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ROOT CROPS IN EASTERN AFRICA

Proceedings of a workshop held in Kigali, Rwanda, 23-27 November 1980

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Root Crops in Eastern Africa

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Résumé

Cette brochure traite principalement des deux tubercules alimentaires les plus importants en Afrique orientale, soit le manioc et la patate douce. Quelques communications portent sur la pomme de terre, l'igname, le taro et l'« enset » dont la consommation est considérable dans plusieurs pays de la région. Le rendement de ces cultures est limité par de nombreux facteurs. Aussi, la recherche effectuée dans le cadre de programmes agronomiques nationaux et internationaux est-elle orientée vers la correction de cette situation en Afrique. Les difficultés rencontrées en cours de travaux et les progrès réalisés sont décrits par des représentants et des consultants de l'Institut international d'agriculture tropicale d'Ibadan (Nigéria) et d'autres pays tel que le Cameroun, le Kenya, l'Ouganda, le Malawi, le Zimbabwe, l'Éthiopie, le Burundi, le Zaïre et le Swaziland.

Resumen

Esta publicación se enfoca en la mandioca y el camote — los cultivos de tuberosas más importantes del Africa oriental. Los trabajos tratan también del *Solanum tuberosum*, *Dioscorea* spp., *Colocasia* sp., *Xanthosoma* sp., y *Enset* sp., que son todos cultivos importantes a los países de esta región. La producción de cada uno es restringida por serios constreñimientos, y el alivio de éstos es el objetivo de varias investigaciones llevadas a cabo por los programas agrícolas nacionales e internacionales en el Africa. El progreso hacia y los problemas encontrados en llegar a este fin son delineados por especialistas representando al Instituto Internacional de Agricultura Tropical en Ibadan, Nigeria, y a los países de Camerún, Kenia, Uganda, Malawi, Zimbabwe, Etiopia, Burundi, Zaire, y Swazilandia.

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Country reports

Research priorities, techniques, and accomplishments in sweet-potato breeding at IITA

S.K. Hahn[1]

Sweet potato is an important staple-food crop in many parts of the tropics and subtropics. It is grown over a wide range of environmental conditions and has a tremendous capacity to produce dry matter per unit of land and time. The major biological constraints to sweet-potato production in the tropics are weevils and viruses. The primary objective of sweet-potato breeding at IITA, therefore, has been to improve sweet-potato clones and populations resistant to weevils and viruses. The sweet-potato-breeding methods and procedures are described in this paper, with particular emphasis on performance evaluation of breeding material. The IITA-improved sweet-potato cultivars with the most weevil-resistant roots and virus resistance are reported. Cultivars with improved agronomic characters, such as keeping quality, dry-matter content, and drought tolerance are also reported.

La patate douce est un aliment de base important dans plusieurs régions tropicales et subtropicales. On peut la cultiver dans divers environnements et elle fournit une quantité impressionnante de matière sèche par superficie et période de culture. Les principaux obstacles biologiques à la production de la patate douce dans les tropiques sont les charançons et les viroses. La sélection génétique de la patate douce à l'IITA a donc eu pour objectif premier d'améliorer les clones et les populations de patate douce résistants à ces deux ennemis. L'exposé décrit les méthodes et les procédés de sélection de la patate douce et met l'accent sur l'évaluation du rendement du matériel génétique. On mentionne les cultivars de patate douce améliorés de l'IITA ayant les racines les plus résistantes aux charançons et la meilleure résistance aux viroses, ainsi que les cultivars possédant des propriétés agronomiques améliorées comme l'aptitude à la conservation, le contenu de matière sèche et la résistance à la sécheresse.

Sweet potato (*Ipomoea batatas*) is the sixth most important food crop in the world, with an annual production of about 1.4×10^7 t from 1.5×10^7 ha (FAO 1977). Although it is produced more in the temperate zone than in the tropics, it is grown widely and is an important staple-food crop in many parts of the tropics and subtropics. Both tuberous roots and leaves are eaten, the former mainly as a source of carbohydrate and the latter as a source of protein and minerals. Both parts have substantial amounts of vitamins, particularly vitamin A. In addition to its importance as a human food, sweet potato provides animal feed and raw material for industrial purposes.

It has a tremendous capacity to produce dry matter per unit of land and time. The caloric production from the edible root of sweet potato in Japan is 2.94×10^7 kcal/ha (an average root yield of 2.1×10^4 kg/ha in 5 months). This is almost five times that of rice, which has an average yield of 4.5×10^3 kg/ha (Murata et al. 1976). It is grown over a wide range of environmental conditions, between latitudes 40°N and 40°S and between sea level and 2300 m. Even on land of low fertility and relatively low pH, it can still produce a considerable yield (Hahn 1977a; Hahn and Hozyo 1980). It requires low production inputs compared with other food crops and is less vulnerable to adverse conditions such as drought and heavy storms. For these reasons, it provides food at a time when other staple foods are in short supply.

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The major biological constraints to sweet-potato production in the tropics are weevils and viruses. Yield reduction from viruses is reported to be 78–80% in Nigeria (Hahn 1975, 1979) and 57% in Uganda (Mukiibi 1977). Weevils cause damage to both tuberous roots and leaves in the field, as well as reducing quality, storability, and market value. Storage is also a problem in the tropics because of rapid physiological losses brought about by high temperatures, serious weevil damage, and storage rots. Likewise, preservation of planting materials is a problem in areas of the tropics with a long dry period.

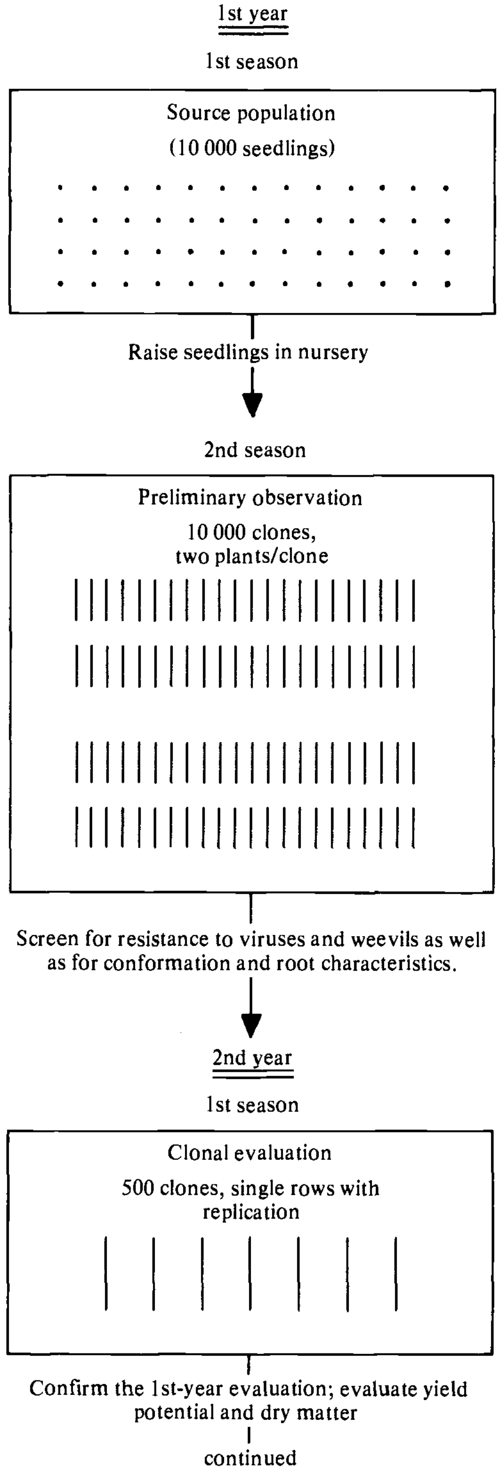
These constraints have seriously limited production; yet they received little attention before 1971 when the International Institute of Tropical Agriculture (IITA) initiated sweet-potato-breeding work. The Institute's objectives were, and still are, to produce cultivars that are capable of high yield in terms of dry matter per unit of land and time; that are resistant to economically important diseases and insects; and that have good keeping qualities, improved consumer acceptability, processing characteristics, nutritional value, and wide adaptation. For the past 8 years, particular emphasis has been placed on breeding improved cultivars that are resistant to weevils and viruses.

Breeding procedures and activities

The sweet-potato-breeding scheme that has been adopted was designed for tropical conditions, especially the prevailing climatic and biological conditions at IITA (Fig. 1).

Sweet potato is normally a cross-pollinated (by insects), vegetatively propagated crop. The recurrent selection system used for population improvement is half-sib family testing and selection between and within families. Mass selection for resistance to viruses and weevils is also being used. This system is aimed at increasing population means and retaining a high degree of genetic variability through continuous, cyclic evaluation, selection, and recombination.

The short-range program for sweet-potato improvement focuses on developing cultivars with resistance to viruses and weevils; the long-range program is more generalized and demands more genetic variability. This two-pronged improvement approach is appropriate for IITA because it allows the Institute to



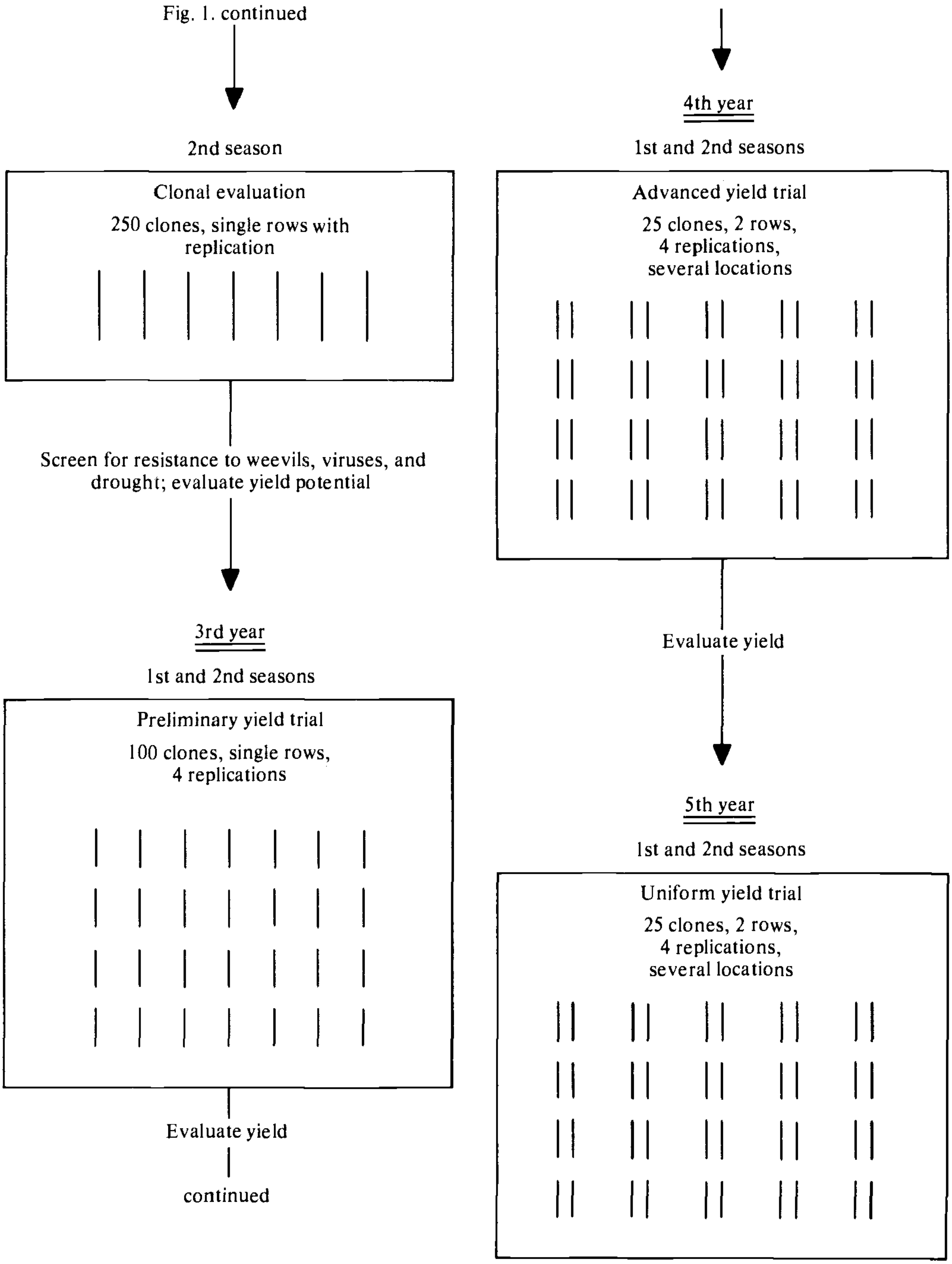


Fig. 1. *Sweet-potato-breeding procedures at IITA.*

serve many national programs, providing them with genetically diverse seed for selection under local conditions. In addition, the conventional intervarietal crossing program is also used to meet specific needs.

Source populations

When IITA began its improvement program in the early 1970s, the first step was to acquire the source populations from which genotypes with desirable characters could be selected. The base material now includes: local and introduced germ plasm and improved populations and families. It was initially difficult for IITA's sweet-potato-breeding program to introduce germ plasm in a vegetative form from outside Nigeria. As an alternative, germ plasm in seed form has been introduced from many countries in Africa, the Americas, and Asia. Nigerian local cultivars were also used and were the starting point for the breeding program. Several clones, selected from the source populations, showed good performance and high breeding values for important traits and were intercrossed in isolation to make new source populations.

Selection

In the 1st season (rainy season) of the 1st year, about 10 000 seedlings are raised in the nursery and are moved to the field 2 months before the end of the rainy season. During the next few months, they are screened for resistance to viruses and weevils and for conformation and tuber characters.

In the 1st season of the next year, the selected clones (about 500) are cloned and planted for observation in a single-row plot 4 m long, with 1 m between rows and 30 cm between plants within rows. A standard variety is also planted every 10 clones for comparison. At this stage, the 1st-year evaluation for resistance to viruses and weevils and for conformation and root characters is confirmed. About 250 clones that are good in terms of establishment, growth, and resistance to viruses and weevils are selected.

In the 2nd season of the year, the selected 250 clones are replanted and screened for resistance to weevils and viruses, drought tolerance, and for yield potential. The most promising 100 clones are selected.

In both seasons of the 3rd year, a preliminary yield trial is conducted for the 100 promising clones. They are planted in single-row plots with four replications. Between-plant spacing is 30 cm within the 10-m long rows that are 1 m apart. At this stage, a more thorough yield evaluation is done in addition to testing for resistance to viruses and weevils and for dry-matter percentage and keeping quality.

In both seasons of the 4th year, the best 25 clones selected from the preliminary yield trial are put forward for advanced yield trials in two-row plots (10 m long, 1 m apart) with four replications. Advanced yield trials are conducted in three locations, covering a wide range of environments. At this stage, more formal performance tests are done for yield, resistance to weevils and viruses, dry-matter percentage, consumer acceptance, adaptation, and keeping quality.

The next year, the most promising 25 clones from the advanced yield trials are advanced to uniform trials in four locations within Nigeria with two-row plots (10 m long, 1 m apart) and four replications. These clones are evaluated for yield, consumer acceptance, keeping quality, and adaptation.

In the 6th year, the elite five clones from the uniform trials are planted for farm-level testing and farmer evaluation. From the 7th year, the clones that are most popular with farmers are multiplied and distributed for popularization.

Accomplishments

The IITA-improved, sweet-potato cultivars with the most weevil-resistant roots are TIS 3053 and TIS 3030 followed by TIS 2154, TIS 2153, TIS 3290, TIS 3017, TIS 2532, and TIS 2544. The cultivars with the most resistant shoots are TIS 2532, TIS 3017, and TIS 3030 followed by TIS 1499 and TIS 1487 (IITA 1978). These clones are high yielding (13–30 t/ha) in Nigeria, well accepted by consumers, white fleshed, dry in texture when cooked, and have good keeping qualities. They also exhibit resistance to viruses; however, the IITA-improved cultivar that shows the most resistance to viruses is TIS 2498 followed by TIS 3053, TIS 3030, TIS 2532, and TIS 3017 (IITA 1979; Terry 1979). These improvements in resistance have been complemented by work on underground-storage systems, which have proved effective against weevil attack (IITA 1979).