The second global meeting of PROMUSA was held in Douala, Cameroon, immediately following the final meeting of the principal investigators of the World Bank/FAO/CFC Banana Improvement Project and preceding the International Symposium ‘Bananas and Food Security’. The meeting was attended by some 70 researchers and consisted of a short plenary session, followed by individual working group meetings. Since the first global PROMUSA meeting was held in Guadeloupe in March 1997, two working group meetings had been held. The Fusarium working group met in Tenerife, in November 1997 and the Virology working group held a meeting in Montpellier in January 1998 on BSV. Reports of these working group meetings are provided in PRO MUSA News (INFOMUSA Vol. 6 No. 2 and Vol. 7 No. 1) and in the publication ‘Banana streak virus: a unique Musa-virus interaction?’.

This second global meeting was thus the first opportunity for the Genetic improvement, Sigatoka and Nematology working groups to meet since the programme was initiated. The members of the Fusarium working group, having already held one meeting, decided against holding another meeting at this time. The working group meetings consisted primarily of informal discussions, with formal presentations of on-going work being kept to a minimum. Each group focused on reviewing priorities set in Guadeloupe and identifying work plans and opportunities for collaboration in the coming years. In addition to individual group discussions, time was also set aside for interactions between the groups and this was considered to be particularly useful. It can be seen from the reports presented below, that each working group is developing its own unique way of operating and various strategies are being developed. For example, the nematology working group is focusing on information—bringing together available information and making this readily accessible, while the virology group is more concerned with the sharing of the work load and responsibilities between members and avoiding duplication of research efforts.

During this second meeting, participants in PROMUSA demonstrated a growing understanding of the programme and an appreciation of the benefits to be gained through the enhanced collaboration and information exchange promoted by PROMUSA. Support for the programme was clearly expressed and encouragingly, several new collaborative initiatives emerged from the meeting.

This second global meeting also provided an opportunity for the PROMUSA steering committee to meet for the first time. This committee is made up of representatives of NARS, ARIs and IARCs and is responsible for providing direction and oversight to the programme. The minutes of this meeting are provided below.

Minutes of PROMUSA Steering Committee meeting held in Douala, Cameroon on 6 and 10 November, 1998

Present
- A.C. Mbwana representing NARS of Eastern and Southern Africa
- R. Perez Duverge representing NARS of Latin America and the Caribbean
- J.C. Norman representing NARS of West and Central Africa – (10 November only)
- L. Sequeira representing ARIs of North America
- J. Stanton representing ARIs of Australia/Pacific – (replacing E. Aitken)
- Ph. Lepoilvre representing ARIs of Europe
- D. Vuyyaleke representing ITA
- E. Frison representing IPGRI
- L. Sas observer (Chairman of PROMUSA Support Group)
- G. Orjeda observer (Coordinator of PROMUSA)
- S. Sharrock rapporteur

Absent with apologies
- W. Dar representing NARS of Asia and Pacific

Modus Operandi and composition of Steering Committee

Composition: The present composition of the Steering Committee, which is based on the major stakeholders in the global agricultural system, was considered to be appropriate. It
was also agreed that since the representatives had been selected by the appropriate regional bodies, the constituencies concerned had been appropriately consulted.

Terms of office: It was agreed that the term of office for a member of the Steering Committee would be one year, renewable to a maximum of six years. The term of office for the Chairman would be one year, renewable up to three years.

Frequency of meetings: The Steering Committee members agreed that they should ideally meet once per year and that this should be linked to a meeting of at least one working group. However, the scheduling of meetings would be dependent on the availability of funding and a pragmatic approach would be required.

Quorum: The Steering Committee consists of nine members and two observers. A quorum is therefore five members.

Role of Steering Committee

It was agreed that the role of the Steering Committee is to provide oversight and direction to PROMUSA. The Steering Committee will also be responsible for setting the programme priorities, based on technical advice provided by the working groups. It will approve the programme strategy and Medium Term Plan and develop strategies to obtain funding support for the programme. It should also commission external reviews of the programme, advocate on behalf of the programme and seek technical advice as appropriate.

Role of Chairperson of PROMUSA Steering Committee

The role of the Chairperson of the Steering Committee is to call Committee meetings, set the agenda and chair the meeting. In addition, the Chairperson will interact closely with the PROMUSA secretariat regarding contacts with donors, working groups and other interested parties. It was agreed that there was no need to appoint a vice-chair. If the Chairperson is unable to perform the necessary duties for any reason, the Committee will appoint a temporary Chair.

Election of Chairperson for PROMUSA

Dr Emile Frison was elected as Chairperson for 1998/99.

Role of PROMUSA Secretariat

The Steering Committee agreed that the secretariat of PROMUSA will be responsible for maintaining records, minutes and reports relating to the programme. It will also organize and facilitate meetings of the working groups and Steering Committee and will ensure information flow within and between members of the working groups. The Secretariat will liaise with the working groups, ensuring that they are operating effectively and will monitor the progress of the programme. The Secretariat will also provide a link between the working groups and the Steering Committee and will report to the Steering Committee every six months on programme progress. Reporting will include a financial report on the secretariat and transaction costs of the programme. The need for transparency in all financial matters was emphasised. The Secretariat will request guidance from the Steering Committee on the allocation of funding within the programme, and on the inclusion of ‘border-line’ projects in PROMUSA, as necessary.

Thematic working groups

Participation: The Steering Committee recommended that the working groups should be open to all interested parties in order to encourage the exchange of new ideas and interests within the working groups. However, it was also recognised that the costs of holding meetings for all members of large working groups would be unacceptably high. It was therefore recommended that the working groups should have two levels of participation. A wide “discussion group” would include all members of the group and they would participate in the exchange of views and information, essentially by e-mail. The second level of participation would be the core group, consisting of members specifically working on the priority research needs identified by the group, and who were willing and able to participate in collaborative projects and in developing new proposals. In addition, it was recommended that the core group should include appropriate representation from both the north and the south and that these should come from a maximum number of institutes. The members of the core group would participate in working group meetings, although other members could also participate at their own expense. It was also recognised that membership of working groups — both at the discussion group level and the core group level — would change over time as priorities of the working groups changed.

Frequency of working group meetings: It was agreed that the working groups themselves should determine the need to meet, and this would also be dependent on the availability of funding.

Number and focus of working groups: It was recognised that the number and focus of the working groups existing within PROMUSA was flexible and new groups might emerge and others finish, as the programme progresses.

Overall scope and priorities of PROMUSA

The focus of PROMUSA is on Musa genetic improvement and there was agreement among members of the Steering Committee that this is appropriate and should not be changed. Other research within the programme should be supportive to breeding efforts and this should be reviewed and prioritised regularly.

Strategy and Medium Term Plan

The strategy and Medium Term Plan of PROMUSA, as described in the Proceedings of the PROMUSA meeting held in Guadeloupe in 1997 was endorsed by the Steering Committee. It was agreed that some minor revisions and updating of the PROMUSA document is required, and that these would be reflected in the updated PROMUSA web page.

Strategies for mobilizing resources

The Steering Committee acknowledged the support provided to PROMUSA by the Australian Government and were informed that a pledge made by the European Union (EU) had not yet materialized due to restructuring and changes in personnel within the EU. However, it is hoped that the EU contribution will be provided in 1999. The Steering Committee noted the difficulties of securing funds for the programme, particularly to cover the transaction costs. It therefore recommended that all project proposals being prepared within the framework of PROMUSA should include a budget line for PROMUSA transaction costs.

A general discussion was held on sources of funds, including traditional donors, development banks and foundations. It was recognised that some donors may be prepared to fund meetings rather than research projects and such possibilities should be followed up by the secretariat. It was also agreed that all Steering Committee members should follow up on personal contacts with donor agencies and make every effort to identify a range of sources of funds for the programme.

In relation to the private sector, it was thought that possibilities may exist for collaboration, such as contract research in specific areas. The need to be proactive and clearly explain research needs and the benefits the private sector might gain from such collaboration was noted. In relation to access to patented technologies, the Chairman suggested that strategies such as the use of ‘philanthropic rights’ should be investigated.

It was also noted that the use of the Germplasm Acquisition Agreement developed by INIBAP may help in making improved germplasm from breeding programmes rapidly available for distribution.

Use of PROMUSA ‘label’

The Steering Committee agreed that only projects which are recognised and agreed by the working groups should be labelled as executed within the framework of PROMUSA. Working groups should therefore
inform the secretariat before submitting such project proposals for funding. Where possible, such projects should include a budget component for PROMUSA transaction costs.

**Progress of PROMUSA**

The Steering Committee members, having had the opportunity to participate in the two-day working group meetings, reported favourably on the progress of the working groups. They agreed that it was clear that the synergy and spirit of collaboration developed in Guadeloupe was continuing and that the participants were developing into a cohesive group of researchers. The Steering Committee was pleased to note some specific points, such as:

- the allocation and distribution of tasks between different members of the virology working group which will lead to increased efficiency and rapid progress in this discipline;
- the formation of two sub-groups within the genetic improvement group (molecular genetics and cytogenetics). These subgroups will work together to develop collaborative projects;
- the idea of the nematology group to bring together all available information in certain areas and publish as PROMUSA publications;
- the close interactions between the Sigatoka and Genetic Improvement groups.

The Steering Committee noted that the PROMUSA working group meetings provide an important opportunity not only for the exchange of information within each group, but also between the different groups. This inter-group interaction was noted as being particularly important and the need to provide sufficient time for this will be taken into consideration in the organization of future meetings.

The Steering Committee also noted the difficulty for some groups to identify 'core members' especially as not all the possible members of each working group were present at the meeting. The need to ensure good representation of all players is important and the Steering Committee recognised the need to ensure that the ARIs and IARCS were not over-represented at future meetings.

**Testing of transgenic plants**

The problems being experienced by researchers in the field testing of transgenic plants was noted by the Steering Committee. It was agreed that the Committee should be proactive in addressing this problem. While it is clear that testing can only be carried in countries where the necessary biosafety guidelines are in place, there may be opportunities for several research groups to take advantage of available testing sites. PROMUSA could play a role in helping to coordinate field testing and in negotiating with countries on behalf of research groups.

**Special support to FHIA**

The Steering Committee underlined the important role that FHIA plays in banana breeding and expressed deep concern for the damage inflicted on the station by the recent hurricane ‘Mitch’. It was recommended that FHIA be contacted as soon as possible and asked to provide information on assistance required to re-habilitate the breeding programme. PROMUSA would take responsibility for identifying and directing emergency support to FHIA.

**Next meeting of the Steering Committee**

It was agreed that the next global PROMUSA meeting should be held in the early part of 2000. The Steering Committee would therefore meet at this time.

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**PROMUSA Genetic improvement working group meeting – Developing collaborative strategies**

**Chairmen:**
Jean-Vincent Escalant, Dirk Vuylsteke

**Interaction facilities and prioritization of topics**

As the Genetic improvement working group is the core of PROMUSA, the group focused on revising the major issues concerning its interaction with the other working groups.

**Sigatoka diseases**

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Status of availability</th>
<th>Research gaps</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genetic resources</td>
<td>Yes</td>
<td>New and more sources of resistance needed (basis is too narrow at present)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other sources of resistance (e.g. transgenic resistance using non-Musa)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pathogen diversity studies</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Resistance mechanisms</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Durability of resistance</td>
<td></td>
</tr>
<tr>
<td>Breeding programmes</td>
<td>Yes</td>
<td>Some breeding programmes for Musa species are going well but a lot of work has still to be done on bananas in Asia/Pacific and the Indian subcontinent (under-researched area)</td>
<td>1</td>
</tr>
<tr>
<td>Available Hybrids</td>
<td>Yes</td>
<td>More needed; e.g. No resistant &quot;Cavendish&quot;- the genetic basis is too narrow (under-researched area: Pacific/Asia)</td>
<td>2</td>
</tr>
<tr>
<td>Early evaluation stage</td>
<td>Yes</td>
<td>Screening methods are needed (the earlier screening the better); screening should include molecular markers</td>
<td>1</td>
</tr>
<tr>
<td>Multi-local and farmers</td>
<td>Yes</td>
<td>Insufficient interaction with partners such as NGOs; farmers, extension services</td>
<td>1</td>
</tr>
<tr>
<td>Global evaluation stage</td>
<td>Yes</td>
<td>Policy on BSV required</td>
<td>1</td>
</tr>
<tr>
<td>Sustainable control methods available</td>
<td>Yes</td>
<td>Problem of adaptation and adoption</td>
<td>3</td>
</tr>
</tbody>
</table>

The following issues/questions were addressed to the Sigatoka working group:

- The Genetic improvement group needs their assistance in:
  a) Evaluating new sources of resistance,
  b) Evaluating pathogen diversity,
  c) Identifying mechanisms and durability of resistance.

1 Global means that germplasm material is virus indexed and can be distributed for evaluation at the global level.
### Virology

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Status of availability</th>
<th>Research gaps</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genetic resources</td>
<td>No</td>
<td>Resistance screening methods identify resistance sources.</td>
<td>1</td>
</tr>
<tr>
<td>Breeding programmes (and biotechnology)</td>
<td>Yes (non conventional breeding is addressing the issue)</td>
<td>Conventional breeding</td>
<td>1</td>
</tr>
<tr>
<td>Available Hybrids</td>
<td>No</td>
<td>Resistance screening methods identify resistance sources.</td>
<td>1</td>
</tr>
<tr>
<td>Early evaluation stage</td>
<td>No (transgenic BBTV resistance only)</td>
<td>Therapy – wider testing and adoption</td>
<td>Irrelevant</td>
</tr>
<tr>
<td>Available control methods</td>
<td>Yes</td>
<td>Only quarantine and sanitation cultural practices</td>
<td>2</td>
</tr>
</tbody>
</table>

1 = High; 2 = Medium; 3 = Low

Questions and issues addressed to the virology working group:

- a) Tools for evaluation are needed.
- b) Define/characterize plant response.
- c) How to evaluate resistance.
- d) What is resistance and what are their components?
- e) Screening methods are needed.
- f) Therapeutic procedures are needed.

### Fusarium wilt

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Status of availability</th>
<th>Research gaps</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genetic resources</td>
<td>Yes</td>
<td>Resistance sources to race 4 and other races. Better and early screening methods.</td>
<td>1</td>
</tr>
<tr>
<td>Breeding programmes</td>
<td>Yes</td>
<td>Asian banana breeding Genetic and resistance mechanisms</td>
<td>1</td>
</tr>
<tr>
<td>Available Hybrids</td>
<td>Yes</td>
<td>Resistance to race 4</td>
<td>2</td>
</tr>
<tr>
<td>Early evaluation stage</td>
<td>Yes (but very few available)</td>
<td>Not enough hybrids</td>
<td>2</td>
</tr>
<tr>
<td>Multi-local and farmers evaluation stage</td>
<td>Global evaluation stage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control methods available</td>
<td>Yes (only annual cropping in rotation system)</td>
<td>Biocontrol</td>
<td>3</td>
</tr>
</tbody>
</table>

1 = High; 2 = Medium; 3 = Low

Questions and issues addressed to the nematology working group:

- a) More sources of resistance and better tools for evaluation are needed by breeders.
- b) More knowledge on nematode variability and pathogenicity.
- c) Assistance is needed in developing earlier and easier standardised methods of screening.

### Collaborative work

Two initiatives for collaborative work were identified during the meeting. The first, to establish a Musa karyology network and the second to establish a genetic mapping network in order to obtain a saturated Musa map. A third topic discussed for possible collaborative activities was induced mutation breeding.

**Karyology collaborative proposal**

Report from: Jaroslav Doležel and Frédéric Bakry

Coordinator: Frédéric Bakry

The meeting was attended by the following researchers:

- F. Bakry (CIRAD, France)
- F. Carreel (CIRAD, France)
- J. Doležel (Institute of Experimental Botany, Czech Republic)
- J. P. Horry (INIBAP, France)
- C. Jenny (CIRAD, Guadeloupe)
- D. Kaemmer (Univ. of Frankfurt, Germany)
- M. Pillay (IITA, Nigeria)
- N. Roux (IAEA, Austria)

This group of scientists met to discuss the current issues related to Musa karyology. It was agreed that there is an increasing gap between knowledge of the...
genome at the molecular level compared with that at the chromosomal level. While there has been rapid progress in genetic mapping, with few exceptions, only limited work has been done recently in the field of Musa karyology. This delay may hamper the progress in many areas of research ranging from Musa taxonomy and evolutionary studies to breeding of improved cultivars.

The group identified the following research priorities in the field of Musa karyology:

**Determination of ploidy levels**
For many accessions (including those held at the INIBAP transit centre in KUL, Belgium) the ploidy has not been determined using reliable methods of chromosome counting and/or DNA flow cytometry. There is an urgent need to screen these accessions. The possibility of identifying laboratories that may provide these accessions is very limited. New methods to determine ploidy levels using flow cytometry have been shown to be very useful tool to determine genome size in Musa. The technique has a potential to estimate genomic constitution. It is expected that the technique will be used on a larger scale. In order to permit comparison of results obtained in different laboratories, there is a need to agree on the use of DNA standards.

**Characterization of karyotype**
In wild and cultivated bananas the knowledge of chromosome structure in Musa is very limited. New methods to study chromosomes at high resolution became available recently. These should be used to characterize Musa chromosomes, including the classification of individual chromosome types and identification of differences between karyotypes of individual species, subspecies and cultivars.

**Estimation of nuclear genome size of Musa accessions using flow cytometry**
Flow cytometry has been shown to be a very useful tool to determine genome size in Musa. The technique has a potential to estimate genomic constitution. It is expected that the technique will be used on a larger scale. In order to permit comparison of results obtained in different laboratories, there is a need to agree on the use of DNA standards.

**Construction of physical chromosome maps**
There is an urgent need to construct physical chromosome maps in Musa. Their combination with genetic maps will result in integrated maps, which will be indispensable tools to study the structure of the genome and to clone genes of interest. An essential step in the development of such integrated maps is the accumulation of sufficient numbers of molecular markers and cytogenetic markers.

**Development of new procedures to analyse Musa chromosomes**
The recent progress in plant cytogenetics has been stimulated by the development of new methods and procedures. These methods, which include localization of low and single copy sequences using FISH, fiber-FISH, or PRINS, and chromosome painting, have to be developed and/or modified for use with Musa.

**Technology transfer**
There is a need for a publication summarising current protocols for Musa karyology including flow cytometry and molecular cytogenetics (INIBAP?). The members of the group are willing to organise training and fellowships for young researchers. Provided sufficient funding could be allocated, the group is willing to organize workshops and training courses on Musa karyology.

**Literature**
Many papers on Musa karyology have been published in local journals and this information is therefore not easily accessible. The establishment of a specialized database on Musa karyology literature is highly desirable (INIBAP?). The database should be regularly updated and be accessible via Internet.

**Interaction between researchers**
Until recently, this has been very limited. In order to stimulate the exchange of information, it was agreed to establish a platform/discussion club on Internet. Dr. F. Bakry agreed to organize the club with a tentative address: promusa.cytogenetics@inibap.fr. A possibility to share this platform with researchers involved in genetic mapping should be considered.

**Conclusions**
The group proposed to invite renowned scientists and pioneers of Musa cytogenetics to join the group. The members of the group agreed to collaborate in order to promote the development of Musa karyology. Dr. F. Bakry agreed to act as a coordinator of the group.

**Towards a banana saturated genetic map to assist breeding programmes: development of SSR markers**
Report from: Françoise Carreel and Dieter Kaemmer
The meeting was attended by the following researchers:
- Peter Balint Kurti (BTI, USA)
- Françoise Carreel (CIRAD, France)
- Dieter Kaemmer (Univ. of Frankfurt, Germany)
- Michael Pillay (IITA, Nigeria)
- Nicolas Roux (IAEA, Austria)
- Kodjo Tomekpe (CRBP, Cameroon).
Not present but willing to participate in the collaborative work:
- Elizabeth Atken (QDPI, Australia)
- Jaroslav Doležel (Institute of Experimental Botany, Czech Republic)
- O.B. Hemeng (CRI, Ghana)
- Jean-Pierre Horry (INIBAP, France)
- Gisella Orjeda (INIBAP, France)
- Rony Swennen (KUL, Belgium).
The group is also open to other researchers who are willing to contribute.

**Genetic maps**
Different genetic maps of Musa have been developed (Faure et al. 1994, Lagoda et al. 1998) using codominant markers (RFLPs, isozymes, STMS) and many dominant markers (RAPDs and AFLPs). Codominant markers always detect the same locus in different crosses under investigation. Acting as anchors for identifying linkage groups, they can be used to establish core maps. On the other hand, most dominant markers are cross specific, but as their development and use are less time-consuming than that of co-dominant markers, they are often used to saturate maps. Only those co-dominant markers that are always linked to the same linkage group in different crosses are considered to be useful and reliable to compare mapping results from different crosses.

The group agreed that the banana genetic map lacks co-dominant, locus-specific and polymorphic markers easily transferable to all laboratories.

The members of the group agreed to collaborate in order to promote the development of a Musa-saturated genetic map which will be useful to:
- get a true understanding of the genetic basis of the inheritance of agronomic and resistance characters despite distorted segregation frequently observed on bananas partially due to translocations,
- localize the main genes involved in the agronomic and resistance characters.
of interest in order to use them in marker-assisted selection (MAS) and ultimately to isolate them and use them in transformation.

- localize the break-point of translocations to increase the efficiency of improvement strategies based on MAS.

**Segregating populations**

There is a mapping initiative being developed by INIBAP, but the DNA from these populations may not be available before the year 2000. CIRAD, CRBP and IITA have obtained different segregating populations according to their breeding goals. Within the BIP project "Field Crosses for Understanding the Inheritance of Black Leaf Streak Resistance in Bananas" CRBP has developed an F2 population from a cross between M. a. burmannicoides 'Calcutta 4' and M. a. balbisiana 'Madang' called the AFCAM20 population. The group discussed the possibility of using this population for the present initiative. The AFCAM20 population has 175 hybrids characterised by 20 STMS, 20 RFLP and 20 AFLP markers. This population could be extended up to 500 hybrids at CRBP.

Different activities necessary:

- Seling of the F1 CAM20 and growth of the hybrids,
- DNA extraction in large quantities, first from 8 individuals to test the quality and polymorphism of the developed markers. Those individuals are the parents of the different segregating population 'Calcutta 4' - Madang - F1 CAM20 - Guyod - Pisang Jari Buaya - Malacensis - Pisang Lilin - M. balbisiana (to be determined),
- DNA extraction in large quantities of the F2 segregating population: up to 500 individuals, to be discussed.

**Markers**

The group agreed to the utility to saturate the map with STMS (Sequence Tagged Microsatellite Site) markers. STMSs are locus-specific, co-dominant and highly polymorphic markers that may be assayed with a non-radioactive urea-polyacrylamide gel electrophoresis, a simple transferable method, less expensive than most of the other molecular techniques. The drawback to this is in the development of STMS markers which is time-consuming and expensive. For this reason the different institute laboratories agree to associate their competence and technical facilities to render the development of these markers less expensive. Different steps to be shared by the different laboratories:

- identification of all the STMSs available in the different laboratories; STMSs already defined and tested or potential STMSs through probe sequences,
- construction of an STMS-enriched DNA library,
- sequencing the probes,
- definition of primers,
- testing STMS quality and polymorphism on the 8 clones listed above,
- characterization of the progeny with the candidate STMSs,
- map construction.

The group agreed that the results of the STMS definition and use of the mapping will be made available and be the subject of a co-publication.

Interaction between researchers: as in the karyology group, in order to stimulate the exchange, it was agreed to establish a platform/discussion club on Internet. Whatever the goals of the breeding programmes, the molecular markers developed and mapped will enhance the improvement strategies through a rapid selection of parents and hybrids.

**Induced bio-diversity**

Mutation induction methodologies as an additional way to assist breeding programmes has been discussed widely.

**Use of induced mutations in conjunction with cross breeding programmes**

a) The mutagenic treatment could be applied at two levels:
- To improve parental lines (diploid wild types or improved diploids),
- To improve the final product (triploid or tetraploid hybrids).

- Among the genetic improvement group there was some discussion concerning the level in which the mutagenic treatment should be used.
- The main characteristics to be improved:
  - Improved agronomic characteristics such as dwarfism and earliness could be obtained in the short term. Disease resistance traits should be considered in the longer term since they are mainly of multigenic origin and reliable, simple and rapid screening methods still need to be developed for such traits.

**Use of induced mutations in structural and functional 'genomics'**

The PROMUSA genetic improvement group expressed the importance of creating a saturated genetic map. Mutants, isogenic lines, doubled haploid lines, deletion stocks and gene banks are of immense utility because they enable connections between DNA sequences with their biological functions revealed by the mutant phenotypes. Thus, it is important to utilize several approaches in characterization and isolation of genes for Musa improvement. Data associating mutations with phenotypes should be linked to the effort of genetic mapping.

The group was reminded that the FAO/IAEA Agriculture and Biotechnology Laboratory can irradiate material free of charge for FAO/IAEA Member States.

**Recommendations**

The lack of a Musa genetic improvement programme in Asia, the region of origin of Musa, is recognised as a serious gap. All local initiatives in this sense focusing on genetic resources and genetic resources improvement should be actively sustained. INIBAP-ASPNET- programme could coordinate these initiatives.

The Asian initiative could be strengthened with exchange of material, information and germplasm.

**The genetic improvement group of PROMUSA**

- strongly recommends to the PROMUSA secretariat that FAO be contacted to open a discussion (or field studies) on the implications of the evaluation and release of transgenic bananas.

The working group recommends prospecting for new Musa balbisiana (wild diploid BB) in the Philippines and India. The group also recommends prospecting for new Musa acuminata, mainly in India, but the Philippines and Malaysia should also be considered.

The genetic improvement group identified as a priority the need for breeders to have better access to existing Musa collections in order to increase the availability of both natural and improved germplasm (diploids and triploids). It was recommended that the MGIS and IMTP databases be utilized to improve the accessibility of information. In addition, it was noted that information about IITA germplasm can be obtained through their annual report and other publications.

**Concerning improved diploids,**

Dr Sathiamoorthy indicated that 18 improved diploids with disease resistance are available from TNAU and IITA has already donated improved diploids to the IMTP to be tested by breeding programmes. Being aware that information and germplasm exchange could be problematic in relation to intellectual property rights, it was recommended that improved Musa diploids could be exchanged under specific bilateral agreements.

It was noted that the IMTP has been enlarged to include available breeding diploid material. It was recommended that the IMTP catalogue initiative should be encouraged and that breeding programmes should provide information on the improved hybrids and breeding diploids they make available for IMTP. It was recommended that all the information concerning hybrids, breeding material and landraces, should be made available on an Internet site, as well as through a publication, in order to facilitate access to everyone. This should be the responsibility of INIBAP.

**Genetic improvement core group**

Based on the following characteristics, the genetic improvement group tried to define a core group:

- Active involvement in genetic improvement
- Willingness to collaborate on common projects
- Experience in formulating proposals
• North-South interactive projects
• Breeding programme producing hybrids
• Genetic transformation team producing transformed plant.

At the present time, the core group is not constituted, but the different institutions listed as follows have been proposed to be included:

<table>
<thead>
<tr>
<th>Institution</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>INIVIT</td>
<td>Qatar</td>
</tr>
<tr>
<td>IITA</td>
<td>Malaysia</td>
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<tr>
<td>FHIA</td>
<td>Egypt</td>
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<td>CRBP</td>
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Participants

The second meeting of the PROMUSA Nematology working group was held at Douala, Cameroon from 8-10 November 1998. Musa nematologists present, in alphabetical order were: Ms. Inge van den Bergh (VASI, Vietnam), Dr Roger Fogain (CRBP, Cameroon), Dr Simon Gowen (University of Reading, UK), Dr Imelda Kashaija (NARO, Uganda), Dr Nigel Price (CABI presently at MoA, Mauritius, Chairperson), Dr Jean-Louis Sarah (CIRAD, France), Dr Paul Speijer (IITA, Uganda), Dr Julie Stanton (QDPI, Australia), and Dr Dirk de Waele (KUL, Belgium). In addition Dr Soorianathsundaram of Tamil Nadu Agricultural University (TNAU, India) took part in some discussions and Ms. Suzanne Sharrock of INIBAP acted as rapporteur. The format of the meeting followed that proposed by PROMUSA and the previously distributed agenda was largely followed. In addition, on the morning of the 10th November a meeting was held with representatives of the PROMUSA Genetic improvement (Breeders) working group.

Status of Musa nematology

Individual researchers gave overviews of their respective Institutes’ current activities in Musa nematology (where these expanded on or where not covered by presentations in the preceding BIP meeting). It was noted that the commencement of activities in Vietnam, through the VVOB/INIBAP linkage and the participation of a representative from TNAU gave the meeting an Asian dimension. It was also noted that the ACIAR, through an upcoming project with QDPI, would be funding overseas nematology (in particular in Mozambique, South Africa and Thailand).

Regarding the overall priorities and strategies of the working group, there was felt little need for any major alterations to the objectives set out in Guadeloupe in 1997. However, in relation to the information provided on the PROMUSA Web page, some institutional changes were noted. Regarding research, the need for new Musa exploration was accorded less priority.

The shortage of people working in nematology worldwide was discussed. The shortage of worldwide taxonomic expertise was noted, with the main gap in Musa nematology considered to be at the intra-specific “pathotype” level, rather than the species level (with some exceptions). In relation to taxonomic studies it was agreed that costs for nematode identification, using both classical and molecular approaches, should be included routinely in project costs for any proposed project.

It was estimated that there might be 15-20 currently identified sources of resistance to Ratoaphlus similis, but only two are considered reliable (Pisang Jari Buaya and Yangambi Km 5). It was agreed that breeders need to be consulted about the “usability” of other sources. No priority was given to further germplasm collecting missions, but it was agreed that new material should be routinely checked as it becomes available—particularly AA diploids. The potential of other approaches

PROMUSA Nematology working group meeting

The Flemish VVOB scheme was recognised as being very useful in placing/stationing young nematologists in the tropics, but has limitations as the number of positions is frozen and 50% must be placed in sub-Saharan Africa. The possibility of increasing student exchanges between participating organizations was discussed and various existing mechanisms to do this described. It was agreed that short-term studentships are not an efficient way of conducting research and longer-term post-graduate and post-doctoral type placements would be better. It was also noted that the MSC. programme at KUL for students from developing countries is under-subscribed within the field of Musa Nematology.

Research needs in Musa nematology

A proposal to enlarge the “Musa nematologists consortium” was presented by Dirk de Waele. This proposed consortium would focus on screening/evaluation experiments and trials and an initial, non-exhaustive list of potential partners has been identified. It was commonly suggested and agreed that this could be developed as a “modular” type global project with different project components and different sources of funding which could be treated independently in the common framework of the global project. However, all evaluations would include standard/reference cultivars in order to enable comparison of results.

It was suggested that similar module-type programmes could be developed for other areas of research.

The shortage of worldwide taxonomic expertise was noted, with the main gap in Musa nematology considered to be at the intra-specific “pathotype” level, rather than the species level (with some exceptions). In relation to taxonomic studies it was agreed that costs for nematode identification, using both classical and molecular approaches, should be included routinely in project costs for any proposed project.

It was estimated that there might be 15-20 currently identified sources of resistance to Ratoaphlus similis, but only two are considered reliable (Pisang Jari Buaya and Yangambi Km 5). It was agreed that breeders need to be consulted about the “usability” of other sources. No priority was given to further germplasm collecting missions, but it was agreed that new material should be routinely checked as it becomes available—particularly AA diploids. The potential of other approaches
to nematode resistance/tolerance evaluation was recognised—such as root system studies, root:shoot ratios etc. The popularity of the recently prepared ‘Musa nematode evaluation guidelines’ was commented on, as was their ‘voluntary’ nature, i.e. research groups were free to select or adapt evaluation methods according to their particular circumstances. It was agreed that a common set of standard/reference cultivars (coming from the same ITC accessions) and a minimum number of common parameters should be used in all evaluations in order to ensure comparability of results. The common parameters which should be used are those related to nematode populations and root damage/health. That is: the number of nematodes per gram and the extent of root necrosis.

It was felt that present methodologies of rapid screening were adequate and acceptable. Any possibility of misidentifying potentially promising material was considered an acceptable risk inherent in all evaluation programmes. It was also felt that as more sources of nematode resistance within Musa were identified there would inevitably arise a need for more detailed studies of the mechanisms behind such resistance. It was agreed that biotechnological approaches to breeding for nematode resistance were, at present, of only long-term importance.

Studies on economic thresholds and interactions with other pathogens/beneficials were considered to be outside the remit of PROMUSA and it was felt that PROMUSA for the moment should restrict itself to its already stated objectives and not overstretch itself.

The role of PROMUSA in Musa nematology

Discussion moved on to the purpose, structure, activities and responsibilities of the Nematology working group, the working group Chairperson and the selected core group. It was felt that problems particular to nematology justified the existence of a Nematology working group within PROMUSA. The generally low profile accorded to nematology requires a working group to bring these pests to the attention of others, in particular breeders. Both the scientific complexity and the wide geographic variability of nematodes needed a working group to highlight information gaps and assist in information exchange. Finally it was felt that a formal Nematology working group might assist in securing project funding. Discussion was held as to the choice and responsibilities of the next Nematology working group spokesperson, and Dr Jean-Louis Sarah (CIRAD) was selected.

It was agreed that the spokesperson of the group should take responsibility for ensuring the exchange of information between working group members and coordinating meetings. The spokesperson should also ensure that all publications and relevant information produced by working group members are supplied to INIBAP for wider distribution. In addition, the spokesperson should ‘signal’ opportunities for projects to interested parties and encourage these partners to compile collaborative proposals. It was agreed that all members of the group (including the spokesperson) should try to identify new partners and sources of funding for collaborative projects.

The composition of a core group was discussed and it was felt that due to the wide geographic and regional variability in both Musa types grown and their nematode pests, a wide ranging core group was needed. Fifteen potential scientists/institutes were identified as potential core group members.

A range of responsibilities for core group members were identified:
- The collation and presentation of their respective regions activities
- Taking an active role in project preparation
- Acting as links between the Chairperson and the wider Nematology working group
- Maintaining links with other researchers in their region

The core group would endeavour to seek funds for the participation of members at meetings, with priority given to those with no other declared sources of funding. The Nematology working group set itself the following clear objectives:
- It is intended to request the organizers of the 2001 Conference in the Republic of South Africa to schedule a specific Musa nematology session within the conference. The working group will endeavour to arrange publication of any papers presented at this session as a special publication, in addition to the normal conference abstracts.
- In time for presentation at this meeting the group will prepare three special publications on the following themes related to Musa nematology:
  - A review of Musa nematode distributions worldwide
  - A review of work conducted on yield losses caused by nematodes to Musa
  - A review of studies of nematode resistance in Musa.

The role of the Musa Nematology working group within PROMUSA

Within PROMUSA the Nematology working group felt that closest links needed to be with the Genetic improvement working group. As part of this collaboration a special meeting was held with this group. Here the application of screening techniques and resistance rating procedures was discussed and the potential of currently used procedures, in particular the inclusion of standard/reference cultivars was considered. It was noted that although the source of material for early screening (tissue culture vs. suckers) may give different absolute results, the ranking of cultivars generally remains the same (with a few exceptions).

In addition the still very limited number of used sources of resistance was emphasised. The Genetic improvement working group pointed out that resistance to any one pest or disease, per se, was not an objective of breeders, whose aims were rather the development of an improved plant, irrespective of what qualities were improved to achieve this. However, it was noted that breeders now consider nematodes and viruses as their main focus in relation to strategic research.

It was agreed that the Nematology working group would compile available information on nematode resistance/tolerance for Musa germplasm and make this available to the Genetic improvement working group as soon as possible.

PROMUSA Sigatoka working group meeting

Introduction

The global spread of black Sigatoka (BS) disease from its centre of origin in the South East Asia/Pacific area to the American and African continents was a major catalyst for the international effort now being directed towards banana and plantain improvement.

As a result of an intensive breeding effort over the past ten years both in Central America, Africa and South America, a range of hybrids with resistance to BS have been developed and are in the initial stages of release to farmers. The pathogen, Mycosphaerella fijiensis is a highly variable organism. It has a high rate of genetic recombination and, as a result, a high capacity for change. There is already evidence of breakdown of resistance in previously resistant varieties, e.g. Paka and T8 in Rarotonga and Tonga.

A key issue from the pathological perspective is the durability of the resistance to the pathogens Mycosphaerella fijiensis and M. musicola in the newly developed hybrids, and the
Main aims
The main priorities from a pathological perspective are:

• Develop a detailed understanding of population structures of the pathogens Mycosphaerella fijiensis and M. muscosa in the different geographical areas. An analysis of populations using molecular markers will indicate the inherent variability within the pathogen population. In addition, inoculation of strains across a range of host genotypes will be necessary to provide information on the pathogenic diversity within the population, as well as to compare host/pathogen interactions between the pathogens.

• Develop methods to determine the rate of change of pathogen structure in response to selection pressure from new banana genotypes.

• Develop a better understanding of the mechanisms and inheritance of resistance in the host, in particular the genetic control of quantitatively and qualitatively inherited resistance. In general qualitative resistance is usually accompanied by a high level of resistance often associated with a Hypersensitive Reaction (HR) while quantitative resistance is associated with Partial Resistance (PR). PR usually results from a host/pathogen interaction which affects different components of the disease (e.g. slow development, reduction of sporulation, etc.).

• Identify sources of resistance. This will include resistance derived from natural germplasm and various forms of transgenic resistance.

• Breeders and pathologists consider that the currently available methods of field screening are adequate for breeding for resistance to black and yellow Sigatoka. Field screening methods are therefore not a priority. However, early screening procedures are needed for testing transgenics etc. Results from these methods should be correlated with field results where possible. Specific areas of interaction and cooperation identified by breeders and biotechnologists are:

  • Assistance in evaluating new sources of resistance, evaluating pathogen diversity and identifying resistance mechanisms and durability.

  • Development of early screening methods, especially for breeding programmes using biotechnology.

In response to these needs the following topics are either under investigation or scheduled.

Screening methods
Artificial inoculations under controlled conditions (CIRAD-CRBP)
Key elements for developing effective artificial screening methods are:

• Identify and standardize optimum quality and quantity of inoculum. It is necessary to avoid both “under testing” or “over testing” plant material.

• The progress being made on in-vitro inoculations of mature leaf tissue offers a valuable tool for the rapid evaluation of host-pathogen interactions. Further refinement of the technique will be ensured.

• Determine optimum environmental conditions for housing plant material after inoculation.

• Establish the relationship between the reactions obtained by in vitro and juvenile plant inoculations and plant reactions in the field.

Toxins (Cornell, BTI, Univ. of Gembloux)
Work to date has shown that at the current stage of knowledge, the use of toxins for rapid early screening of germplasm is unreliable.

Results of work from various areas where screening of germplasm using toxins, (e.g. Cuba) are variable.

It is known that sensitivity to toxin production is not a factor in the infection of plants with HR, e.g. Yangambi Km 5 is highly susceptible to crude extracts of toxin. Strains which attack Yangambi and those which do not both produce toxins. Differential response to toxins is quite likely to be a factor in plants expressing PR.

Nevertheless work in this area is in process with the aim of:

• Determining the relationship between the aggressiveness of the pathogen and toxin production.

• Developing a better understanding of the relationship between toxin production in the pathogen and field resistance and susceptibility.

Two approaches are being taken: a conventional method of comparing toxin production of strains of the pathogen known to differ in aggressiveness and a mutagenesis approach using strains of the fungus from which toxin production will be eliminated.

Pathology inputs to field experimentation
Routine field evaluations
Sigatoka evaluations carried out as a normal part of the evaluation of progeny from breeding programmes.

IITA, CORBANA, CIRAD, EMBRAPA, QDPI, FHIA, NARO, CRBP.

Determination of pathogen population structure in field trial areas
This is of great importance and is of particular relevance to the IMTP programme. Pre-existing pathogenic diversity in the test area and changes in the population will affect the stringency of evaluation of the germplasm. Structure of both black and yellow Sigatoka populations should be evaluated.

CIRAD, CRBP, Univ. of Frankfurt, Horticentresearch, QDPI.

Evaluations of diversity using molecular marker analysis have demonstrated the diversity within and among geographic populations of Mycosphaerella. This information must now be correlated with detailed studies of variation in virulence and pathogenicity.

Germplasm will be challenged by a greater range of pathogenicity in some locations e.g. Southeast Asia, than in others.

Efficacy, durability and management of resistance
At the present stage of resistance breeding it is suspected that resistance has a relatively narrow genetic base.
The following activities are required:

- Analysis of resistance (CIRAD-CRBP, IITA, FHIA)
  - What genes are involved, how many?
  - How are they inherited? Will PR be masked by HR?
- Different forms of resistance (CIRAD-CRBP, IITA, FHIA)
  - Natural Germplasm
    It will be necessary to identify specific kinds of interactions which would indicate different genotypes conferring PR.
  - Transgenic plants (CATIE/KUL)
    Development of early screening methods will be essential to be able to evaluate the large numbers of individuals involved.
    It will be important to expose transgenic material to a wide range of strains of the pathogen to represent the genetic diversity in the populations.

New species of fungus causing leaf spot disease (CIRAD)
A “new” leaf spot disease has recently been reported from the South East Asian region. Leaf specimens were sent to CIRAD from collections in Asia between 1992 and 1995 to determine whether they were black or yellow Sigatoka. Diagnosis showed that there was a previously unrecorded fungus associated with the spots. There was no evidence of either the YS or BS pathogens. The new fungus had a Septoria anamorph stage, and a Mycosphaerella teleomorph stage. Isolation of the organism and reinoculation to banana reproduced the original symptoms and confirmed pathogenicity of the new fungus. Phylogenetic analysis based on sequences of the Internal Transcribed Spacers (ITS) of ribosomal DNA from different leaf spot pathogens of bananas was consistent with the definition of a new species. A molecular diagnostic method based on digestion of PCR-amplified ITS regions with several restriction enzymes was also developed to distinguish these pathogens. Application of the method confirmed that the new fungus isolated from all the localities sampled belonged to the same species.

The fungus has been confirmed from India, Sri Lanka, Thailand, Vietnam, Malaysia and Mauritius.

The importance of this pathogen both as the cause of disease in Asia and as a potential threat to other areas has yet to be determined.

Priority should be given to determining:
- Its distribution in the region,
- Its pathogenicity on Musa genotypes including genotypes resistant to black and/or yellow Sigatoka,
- The genetic diversity of the populations of the fungus in the different countries in which it is found.

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PROMUSA Virology working group meeting

Administrative and miscellaneous matters

The meeting was held from 7-9 November 1998 in Douala, Cameroon. Glyn Harper was appointed spokesperson for the group. Roger Hull (John Innes Centre) will continue to be the liaison person for the group. The group discussed the feasibility of establishing a Web site page for the group, linked to the PROMUSA Web site. This would contain scientific information. This could be developed by the John Innes Centre in collaboration with the PROMUSA/INIBAP Web service. E-mail will continue to be the main system of information exchange among group members (group mail address).

The group agreed that the frequency of its meetings cannot be fixed, and depends on the group’s wishes and on available funds.

The group recalls that the production and supply of antisera are limited to the virus indexing centres (VICs) and for research use. At the current rate of use there is 20 years’ supply. Protocols for the production of antisera are available.

Session I: Potexvirus

John Thomas and Marie-Line Caruana made short presentations.

John Thomas reported that the filamentous (flexuous) particles were isolated from the ABB-Pisang Awak ‘Ducasse’ cv. The particles are stable in CsCl, and the yield is about 0.1mg/kg. The virus degrades on storage, Polyclonal antisera recognise a 31 kDa protein in western analysis although the sequence analysis predicts 26 kDa.

DAS-ELISA is efficient on midrubs or leaf tissue sap extracts. The virus is often associated with banana bract mosaic virus (BBMV) and banana streak virus (BSV). The virus genome size is approx. 7.9 kb, which makes it a large potexvirus; it could therefore have been a toencevirus, though its morphology is more like that of a potexvirus.

The mechanical transmission of the Ducasse virus has not been possible, although potexviruses are usually transmissible this way. Transmission via an intermediate host plant has not been possible so far nor by insect transmission. Although apparently seen in single...
infection, the suggestion was made that co-infection, co-transmission or some helper component may be required.

Some minipreps show flexuous rods by EM but are ELISA negatives for potex and BBMV. A PCR test was specific for the Ducasse strain which, unusually for a potex, was a mild form with very mild or absent symptoms.

Marie-Line Caruana reported the systematic presence of a potexvirus in co-infection with the potyvirus BBMV in a plant affected with the banana bract mosaic disease. Specific monoclonal is obtained against this potexvirus and reacts with a 30kDa protein in western blots. Combining with Ben Lockhart’s polyclonal anti M’bouroukou potexvirus, it permits a reliable detection of the potex in banana extracts by ELISA.

Serologically related filamentous particles are identified alone in various cultivars in the Guadeloupe banana collection particularly in the AAB genome and in several accessions in the INIBAP Transit Center. No or only mild visual symptoms are associated with these potexvirus-like particles. The same types of viral particles are also encountered in co-infection with cucumber mosaic virus (CMV) and BSV related to severe attacks and damages caused by the latter. In the case of CMV infection they are strongly related to an additional symptom of necrosis. These different potexvirus-like particles are serologically related. Alone, they are propagated only vegetatively and particles are serologically related. Alone, they are propagated only vegetatively and in several accessions in the INIBAP collection particularly in the AAB genome

**Current research activities**

- **Comparison of impact CMV vs. CMV + Potex (CIRAD Guadeloupe)**
- **BSV + Potex (CORPOICA Colombia/INIBAP)**
- **Studies in Puerto Rico (University of Minnesota)**
- **Role of potexvirus in co-infection with potyvirus in the BBrMD (CIRAD, Montpellier)**
- **Mechanisms of transmission in co-infection (CIRAD, Montpellier).**

**Session II: Banana streak virus**

John Thomas, Ben Lockhart, Glyn Harper and Hong-Ji Su updated the group on recent results.

John Thomas reported that the sequence of the isolate from AAA-Red «Red Daaca» cv. was that same as the Onne isolate and that there appeared to be a low incidence of many different BSV strains in Australian Musa. In intensive well-managed plantations on cv. Williams, the effect of BSV appears to be only significant on crop cycle length (1-week delay) with a 2% loss in yield per annum. A similar but additive loss is reported for the rattoon crop. However, in poor agricultural conditions or under temperature fluctuations, the effect on yield would be greater.

Ben Lockhart presented research showing a BSV sequence integrated in a complex, re-arranged form in cv. Obino L’Ewai. The present objective is to develop tools which might identify the genotypes that contain an activatable sequence of the virus. In Calcutta 4 (M. acuminate sp.) and AAA Cavendish (Williams, Dwarf Cavendish cvs.) activation has not been observed. PCR probes have been developed, including part of the Musa genome flanking BSV sequence and of the BSV integrated genome (beginning of BSV sequence). The output of the research will see the possibility of identifying not activatable parental varieties, which could be used by breeders. A possible link of the activatable BSV sequence to the B genome of Musa was suggested by PCR results.

Glyn Harper reported on the work conducted at the John Innes Centre using S-SAP and fluorescence in situ hybridization on Obino L’Ewai (AAB) DNA and chromosomes. Observations suggest that the integrated BSV sequence identified in the John Innes Centre and Minneapolis, is concatenated perhaps including inversions, may be activated by somatic recombination, and that the probability of activation might be linked to the number of times the integrated sequence is repeated. This suggests a possible PCR based diagnostic, similar to Ben Lockhart’s for non or low activation potential parental Musa lines for breeders.

Hong-Ji Su presented his novel observation that Pseudococcus comstocki (two biotypes) were able to transmit BSV very efficiently from tissue culture mother plants, with a 3-week incubation before symptoms were seen. The BSV strain used showed differential cultivar effects with Cavendish having more severe symptoms than Lakatan and Myers the least severe. His analysis of mixed infection showed that BSV symptoms dominated those of CMV, whereas BSV dominated BBTV at an early stage but as the infection progressed BBTV gradually came to dominate.

**Indexing procedures:** Discussions were held on the indexing procedures in use at the VICs. When to index the plant material: immediately after its introduction in vitro or after several (how many) cycles of multiplication? It was concluded that indexing might be more efficient using PCR primers / probes to detect excised DNA as well as the capsid. IC-PCR followed by ELISA as an alternative to gel-based detection for BSV + Potexvirus (multiplex PCR-ELISA) could be the first step in indexing (pre-indexation). Only negative plants would follow the subsequent steps of indexing. John Thomas and Marie-Line Caruana shall establish a proposal for a revised indexing procedure, in collaboration with FUSAGx. Cost effectiveness should be estimated.

**Planned research activities**

- **Continuation of the characterization of the activatable sequence (John Innes Centre and University of Minnesota)**
- **Combination with work on cytogenetics (CIRAD and John Innes Centre)**
- **Eradication, therapy methods and effect of stress factors (FUSAGx)**
- **Ongoing studies on the effect of in vitro culture on the expression of BSV are being conducted at FUSAGx**
- **CORPOICA, FUSAGx + KUL + John Innes Centre and at CIRAD**
- **CORBANA + University of Costa Rica + University of Minnesota.**

**Session III: Banana bunchy top virus**

Doug Becker, John Hu and Hong-Ji Su reported on the status of virus resistance transferred through transformation and future prospects.

Doug Becker described the transformation of Bluggoe and Cavendish with BBTV replicase, defective replicase, Rb and coat protein constructs for BBTV resistance. These lines are currently being...
challenged in Australia. In addition, BBrMV resistance trials are also being planned for India, or possibly the Philippines.

John Hu reported on the detection of BBTV with an expressed coat protein antisera which works well by ELISA and IC-PCR for Hawaiian BBTV strains. Plants transgenic for BBTV replicase, replicase mutants and coat protein gene constructs have been produced, a small proportion (6%) apparently resistant to first challenge of BBTV. This is a very encouraging result. However John pointed out that many transgenic plants may have to be produced to be able to select resistant but agronomically good plants.

Hong-Ji Su reported on the pathological and molecular characterisation of BBTV isolates. BBTV strains showing varying severity (severe, intermediate and mild/latent) could be transmitted by Pentalonia and differentiated by PCR with different primer pairs. Latent isolates could be detected in other Zingiberales.

Session IV: Other viruses

Cucumber mosaic virus: the group estimated that CMV was not relevant to the group and is not a priority, since it is more a management problem at plantation level.

Banana Dieback virus: Jackie Hughes, IITA, has previously reported on this isometric particle. However there was no further information at this time.

Ben Lockhart reported on the observation of an isometric particle different from BSV in Eastern Java.

Session V: Priority activities to be undertaken in the framework of PROMUSA

The group summarized the activities, which should be directly linked with PROMUSA. This was presented in a plenary session under three headings:

a) Development of reliable virus detection methods

Aims
- to prevent dispersal of virus infected germplasm
- to define and limit the geographical distribution
- to improve detection methods, e.g. IC-PCR for BSV + Potexvirus, and reflect these in virus indexing procedures.

Future
- Establish that Onne strain of BSV is a major strain present as episomal infection in germplasm as this has a bearing on detection methods (QDPI / CIRAD)
- Develop IC-PCR for BSV (based on Onne strain) + Potex (FUSAGx / QDPI)
- PCR to differentiate integrated and episomal BSV sequences to detect low or no symptoms in plants (FUSAGx / JIC)
- Revise detection procedures for VIC (QDPI / CIRAD).

b) BSV

Current
- Integrated BSV sequences have been well described. A plausible mechanism has been proposed to describe the activation of BSV from this sequence.
- A possible diagnostic assay is being developed to assist breeders in selecting material with lower (or no) probability of activation.

Future
- Planning experiments to investigate the reduction in the level of activation of episomal BSV in tissue culture (FUSAGx)
- Investigate differences between Musa varieties in the activation of episomal BSV during tissue culture (John Innes Centre + Univ. of Minnesota + FUSAGx + KUL + CIRAD)
- Investigate the mechanism of activation (CIRAD + Univ. of Minnesota + John Innes Centre)
- Investigate the linkage of integrated sequences (to B genome for example) (CIRAD + Univ. of Minnesota).

Transgenic virus resistance

Aims
- To eliminate particular viruses as a constraint to production

Prospects
- Transgenic plants showing initial promise for BBTV, many other plants ready to be challenged for BBTV and BBrMV.

Criteria for participating in the Virology core group

The group discussed the criteria for participation in the Virology core group. These were identified as follows:
- Ongoing research on banana viruses
- At least one scientist working on Musa virology full time or capabilities of a particular value to the programme (VIC representatives for example)
- Research undertaken falls within the PROMUSA priorities.

On the basis of these criteria, the composition of the Virology core group was established as follows:
- John Hu, University of Hawaii
- Charles Michel, FUSAGx, Belgium
- John Thomas, QDPI, Australia
- Hong-Ji Su, National Taiwan University
- Emile Frison, INIBAP, France
- Gerard Pietersen, ARC – Plant Protection Research Institute, South Africa
- Marie-Line Caruana, CIRAD, Guadeloupe
- Glyn Harper, Roger Hull John Innes Centre, UK
- Ben Lockhart, University of Minnesota, USA
- Douglas Becker, QUT, Australia
- Jackie Hughes, IITA, Nigeria
- Jean-Pierre Horry, INIBAP, France (observer).

Visit of CRBP Banana field collection at Nyombé.