ROOT CROPS IN EASTERN AFRICA

Proceedings of a workshop held in Kigali, Rwanda, 23-27 November 1980
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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 África 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 África. 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, Etiopía, Burundi, Zaire, y Swazilandia.
Contents

Foreword 5

Participants 7

Discussion summary 10

Breeding
Historical perspectives of cassava breeding in Africa B.D.A. Beck 13
Research priorities, techniques, and accomplishments in cassava breeding
at IITA S.K. Hahn 19
Research priorities, techniques, and accomplishments in sweet-potato
breeding at IITA S.K. Hahn 23
Sweet-potato improvement in Rwanda M.J.J. Janssens 27
Sweet-potato improvement in Cameroon H.J. Pfeiffer 33
Strategy for developing a national potato program for Rwanda P. Vander
Zaag 39

Plant protection
Increasing and stabilizing cassava and sweet-potato productivity by dis-
ease resistance and crop hygiene E.R. Terry and S.K. Hahn 47
Effects of soil fertility on cassava bacterial blight in Rwanda I. Butare
and F. Banyangabose 53
Distribution and importance of Xanthomonas manihotis and X. cassavae
in East Africa D.M. Onyango and D.M. Mukunya 56
Cassava mosaic disease E.J. Guthrie 59
Pest control for cassava and sweet potato K. Leuschner 60
Cassava green mite: its distribution and possible control Z.M. Nyiira 65
Biological control of cassava mealybug and cassava green mite: front-line
release strategy K.M. Lema and H.R. Herren 68
The mealybug problem and its control T.P. Singh 70

Agronomy
Economics of research and development of root and tuber crops in Zanzi-
bar, Tanzania A.J. Carpenter 75
Agronomic research on cassava cultivation in Rwanda
J. Mulindangabo 78
Agronomic effects and economic importance of fertilizers on yams in
Cameroon S.N. Lyonga 81
Country reports
Cameroon H.J. Pfeiffer and S.N. Lyonga 89
Kenya G.H. de Bruijn and E.J. Guthrie 95
Uganda Z.M. Nyiira 99
Malawi R.F. Nembozanga Sauti 104
Zimbabwe A.G. Rowe 107
Ethiopia Terefe Belehu 109
Burundi D. Cimpaye 111
Zaire T.P. Singh and N.B. Lutaladio 114
Swaziland W. Godfrey-Sam-Aggrey 119

References 122
The prevailing socioeconomic conditions of the smallholder farmer in Africa militate against the widespread use of insecticides not only because of the costs of the chemicals but because of the long-term side-effects from their misuse. Thus, other means of pest control must be sought. Agricultural researchers must concentrate on building-in host-plant resistance, identifying and introducing natural enemies of the offending pests, and developing agronomic practices that discourage the buildup and spread of the pests. Progress along these lines for two important staple root crops — cassava and sweet potatoes — in Africa has been considerable over the last 10 years; the focus and accomplishments of work to date are reviewed in this paper.

La situation socio-économique actuelle des petits exploitants africains empêche le recours généralisé aux insecticides, tant à cause du coût des produits chimiques que des effets secondaires à long terme de leur mauvaise utilisation. Il est donc impératif de trouver d'autres formes de lutte. Les chercheurs agricoles doivent se concentrer sur le renforcement de la résistance des plantes hôtes, l'identification et l'introduction des ennemis naturels des insectes et le développement de pratiques agronomiques qui puissent enrayer l'accroissement et la propagation des insectes. On a fait des progrès considérables dans ces domaines pour deux importantes racines alimentaires de base — le manioc et la patate douce — en Afrique au cours des dix dernières années ; l'article passe en revue les objectifs et les résultats des travaux réalisés jusqu'à présent.

Tropical root crops contribute substantially to the carbohydrate diet of people in West, Central, and East Africa. Cassava is the most important crop in Central Africa and parts of West Africa. Sweet potatoes are very important in East Africa and, to a lesser extent, in the rest of Africa. According to the Food and Agriculture Organization of the United Nations (FAO 1976), Africa is the biggest cassava producer in the world.

In Africa, cassava and sweet potatoes are mainly grown together with maize, beans, and vegetables. The crop varieties grown under these conditions are generally poor yielding but fairly well adapted to the ecological conditions and pest fauna. With the increasing demand for food, improved agricultural practices like monocultures and high-yielding varieties are slowly being adopted. This trend certainly will change, and is already changing, the pest status in these crops. One has to anticipate the resulting problems by developing pest-management programs for these crops.

Knowledge of insects and mites attacking these crops is still limited. Although the main pests have been identified, the basic biological and, in many cases, yield-loss data are lacking.

This paper presents some of the available knowledge, together with control approaches that might work under African conditions.

Cassava pests

Until recently, cassava in Africa was relatively free of major pests. The reason probably was that most of the pest species attacking cassava in South America were not introduced with the plant, and relatively few African insect and mite species have adapted to cassava, probably because of its cyanide content.

Until 1970, only the whitefly (Bemisia tabaci), the vector of CMD; the red spidermite (Tetranychus cinnabarinus); the white scale
(Aonidomytilus alleius); and a grasshopper (Zonocerus variegatus) were damaging cassava. Zonocerus and Tetranychus defoliate cassava during the dry season, starting from the lower old leaves and progressing slowly to the top of the plant. With heavy attack and repeated defoliation, damage from Zonocerus may reach 60% (COPR 1977).

The whitefly itself does not cause much damage to cassava, but whitefly density in the field is highly correlated with the incidence of cassava mosaic disease (Fig. 1). White scale attacks the cassava stems and may prevent sprouting if infested stakes are used as planting material. At present, all these pests are controlled by natural enemies. However, this is not the case for two pest species introduced into Africa about 1970 by vegetative planting material from South America: the cassava green mite (Mononychellus tanajoa) and a mealybug (Phenacoccus manihoti).

The green mite was first observed in Uganda (Nyiira 1972) and, since then, has spread to Kenya, Tanzania, Burundi, Rwanda, Zaire, Nigeria, Benin, and Togo. It is a dry-season pest that attacks cassava shoots. The symptoms are yellowing of young leaves and inhibition of new leaf development. One generation takes about 10–12 days. Adults are carried by wind over long distances. Yield losses up to 40% were reported by Nyiira in 1975. Phenacoccus manihoti was first observed around Kinshasa (Zaire) (Leuschner 1976) and, since then, has spread to Angola, the Congo, Gabon, Senegal, Gambia, Nigeria, Benin, and Togo. Like the green mite, the mealybug attacks the shoot, prevents new leaf growth, and defoliates the plant in the late dry season. The insect is parthenogenetic, and one life cycle is completed in about 20 days. The pest disperses by wind (crawler stage) and on cuttings. It results in yield losses from 20% to 50% and may kill young plants. Both pests decrease to subeconomic levels during the wet season.

**Sweet-potato insects**

The main harmful insects on sweet potatoes in Africa are the weevils Cylas formicarius and C. puncticollis. The former is mainly distributed over East Africa, whereas the latter is a West and Central Africa species. The weevils are similar in their behaviour: they attack the leaves, the stem, and the sweet-potato tuber. Females lay about 200 eggs, and the life cycle is 20 days. Economic damage is attributable to tuber attack and, to a lesser extent, to stem attack (Cockerham et al. 1954). The weevil population increases during the dry season because of higher temperatures and soil cracks that expose the tubers. The larvae not only tunnel into the tuber but also deposit wastes that give the tuber a disagreeable taste.

In addition, secondary fungus and bacterial infections arise and destroy the tuber. Loss of tubers has been reported as high as 90% in India (Fröhlich and Rodewald 1970) with high weevil infestations, but, normally, losses range between 10% and 50%. The damage continues during storage.

Minor pests are the sweet-potato hornworm (Agrius convolvuli) and a tortoise beetle (Conchylotaenia punctata). Both are leaf feeders, their contribution to yield loss being unknown at present (PANS 1978).

Because of the low educational standard of African farmers, lack of money, irregular supplies of insecticides, and the relatively undisturbed agroecosystems in Africa, measures to control pests should be well planned and should only include the use of insecticides when no other control is feasible. This means that the three fundamental tactics should be:

- To build-in host-plant resistance;
To determine natural enemies of the pests and their potential for use in biological control; and
To investigate cultural practices that will limit the pests.

**Cassava pest control**

Cassava tolerates, and compensates for, pest damage well. The reason is that it has a long growth period (1–2 years). Thus, during the dry season, when the pests in Africa are a problem, the plant grows very slowly because of the water shortage but is able to compensate during the following rainy season.

This ability of cassava to tolerate and compensate for damage caused by insects and mites makes it especially attractive for development of resistant or tolerant varieties because the level of resistance or tolerance need not be too high.

Programs to identify resistance against *Zonocerus, Mononychellus,* and *Phenacoccus* are under way and have already yielded some positive results. High levels of resistance have been found for *M. tanajoa* in Zanzibar and Ukuriguru (Shukla 1975) in Tanzania and in IITA. Plants exhibiting resistance have hairy young leaves and good vigour. Also, some resistance to *Phenacoccus* may have been recently identified, as Ezumah et al. (1979) have reported clones on which no mealybug colonies become established. Likewise, for the red spidermite, clones that have reduced susceptibility have been found, although the level of resistance is not yet satisfactory. Finally, clones on which a *Zonocerus* attacked and fed on only the lower leaves have been identified (Leuschner 1977a).

These findings are encouraging; it is now up to breeders to utilize the resistant clones and, if possible, to combine their characteristics with other desirable characters like disease resistance and high-yield potential.

A biological control program has been started by IITA, in collaboration with the Commonwealth Institute of Biological Control, for the mealybug and green mite. Predators and parasites will be sampled in South America, identified, and tested for their efficiency.

In general, pest outbreaks and damage to plants are more severe when the plants are under stress from other factors such as drought, poor soil fertility, or poor adaptation to a certain environment. This is certainly the case with spider mites, mealybugs, and scale insects. Observations in Zaire of cassava planted on rich alluvial soils with a high water table compared with that on poor laterite soils with a low water table indicated that the mealybug infestation was much higher on the poor soils. The same applies to the green mite in Tanzania.

Planting time is another factor contributing to the amount of infestation by mealybugs and green mites and the consequent yield losses. Cassava plants younger than 6 months suffer greater yield losses than do older plants with well-established root systems.

Therefore, things that improve plant health, like crop rotation, an increase of organic matter (mulch), use of healthy cuttings, and proper planting time, can significantly reduce yield loss. In the case of mealybug attack on cassava in Zaire, 4 months' delay in planting resulted in 31.2% yield loss compared with none for cassava planted at the beginning of the rainy season. The effects of other agricultural practices, like mixed-cropping systems, have to be investigated thoroughly in Africa. For example, mixed-cropping systems reduce pest incidence, but the reason is not clear. The low population of each crop and the influence of barrier crops are possible factors.

Because of the low unit value of cassava, as well as the socioeconomic constraints to cassava production, insecticides and acaricides should not be used in intensive cassava production. Chemical control should be limited to the treatment of planting materials. Treating the stakes with malathion or kelthane delays infestation by green mites and mealybugs considerably. Reinfestation can only take place by airborne crawlers and mites, and their density is low at the beginning of the dry season (Nwanze 1978). In the case of mealybugs in Zaire, it is only in August–September that crawler density markedly increases.
**Sweet-potato pest control**

Compared with cassava, sweet potato is a short-lived crop. The time from planting to harvest is 4–6 months. Its economic threshold for pest damage is much lower because it cannot compensate by growing for a longer period. Therefore, pest-control methods must be more efficient. Fortunately, sweet potatoes have only one economically important pest (*C. puncticollis*); therefore, control strategies can focus on it.

As with cassava, host-plant resistance against *Cylas* would be the easiest way to control this insect in Africa because no additional input by the farmers would be required. Unfortunately, breeding for resistance is still in the early stages: 700 cultivars collected from all over the world have been screened but only low levels of resistance have been found, and crossing the clones with each other has only produced clones with moderate levels of resistance. The difference in susceptibility (Fig. 2) between the moderate and susceptible clones (Hahn 1977b; Leuschner 1977a) is not sufficient, especially at the beginning of the dry season. Thus, additional means of control have been studied.

Biological control against the weevil is not promising at present either, because no efficient parasites or predators have been found to combat the pest during the dry season. Nevertheless, one fungus, a *Boveria* sp., has been found to be very efficient under the humid conditions of the wet season, and more investigations are needed.

Various cultural-control methods have been tested, and two factors have been shown to contribute significantly to the control of the weevil: use of clean planting material (cuttings) and reridging of plots. Clean cuttings can be obtained from the end of the vine, but larvae have been found to exist everywhere else on the vine. Reridging is an old method practiced by people in Indonesia. The idea behind it is to keep the growing tuber deeply buried because *Cylas* weevils are not able to penetrate the soil; they depend on cracks and other crevices to reach the tuber.

In two trials conducted in the beginning and end of the rainy season, the best sweet-potato variety in terms of weevil resistance was compared with a susceptible one. During the first 2 months of the growing season, every 15 days five blocks of the trial were reridged. After 30–45 days, the combination of low-level resistance and reridging resulted in a very low amount of damage to tubers (Fig. 3). This shows that, without insecticides, it is possible to reduce the level of weevil infestation (Leuschner 1977a).

The problem of weevil damage during storage of sweet potatoes remains. In storage, even a small weevil population can heavily damage the harvest within 5 weeks. In this case, insecticides must be used, and actellic and synthetic pyrethroids have proved satisfactory when applied once at the beginning of storage.

**Quarantine**

Root crops have one thing in common: they are vegetatively propagated, the planting material serving as transportation for pests
like mites, mealybugs, and scale insects. In Africa, diseases or pests that occur in one country are spread over the whole continent within a few years because of the increasing movement of people. Within the last 10 years, cassava alone has faced two new problems imported: mealybugs and green mites.

It is, therefore, essential that all governments exercise controls and quarantine on planting materials. New varieties of root crops should be imported only in seed form. These seeds should pass through a plant-quarantine station, or, if this is not possible, they should be planted in isolation.