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WINBAN crown rot project
The general objective of INIBAP is to improve the productivity of smallholders who grow banana and plantain mainly for domestic consumption. However, the wellbeing of those smallholders whose livelihood is derived from growing dessert bananas and plantains for export is also an INIBAP concern.

INIBAP’s specific objectives are:
- to initiate, encourage, support, conduct and coordinate research aimed at improving the production of banana and plantain;
- to strengthen regional and national programs concerned with improved and disease-free banana and plantain genetic material,
- to facilitate the interchange of healthy germplasm and assist in the establishment and analysis of regional and global trials of new and improved cultivars;
- to promote the gathering and exchange of documentation and information; and
- to support training for researchers and technicians.

INIBAP is an institution supported by the Consultative Group for International Agricultural Research (CGIAR). In May 1994, INIBAP was brought under the governance and administration of the International Plant Genetic Resources Institute (IPGRI) to enhance opportunities for serving the interest of small-scale banana and plantain producers.

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Cover photo
Le Dinh Danh, Director of the Phu Ho Fruit Crop Research Center, holds the peduncle of Musa itinerans, a wild species cultivated in Viet Nam for use as a source of building materials and pig food, at Bằng Luan, north Viet Nam (Photo: David Jones, INIBAP)

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Collection, characterization, evaluation and conservation of the indigenous Musa germplasm of Viet Nam - a progress report

By Nguyen Dang Khoi and Ramon V. Valmayor

Edible banana cultivars originated in Southeast Asia and Viet Nam is located within the center of genetic diversity of Musa germplasm. However, Viet Nam's wealth in Musa genetic resources have never been fully assessed and harnessed due to the country's prolonged struggle for independence. With the restoration of peace, the agriculture sector has realized major gains. Vietnamese scientists have resumed cooperative projects with regional and international organizations including those in the area of plant germplasm conservation and management. In January 1994, INIBAP and IPGRI-APO approved a grant to fund a proposal submitted by INSA (National Institute of Agricultural Sciences) for the collection, characterization, evaluation and conservation of the indigenous Musa germplasm of Viet Nam. INIBAP's contribution was part of an allocation provided for germplasm collecting by UNDP under the International Musa Testing Program.

Project goals and objectives
- to launch prospection missions and collect wild and cultivated Musa germplasm from all regions of Viet Nam
- to establish a national Musa field collection at Phu Ho Fruit Research Center, Vinh Phu Province, north Viet Nam with a duplicate collection at Long Dinh Fruit Research Center, Tieng Giang Province, south Viet Nam,
- to characterize the banana germplasm using the standard INIBAP/IPGRI descriptors list and classify all indigenous Musa species, identify synonyms and select superior clones,
- to evaluate the banana germplasm materials for productivity, fruit quality and resistance to pests and diseases,
- to establish an in vitro collection at the Biotechnology Department, INSA,
- to duplicate Viet Nam's banana germplasm at the INIBAP Transit Center in KUL, Belgium and index the accessions for virus disease. INIBAP will hold these materials in trust for the world community and make them available to breeding programs, NARS regional institutes and universities for evaluation and utilization;

Cooperating institutions and key personnel

Lead institution
• Dr Tran Dinh Long, Deputy Director, INSA, Biotechnology Department,
• Dr Ho Huu Nhi, Head of Officer-in-charge of the Tissue Culture Laboratory.

Cooperating institutions
• Mr Le Dinh Danh, Director, Phu Ho Fruit Research Center,

Le Dinh Danh and Hugues Tézenas du Montcel hold the pseudostem of a wild Musa species, believed to belong to the section Rhodocloemys, found near Yen Bai, Hoàng Liên Sơn Province, north Viet Nam (Photo: David Jones, INIBAP)
Dr Nguyen Minh Chau, Director, Long Dinh Fruit Research Center, 
Dr Nguyen Nghia Thin, Officer-in-charge of Herbarium, University of Hanoi.

Resource persons
- Dr David Jones, Scientific Research Coordinator and Plant Pathologist, INIBAP, Montpellier, France,
- Mr Hugues Tézenas du Montcel, Head of Banana and Plantain Program, CIRAD-FLHOR, Montpellier, France.

Project duration and cost
The project duration is 2 years and April 1994 was the starting date. This project is jointly funded by INIBAP and IPGRI-APO with a total budget of $30,000.

Accomplishments to date
Two collecting teams were organized. The northern team headed by Dr Le Dinh Danh launched four prospection missions. Each mission covered a distinct agro-climatic area in north and central Viet Nam, regions well-known for their highly varied ecological zones. Dr D. Jones and Mr H. Tézenas du Montcel participated in the fourth collection mission. Both are experienced banana explorers and were team members of the highly successful banana collection missions to Papua New Guinea sponsored by IBPGR (now IPGRI), INIBAP, QDPI, and CIRAD-IRFA (now CIRAD-FLHOR) in 1988-1989. The southern team under Dr Nguyen Minh Chau was assigned to the highly uniform agro-climatic zone of south Viet Nam and launched only one extended mission which lasted for 41 days.

The five prospection missions collected a total of 107 accessions. Edible banana cultivars comprised 88 accessions while the remaining 19 were wild species. The wild species included *Musa* itinerans, *Musa* coccinea and a few unidentified species of ornamental *Musa* and *Ensete*. An interesting observation is the popular use of the apical meristem of wild *Musa* and *Ensete* as a vegetable by indigenous inhabitants living near forested areas. Some communities actually plant *Ensete* seedlings which are harvested before the plants flower to collect the central bud for family consumption. An unusual specimen of *Ensete* which produces suckers was collected and is now growing at the Phu Ho field germplasm bank.

The ubiquitous *Musa* balbisiana is semi-cultivated. Together with *Musa* itinerans, it is often an earlier coloniser after forested upland areas cleared for agriculture are abandoned. They are widely grown in farmer’s backyards for various purposes. The pseudostems are fed to pigs, the leaves are used as wrapping material in the preparation of local delicacies, the male bud is a popular vegetable and the fruits have medicinal value. The young pseudostem of *Musa* itinerans are likewise used by cultural minorities as hog feed. A very attractive wild *Musa* species, which is believed to be in the section Rhodochlomys, was also collected and is bound to catch the interest of ornamental growers.

The 88 edible cultivars collected represent the rich variability of desert and cooking banana types in Viet Nam. Plantains are rare. The collecting reports describe the pests and diseases associated with the popular cultivars. Fusarium wilt, Sigatoka, banana bunchy top and mosaic are the common diseases, while weevil borer is widespread. A most important observation is the high resistance, if not immunity, of the wild species to the common banana diseases in Viet Nam.

The objectives of the first year of prospection, collection and establishment of field germplasm banks have all been accomplished. The project personnel will soon be undertaking the objectives of the second year, which are the characterization of the germplasm collected, the duplication of the entire collection in vitro at INSA, and the duplication of this in vitro collection for the INIBAP Transit Center at KUL, Belgium.

The field germplasm collections established in north and south Viet Nam will serve as centers for identifying desirable clones and promising breeding lines. They will also act as reservoirs of propagating material to be used for the multiplication of superior cultivars for dissemination to provide fruits for local markets and the export trade.

Nguyen Dang Khoi, Former Coordinator for National PGR System is Deputy Director at INSA, Hanoi, Viet Nam.

Ramon V. Valmayor is Regional Coordinator at INIBAP-ASPNET, Los Baños, Laguna, Philippines.
Goldfinger in Australia: a banana variety with potential

The banana variety SH-3481 (FHIA-01) was introduced from the FHIA breeding program in Honduras in 1989. It is now popularly known as Goldfinger. It was produced by a cross of a dwarf Lady Finger type (Dwarf Prata = Santa Catarina Prata AAB ‘Pome’) with SH-3142 which has some resistance to burrowing nematodes, Sigatoka leaf diseases and Fusarium wilt. Goldfinger has generated a lot of interest recently with the discovery that it is resistant to Fusarium wilt race 1 and 4 which are a major problem in southern Queensland and northern New South Wales. This article details the current status of its evaluation.

**Plant and bunch characteristics**

Some plant crop information is presented in Table 1. Goldfinger plants were 55-83 cm taller than Williams, but were 53 cm shorter than Lady Finger. Goldfinger bunches were heavier than Williams, but were harvested later. Overall yield in the plant crop was comparable to Williams. The plant has slightly droopy leaves and the broad high shoulders of the bell (male bud) are very distinctive. In southern Queensland bunched plants of Goldfinger have withstood wind better than many other varieties. The leaves remain quite green in southern Queensland during winter which is a characteristic of some cultivars with tolerance to Fusarium wilt.

**Pest and disease status**

Goldfinger is remarkably resistant to pests and diseases. As mentioned earlier it is resistant to Fusarium wilt race 1 and 4 which would make it a potential replacement for susceptible varieties. From preliminary observations, it is apparently resistant to burrowing nematodes probably inherited from its resistant parent SH-3142. It has high level of resistance to black Sigatoka in the Americas and Africa. It has also been shown to be resistant to crown rot overseas. On the downside, it is susceptible to leaf speckle (*Mycosphaerella musae*), but in north Queensland this may be contained by regular deleafing. As well, it has a similar susceptibility to banana weevil borer as the Cavendish types. Goldfinger has also been prone to the physiological disorder, maturity bronzing, in one trial at Mission Beach. Goldfinger is also highly susceptible to bunchy top disease, but this is a useful characteristic because the variety cannot be a hidden carrier of the disease.

**Fruit quality**

Finger length for Goldfinger is exceptionally good with most fruit on the bunch being extra large by Cavendish standards. Overseas results indicate that fruit greenlife is good being comparable to Cavendish. Goldfinger ripens to an attractive golden yellow which can be achieved without controlled ripening conditions. The fruit taste is closer to Pome than Cavendish. The fruit pulp is softer and more mucilaginous than either of these varieties.

**Marketing potential**

Because of Goldfinger’s high level of resistance to pests and diseases it will require fewer pesticides. With consumers becoming more and more conscious of chemicals this could be an important marketing approach. Lower pesticide inputs will also lead to reduced costs of production and reduced chemical handling risks. In some si-

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**Impact of a new FHIA hybrid**

**Goldfinger in Australia: a banana variety with potential**

Jeff Daniels, Ken Pegg, Chris Searle, Mike Smith, Tony Whiley, Peter Langdon, Neil Bryde and Tim O’Hare

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A typical bunch of Goldfinger
tutions it could be possible to produce Goldfinger without the use of any pesticides or totally organically. An organic/pesticide free market could be developed.

Because Goldfinger is different to other varieties it needs to be sold as a totally new product. This brings with it the problems/opportunities of market development.

Goldfinger was officially released to the banana industry in Australia on May 1995.

Further varieties from overseas breeding programs will soon be evaluated in the field as part of INIBAP’s International Testing Program. Hopefully they will include varieties with similar pest/disease resistance to Goldfinger to help curb the use of pesticides in banana production.

All the authors are employed by the Queensland Department of Primary Industries (QDPI).

Jeff Daniells and Neil Bryde are based at the South Johnstone Research Station, PO Box 20, South Johnstone QLD 4859, Australia; Ken Pegg and Bob Davis at the Plant Protection Unit, 80 Meiers Road, Indooroopilly Qld 4068, Australia; Chris Searle, Mike Smith, Tony Whiley and Peter Langdon at the Maroochy Horticultural Research Station, PO Box 5083, Nambour Qld 4560, Australia; Tim O’Hare at the International Food Institute of Queensland, 19 Hercules St., Hamilton, QLD 4007, Australia; Ron Peterson at QDPI, PO Box 1054, Mareeba Qld 4880, Australia.

### Table 1. Plant crop characteristics of Goldfinger (FHIA-01) in north Queensland

<table>
<thead>
<tr>
<th>Variety</th>
<th>Planting to bunch harvested (months)</th>
<th>Bunch weight (kg)</th>
<th>Finger length (cm)</th>
<th>Pseudostem Height (m)</th>
<th>Yield t/ha/yr*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mission Beach</td>
<td>Goldfinger</td>
<td>13.6</td>
<td>36.9</td>
<td>26.4</td>
<td>2.75</td>
</tr>
<tr>
<td></td>
<td>Williams</td>
<td>11.8</td>
<td>28.7</td>
<td>23.8</td>
<td>2.20</td>
</tr>
<tr>
<td>South Johnstone</td>
<td>Goldfinger</td>
<td>14.4</td>
<td>34.3</td>
<td>25.5</td>
<td>2.74</td>
</tr>
<tr>
<td></td>
<td>Williams</td>
<td>12.4</td>
<td>30.5</td>
<td>29.0</td>
<td>1.91</td>
</tr>
<tr>
<td></td>
<td>Lady Finger</td>
<td>14.1</td>
<td>20.2</td>
<td>19.4</td>
<td>3.27</td>
</tr>
</tbody>
</table>

* Plant density approximately 1500 plants/ha

### Table 2. The severity of Sigatoka/yellow Sigatoka on banana varieties at South Johnstone

<table>
<thead>
<tr>
<th>Variety</th>
<th>Youngest leaf spotted+</th>
<th>33% Necrosis #</th>
</tr>
</thead>
<tbody>
<tr>
<td>Williams</td>
<td>4.7</td>
<td>7.3</td>
</tr>
<tr>
<td>Goldfinger</td>
<td>6.1</td>
<td>12.0</td>
</tr>
<tr>
<td>SH-3142</td>
<td>5.9</td>
<td>8.8</td>
</tr>
<tr>
<td>Santa Catarina Prata</td>
<td>5.4</td>
<td>8.2</td>
</tr>
<tr>
<td>Ducasse</td>
<td>ND</td>
<td>ND</td>
</tr>
</tbody>
</table>

* Averages of monthly ratings in March, April and May 1994
+ Youngest leaf spotted = numerical leaf position from top of plant with 10 mature leaves
# 33% necrosis = numerical leaf position from top of plant with more than one third of the leaf area killed by the leaf spot fungus
ND = no disease symptoms, more than 12 green leaves were present.

Goldfinger: Not as resistant to Sigatoka/yellow Sigatoka as first thought

Goldfinger (FHIA-01), a hybrid developed from Prata in Honduras, has been considered to have potential for the production of bananas without pesticides including fungicides for leaf spot control. However, recent trial results indicate the level of Sigatoka/yellow Sigatoka leaf spot (Mycosphaerella musaeicola) and leaf speckle (Mycosphaerella musae) damage to Goldfinger could be sufficient to reduce yield/quality under some circumstances if fungicides are not applied.

Table 2 shows leaf spot data from a recently completed trial at South Johnstone Research Station. The Cavendish variety, Williams, was the most severely damaged by leaf spot - the youngest leaf spot being 4.7 on average. Santa Catarina Prata (Dwarf Lady Finger) and SH-3142 the respective female and male parents of Goldfinger were also severely damaged by leaf spot, but not quite as badly as Williams. The youngest leaf spot for Goldfinger was 6.1, which is only slightly less severe from those already mentioned. However, the speed by which the spot stage progressed to major leaf necrosis (death) for Goldfinger was much slower than the other varieties thus indicating a degree of resistance. Ducasse (ABB ‘Pisang Awak’) was immune to leaf spot in the trial.

Leaf spot disease pressure was very high and less damage would be expected under normal circumstances. The effect of disease levels on yield and quality of Goldfinger is unknown. It is our experience from elsewhere that Goldfinger usually has sufficient resistance to leaf spot to avoid yield/quality problems especially if regular deleafing of diseased lower leaves is practiced. This strategy is also particularly effective against leaf speckle on Goldfinger - a disease to which it is also susceptible. A mid-autumn assessment of speckle damage (based on presence or absence) in a mixed unsprayed planting at Pimpama (Southern Queensland) this year revealed that in unbunched plants of Goldfinger, the youngest leaf affected by the disease was 5.8, similar to 5.3 for Santa Catarina Prata, but more than a whole leaf better than 4.1 for the Cavendish variety Giant Parfitt. However, a speckle disease index (see below) designed to score overall severity indicated a large difference between Giant Parfitt (12.8) Goldfinger (3.3) and Santa Catarina Prata (4.3).

Spelcke disease index:

(number of leaves diseased x % leaf area affected x 100) / total number of leaves

The response of Goldfinger to these leaf diseases highlights some of the serious shortcoming of relying solely upon overseas breeding programs for disease resistant varieties. Goldfinger was developed in Honduras in the absence of Sigatoka/yellow Sigatoka and leaf speckle. Thus breeding material used in such programs cannot be screened for the important diseases affecting banana production in Queensland.

The male parent of Goldfinger - SH-3142 is highly susceptible to yellow Sigatoka.
by J. Daniells, J. E. Thomas, M. Smith

Banana streak virus (BSV) is endemic to the banana variety Mysore (ABB) in Australia. BSV is characterized by yellow streaking of the leaves which becomes progressively necrotic producing a black streaked appearance in older leaves. The presence of BSV in Mysore is a disappointment because Mysore would be very useful as a disease resistant backyard banana and as a replacement variety resistant to black Sigatoka for the Cape York buffer zone between the north Queensland industry and Papua New Guinea. Mysore is resistant to yellow and black Sigatoka and Races 1, 2 and 4 of Fusarium wilt making it ideal for disease control programs. In addition it has a good flavor which would satisfy many consumers.

During 1992-1993, the female fertility of several varieties at South Johnstone Research Station, north Queensland were evaluated as part of a preliminary feasibility study of banana breeding for Queensland. Mysore was amongst the parents screened for female fertility. During 1992-93, 10 bunches of Mysore, a total of 60 individuals hands, treated were pollinated. SH-3362, an elite diploid from the FHIA breeding program, was used as male parent. A total of 18 seeds were recovered from the mature bunches resulting from these pollinations. The possibility of pollen contamination was eliminated by enclosing the inflorescence of both the male and female parents in muslin cloth covers prior to anthesis.

From the recovered seeds, only one embryo proved to be viable. This hybrid was propagated in vitro. Some of these in vitro plants were then grown on in the field and others were tested by electron microscopy serology for the presence of BSV. The hybrid has droopy leaves characteristic of tetraploids but chromosome counts have shown that the hybrid is triploid like its female parent Mysore.

The characteristic BSV symptoms of chlorotic streaking of leaves were seen in field grown plants of the Mysore hybrid in north Queensland. These symptoms were also present in the female parents of Mysore used in the pollinating. No such symptoms were present on the SH-3362 male parents. Electron microscopy serology tests of leaf tissue from field grown plants of Mysore and the Mysore hybrid confirmed the presence of BSV. This indicates that BSV can be transmitted via seed. No BSV was detected in leaf samples of SH-3362.

If Mysore is to be used in disease control programs and in breeding programs either a BSV-free accession is required or some means of eliminating the virus from infected plants is required. QDPI have acquired the BSV-free from INIBAP. QDPI has also meristem-cultured a local Mysore selection in an attempt to free it of BSV. Field results are expected soon.

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The north eastern part of India is a sub-tropical (high humid) region and the natural home for a large number of wild Musa species. The region is well known for high rainfall (500mm to 3000mm per annum) and the soil is acidic in nature with the pH range of 4.0 to 5.5. A large number of diploid and triploid Musa types are found in the plains and hills of the region in wild, semi-wild or in cultivated conditions. Among the different cultivars grown in this region, ‘Bhimkal’ is one of the most popular. It is grown mostly in home gardens.

The plants are very tall and robust (height maximum 12m) with a light-green pseudostem. The circumference of the pseudostem near the ground ranges from 1.25m-1.30m. The cropping period is reported to be 34-40 months. A mature bunch can weigh 25 to 35kg with 10-12 hands per bunch and 12-14 fingers per hand. The fruit is 18-22cm in length and 15-20cm in circumference. Fruit quality is more or less similar to other traditional commercial triploid (AAB, AAA) cultivars grown in the eastern part of India. The fruit pulp has an attractive flavor. Another unique feature of this cultivar is that it has good drought tolerance and is free from diseases and pests including nematodes. In fact, no pest or disease have so far been reported in this cultivar.

Inhabitants of this region utilize all the parts of the plant in different ways and it is called “banana for all purposes”. The leaf and leaf sheath are used as dinner plates. A valuable alkali is extracted from the pseudostem, corm and fruit skin which is used by rural folk for preparing various dietary items. The alkali is also used to get relief from stomach upset, cold fever and influenza. The plant can resist wind and storm damages because of its strong and hardy pseudostem. Plants are also grown around fields as a wind barrier. The tender pseudostem and male flowers are used as vegetables.

Fruit from this cultivar has numerous uses. The pulp, after separation from the seed, is mixed with rice powder and cooked. This is considered to be one of the best baby foods. The ripe fruit is also eaten as a dessert banana in rural areas. It is believed that the fruit is a source of various medicines. The important chemical qualities of the fruit are presented below:

a. Pulp-peel ratio 2.05-2.08
b. Pulp-seed ratio 2.52-7.06
c. Number of seeds/fruit 167-238
d. Total soluble solids (%) 2.6-5.0
e. Titrable acidity (%) 0.128-0.192
f. Reducing sugar (%) 5.88-12.11
g. Total sugar (%) 10.89-14.99

(Editors note: Bhimkal resembles Pisang Awak (AAB) in many respects)

The authors are based at the Horticultural Research Station, Assam Agricultural University, Kahikuchi, Azara, Guwahati-781017, Assam, India
Mycosphaerella fijiensis Morelet, the causal agent of black leaf streak/black Sigatoka disease (BLS), seriously affects banana and plantain production worldwide. The fungal pathogen severely reduces photosynthetic leaf tissue which leads to yield losses of up to 90% (Fouré, 1985). Since the first description of the disease in Fiji in the 60s (Rhodes, 1964), the pathogen has spread to many major banana growing areas and has caused epidemics on Pacific islands and in Latin America. It also appeared in Africa about 20 years ago. The intensive application of fungicides to dessert banana plantations and the breeding of resistant plantain hybrids are both considered necessary for the stable production of fruit in Africa today. However, the evolution and population dynamics of *M. fijiensis* is not at all understood, and the appearance of fungicide-resistant or resistance breaking fungal strains cannot be forecasted though they are to be expected.

In spite of its importance to all banana growers from big companies to small subsistence farmers, the population dynamics, population drift(s), genetic make-up, genetic variability and mutation frequency of *M. fijiensis* is virtually unknown. Though differences in virulence between isolates have been reported (Fullerton and Olsen, 1991), they could not be associated with morphological characteristics. Only recently, the genome of *M. fijiensis* became the target of several research project. Using PCR-based techniques, Dr. A. Johansen detected random amplified polymorphic DNA (RAPD) bands specific for either *M. fijiensis* or *M. muscicola*. (Johansen and Jeger, 1993), Dr X. Mourichon and co-workers exploited restriction fragment length polymorphisms (RFLPs) to discriminate between the two species (Carlier et al., 1994). A more comprehensive study on various isolates of *M. fijiensis* from all over the major banana growing areas of the world, revealed considerable genetic variation. The highest level of variability was found in Papua New Guinea and the Philippines which suggests that this region may be the center of origin of the fungus. Since only a few genotypes of the fungus have been introduced recently into Latin America and Africa, genetic variability in these continents seems to be much lower (Carlier et al., 1994).

Other ascomycete populations, such as *Ascochyta rabiei*, a chickpea pathogen (Weising et al., 1991; Kaemmer et al., 1992; Morjane et al., 1994) have been analyzed and high-density geographic maps developed for all genotypes of this fungus in Tunisia. A series of analytical techniques involving microsatellites (e.g. microsatellite fingerprinting, microsatellite-primed PCR, semi-random microsatellite analysis, random amplified microsatellite polymorphism detection, and sequence-tagged microsatellite site technologies) have been developed. The application of one of these techniques, microsatellite fingerprinting of *M. fijiensis* allowed the detection of genetic variability on various level in Nigeria.

**Genetic variation between isolates on the plant- and lesion-level**

Forty different isolates from three different locations in Southern Nigeria were collected and isolated from single spores. Using a hierarchical sampling strategy, genetic variability was detected at different levels. For instance, variation in fingerprint patterns was found between isolates from the same lesion, as well as between isolates from different locations (Müller et al., 1995).

DNA from mycelia of single-spored isolates was digested with different restriction enzymes, separated on agarose gels and subsequently hybridized within the dried gel with different 32p-dATP-labelled oligonucleotides homologous to simple sequence repeats. Optimal enzyme/probe combinations were detected using autoradiography (Figure 1).

Mathematical analysis was performed by the computer program package TREECON. First, the fingerprint pat-
terns were converted into a 0/1 matrix. Then, a single distance matrix was calculated and a phenogram generated using the neighbor-joining method. This phenogram showed the genetic distances between the isolates and gave an impression of whether relationships between isolates or groups of isolates are close or distant. Figure 2 shows such a phenogram based on the fingerprint patterns of Figure 1. Significance of the data was tested by bootstrap analyses and is indicated at the branching points of the phenogram.

The fingerprints in Figure 1 show 8 isolates (Table 1) from three different cultivars (Valery, Bluggoe, Agbagba) from different locations (Onne, Kpite, Umudike). It is obvious that the fingerprint patterns of the isolates can be assigned to the different locations and host plant genotypes. However, the isolates from one plant can also be divided into subgroups indicating genetic diversity on the plant level. We found variation among isolates from one single lesion (e.g. Mf135/Mf137 and Mf246/249; Figure 2).

Fingerprinting with oligonucleotide probes proved to be a reliable technique to detect genetic variation down to very small differences even between individuals, but at the same time allowed groups of closely related genotypes to be defined.

**Genetic variation between isolates from different host cultivars**

Isolates collected from different host cultivars were also analyzed to look for different genotypes, which might be predominant on one particular host, suggesting the existence of different pathotypes. The susceptibility of the three host cultivars to BLS increases in the following order: Bluggoe < Agbagba < Valery. As the phenogram (Figure 2) shows, the different isolates can be grouped according to their host plant origin, though the number of isolates was very restricted. An isolate of the chickpea pathogen Ascochyta rabiei served as an "outgroup". The single isolate from Kpite (Bluggoe, Mf195) seems to be more similar to the four isolates from Onne (Valery, Mf135-Mf145) than to the three isolates from Umudike (Agbagba, Mf246-252). This fact may mean that the geographical distance is of higher importance for the genetic distance than the differences in the susceptibility of the host plant genotype. The geographical distance between Onne and Kpite is only one third of the distance of both of these two sites from Umudike. Moreover, the Kpite isolate from Bluggoe which has some resistance, seems to more closely resemble the isolate from the very susceptible Valery than the one from the less susceptible Agbagba.

The most interesting result of our work is that genetic diversity is not only detectable between isolates from very distant locations, but also between isolates from the same location and even from the same lesion. This has several consequences for our interpretation of genetic diversity, the distribution of genotypes, and the dynamics of M. fijiensis populations. Our observations match with the idea of founder populations. Only few genotypes spread over a specific region and genetic diversification follows as a consequence of either sexual recombination and/or environmental influences. It is also important to know more about the pathogen's potential for genetic changes, because this again has consequences for the appearance of new genotypes breaking host plant resistance or developing tolerance against fungicides.

Preliminary work with a larger number of isolates and the development of new molecular markers and marker techniques are currently being pursued. The prime goal of developing molecular markers is to assign them to interesting traits of the organism under consideration. In the case of a pathogen like M. fijiensis the most interesting trait is, of course, its virulence. There are several hints that different pathotypes of M. fijiensis indeed exist which show different degrees of aggressivity towards the different host-cultivars. However, a rating system in the form of a host differential set is required, against which the aggressivity of the different isolates can be tested. Once the isolates are differentiated into pathotypes, these can be assigned to certain genotypes identified by molecular marker techniques. We are presently looking for partners with experience in the phytopathological screening to complement our work on the molecular biology of M. fijiensis.

**References**


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**Table 1. Source of isolates of M. fijiensis**

<table>
<thead>
<tr>
<th>Isolate</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mf135</td>
<td>from lesion 1 on leaf 12 of Valery (AAA 'Cavendish') at Onne</td>
</tr>
<tr>
<td>Mf137</td>
<td>from lesion 1 on leaf 12 of Valery (AAA 'Cavendish') at Onne</td>
</tr>
<tr>
<td>Mf144</td>
<td>from lesion 1 on leaf 12 of Valery (AAA 'Cavendish') at Onne</td>
</tr>
<tr>
<td>Mf145</td>
<td>from lesion 1 on leaf 12 of Valery (AAA 'Cavendish') at Onne</td>
</tr>
<tr>
<td>Mf195</td>
<td>from lesion 1 on leaf 11 of Bluggoe (ABB 'Bluggoe') at Kpite</td>
</tr>
<tr>
<td>Mf246</td>
<td>from lesion 1 on leaf 4 of Agbagba (ABB 'Plantain') at Umudike</td>
</tr>
<tr>
<td>Mf249</td>
<td>from lesion 1 on leaf 4 of Agbagba (ABB 'Plantain') at Umudike</td>
</tr>
<tr>
<td>Mf252</td>
<td>from lesion 2 on leaf 4 of Agbagba (ABB 'Plantain') at Umudike</td>
</tr>
</tbody>
</table>

**Recommended experimental designs for selection of plantain hybrids**

By Rodomiro Ortiz and Dirk Vuylsteke

Although plantain and banana have previously been considered intractable to conventional genetic improvement, due to triploidy and the high level of sterility, large numbers of high-yielding and resistant tetraploid hybrids are now being produced at both the International Institute of Tropical Agriculture (Vuyysteke et al., 1993) and the Fundación Hondureña de Investigación Agrícola (Rowe and Rosales, 1990). This proliferation of promising hybrids has led to the need to develop a scheme for hybrid selection.

**Table 1: Evaluation of plantain hybrids**

<table>
<thead>
<tr>
<th>Steps</th>
<th>Duration</th>
<th>Type of trial</th>
<th>Numbers involved</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12-18 months</td>
<td><strong>EET:</strong> Early Evaluation Trial (Data recorded on BSR, bunch size, fruit parthenocarpy, dwarfness)</td>
<td>&gt;100 clones</td>
</tr>
<tr>
<td>2</td>
<td>1-2 years</td>
<td><strong>PYT:</strong> Preliminary Yield Trial (Data recorded at harvest, yield potential, resistant pests/diseases)</td>
<td>25-30 EET selected clones</td>
</tr>
<tr>
<td>3a</td>
<td>2 years</td>
<td><strong>MET:</strong> Multilocational Evaluation Trial (Data recorded at harvest, field evaluations, postharvest quality &amp; durability, and other pests/diseases)</td>
<td>8-15 PYT selected clones + parents &amp; local cvs for checks, RCD</td>
</tr>
<tr>
<td>4</td>
<td>LET: Local Evaluation Trial</td>
<td><em><strong>Note:</strong> Rapid testing by NARS for release to farmers (only of local relevance)</em></td>
<td>_<strong>Note:</strong> Other breeding materials coming from conventional or biotech programs through global network testing (IMTP/INIBAP) _</td>
</tr>
<tr>
<td>5</td>
<td>2-3 years</td>
<td><strong>AMYT:</strong> Advanced Musa Yield Trial (Data recorded on BSR, bunch size, fruit parthenocarpy, disease resistance)</td>
<td>3-5 advanced selected clones</td>
</tr>
<tr>
<td>6</td>
<td># years</td>
<td><strong>OFT:</strong> On-Farm Trials (to release new cultivars &amp; develop agronomic practices to maximize its yield: “cultivar profile”)</td>
<td>1-2 new cvs with traditional cvs. # plots. # rep. # treatments (density, mulching, N-P-K, etc.)</td>
</tr>
</tbody>
</table>

Step 1 & 2 undertaken at Onne (Nigeria) by the Plantain and Banana Improvement Program of ITA.

Step 3a undertaken by ITA in collaboration with National Agricultural Research System (NARS).

Step 3b undertaken by the International Network for the Improvement of Banana and Plantain (INIBAP) in collaboration with ITA & other breeding programs and NARS.

Step 4 undertaken by NARS with ITA & INIBAP support.

Step 5 undertaken by NARS with ITA & INIBAP support.

Step 6 undertaken by NARS (if required with inputs from ITA & INIBAP).

West Africa

Musa breeding consists of two stages: (1) the production of promising hybrids and (2) the testing of elite hybrids before release to farmers. One major limiting factor for testing the yield potential of plantain and banana is its land requirement: each plant requires 6 m².

The objective of this research was to determine the minimum number of sampled plants needed per clone, and the most efficient field layouts for testing bunch weight at different stages of the breeding program.

Data from a yield trial, comprising plantain-banana hybrids along with their plantain parent, were used to determine the optimum plot size and number of replications required per location for yield trial. The method of maximum curvature (J ustensen, 1932) was used to determine sample size. Type I and Type II error probabilities and the availability of breeding materials were considered in calculating the plot size and number of replications required for a statistically adequate comparison of bunch weight.

In the early stage of the breeding process, performance of the plantain or banana parent is compared with the performance of selected hybrids. In more advanced stages of the breeding process, the relative performance between hybrids can be used as the selection criterion for the best genotypes.

In preliminary stages of the program (Early Evaluation Trials, EET, or Preliminary Yield Trials, PYT) large numbers of clones are evaluated (100 or more) to determine which are to be selected for further testing. Planting material is limited at this stage, typically 1-5 plants/clone, and material is only available for unreplicated plots or limited replications in EET or PYT, respectively.

In the early selection stages, it is most important not to reject valuable material. Therefore, the use of a probability level of 10% (EET) or 5% (PYT) is appropriate to select those hybrids with at least equal (EET), or significantly higher (PYT) bunch weight than the parental cultivar. This approach keeps Type II error (or false acceptance of null hypothesis) low.

In more advanced stages of the program (e.g., Multilocal testing or Advanced Trials), elite hybrids should be differentiated with a significance level of 1% (highest hybrid mean -2 or 3 SE) or 0.1% (highest hybrid mean -3 or 4 SE). This requires an increase in the number of replications to protect against Type II error.

Currently, the Plantain and Banana Improvement Program (PBIP) of the International Institute of Tropical Agriculture uses augmented designs in EET on the breeding station; the plantain cultivar is evaluated in replicated plots, but non-replicated plots of 5 plants each are used for the hybrids. Selected materials are evaluated in randomized complete block designs (RCBD) with 2 replicates of 4 plants.
each for PYT in one location, and in RCBD with 2 reps of 5 plants for multi-loca-
tional testing in at least 10 different locations of West and Central Africa (table 1). For advanced testing of elite hybrids, PBIP recommends 1 of 2 strategies: (1) that national programs use a trial design such as a RCBD with 4 reps of 5 plants for advanced testing of elite hybrids for at least 2 years (plant crop and ratoon) and at 10 different sites in the targeted ecoregion, or (2) that national programs reduce replications to 1-2 per site, but increase the number of sites to be between 30-40 in the target area.

References


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East Africa

Banana production and research in Zimbabwe

by E. Mwashayenyi

Banana is a very important fruit in world commerce and is probably only surpassed by citrus in this regard (Samson, 1986). Banana production and marketing have improved over the years, a trend which could be attributed to improved production techniques, widespread dissemination of superior cultivars and improvements in post-harvest handling. There are a number of well known, important cultivars grown in Africa although the majority grown in villages may as yet be uncharacterized (Rice et al, 1987). The main commercial cultivars in Zimbabwe are Dwarf Cavendish and Williams (AAA ‘Cavendish’). Dwarf Cavendish has satisfactory yields, but does not transport well and is susceptible to choke throat. Williams has a higher yield, is more tolerant to cooler conditions, but is prone to topping due to its height.

Production

With the exception of the odd plant found in some homesteads around the country, banana production is confined to the wetter parts of the country. The tonnage contributed by the small-scale or communal farmer is very significant. However, production statistics are not readily available. Major European Economic Community (EEC) funded fruit projects, (whose objectives include increasing accessibility to markets) in the main fruit producing areas has led to a steady increase in hectarage under banana. Many communal area farmers in the wettest parts of the country (more than 900mm/year), mainly the Rusitu and Honde Valleys, rely on rainfall to supply the water requirements of their crop. Some have realized the benefits of supplemental rainfall with irrigation water and have harnessed rivers and streams for this purpose. Farrow irrigation is practiced.

A large percentage of the crop is found in small, mixed stands with agronomic and horticultural crops such as maize, cassava, avocado, mango and pineapple. However, the area under large-scale, commercial production has increased markedly over the years. In 1983, it was estimated that commercial plantations covered 320 hectares and 600 hectares in 1988. Since then this figure has been exceeded. Producing areas range from the very wet Burma Valley to the wet (above 750mm/year) Shamva area and the dry Zambezi and Sabi-Limpopo Valleys’ (less than 600mm/year). According to the Banana Growers’ Cooperative the average plantation is around 60-100 hectares. Yields vary considerably from as low as 20 tonnes/ hectare to well over 50 tonnes/hectare, depending on cultivar and producer. Overhead, flood and trickle irrigation systems are used. Most of the bananas produced in Zimbabwe are for the fresh market. A smaller percentage of fruit finds its way to the processing industry e.g. ice-cream. Virtually no cooking bananas are produced in Zimbabwe. The bulk of the fruit is consumed on the local market although some goes to external markets. Growers normally sell green fruit to wholesalers who ripen the fruit naturally or artificially using ethrel or ethylene.

Constraints

Problems in Zimbabwe are not as serious as those experienced elsewhere. However, there are a few which may need special attention. The banana is a tropical crop and the subtropical nature of the Zimbabwean climate does not offer the best environment for the crop. There is some degree of seasonality in the production and hence in the marketing of bananas, although the fruit can still be found on the market throughout the year. Nematodes are a problem in the sandier parts of the country as is the case in Kariba. If fumigation and rotation are ignored, heavy crop losses may occur. In the drier parts of Zimbabwe irrigation water may be a problem as the crop requires much water and yields decline significantly if there is moisture stress. Wind damage may be a problem especially where windbreaks are not in place. If crop management is poor, problems such as sunscorch and cigar-end rot (Verticillium theobromae) develop. A more serious problem to the communal farmer is that of marketing. Growers in Rusitu Valley for example, produce a lot of fruit, yet distance from the main markets and poor accessibility of roads during the rainy season means that some of the fruit goes to waste. The EEC funded fruit projects in these areas have provided transport for hire and hence increased accessibility to markets. However, the situation will only be fully redressed when the roads are tarred and post-harvest handling facilities become more available.

Research

Previous work on the crop included studies on numbers of stems per matt, time of sucker selection, nutrition and...
planting density (Department of Research and Specialist Services, 1976, 1982-87). Yield trials showed that Dwarf Cavendish gave about 50 tonnes/hectare while Williams gave about 75 tonnes/hectare (Gilmour, 1983). However, yields of up to 100 tonnes/hectare for Williams were not unusual. An all year round production schedule was produced.

Current work includes:

Leaf pruning studies
Yield in a banana plantation is a function of bunch mass, number of bunches per hectare and crop cycle time. Pruning of surplus leaves is a common operation in banana production. If leaves are pruned before bunch initiation, flowering is delayed and cycle time increased. The microclimate is changed by leaf pruning especially light penetration and temperature. The objectives of this trial are to find out the effect of pruning surplus leaves at bunch emergence on the size of yield and crop cycle and how pruning interacts with planting density to in Dwarf Cavendish.

Cultivar evaluation
Only two commercial, dessert banana cultivars are available in Zimbabwe which underlines the need to evaluate new ones, particularly those which might outyield Williams. The need to increase or maintain the production of current cultivars also remains a priority. Tissue culture techniques are often used elsewhere for rapid multiplication and production of clean planting material. The objective of this study is to evaluate the potential of new Cavendish cultivars (Poyo, Petite Naine and Grande Naine) imported in vitro, from France and weaned at Zimbabwe’s Lowveld Research Stations.

Conclusion
Banana production in Zimbabwe looks set to increase with further diversification of farmers into horticultural crops. This diversification is partly due to dwindling profit margins associated with growing agronomic crops such as maize, wheat and cotton. Improved production techniques, imparted by both research and extension staff, are also playing a big role in increasing production particularly in communal areas.

References

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Latin America

Black Sigatoka disease in Venezuela

Consultancy report to INIBAP adapted for INFOMUSA by David Jones

This article is the summary of a report on a mission on 20-25 February 1995 to advise the Plant Health Service of Venezuela on the management of black Sigatoka disease caused by Mycosphaerella fijiensis. The objectives of the mission were to visit the areas affected by black Sigatoka to the south of the Lake Maracaibo, to present seminars to officers of the Plant Health Service of Venezuela (Servicio Autónomo de Sanidad Agropecuaria, SASA) and technicians from other institutes working on banana and plantain, and to help develop a plan for the control of the disease. This mission was sponsored by INIBAP.

Plantain area south of the Lake Maracaibo
The consultant accompanied Dr Oscar Haddad (CENIAP) and Ms Sonia Torres (SASA) on visits to farms in the area near El Vigia where 50,000 ha of plantain is grown. Black Sigatoka was causing severe damage to plants despite the lack of rain for two months. No disease control practices were being employed on the majority of farms.

Most farms that were attempting control were treating plants with alternate sprays of propiconazole and benomyl as an oil emulsion at the rate of 7-8 L/ha. Private companies provided ground spray equipment and helicopters, and recommended to growers what fungicides should be used. Fungicide was applied on a regular basis regardless of variations on the weather that influence disease development. Therefore, the number of applications may have been insufficient to control black Sigatoka in the wet season, but more than necessary in the dry season.

Cultural methods of disease management, such as the removal of severely affected leaves and leaves hanging down the pseudostem to reduce inoculum levels, were either not being practised or were being undertaken too infrequently. Plants that had been harvested were also not being immediately cut down and chopped into pieces. In addition, leaves with severe necrosis that had been removed were left lying on the ground instead of...
being stacked in heaps to reduce the surface area of tissue that could be liberating spores. It was also thought that the density of planting and plantation layout could be improved to get better coverage with fungicides and increase yields. These cultural practices are a very important supplement to chemical control techniques.

Information supplied by plantain growers indicated that the cost of 12-15 fungicide treatments a year was about US$ 350 per hectare. Although this considerably increased the cost of production, the price of plantains in the domestic market was high enough to cover the expense of black Sigatoka control.

APASLAGO, a cooperative of 80 plantain growers with a total of 1,200 ha under production, was visited and current black Sigatoka management practices discussed with Mr Rafael Urdaneta, the President. The cooperative had its own helicopter and provided a fungicide application service to members and also surrounding farms.

**Banana area near Maracay**

The objective of this visit was to determine whether black Sigatoka disease had arrived in the Maracay banana growing area near Caracas which lies 500 km to the east north east of El Vigia. An area in the Municipio Bolivar of the State of Aragua where 60 banana growers tend small plots ranging from 0.2 to 2.0 ha was inspected. No black Sigatoka symptoms were observed. However, symptoms characteristic of yellow Sigatoka disease caused by M. musi cola were seen. It was thought that the high density of plants and flood irrigation practices, which result in 15 cm of water being present on the ground for several days, provided enough humidity for the development of this disease.

In one farm, several plants of different cultivars were seen with symptoms of banana streak virus (BSV). Most of the plants with symptoms were located along a road on the edge of the farm. Symptoms of BSV were not apparent on plants towards the center of the farm. The farm was surrounded by sugarcane plantations and it is possible that the virus was being carried by M. fijiensis vector from the cane to banana plants. The leaf symptoms have been noted previously by SASA offices, but had not been associated with BSV infection. A survey to determine BSV distribution was suggested and also the destruction of affected plants.

**Seminars**

Two seminars on black Sigatoka were given in Venezuela. The first was held in Mérida near El Vigia with an audience of SASA representatives from different States, FONAIAP, MAC, the University of los Andes and plantain growers. The second was held in Maracay to local members of the organizations mentioned above and also people from the Central University of Venezuela. Aspects of identification, epidemiology, control and fungicide resistance were covered.

**Recommendations for control**

Chemical control was believed necessary for the control of black Sigatoka in False Horn Plantain south of Lake Maracaibo. Alternate applications of propiconazole and benomyl, or others of a similar efficacy, were recommended for the rainy season and it was believed these should be applied in oil-emulsion (5-10 L/ha) or in oil alone (15 L/ha). Five treatments of propiconazole and five of benomyl during the rainy season were thought necessary to give acceptable control. During the dry season, oil without fungicide was advised at rates of 5-10 L/ha depending on disease severity. Protectant fungicides, such as mancozeb and tridemorph, were also considered to be suitable for dry season control. The importance of limiting the use of systemic fungicides to prevent the development of the resistance was stressed. It was speculated that once the disease was under control the amount of inoculum levels in plantations would fall enabling the number of applications of fungicides to be reduced.

From weather data, a total of 15 applications of fungicide a year was considered to be sufficient to give good control provided spray equipment was well calibrated, emulsions were well prepared and the applications could be oriented to give adequate coverage. Cultural practices to reduce inoculum levels were also emphasized as being important including good drainage so that excess water quickly drains from plantations.

It was recommended that small growers investigate planting at high density (2500-2800 plants/ha) and annual cropping techniques as this would result in an homogenous plantation that would facilitate fungicide application. It was also thought appropriate to establish a system of disease monitoring and to determine the effect of weather patterns on disease development. This would lead to the better timing of fungicide sprays which could reduce overall use.

It was also suggested that people should be trained in disease assessment, in monitoring the sensitivity of M. fijiensis to fungicides and in all practical aspects of disease management. These people should then work directly with growers and have the ability and willingness to train others.

Finally, the need for a cohesive program for the introduction, evaluation, multiplication and distribution of black Sigatoka resistant germplasm was advised. INIBAP has sent FHIA-01, FHIA-02 and FHIA-03, black Sigatoka resistant hybrids from the Honduran breeding program, to Venezuela for evaluation trials and further propagation. Other new germplasm, such as FHIA-21, a hybrid plantain resistant to black Sigatoka, also offers hope for the future.
WINBAN crown rot project

By Ulrike Krauss

In early 1994, the Crown Rot Project was launched at the Research and Development Division of WINBAN, St. Lucia. This project is part of an ongoing collaboration between WINBAN and the Natural Resources Institute (NRI), UK. NRI is funding the research program which is based in the Caribbean for an initial period of two years. The project has the aim to reduce the amount of fungicides currently used to control the postharvest disease crown rot.

Crown rot is caused by a complex of fungi of which Colletotrichum musae is the main pathogen and Fusarium moniliforme, Fusarium pallidoroseum, Nigrospora sphaericus and Botryodiplodia theobromae are minor pathogens. The major pathogen establishes a latent infection in the field at early stages of fruit development. When the banana hands are severed from the rachis during harvest, fungal spores enter the wound and initiate disease development at this window of opportunity. Crown rot symptoms usually only become apparent during fruit ripening. However, at this stage, disease can progress rapidly making crowns unsightly and unappealing to consumers. In severe cases, the rot penetrates the pulp which renders the fruit unmarketable.

Currently, crown rot is controlled in the Caribbean by dipping clusters in solutions of the fungicides "imazalil" or "thiabendazole" (TBZ). A related TBZ-fungicide is also used in aerial sprays against leaf spot and the regular exposure on one island has already led to the resistance of some crown rot fungi to this agrochemical.

The crown rot project aims to reduce the amount of fungicide being used, handled and disposed of in the Windward Islands in order to move towards a more environmentally-friendly banana production system. Several indigenous organisms with potential for biological or integrated disease control have already been identified and are presently under-going further evaluation. Whereas only few bacteria appeared effective, mycoparasites (fungi parasitising other fungi) show great promise. Some of them attack the whole range of fungi involved in the disease complex, including structures which are very resistant to fungicidal attack such as conidia and haustoria. Other show great tolerance to fungicides themselves and could thus be combined with reduced concentrations of fungicide in an integrated disease management system. Additionally, plant extracts are being tested as alternatives to synthetic fungicides.

It is hoped that mycoparasites can be produced locally on agricultural by-products. This would limit growers' dependence on expensive fungicides. In addition, European consumers will be offered a more organic option for their fruit bowl which is in accordance with the general trend towards more environment- and health-conscious customers.

For further information, write to Ulrike Krauss:
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In vitro and greenhouse selection of Musa for resistance to black Sigatoka (Mycosphaerella fijiensis Morelet)

A methodology to obtain crude extract of Mycosphaerella fijiensis to test its biological effect on leaves of Musa plants derived from tissue culture in the greenhouse as well as on in vitro Musa plants with different degrees of resistance was established.

Eight monospore cultures of the fungus were used. Cultivars tested were Grande Naine (AAA ‘Cavendish’), Musa acuminata ssp burmanica (AA type ‘Calcutta 4’), Curraré (AAB ‘Plantain’), EMBRAPA-403 (AAAB hybrid), Saba (AAB/BBB) and Yangambi Km5 (AAA ‘Ibota’). Grande Naine and Calcutta 4 leaves were inoculated with conidia. The resistance of the germplasm was assured and also the possible occurrence of strains of M. fijiensis with different virulences.

Crude extract was obtained by inoculating a medium (M-1-D) with M. fijiensis isolates using the methodology described in the thesis. The application of 20µl of the crude extract, diluted in 0.5% sodium carbonate and 0.1M monobasic phosphate, caused the development of leaf lesions in all of the cultivars. However, evaluations at 24, 48, 72 and 96 hours showed differences in degrees of resistance among the germplasm tested.

When 60µl of the crude extract, diluted in 0.5% sodium carbonate and 0.1M monobasic phosphate was used, necrosis was observed in the most external cells of a callus of Grande Naine. Seventy-two hours after the medium was inoculated with the extract, the damage observed was directly proportional to the concentration. The use of high concentrations of the crude extract did not cause a necrotic reaction in callus of Calcutta 4, which is resistant to M. fijiensis.

Histological analysis of leaf tissue inoculated with conidia showed that the greatest accumulation of phenolic compounds was localized in the underlying cell level in the Calcutta 4 clone and in epidermal cells in the Grande Naine cultivar. This could partially explain the behavior of these clones to M. fijiensis.

In an analysis of leaf tissue from the six clones inoculated with crude extract, the Grande Naine and Curraré cultivars showed the highest levels of phenolic compounds 96 hours after
Factors influencing the development of black Sigatoka disease on plantain and plantain hybrids

By Dr K. N. Mobambo

PhD Thesis in Crop Science, Rivers State University of Science and Technology, Port Harcourt, Nigeria

Plantain cultivation is threatened by black Sigatoka, an airborne fungal leaf spot disease, caused by *Mycosphaerella fijiensis* Morelet. Studies on plantain and plantain hybrid responses to black Sigatoka were conducted both on-farm and on-station to clarify relationships between ecological factors and disease incidence and/or severity.

The on-farm survey was carried out in both dry and rainy seasons in two geomorphological zones (Meander belts and Coastal plain sands) of Rivers State, Nigeria. Four locations were selected in each zone and two traditional farming systems (homestead gardens and field) were studied in each location. Less black Sigatoka infection was observed in the Meander belts than in the Coastal plain sands. Plantain grown in the homestead gardens had a lower level of disease severity than those planted in the fields. These differences are attributable to the relatively higher soil fertility in the Meander belts and in homesteads.

At the Onne Station of the International Institute of Tropical Agriculture (IITA), 110 plantain cultivars collected from different parts of the world were screened under conditions of natural infection. All plantain cultivars were susceptible to black Sigatoka. The disease developed more quickly in the...
rainy season before flowering than in the dry season. Plantain has a slower development after flowering than before flowering, due probably to the change in the host plant physiology.

Three plantain hybrids (TMPx 597-4, 548-4, and 548-9, produced by crossing the local plantain cultivar Obino l’Ewai with the wild banana clone Calcutta 4, were evaluated for black Sigatoka resistance in an early screening trial. Using young plants derived from tissue culture, the three hybrids were compared with their parents for their response to black Sigatoka infection. Results showed that Calcutta 4 was highly resistant, the hybrids were partially resistant, and Obino l’Ewai was susceptible.

In a clonal evaluation experiment, the three plantain hybrids were evaluated and compared with their female plantain parent (Obino l’Ewai) for black Sigatoka resistance and yield performance over two cropping cycles. The treatments for Obino l’Ewai were with or without fungicide. The three hybrids had significantly less leaf spot damage than Obino l’Ewai, both with and without fungicide treatment. The disease effect on plantain yield was much more severe in the ratoon crop (second cycle) than in the planted crop (first cycle) due to associated effects of depleted soil nutrients. The gain in plantain yield due to fungicide treatment was 33% in the planted crop and 76% in the ratoon crop, as determined in each cropping cycle from the difference in yield between the fungicide-treated and non-treated plantain. Yield reduction from the planted crop to the ratoon crop was 89% in non-treated plantain, 70% in fungicide-treated plantain, 43% in TMPx 548-9, 29% in TMPx 597-4 and 18% in TMPx 548-4, the most stable producer over cropping cycles, in addition to showing durable host plant resistance. 

Source: IITA Research N°9, september 1994 – p.22

Dr K. N. Mobambo is phytopathologist, BP 4767, Kinshasa-Gombe, Zaire

Strategic research

Cryopreservation of Musa germplasm

Musa germplasm is now routinely preserved in vitro as proliferating meristems under slow growth conditions (medium-term conservation) as is the case at the INIBAP Transit Center at K.U.Leuven, Belgium (De Smet and Van den houwe, 1991). Although growth is considerably reduced, the occurrence of somaclonal variation remains a serious problem (Vuylsteke et al., 1991; Côte et al., 1993). In addition, the maintenance of a large in vitro collection is very labour intensive and subject to contamination and human error during subculture. Therefore, the cryopreservation or storage of cells or tissues at ultra-low temperature (i.e. at -196°C which is the temperature of liquid nitrogen) is attractive for long-term storage purposes since growth ceases entirely due to the unavailability of liquid water and inhibition of all chemical reactions. Hence, in theory, cryopreserved tissue is not subject to somaclonal variation.

In principle, cryopreservation is applicable to any plant tissue type with regeneration potential. An efficient cryopreservation method for dried zygotic embryos of Musa acuminata and M. balbisiana was developed at CATIE, Costa Rica (Abdelnour et al., 1992). However, seed and zygotic embryo production in Musa is restricted mainly to wild, seed producing varieties. In addition, the exact genetic constitution of such material is unknown and thus unsuitable for the establishment of germplasm collections. To cryopreserve seedless, sterile cultivars, which are only propagated vegetatively, an efficient in vitro regeneration system is required. This requirement is met by meristem cultures, cell suspensions and somatic embryos.

At the laboratory of Tropical Crop Husbandry of K.U. Leuven, the potential of embryogenic banana cell suspensions and meristem cultures for cryopreservation is being investigated (Panis, 1995).

Cryopreservation of embryogenic suspension cultures

Embryogenic cell suspensions are useful for high multiplication purposes, protoplast production (Panis et al., 1993) and subsequent electroporation (Sagi et al., 1994) and genetic transformation through particle bombardment (Sagi et al., 1995). As the initiation of suspension cultures takes several months (Dhed’a et al., 1991), it is important to preserve them safely without risk of somaclonal variation or microbial contamination.

An efficient cryopreservation protocol for embryogenic Musa suspensions was developed for the ABB cooking banana cultivar Bluggoe (Panis et al., 1990) (Table 1). Extracellular ice-initiation at -7.5°C during the slow freezing process prevented excessive supercooling and enhanced post-thaw regrowth capacity by about 30%. Post-thaw viability determinations were assessed chemically with FDA (fluorescein diacetate) and by regrowth on semi-solid medium. The cytoplasmatic density of embryogenic cells, which is related to age, is crucial. The older, and thus the more vacuolated the cells are, the lower the chance for survival and recovering after thawing (Fig.1). Growth studies of cell suspensions revealed that an optimal cryopreservation ability corresponds with the early exponential growth phase (7 to 14 days after last subculture). Frozen-thawed embryogenic cell suspensions were successfully regenerated into normal plants, but organised cell groups like proembryos fail to survive freezing.

Table 1. Cryopreservation protocol using the slow cooling method for embryogenic Musa cell suspensions

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cell suspensions are taken 1-2 weeks after their last subculture</td>
</tr>
<tr>
<td>2</td>
<td>Cryoprotection with 7.5% DMSO for 1 hour</td>
</tr>
<tr>
<td>3</td>
<td>Transfer to cryotube</td>
</tr>
<tr>
<td>4</td>
<td>Slow cooling (1°C/min) to -40°C with ice-initiation at -7.5°C</td>
</tr>
<tr>
<td>5</td>
<td>Storage in liquid nitrogen (-196°C)</td>
</tr>
<tr>
<td>6</td>
<td>Rapid thawing in water bath of 40°C</td>
</tr>
<tr>
<td>7</td>
<td>Plating on semi-solid regeneration medium without washing</td>
</tr>
</tbody>
</table>

By Bart Panis

Ph D Thesis, KUL, Neverlee, Belgium

INFOMUSA — Vol 4, N°1 17
This optimized cryopreservation method was applied to suspensions of other cultivars (Panis et al., 1994b). Different FDA viability rates were observed (Table 2). Only the suspension of the ABB/BBB cooking banana cultivar Cardaba was unable to recover after freezing. The others regenerated through somatic embryogenesis (Fig. 2) into plantlets. It was concluded that the capacity of a Musa suspension to be cryopreserved in liquid nitrogen probably does not depend on its genotype, but rather on the quality and the amount of embryogenic cells in suspension. The presence of starch grains, in particular, adversely affects the regrowth potential after freezing.

**Cryopreservation of meristem cultures**

Meristems excised from in vitro proliferating clumps were subjected to a slow freezing protocol similar to the one proven to be successful for cell suspensions. Irrespective of the cooling rate, preculture treatment and cryoprotective agent, regrowth capacity was totally lost as soon as a temperature was reached at which ice crystallisation took place. Also the application of highly concentrated vitrifying solutions (Sakai et al., 1990) were inappropriate because of their apparent toxicity.

The encapsulation-dehydration method (Table 3) has proved to be highly successful for meristems of many plant species, such as grape vine (Vitis vinifera) (Plessis et al., 1993), mulberry (Morus bombycis) (Niino and Sakai, 1992) and sugar cane (Saccharum species) (Gonzalez et al., 1993). Differential scanning calorimeter (DSC) analysis revealed that the conditions met in Table 3 avoided ice crystallisation and devitrification during cooling and thawing, respectively. This resulted in a maximum post-thaw recovery of 8.1% for meristems of Bluggoe (Panis et al., 1994a). This method opens the prospect that frozen meristems (Figure 3) can be regenerated into normal plants. The frequency of post-thaw regeneration could not be improved with slower cooling rates, sucrose preculture of meristematic clumps or regrowth media containing higher sucrose levels. The sensitivity of Musa meristems to high sucrose concentrations and dehydration especially interferes with higher post-thaw viability rates. A gradual increase in sucrose levels could, however, only partially overcome this problem.

An advantage of the encapsulation-dehydration method compared to, for example, the slow freezing method, is that plant regrowth occurs directly by a reactivation of the embedded meristem and not via an intervening callus phase. This suggest that a sufficient number of cells in the apical region survive freezing (Scottez et al., 1992). This is also observed for Musa meristems. Because of this, the risk of somaclonal variation should be smaller and the speed of recovery faster than when a callus phase is involved.

Lastly, a very simple cryopreservation method with potential application to all Musa species/cultivars was developed (Panis et al., 1994a). Its essential step consists of the addition of sucrose to the preculture medium (Table 4). As with encapsulated Musa meristems, regrowth proceeded directly from the original meristem without an intermediate callus phase (Fig. 4). This simple cryopreservation method was successfully applied to different cultivars belonging to distinct Musa groups and resulted in survival rates ranging from 7% to 58% (Table 2).

The importance of sucrose in the pregrowth media was shown by histocytochemical studies, dry weight measurements and the fact that sucrose could not be replaced by mannitol. The proposed modes of action of a sucrose preculture in enhancing freeze resistance are numerous. It depresses the freezing point and the amount of freezable water because it reduces the moisture content due to its osmotic effect and sucrose uptake (Engelmann and Duval, 1988). It is possible that it

![Figure 1. Influence of time of subculture after freezing embryogenic cell suspensions on survival expressed as growth (% of inoculated surface) and FDA viability (%).](image)

**Table 2. Survival rate (%) of different banana varieties/cultivars after cryopreservation**

| Variety/cultivar | Meristem Embryogenic cell suspension
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Guyod (AA)</td>
<td>11</td>
</tr>
<tr>
<td>M. babudiana (BB)</td>
<td>27</td>
</tr>
<tr>
<td>Kamaramasenge (AB)</td>
<td>9</td>
</tr>
<tr>
<td>Cavendish (AAA)</td>
<td>7</td>
</tr>
<tr>
<td>Grand Naine (AAA)</td>
<td>14</td>
</tr>
<tr>
<td>Three Hand Planty (AAB)</td>
<td>38</td>
</tr>
<tr>
<td>French Sombre (AAB)</td>
<td>NT</td>
</tr>
<tr>
<td>Aibagba (AABB)</td>
<td>25</td>
</tr>
<tr>
<td>Bluggoe (ABB)</td>
<td>43</td>
</tr>
<tr>
<td>Monthan (ABB)</td>
<td>58</td>
</tr>
<tr>
<td>Cardaba (ABB/BBB)</td>
<td>NT</td>
</tr>
</tbody>
</table>

* viability rates according the FDA (Fluoresceine diacetate) test

* NT: Not tested.

![Figure 2. Somatic embryo formation of the ABB cooking banana cultivars Bluggoe (A) and Monthan (B), and the AAB plantain cultivar Three Hand Planty (C), one month after cryopreservation of its cell suspensions (bar = 1 mm).](image)
maintains the liquid crystalline state of the membrane bilayers and stabilises proteins under frozen conditions (Kendall et al., 1993). An indirect effect of sucrose could be the accumulation of water stress protective compounds induced by a mild osmotic stress (Delvallée et al., 1989).

This method holds much promise for the long term storage of Musa germplasm because of its simplicity, speed and potential applicability to many, if not all Musa types.

Conclusions
Because Musa is currently stored long-term as meristem cultures under slow growth conditions, the occurrence and identification of somaclonal variation of the material in storage is an important issue. It is widely accepted that, during storage in liquid nitrogen, no additional variation is created, although the extreme low risk of mutation by background radiation cannot be excluded. This means that verification of the true-to-typeness of the material intended for cryopreservation, is of utmost importance. To date, no reliable method has yet been developed for Musa to detect variants at an early stage. Research using techniques such as RAPD, RFLP and AFLP to determine polymorphism deserves higher priority.

The question whether embryogenic cell suspensions or proliferating meristems should be preserved depends on the purpose. Cryopreservation of embryogenic suspensions has the main advantage that the material stored has a large multiplication potential that can readily be used for genetic transformation. However, the initiation of such embryogenic suspensions from somatic tissues is still a very time consuming process. Moreover, many cultivars do not yet respond favourably towards the initiation of embryogenic cells. The main advantage related to the cryopreservation of proliferating meristems lies in the easy access to material to be preserved and its applicability to many, if not all Musa types. More specific advantages are its simplicity and speed.

Therefore, proliferating meristems are currently the material of choice for long-term preservation of Musa germplasm.

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References
New banana research center underway

The National Research Center on Banana Podavur, Tamil Nadu, India

Adapted by David Jones from a note circulated during the 4th INIBAP-ASPNET RAC meeting held at TBRI, Taiwan, 21-24 November 1994.

K. L. Chadha

M usa is one of the most important fruit crops grown in varying agro-ecological conditions in India and has a great socio-economic relevance. The country is believed to be a center of diversity. Although banana and plantain contributes to 24% of total fruit production, there are many constraints which impede productivity. Thus, to increase the production and productivity of Musa by harnessing the resources available in the country, ICAR decided to establish a National Research Center on Banana (NRCB). Subsequently, a site offered by the Government of Tamil Nadu State located at Podavur, near Tiruchirapalli, was selected for the establishment of NRCB. This was handed over by the Department of Agriculture, Tiruchirapalli to the Project Coordinator and Officer-in-charge, NRCB on 21 August 1993.

The center has made substantial progress in collecting Musa germplasm. To date, 425 accessions have been collected from the banana growing states of Kerala, Tamil Nadu, Gujarat, Maharashtra, Assam, Andhra Pradesh and Bihar. These accessions are being characterized and evaluated for their agronomic characteristics. Two wild Musa sp., which have resistance to leaf spot disease, were also collected.

The center is collaborating with INIBAP in the evaluation of new hybrids from breeding programs under the International Musa Testing Program (IMTP) Phase II. It is also organizing the testing of FHIA hybrids recommended for release after IMTP Phase I at multilocational sites across India.

Details of banana accessions collected at NRCB, Trichy:

<table>
<thead>
<tr>
<th>Clone</th>
<th>Number of accessions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Musa sp.</td>
<td>5</td>
</tr>
<tr>
<td>AA</td>
<td>15</td>
</tr>
<tr>
<td>AB</td>
<td>25</td>
</tr>
<tr>
<td>AAA</td>
<td>75</td>
</tr>
<tr>
<td>AAB</td>
<td>80</td>
</tr>
<tr>
<td>ABB</td>
<td>120</td>
</tr>
<tr>
<td>ABBB</td>
<td>2</td>
</tr>
<tr>
<td>Unidentified</td>
<td>103</td>
</tr>
<tr>
<td>TOTAL</td>
<td>425</td>
</tr>
</tbody>
</table>

The center has the following future program:
- Collection, conservation and evaluation of banana germplasm in the field genebank.
- Improvement of banana for resistance to diseases and nematodes through hybridization and in vitro breeding techniques.
- Screening of germplasm against diseases and nematodes to identify sources of resistance.
- In vitro propagation for mass multiplication of disease-free plants.
- Studies on detection of virus diseases using serological techniques.
- Studies on nutrition, water and production systems for developing cost-effective technology.

K. L. Chadha is Deputy Director General (Horticulture), Indian Council of Agricultural Research (ICAR), New Delhi-110001, India

Books etc... Just published

Banana and Plantain: Directory of Researchers - compiled and edited by E. Arnaud.

The second edition of the directory of banana and plantain researchers is the result of a worldwide survey carried out by INIBAP (see INFO-MUSA Vol. 3, n°1). This 336 page-directory identifies the key areas of interest of each researcher and will be useful for those who wish to collaborate to resolve problems of mutual concern. This edition contains 573
entries and thematic, geographic and institutional indexes.

The editor, Elizabeth Arnaud, is in charge of the INIBAP Banana Research Information System.

Orders for copies should be placed with INIBAP, Info/Doc Service, Parc Scientifique Agropolis, 34397 Montpellier Cedex 5, France. USD 40. ISBN 2-910810-04-6.

A Provisional Checklist of Banana Cultivars in Uganda. D.A. and E.B. Karamura.

The East African Highland banana subgroup (AAA ‘Lujugira/Mutika’), contains many cultivars and the East African Highland plateau is generally accepted as a secondary centre of diversity for the crop. The importance of the crop as the staple food for more than 70% of the population of Uganda and the recent pest, disease and plant nutrition problems discovered in the banana growing regions of the country have necessitated the initiation of research programmes. However, unlike other crops, banana cultivars in Uganda have a considerable number of names. Some may be synonyms due to the many languages spoken; others may be due to mutations such as coloration of pseudostem, petiole and midrib. In response to these phenotypic characters, farmers tend to give a name that depicts a particular, usually dominant mutation. This has resulted into a confusing nomenclature and no one has been sure how many cultivars occur in Uganda.

In this regard, the provisional checklist of Ugandan cultivars is invaluable. As well as the East African Highland banana subgroup, it also contains information on other cultivars grown. It will assist researchers, extensionists as well as the farmers in the identification of the cultivars they encounter.

Please contact INIBAP Headquarters to obtain a copy.


This 107-page manual is a set of recommendations developed using the collective experience of the professional staff of WINBAN Research & Development Division and Caribbean farmers. The information given in the manual covers all the aspects of banana cultivation under Windward Islands conditions, including soil and water management, planting methods, field establishment, fertilization, weed, pest and disease control, bunch protection, harvesting and handling.

Contact: Windward Islands Banana Growers’ Association, Research & Development Division, P.O. Box 115, Castries, St Lucia, WI. ISBN: 976-8117-00-1. Fax: +809 453 16 38.

Mejoramiento de la Producción del Cultivo de Plátano - ICA-CORPOICA

Plantain, which is cultivated on 400 000 ha with a production of 2.5 million tons/year and a consumption of 67.5 kg/capita/year is a major crop in Colombia. Much research has been undertaken on plantain in Colombia and this 256-page book (in Spanish) contains the results of the second phase of a cooperative project supported by various national and international institutions including ICA, CORPOICA, Comité Departamental de Cafeteros del Quindío, IDRC, INIBAP and INPOFOS. Topics include genetic improvement, soils, physiology, plant pathology, entomology and agricultural practices.


Bananas and Plantains - edited by S. Gowen.

Banana and plantain are of great importance both as cash-yielding export crops and as the staple food in many countries. This book covers all of the major aspects of banana and plantain, providing an invaluable reference source for a wide range of professionals involved with Musa.

Aspects covered include: cultivation, nutrition and response of the crops to their environment; molecular and genetic aspects, including in vitro culture; pests, diseases, harvesting and fruit care; nutritional value of bananas and plantains; processing, and the place of banana in the world economy.

Chapters of the book have been written by experts from many countries, drawing upon a wealth of experience, to provide a book useful to plant and agricultural scientists, nutritionists, food scientists and technologists.

The editor, Simon Gowen, is a nematologist at the Natural Resources Institute and Honorary Senior Research Fellow at the University of Reading, UK.


How to choose exotic fruits?

Already very fond of citrus, pineapple, avocado, banana or mango, European consumers are increasingly attracted to “exotic” fruit. If litchis, passion fruits, papayas, cashew nuts are familiar, others are not because they either cannot be identified or their taste is unknown.

How do we choose the best of these fruits? Should we buy them ripe or green? Is it possible to conserve them? CIRAD-FLHOR and COLEACP (Comité de liaison Europe-Afrique-Caraïbes-Pacific pour la promotion des produits horticoles) have just co-published a book in French on this topic entitled La protection des fruits tropicaux après récolte. The author, Etienne Laville, is an internationally recognized specialist.

This 192-page book includes general data on fruit physiology, mechanical damage, protection techniques, and diseases. There are 72 color photographs, a bibliography and useful addresses for further information.

The book is of interest for all those working on tropical fruits: researchers, producers, import/export traders, wholesale dealers, shopkeepers and consumers.

It costs FF190 and is available from CIRAD-FLHOR, Service Edition, BP 5035, 34032 Montpellier Cedex 1, France.

Erratum

We apologize for the typing error on the name of Mrs N.M. Wabule (cover photo INFOMUSA Vol. 3, No. 2). Another error has also been detected in the same issue: the work on nematode resistance carried out by Roger Fogain is funded by CRBP and not by CIRAD (p. 28).
Announcements

The First International Conference on Banana and Plantain for Africa will take place at the International Conference Centre Kampala, Uganda, from 6 to 10 May 1996. The theme covered will be “Sustaining banana and plantain production for improved incomes and food security in Africa in the twenty-first century”.

It will be hosted by the National Agricultural Research Organization (NARO, Uganda) in collaboration with the International Institute of Tropical Agriculture (IITA) and INIBAP.

Across Africa, socioeconomic cultures based on banana and plantain have evolved over centuries, making the crop not only the most important staple food in the region, but also a source of income, medicine and cultural value. However, over the last few decades, banana and plantain production in Africa has failed to keep pace with banana and plantain production in other areas, the crop is being replaced by root crops which lack the environmental friendliness of banana and plantain. The future of banana-based cropping systems in Africa is threatened, requiring a re-think of management strategies. The conference, therefore, is intended to enable researchers, extensionists and policy makers in Africa and elsewhere to discuss new strategies consistent with changes in population, environment, technology and socioeconomic structure, and which will enable banana and plantain to play important roles in the development of sustainable productive systems in the region. The conference will bring together and integrate disciplines covering germplasm, pests and diseases, soil fertility and crop management, post harvest and socioeconomic aspects of banana and plantain production. In addition, prospects for coordination of research efforts will be discussed to include information exchange, training and technology transfer.

For further information, please contact Dr E.B. Karamura, Chairman Organizing Committee. The First International Conference on Banana and Plantain, National Agricultural Research Organization (NARO), Kawanda Agricultural Research Institute, PO. Box 7065, Kampala, Uganda. Tel: 256-41-567158 - Fax: 256-41-234922.

The Organization of Nematologists of Tropical America (ONTA), together with the European Society of Nematologists (ESN) and the Society of Nematologists (SON) organize the Third International Nematology Congress in Gosier, Guadeloupe, FWI, on 7-12 July 1996. It will be hosted by the Institut national de la recherche agronomique (INRA), in collaboration with the Institut français de la recherche scientifique pour le développement en coopération (ORSTOM) and the Centre international de recherche agronomique pour le développement (CIRAD). The official language of the congress will be English.

Further information could be obtained by contacting Alain Kermarrec, INRA, BP 1232, F-97185 Pointe-à-Pitre Cedex, Guadeloupe, FWI. Tel: 590-255540 - Fax: 590-941172 - Email: kermarre@antilles.inra.fr or thinc@antilles.inra.fr

Industrial Production of Banana Paper

Motivated by the pilot project in the production of paper comprised of fibre from banana “pinzote” and office waste paper undertaken by EARTH in 1991, three local companies (Papel Natural de Costa Rica, CARTOTECNICA and CONAPA) have completed studies oriented toward the use of these fibres for commercial production of paper products. This project is currently under development. Paper Natural de Costa Rica has already launched a line of products labelled “EARTH”, including paper, cardboard, notepads, letter paper, envelopes, post cards and notebooks.

The University provides the fibre that is used as primary material in the production of these items, and in return receives a percentage of the sales. This money is then deposited in a scholarship fund which benefits Latin American students with limited resources who wish to study at EARTH.

“We have demonstrated that items of great commercial value can be produced from agricultural wastes and contaminites. This project has fundamental educational component because it offers agroindustrial businesses alternatives for the management of their wastes. In addition, the consumption of banana paper reduces deforestation linked to paper production, particularly when fibre is scarce in the international market”, Ing. Carlos Hernandez, Coordinator of Special Projects at EARTH.

Excerpt of EARTH News Letter Vol. 5 November 1994-February 1995; EARTH, PO Box 4442, 1000 San José, Costa Rica

News from INIBAP

Current activities

Fact Sheets

INIBAP Musa Disease Fact Sheet No. 4 on banana bunchy top disease is now available. This information sheet has been written by Drs J. Thomas (QDPI), M-L Iskra-Caravana (CIRAD-FLHOR) and D. Jones (INIBAP).

The next Fact Sheet to be issued will be on Fusarium wilt. It is in the final stages of preparation by Dr N. Moore (QDPI), Dr S. Bentley (Cooperative Research Center for Tropical Plant Pathology), Mr K. Pegg (QDPI) and Dr D. Jones (INIBAP).

INIBAP Transit Center to collaborators in 19 countries who will screen the material for disease resistance at 33 sites according to IMTP guidelines. Recent reports indicate that the first trials are already being planted in some countries. Information from all sites should be available for discussion and analysis at the 2nd IMTP Global Conference that will be held in Kampala, Uganda in May 1996 and hosted by NARO.
INIBAP has already acquired germplasm from breeding programs that will be evaluated in IMTP Phase III. More will be sent in the near future. This material will be dispatched to INIBAP VICs for virus indexing in 1995.

**MGES (Musa Germplasm Exchange System)**

INIBAP has further rationalized the health status of the in vitro germplasm at the INIBAP Transit Center following discussions with Musa virologists and the Officer-in-charge of the ITC. INIBAP now feels that it cannot make available accessions that have not been virus tested, even on the understanding that they are most likely of a high health status (see INFOMUSA Vol.3 No. 2, Dec. 1994, p. 29). INIBAP considers that, given the realization that banana streak virus (BSV) is much more widespread than was first realized and can occur as a latent infection in some circumstances, all germplasm should be quarantined in an INIBAP virus indexing center (VIC) and screened for BSV before release.

This change means that INIBAP now has four distinct categories of germplasm in the ITC:

1. **Virus tested** - Accessions that have been virus indexed at INIBAP-VICs or at other institutes to acceptable standards and are available for distribution.

2. **Unavailable 1** - Accessions that need to be virus indexed at one INIBAP-VIC.

3. **Unavailable 2** - Accessions that need to be virus indexed at two INIBAP-VICs because they originate in a country where there is a risk that they may carry banana bunchy top virus.

4. **Virus infected** - Accessions found to carry virus but retained pending development of therapeutic protocols.

FAO and IPGRI are calling a meeting of Musa virologists in Rome on 21-23 June 1995 to review the "Technical Guidelines for the Safe Movement of Musa Germplasm" which were first developed in 1988. This meeting will be attended by INIBAP’s Scientific Research Coordinator, two of the Officers-in-charge of INIBAP’s VICs and other Musa disease experts from around the world. It is expected that new guidelines will be defined which will become the standard for Musa exchange for the years to come. The outcome of the meeting held in Rome will be presented in the next issue of INFOMUSA.

**MGIS (Musa Germplasm Information System)**

MGIS has made significant progress thanks to excellent collaboration between project partners. The initial groundwork on the MGIS Database has been completed by CIRAD consultants in collaboration with the INIBAP staff, Dr M. Perry, IPGRI’s SINGER project Coordinator, and the officers-in-charge of the INIBAP Transit Center and the CIRAD-FLHOR Virus Indexing Center. As part of the consultancy, INIBAP undertook a survey to evaluate the computer equipment available to curators of the Musa collections. The information has been analyzed in order to choose the most appropriate technical solutions for MGIS, such as the selection of software and hardware, and the data exchange medium.

A revised version of the Banana Descriptors is being developed and will be published as an INIBAP/IPGRI and CIRAD co-publication. This trilingual user’s guide of Musa descriptors will be included in the IPGRI series of Descriptors Lists after appraisal by experts. As well as descriptors, this guide will include color plates and drawings to illustrate the characters, a color chart for the morpho-taxonomic observation of Musa, MGIS questionnaire forms and lists of codes for collections and collection missions. This guide should be published early in 1996.

At the end of 1994, INIBAP received Musaogue cards of 244 accessions collected in Papua New Guinea and evaluated by Mr. Jeff Daniells at QDPI’s South Johnstone Research Station (Australia). A Musaogue card contains the main agronomic characteristics of an accession observed in the field and is illustrated with a color photograph of the plant. INIBAP intends to publish this important work during 1995/96.

INIBAP received 107 MGIS forms on accessions collected in Viet Nam in 1994/95 by the National Institute for Agricultural Sciences (INSA). The forms contain information on the identification of each collected accession, some observations on the presence of pests and diseases, data collected through interviews with farmers and in situ morpho-taxonomic observation. Complementary information on botanical classification and evaluation in the collection will be provided in the second phase of the project which is supported by UNDP. The data will be recorded in the MGIS database once the software has been developed.

The implementation of the morpho-taxonomic study of reference varieties began following the selection of reference accessions by Dr Jean-Pierre Horry, Germplasm Officer and Dr David Jones, Scientific Research Coordinator. A first consignment of 12 virus tested cultivars and one wild species (Table 1) is being prepared at the INIBAP Transit Center. The accessions will be sent to the 9 curators undertaking this study (Table 2) in May-October 1995. The remaining accessions will be dispatched in 1996 after virus indexing.

The first MGIS Steering Committee Meeting was held on 22 May 1995 in Montpellier, France. The main issues of the project were discussed. The next important step of the MGIS project is to undertake the development of the programs for the database's software. A timetable has been developed in order to release a package for a users' test at the end of 1996.

The on going activities associated with MGIS have shown that much important information already exists on Musa biodiversity. MGIS should become the appropriate platform to record and make this information available to the Musa community, including farmers, extensionists and researchers.

### Table 1. Initial reference varieties for taxonomic studies

<table>
<thead>
<tr>
<th>ITC N°</th>
<th>Name of Accession</th>
<th>Group</th>
<th>Sub-Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>0073</td>
<td>Calcutta 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0249</td>
<td>Ceylan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0269</td>
<td>Cachaco</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0459</td>
<td>Ney Poovan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0563</td>
<td>Pisang Mas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0650</td>
<td>Pisang Ceylan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0743</td>
<td>Figue Famille A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0885</td>
<td>Naktingwa</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1123</td>
<td>Yangambi</td>
<td></td>
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### Table 2. Curators participating in the morpho-taxonomic study

<table>
<thead>
<tr>
<th>Dr Silvio Belalciar</th>
<th>CORPOICA, El Agrido, Colombia</th>
</tr>
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<tbody>
<tr>
<td>Dr Kodjo Tomekoe</td>
<td>CRBP, Nyombi, Cameroon</td>
</tr>
<tr>
<td>Mr Christophe Jenny</td>
<td>CIRAD-FLHOR, Neufchâteau, Guadeloupe</td>
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<tr>
<td>Dr Christian Lavigne</td>
<td>CIRAD-FLHOR, La Foa, New Caledonia</td>
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<td>Mr Orlando Pascua</td>
<td>BPI, Daveo, Philippines</td>
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<tr>
<td>Dr Franklin Rosales</td>
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<tr>
<td>Dr Rodomiro Ortiz</td>
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<tr>
<td>Mr Kabonyi Sebasigari</td>
<td>IRAZ, Gitega, Burundi</td>
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<tr>
<td>Mrs Deborah Karamura</td>
<td>NARO, Kawanda, Uganda</td>
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</table>
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