The lack of progress in the design and development of an appropriate environment is, I believe, attributable to the absence of mathematical calculations to guide the research. Yam tubers can theoretically be stored under either isothermal or adiabatic conditions.

Mathematically one can predict that, under isothermal conditions, the weight of the tuber would remain constant with the internal energy of the tuber being utilized for increasing the randomness of the molecular structure of the tuber, whereas, under adiabatic conditions, the weight of the tuber would change inversely with a change in temperature — i.e., a slow rise in temperature would produce a gradual decrease in weight. The isothermal conditions are unsuitable for the storage of yam tubers because the increasing molecular disorder at a constant tuber weight would shorten the life of the tuber. An adiabatic environment, on the other hand, should be suitable because it allows the weight of the tuber to decrease slowly, ensuring that the internal energy of the tuber is utilized for counteracting the internal forces of molecular repulsion resulting from the decreasing weigh.

ROOT-KNOT SUSCEPTIBILITY OF CROPS GROWN WITH YAM IN NIGERIA

U.G. ATU AND R.O. OGBUJI

Ten crops traditionally grown with yam in southern Nigeria were tested for resistance to *meloidogyne incognita* race 2, in 1979-80. Results, based on gall indices and recovery of the larvae from soil root, showed that *Corchorus olitorus*, *Sphenostylis stenocarpa*, *Hibiscus esculentus*, and *Cucurbita pepo* were highly susceptible; *Amaranthus sp.*, *Citrullus sp.*, *Zea mays*, and *Manihot esculenta*, moderately susceptible; *Telfairia occidentalis*, resistant; and *Mucuna prunens*, highly resistant. Planted on yam mounds, these crops could play an important role in altering the populations of root-knot nematodes.

EFFECTS OF COVER PLANTS ON ROOT-KNOT NEMATODE POPULATION

U.G. ATU AND R.O. OGBUJI

In areas where yam is usually the first crop in a rotation after fallow, it makes sense to manage the fallow lands so that the soil is not only fertile enough to support yam but also free from the pests affecting the crop. Recognizing this, we evaluated 14 cover plants commonly found or grown in fallow in southern Nigeria for their resistance to root-knot nematode, *Meloidogyne incognita*. In glasshouse and field experiments, *Crotolaria retusa*, *Arachis hypogaea*, *Stylosanthes gracilis*, *Tagetes patula*, and *T. erecta* were highly resistant; *Centrosema sp.*, *Panicum maximum*, *Eupatorium odoratum*, and *Aspilia latifolia* were resistant; and *Calopogonium sp.*, *Pueraria sp.*, *Cajanus cajan*, *Vigna unguiculata*, and *Cynodon dactylon* were susceptible.

SURVIVAL OF BOTRYODIPLODIA THEOBROMAE IN YAM TISSUES

B.I. ADERIYE AND S.K. OGUNDANA

We investigated persistence of *Botryodiplodia theobromae* a yam-rot pathogen, and found that the fungus survived in the stem for 6 months; in the tubers for more than 8 months, and in the leaves for only 3 months. It was also viable for at least 10 months in sterile soil samples inoculated with infected yam tuber pieces.

VARIABILITY IN THE CHEMICAL COMPOSITION OF YAMS GROWN IN CAMEROON

T. AGBOR EGBE AND S. TRECHE

We analyzed 98 cultivars belonging to eight yam species for mineral, protein, lipid, sugar, and cell-wall constituents. For most of the nutrients, intraspecific variability was as high as interspecific variability, but significant differences in the average values per species were found between *Dioscorea alata*, *D. dumetorum*, and the *D. cayenensis-D. rotundata* complex.

MINERAL CONTENT OF YAM TUBERS: RAW, BOILED, AND AS FLOUR

A. BELL

The zinc, copper, iron, manganese, magnesium, calcium, and total phosphorus content of 20 yam varieties belonging to 7 edible species, i.e., *Dioscorea rotundata*, *D. cayenensis*, *D. alata*, *D. esculenta*, *D. liebrechtsiana*, *D. schimperiana*, and *D. dumetorum*, was determined. The tubers were analyzed before and after being boiled and being converted into flour. The mineral composition of the tuber after treatment varied little from that before treatment. The greatest loss recorded was in magnesium and phosphorus as a result of boiling the peeled tuber.

INTRODUCTION OF FLOUR FROM DIOSCOREA DUMETORUM IN A RURAL AREA

G. MARTIN, S. TRECHE, L. NOUBI, T. AGBOR EGBE, AND S. GWANGWA'A

We taught 25 village volunteers a simple method to produce flour from *Dioscorea dumetorum* tubers by drying precooked slices and grinding them in a diesel-powered mill. Enriched porridge and fufu prepared during a demonstration session were tasted, the latter with local sauces. The volunteers were then asked to feed their households flour, and, each week, we recorded the number of times the flour was eaten. After 12 weeks, results showed that all but three households ate the flour regularly. They thought it was good and, if available, could substitute for other flours used locally, especially for infant feeding. The flour processing was possible at the village level, and they recommended changes in some of the steps.

IN-VITRO METHODS FOR COCOYAM IMPROVEMENT

E. ACHEAMPONG AND G.G. HENSHAW

We have multiplied cocoyam germ plasm through protocorm production in vitro, and the method can theoretically yield more than 1 million plants a year. Cultures have been stored in vitro on reduced nutrient media for 80 weeks or more under conditions close to ambient. The basic tissue-culture methods employed should eliminate diseases and viruses and enable international transfer of germ plasm.

PRODUCTION OF HYBRID XANTHOSOMA SAGITTIFOLIUM AND TEST FOR RESISTANCE TO PYTHIUM MYRIOTYLUM

A. AGUEGUIA AND S. NZIETCHUENG

Macabo or new cocoyam (*Xanthosoma sagittifolium*) can be reproduced asexually in Cameroon because of the application of flowering-induction techniques and artificial pollination. The Institute of Agricultural Research (Njombé) has developed conditions that are suitable for seed germination and later growth of the plantlets, and these conditions are currently being used in the large-scale production of hybrids. Preliminary tests on hybrid clone resistance to *Pythium myriotylum*-induced root rot yielded inconclusive results. Research is being pursued in this area.

**GROWTH AND DEVELOPMENT OF COLOCASIA AND XANTHOSOMA SPP.
UNDER UPLAND CONDITIONS**

M.C. IGBOKWE

Dry-matter accumulation by the different parts of cocoyams, *Xanthosoma sagittifolium* and *Colocasia esculenta*, was studied for 2 years (1980-81) under the upland conditions at Umudike Nigeria. Sprouting started within 2 weeks after planting and was almost completed by 4 weeks leaf production, especially for *X. sagittifolium*, was slow in the first 6 weeks but, thereafter increased rapidly, reaching a maximum at 16-20 weeks after planting. Leaf-area index was also maximum at this time. Cormel bulking was noticed as early as 8 weeks but became prominent at about 12 weeks. Maximal development of corms and cormels was achieved in *C. esculenta* at 22-26 weeks and in *X. sagittifolium* at about 26 weeks. At this period, leaf dry matter and leaf-area index were minimal and cormel production accounted for 40-70% of the total tuber yield. Prolonging the duration of maximal foliation (to beyond 20 weeks after planting) would considerably increase the yield of Nigerian cocoyams.

EFFECTS OF WATER-TABLE DEPTH ON COCOYAM

B.S. GHUMAN AND R. LAL

Physiological response of cocoyam (*Colocasia esculenta*) to different water tables was investigated in a lysimeter study during the dry season of 1981-82. Test cultivars were TCe 23 and TCe 36. Water tables were maintained at 15, 30, 50, and 70 cm below the soil surface. The control was without a water table, the plants being watered equal to an average pan evaporation on alternate days. The differences in water table did not affect stomatal resistance of the cultivars. In general, the stomatal resistance was minimal, about 3 seconds/cm, just after sunrise, increasing slowly to 6.5 seconds/cm just before sunset in all treatments. The average leaf-water potential at 1515 h increased from -6.6 to -5.1 bars in TCe 23 and from -6.4 to -4.0 bars in TCe 36 with the lowering of water table from 15 to 50 cm, and there was not appreciable change with further lowering of water table. In the controls, leaf-water potential was -3 bars in TCe 23 compared with -5 bars for TCe 36 at 1515 h. There was no direct relationship between stomatal resistance and air temperature, solar radiation, or relative humidity, but leaf-water potential of both cultivars decreased rapidly with increasing air temperature and solar radiation and decreasing humidity. Total water use was the highest, 68.8 cm in 89 days, in lysimeters that had a water table at 15 cm deep and the lowest, 14.9 cm, in lysimeters with a water table at 70 cm.

INTERCROPPING COCOYAMS WITH PLANTAIN: EFFECTS ON THE YIELD AND DISEASE OF COCOYAMS

M.C. IGBOKWE, O.B. ARENE, T.C. NDUBUIZU, AND E.E. UMANA

Cocoyams were intercropped with plantain at various populations at Ikom, Uyo, and Umudike in 1981. The cocoyams were tested at 10 000, 20 000, 30 000, and 40 000 stands/ha, and plantain populations were 800, 1600, 2400, and 3200 stands/ha. Averaged over all populations, *Xanthosoma sagittifolium* had decreased corm and cormel yields (24% less than sole crops) at all three locations. *Xanthosoma* yields decreased with increasing plantain populations. At Ikom, the reduction in yield was 46.6% at a population of 2400 stands/ha as against 11.6% at a population of 1600 stands/ha. In contrast, plantain populations had an insignificant effect on *Colocasia esculenta* yields probably because the profuse suckers produced by *Colocasia* suppressed plantain growth. Larger cocoyam yields were obtained at Ikom (basaltic soils) than at Umudike and Uyo (acid sands). *Sclerotium rolfsii* was observed at both Uyo and Ikom. Although it did not cause marked reductions in yield, it may have contributed to postharvest decay. At 1600 plants/ha for plantain and 20 000 plants/ha for *X. sagittifolium*, yields of the latter were highest and *S. rolfsii* prevalence was low.

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**ROOT ROT OF XANTHOSOMA SAGITTIFOLIUM CAUSED BY
PYTHIUM MYRIOTYLUM IN CAMEROON**

SAMUEL NZIETCHUENG

In Cameroon, root rot of macabo (or new cocoyam) (*Xanthosoma sagittifolium*) is a disease caused by *Pythium myriotylum*. It is widespread in the major areas of cultivation. Its development is directly related to certain environmental factors, such as heavy rainfall accompanied by high temperatures. The disease is transmitted primarily via infected seed (corms) and soil. High plant densities accelerate spread. Metalaxyl has proved effective against *P. myriotylum*, whereas Aliette has not.

SWEET-POTATO PRODUCTION POTENTIAL IN RWANDA

G. NDAMAGE

Screening trials conducted under the ecological conditions prevailing in Rwanda enabled staff at Institut des sciences agronomiques du Rwanda (ISAR) to identify sweet-potato varieties for all ecological regions except the acid soils of the Zaire Crest-Nile highlands. Rusenya, Caroline lee, Nyiramujuna, and Rutambira clones have proved to be highly stable producers, but early, stable varieties that are adapted to the conditions existing at high altitudes have yet to be developed. Various planting techniques have been tested, and fertilization trials showed that two treatments, i.e., 0.02 t N, 0.05 t K₂O, and 35 t of manure; and 35 t of manure/ha alone, improved yields. In the dry regions, mulching produced spectacular results, increasing yields by 285 %. The most beneficial effects were achieved with mixed stands of sweet potato-soybean-climbing bean-maize (land-equivalent ratio—LER = 1.53) and soybean-sweet potato-soybean-maize (LER = 1.60). Farm experiments on hillsides revealed that Rusenya, Caroline lee, Rutambira, and Nyiramujuna produced good results and that ridge cropping was adopted by the local farmers.

COMPORIMENT STUDIES WITH SWEET POTATOES IN THE HIGHLAND ZONE OF CAMEROON

S.N. LYONGA AND J.A. AYUK-TAKEM

Comportment and stability studies were conducted with sweet potatoes on sites ranging in altitude from 1176 m to 1500 m in the wet and dry seasons. Palatability and ambient-storage tests were also carried out with these cultivars. In the first trial involving 11 Cameroonian and 3 exotic varieties. Pa 8 was identified as being high-yielding in the wet season and Pa 4 was the highest yielding cultivar in the August-January planting. Variety Pa 11 had good palatability (6.9 out of a total score of 10.0) and ambient-storage (7.0 of 10.0) scores. In the second trial involving six sweet- potato cultivars, cultivar Tib 1 from the International Institute of Tropical Agriculture, Ibadan, was observed to be high-yielding in both the wet and the dry seasons, had a good taste score of 7.5/10.0, and had an average storage score of 5.5/10.0 at 45 days after harvest. Stability studies involving six cultivars grown from 1975 to 1978 were undertaken with Eberhart and Russell's (1966) regression method and Francis and Kannenberg's (1978) genotype-grouping technique. Variety Tib 1 was identified as being relatively stable in performance.

**EFFECTS OF VESICULAR-ARBUSCULAR MYCORRHIZAE, TEMPERATURE
AND PHOSPHORUS ON FUSARIUM WILT SWEET POTATO**

J.M. NGEVE AND R.W. RONCADORI

Three sweet-potato cultivars were inoculated with *Fusarium oxysporum* f. sp. *batatas* (FOB) alone, vesicular-arbuscular *mycorrhizae* (VAM) fungi alone, or a combination of the two and grown at two temperatures and in soil with different levels of phosphorus. At 32°C, *Fusarium* wilt prevalence and severity were highest when plants were inoculated with FOB alone but, at 21°C, were highest when plants were inoculated with FOB and VAM jointly. Wilt prevalence and severity increased with increasing P fertilization, and VAM conferred protection to plants at low-P fertility (5: 10: 15 N, P, and K, ppm/g soil being 10, 4.4, and 8.3, respectively). This is the first report of the Interaction of VAM fungi, P fertility, and temperature on *Fusarium* wilt of sweet potato. The role of VAM fungi in protecting plants against wilt and possible explanations for the observed results are discussed.

**ON-FARM TRIALS AS A LINK BETWEEN RESEARCH AND TECHNOLOGY
TRANSFER**

H.J. PFEIFFER

The steps taken by the Cameroon National Root Crops Improvement Programme in its attempts to popularize sweet potato are presented, as are the results of researcher-managed verification trials on farms and farmer-managed trials. Compared with local cultivars, the varieties tested by the program proved to be highly productive, with good quality, in all the agroecological areas in Cameroon. Field days were organized at harvest time, emphasizing improved production techniques. Farmers made their own choices and took cuttings from the best clonal material for multiplication and production on their farms.

PLANTAIN IN ROOT-CROP FARMING SYSTEMS

S.K. KARIKARI

With an estimated world production of 3.5×10^8 t, root crops and plantains provide food for about 1 billion people in the tropics. Traditional members of farming systems in the tropics, they were neglected by researchers until recently. I believe that funding for research is still inadequate. The plantains are similar to root crops in many respects and are grown with them in many areas of Africa. Research for the two crops should be cooperative, and the International Society for Tropical Root Crops and the International Association for Research on Plantain and other Cooking Bananas should work together to foster cooperation.