European Food Safety Authority

The EFSA Journal (2008) 651, 1-23

Pest risk assessment made by France on *Banana bract mosaic virus* considered by France as harmful in French overseas departments of French Guiana, Guadeloupe, Martinique and Réunion[1]

Scientific Opinion of the Panel on Plant Health

(Question No EFSA-Q-2006-108)

Adopted on 20 February 2008

PANEL MEMBERS

Richard Baker, David Caffier, James William Choiseul, Patrick De Clercq, Erzsébet Dormannsné-Simon, Bärbel Gerowitt, Olia Evtimova Karadjova, Gábor Lövei, Alfons Oude Lansink, David Makowski, Charles Manceau, Luisa Manici, Dionyssios Perdikis, Angelo Porta Puglia, Jan Schans, Gritta Schrader, Robert Steffek, Anita Strömberg, Kari Tiilikkala, Johan Coert van Lenteren and Irene Vloutoglou

SUMMARY

Following a request from the European Commission, the Panel on Plant Health was asked to deliver a scientific opinion on 30 pest risk assessments made by France on organisms which are considered by France as harmful in four French overseas departments, i.e. French Guiana, Guadeloupe, Martinique and Réunion. In particular, the Panel was asked whether these organisms can be considered as harmful organisms for the endangered area of the above departments, in the meaning of the definition mentioned in Article 2.1.(e) of Directive 2000/29/EC and thus potentially eligible for addition to the list of harmful organisms in Directive 2000/29/EC.

This document presents the opinion of the Panel on Plant Health on the full[2] pest risk assessment conducted by France on *Banana bract mosaic virus* (BBrMV) with French Guiana, Guadeloupe, Martinique and Réunion considered as endangered area.

Banana bract mosaic virus (BBrMV) is a recently characterised virus of the genus *Potyvirus* family *Potyviridae* (Thomas *et al.*, 1997), which infects banana and plantain. It is an aphid transmissible virus and can cause serious losses due to yield reduction and malformation of fruits.

The Panel examined in detail the risk assessment provided, and considered the accuracy and quality of the information provided and methods applied for pest risk assessment purposes. The review was based on the principles and terminology of the International Standard on

[1] For citation purposes: Scientific Opinion of the Panel on Plant Health on a request from the European Commission on Pest risk assessment made by France on *Banana bract mosaic virus* considered by France as harmful in French overseas departments of French Guiana, Guadeloupe, Martinique and Réunion. *The EFSA Journal* (2008) 651, 1-23

[2] The full pest risk assessments have been made according to the Guidelines for the European and Mediterranean Plant Protection Organisation (EPPO) pest risk assessment scheme in EPPO Standard PM 5/3 (1) (EPPO Bulletin 27, 281-305).

Phytosanitary Measures ISPM No. 11[3]: Pest risk analysis for quarantine pests including analysis of environmental risks and living modified organisms (2004) by the International Plant Protection Convention (FAO, 2007b).

The review evaluated the accuracy and relevance of data, the information provided for pest risk assessment purposes, the quality and quantity of data considered, and the quality of methods applied to conduct the risk assessment.

Following analysis of the French document and from additional information sought, the Panel established that BBrMV is a well-characterised virus, for which reliable assays, mainly based on PCR, are currently available for identification. All four aphid species, known to have the ability to transmit BBrMV, are present in the French overseas departments, providing conditions suitable for its further spread after entry.

Taking into considerations these elements the Panel concludes that:

- The most important potential pathway of entry for BBrMV into the French overseas departments is through the import of infected banana propagating materials (vitroplants, suckers). Minor pathways include the introduction of infected cultivars by private individuals and the import of banana fruits and leaves.
- The current French regulations provide the means to ensure that the probability of entry of BBrMV is extremely low. In the absence of those regulations, the probability of entry would be higher, and has been considered by the Panel as low/medium. Although propagation material represents the main entry pathway, BBrMV is noted as currently restricted in distribution to a small number of countries in Asia and the Pacific.
- There is a high probability of establishment of BBrMV in the PRA area[4]. As plant propagation material represents the main pathway for introduction, the establishment of the virus, after planting of infected material, is assured.
- There is a potential for negative economic and social consequences should BBrMV be introduced, in particular concerning Guadeloupe and Martinique where banana crops form a major part of the agricultural economy.

The Panel recognises that there are some areas of uncertainty, concerning the biology of BBrMV, such as symptom expression and host range. However, these uncertainties are considered unlikely to affect the conclusions reached by the Panel.

The overall conclusion of the Panel is that BBrMV poses a risk to the banana crops of the four overseas departments and thus qualifies for risk management measures. BBrMV is therefore considered potentially eligible for addition to the list of harmful organisms under Directive 2000/29/EC.

Key words: ***Banana bract mosaic virus*, French overseas departments, *Musa* spp., pest risk assessment, potential harmful organism, Potyvirus.**

[3] ISPM: International Standard for Phytosanitary Measures. ISPM No. 11: Pest risk analysis for quarantine pests, including analysis of environmental risks and living modified organisms.
[4] PRA area is the area in relation to which a Pest Risk Analysis is conducted [FAO, 2007a].

TABLE OF CONTENTS

BACKGROUND AS PROVIDED BY THE EUROPEAN COMMISSION[5]

The current Community plant health regime is established by Council Directive 2000/29/EC on protective measures against the introduction into the Community of organisms harmful to plants or plant products and against their spread within the Community (OJ L169, l0.7.2000, p. l), as last amended by Commission Directive 2006/35/EC (OJ L88, 25.3.2006, p. 9).

The Directive lays down, amongst others, the technical phytosanitary provisions to be met by plants and plant products and the control checks to be carried out at the place of origin on plants and plant products destined for the EC or moved within the EC, the list of harmful organisms whose introduction into or spread within the EC is prohibited and the control measures to be carried out at the outer border of the EC on arrival of plants and plant products. A harmful organism is defined in its Article 2.1.(e) as: any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products.

However, the provisions of the Directive are at present not yet applicable to trade in plants and plant products between the French overseas departments and the remainder of the Community. In view of the special nature of the agricultural production of the French overseas departments, additional protective measures justified on grounds of the protection of health and life of plants and plant products therein should be given.

France has therefore prepared for 4 departments (Guadeloupe, Guyana, Martinique and Réunion 130 pest risk analyses (PRA) on organisms which are considered by France as harmful for the most important crops grown in these departments, such as banana, sugar cane, pine apple, rice, coffee, orchids, Palmae, etc. These PRAs cover a wide range of harmful organisms, such as insects and mites (54), fungi (14), bacteria (20) and virus (42).

In accordance with the discussions on this topic in the meeting of the Standing Committee on Plant Health on 27 and 28 April 2006, it was agreed that in a first phase France would select 30 PRAs among the 130 PRAs initially transmitted. They cover harmful organisms (insects, mites, fungi, bacteria and virus) affecting citrus fruit and bananas grown in the above departments.

Two types of PRA have been made: a full PRA for harmful organisms for which the probability of introduction into the French overseas departments is high with economic important crops and a simplified PRA for organisms for which the probability of introduction is extremely low.

The full PRAs have been made according to the Guidelines for the European and Mediterranean Plant Protection Organisation (EPPO) pest risk assessment scheme in EPPO Standard PM 5/3 (1) (EPPO Bulletin 27, 281-305). This scheme aims at assessing the potential risk of a particular pest (or harmful organism) for a clearly defined area through a quantitative evaluation of that risk based on questions to which replies are given on a 1-9 scale. Expert judgement is used in interpreting the replies. Moreover for each of the 130 harmful organisms a data sheet containing the most important data on the organism has been made according to the EPPO Standard PM 5/1 (1) on Checklist of information required for PRA (EPPO Bulletin 23, 191-198). The guidelines are based on many years experience of EPPO experts in the EPPO Panel on PRA and the EPPO Panel on phytosanitary measures. They conform with the International Standards on Phytosanitary Measures (ISPM) No 11 (Guidelines on PRA for quarantine pests) and use the terms of ISPM No 5 (Glossary of phytosanitary terms).

The simplified PRAs contain in a "synthetic fiche" the information available allowing the assessment of the risk associated with the relevant organism.

[5] Submitted by the European Commission, ref. SANCO E/1/VE/svi D(2006)510488

TERMS OF REFERENCE AS PROVIDED BY THE EUROPEAN COMMISSION

EFSA is requested, pursuant to Article 29(1) and Article 22(5) of Regulation (EC) No 178/2002, to provide a scientific opinion on 30 PRAs made by France on organisms which are considered by France as harmful in 4 French overseas departments, i.e. Guadeloupe, French Guiana, Martinique and Reunion, and in particular whether these organisms can be considered as harmful organisms for the endangered area of the above departments in the meaning of the definition mentioned in Article 2.1.(e) of Directive 2000/29/EC and thus potentially eligible for addition to the list of harmful organisms in Directive 2000/29/EC.

ACKNOWLEDGEMENTS

The European Food Safety Authority wishes to thank the members of the Working Group for the preparation of this opinion: Mariano Cambra Alvarez, Thierry Candresse, Nuria Duran Vila, Bärbel Gerowitt, Harm Huttinga, David Jones, Olia Karadjova, Mária Kölber, Cornelia Pasberg-Gauhl, Matilde Tessitori and Stephan Winter.

ASSESSMENT

1. Introduction

This document presents the opinion of the Panel on Plant Health on the pest risk assessment conducted by France on *Banana bract mosaic virus* with the French overseas departments of French Guiana, Guadeloupe, Martinique and Réunion considered as endangered area.

1.1. General introduction to *Banana bract mosaic virus*

*Banana bract mosaic v*irus (BBrMV) is a recently described filamentous virus on banana (Magnaye and Espino, 1990). It is a distinct member of the genus *Potyvirus* in the family *Potyviridae* (Thomas *et al.*, 1997). BBrMV occurs naturally on cultivated banana (*Musa* spp.) (Thomas *et al.*, 2000). Symptoms have also been observed on the ornamental banana *M. ornate* growing in close proximity to affected banana cultivars (Thomas *et al.*, 2000). Although no host is known other than *Musa* spp., Dale (2004) noted that studies on the host range of BBrMV have not been comprehensive enough to completely rule out the possible existence of non-*Musa* hosts.

The virus has a limited occurrence as it has so far only been reported from certain countries in Asia and Oceania. BBrMV is not known to be present in the PRA area.

The virus causes typical mosaic symptoms on floral bracts. Symptom expression may vary over time and depending on banana genotypes, varieties, temperature and country (Thomas *et al.*, 2000). Yield losses of up to 40% have been reported in 'Saba' and 'Cardaba' (ABB genome) cooking banana cultivars (Roperos and Magnaye, 1991).

BBrMV is transmitted experimentally by the cotton or melon aphid, *Aphis gossypii* Glover (Homoptera: Aphididae), the corn aphid, *Rhopalosiphum maidis* Fitch (Homoptera: Aphididae), the banana aphid, *Pentalonia nigronervosa* Coquerel (Homoptera: Aphididae) and the cowpea aphid, *Aphis craccivora* Koch (Homoptera: Aphididae) in a non-persistent manner (Thomas *et al.*, 2000; Selvarajan *et al.*, 2006). All these aphid species are known to be present in the PRA area (see 2.2.2.1.). BBrMV can be spread over long distances via the international movement of vegetative propagation material, particularly micropropagated plantlets (vitroplants) (Diekmann and Putter 1996; Thomas *et al.*, 2000).

French phytosanitary regulations addressing BBrMV are in force for the area covered by the PRA (JORF 16/02/1992).

1.2. The document under scrutiny

The assessment of risks of the organism is presented by the French risk assessors in a so-called full pest risk assessment made according to the Guidelines for the European and Mediterranean Plant Protection Organisation (EPPO) pest risk assessment scheme [EPPO Standard PM 5/3 (1)].

Based on this document, France requested *Banana bract mosaic virus* be added to the list of harmful organisms in Directive 2000/29/EC.

1.3. Evaluation procedure

The Panel examined in detail the documents provided, and considered the accuracy and quality of the information and methods applied for pest risk assessment purposes.

The evaluation of the French document was conducted on the basis of an English translation from an original submission in French, which remains the reference language.

Detailed comments have been made only for the questions where it was considered that the French assessment is incorrect or could be improved. Where the Panel has uncovered new information that supports the French pest risk assessment, this has been noted. While the literature has been checked and additional data has been sought, no new analysis has been undertaken. The Panel has noted where it considers the risk scores provided by France were too low or too high but has not suggested an exact score.

1.4. General comments on the document

The document comprises 24 pages and is divided into two parts:

- Part I "Information required for Pest Risk Analysis" provides background information on the biology, geographical distribution, host range, establishment potential, control, spread and impact of the pathogen required for the assessment
- Part II "Pest Risk Assessment" contains the assessment of the risks posed by the organism

In general, the Panel found the French document to be difficult to assess. The document was prepared in 2003 and includes only 7 references. It is somewhat outdated and would have required updating.

The Panel identified in the document the following shortcomings:

- Specific statements made in the document and provided background information on the pathogen and the disease are not substantiated by scientific evidence and references on these aspects are not included in the provided list of references. This made it difficult to determine the accuracy of specific statements, greatly complicating the evaluation. In addition, the references cited were not provided as additional documentation, despite the fact that some of them are not readily available.
- The document does not take into account the new situation in the PRA area should the current phytosanitary regulations governing the imports of banana plant material be lifted. As a consequence several entry pathways were not or only cursorily evaluated.
- Potential impacts (economic, social, environmental) were not analyzed in details and precise background information for each of the four French overseas departments (e.g. climatic conditions, distribution of banana plants in commercial plantations and private gardens, cropping systems and agricultural practices etc.) are either limited or lacking in the document.
- A number of estimates provided in Part 2 are not justified or substantiated by the background information provided in Part 1 of the document.
- Probabilities of entry and establishment, introduction, impacts and an overall risk rating are expressed in qualitative terms such as "low" "moderate" "high" etc. However, the numeric and descriptive ratings used in the document are not explained, and thus do not allow for accurate interpretation.
- Ratings for probability of entry, etc. are calculated as means of the scores given for the essential questions. Certain questions are considered to be essential and others are not but

explanation is missing. The use of decimals (e.g. 7.05) to express the ratings is giving a false impression of accuracy.

- The method of combining risk ratings and ascribing an overall risk rating is not defined and assumes equal weighting to the questions.
- Uncertainties were not discussed and assessment techniques for them were not proposed by the French document.

The Panel reviewed a translation of the original French document. In cases of doubt, the Panel has referred to the original French text.

2. Evaluation of the pest risk assessment

2.1. Pest categorization

2.1.1. Identity of pest

The French document identifies the virus as banana bract mosaic potyvirus or BBrMV. The Panel notes that the currently accepted name by the International Committee on Taxonomy of Viruses for this pest is *Banana bract mosaic virus* (Berger *et al.*, 2005).

The Panel agrees with the description in the French document of BBrMV as a filamentous virus, whose genome corresponds to that of a potyvirus (Thomas *et al.,* 1997).

The French document does not address the question of the relationship of BBrMV to other quarantine pests[6]. Although weak serological relationships have been demonstrated between BBrMV and other potyviruses (Thomas *et al.,* 2000), the Panel concludes that there is no quarantine agent closely related to BBrMV.

The French document describes the main symptoms of BBrMV as characteristic mosaics on the bracts, pseudostems and fruits of infected plants.

Although it agrees with this description, the Panel stresses that the issue of symptom expression is more complex than discussed in the French document. Symptoms, described in early literature when BBrMV was poorly characterized, might have been confused with those of *Cucumber mosaic virus* or *Abaca mosaic virus*. In addition, beside the characteristic bract mosaic, the colour and severity of mosaic symptoms and streaks caused by BBrMV on the pseudostem and young leaves, might vary depending on the cultivar, the virus strain/isolate and the environmental conditions of the infected plant in different countries. Similarly, variations in the intensity of symptoms on fruits have been described, ranging from mild to severe malformation and size reduction. In southern India, 'Nendran' (syn. 'French Plantain'; ABB genome) is severely affected by BBrMV. Suckering is suppressed and emerging suckers are distorted. Leaf sheaves separate from the pseudostem and leaf petioles arrange themselves fan-like on one plane. Plants are also stunted (Thomas *et al.,* 2000). At the other end of the spectrum, latent infections may also occur (Rodoni *et al.,* 1997; Thomas *et al.,* 1997; Thomas *et al.*, 2000).

The Panel concludes that, although the French document presents an appropriate general description of the symptoms caused by BBrMV, it failed to detail the variability associated with these symptoms.

[6] A quarantine organism is a pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled [FAO, 1990; revised FAO, 1995; IPPC 1997].

The French document indicates that BBrMV appears to be systematically associated with *Banana mild mosaic virus* (BanMMV) in the field. The Panel was unable to support this claim after studying the available scientific literature. Although the two viruses are frequently found together in infected banana (Thomas *et al*., 2000), BBrMV alone is known to cause the symptoms associated with the bract mosaic disease (Thomas *et al*., 2000). In particular, Thomas *et al.* (2000) indicates that "The banana aphid, *Pentalonia nigronervosa*, transmitted BBrMV but not BanMMV, from banana plants infected with both viruses". This observation would indicate that if present in a mixed infection, BBrMV and BanMMV can be separated by the differential aphid transmission of BBrMV.

The French document contains one sentence about serological detection methods, indicating that a polyclonal serum is available and an ELISA kit is marketed. The Panel confirms the validity of this information, but notes that production of other polyclonal antisera and the use of monoclonal antibodies have also been reported before 2003 (Sharman *et al.,* 2000a; Thomas *et al.,* 2000*).* This was overlooked by the French document.

The French document indicates that molecular detection is possible using degenerate primer pairs for the general detection of potyviruses and specific primers developed from the sequence of the BBrMV 550 isolate purified from the Cardaba cultivar (Philippines). Although the Panel agrees with this statement, it notes that additional publications were already available at the time of preparing the French document (Bateson and Dale, 1995; Thomas *et al.,* 1997; Sharman *et al*., 2000b), which were not cited in the French document and which confirm the availability of reliable detection of BBrMV using PCR-based assays.

The overall conclusion of the Panel is that BBrMV is now a well characterized virus for which suitable detection techniques are available.

The French document lists countries in the order of BBrMV appearance: Philippines (Magnaye and Espino, 1990), India and Sri Lanka (Diekmann and Putter, 1996), but the presence of the virus in Thailand and Samoa (Rodoni *et al.*, 1999) is considered unconfirmed by the French document. Rodoni *et al*. identified several BBrMV partial genomic sequences from Thailand, Vietnam and Western Samoa. The Panel considers, however, that, because the plants analyzed in this work were unusual in not displaying typical BBrMV symptoms, the presence of the virus in these three countries is still uncertain.

The overall conclusion of the Panel, in agreement with the French document is that BBrMV has been reported only from a few countries in Asia and that the reports from Thailand, Vietnam and Samoa require further confirmation.

2.1.2. Presence or absence in PRA area

The French document indicates that BBrMV has not been recorded in the PRA area. The Panel agrees that BBrMV is not known to occur in any of the four French overseas departments.

2.1.3. Regulatory status

French legislation

The French document provides a detailed description of the current phytosanitary regulations concerning banana viruses, including BBrMV, for the four French overseas departments.

For all four French overseas departments, BBrMV is listed as “bract mosaic disease” in Annex II B (organisms that may not be imported if present on specific plants or plant products) of the JORF 16/02/1992. The Annex V of the same Decree forbids the introduction of all parts of *Musa* spp. plants or of related genera. Banana fruits may only be imported from Dominica,

Martinique and Guadeloupe in Martinique, Guadeloupe and Guiana and may not be imported into Réunion at all.

BBrMV is listed in Annex A (Guadeloupe, Martinique and Réunion) or in Annex B (French Guiana) of the JORF 31/08/2000, listing pathogens under mandatory control.

Importation of banana vitroplants is permitted into the French overseas departments only after delivery of a special import licence conditioned by the fact that the mother stocks that have undergone a one-year quarantine process during which they are indexed for the presence of viruses, including BBrMV (JORF 19/11/1995).

The Panel concludes that the current French regulations provide an effective way to control the entry of BBrMV in the PRA area.

EC legislation

The Panel confirms that BBrMV is not a regulated pest in the EU.

2.1.4. Potential for establishment and spread in PRA area

Musa spp. hosts are present in the PRA area

The French document indicates that BBrMV can be spread by three aphid species (*A. gossypii, P. nigronervosa* and *R. maidis).* The Panel was able to confirm the presence in the PRA area of *P. nigronervosa* (Cocquerel, 1859 in Vayssières *et al*., 2001; Robson *et al.,* 2006), *A. gossypii (*Remillet, 1978), *R. maidis* and also of *A. craccivora* (Plénet, 1965 in Vayssières *et al.,* 2001), reported recently as vector of BBrMV in India (Selvarajan *et al*., 2006).

Although field transmission has not been proven, the presence of the vectors in the PRA area indicate a potential for field spread. The Panel also notes that other aphid species may be able to contribute to the field spread of BBrMV.

BBrMV is also spread by the propagation of infected plant material. The Panel agrees that conventional planting material (suckers and corms) is an important pathway for the spread of the virus.

The Panel agrees with the French document, which indicates that ecoclimatic conditions are of limited impact in the case of a virus. BBrMV is an obligate parasite, which exists within living tissues of banana. Therefore, its ecoclimatic requirements can be estimated as being similar to those of its *Musa* spp. hosts. It can be safely assumed that BBrMV would be able to replicate in infected plant propagation material after arrival in any of the four French overseas departments.

The Panel concludes that local conditions in the four French overseas departments would allow the establishment and spread of BBrMV if it was to be introduced.

2.1.5. Potential for economic consequences in PRA area

The French document describes the forms of direct damage caused by BBrMV on banana, but does not provides detailed data on the potential economic consequences (yield and/or quality loss, loss of export markets, cost of eradication and control, etc.) of the introduction of the pathogen into the four French overseas departments. The Panel established that a figure of 40% loss is frequently cited in the literature for BBrMV infection, although sometimes in relation to differently named varieties (Espino *et al.*, 1990; Bateson and Dale, 1995 in Rodoni *et al.*, 1997; Thomas and Magnaye, 1996 in Thomas *et al.*, 2000).

In the French document there is a short description about the importance of banana crops in the French overseas departments, based on the data from the Agreste database of the French Ministry of Agriculture. From the data provided and from further analysis of the data available

in Agreste, the Panel concludes that banana represents a very important component of agricultural production for Guadeloupe and Martinique, while it is of lower importance for French Guiana and Réunion.

Based on the above findings, the Panel concludes that BBrMV has the potential for economic consequences in the PRA area.

2.1.6. Conclusion of pest categorization

Banana bract mosaic virus is not known to occur in the PRA area, it has a potential for establishment and spread and a potential for negative economic consequences in the PRA area.

2.2. Assessment of the probability of introduction and spread

2.2.1. Probability of entry of the pest

2.2.1.1. Identification of pathways

The French document identifies two possible entry pathways. The major one is considered to be the commercial importation of banana vitroplants. The second one is the introduction of infected cultivars by private individuals. Only the major vitroplant pathway is then analyzed, and then only under a scenario considering that the current phytosanitary regulations remain into effect.

The Panel agrees that these two pathways are correctly identified and that the large-scale commercial importation of vitroplants constitutes the most important entry pathway. However, commercial importation of virus-infected conventional propagation also represents a potential entry pathway, despite the fact that it is currently closed by the French regulations. This pathway was not addressed in the French document.

The Panel also considers that trade in banana fruit or leaves in the absence of the current regulations, might represent an additional pathway of entry, which has been overlooked in the French document.

2.2.1.2. Probability of the pest being associated with the pathway at origin

The French document provides no information on the prevalence of the pathogen in the areas of origin or on the cultural and commercial procedures applied for the management of the pathogen in the contaminated areas, from which *Musa* spp. could potentially be imported into the four French overseas departments in case the current ban is lifted.

The Panel agrees with the French document that the risk associated with the vitroplants pathway at origin is very low under the current French regulations. However, the Panel established that in 2003 a consignment of micropropagated banana plantlets infected by BBrMV was intercepted in Brazil (Marinho and Batista, 2005), demonstrating that despite the quality control practices generally associated with the commercial production of vitroplants, the possibility of introduction of BBrMV through this pathway should not be overlooked. Therefore, the Panel considers that the probability of entry would be increased to a low to medium level should the current French regulations be removed.

Given the limited geographical distribution of BBrMV and the great distance separating the affected area from the PRA area, the Panel considers that the French overseas departments are unlikely to import banana plant propagation material (other than vitroplants), banana fruit or

plant parts from the affected area and that the probability of BBrMV to be associated with the corresponding pathways at origin is low, with the possible exception of Réunion.

2.2.1.3. Probability of survival during transport or storage

Given the viral nature of the pathogen under consideration, it is considered highly likely to survive during transport and storage as long as the infected banana material remains viable.

2.2.1.4. Probability of pest surviving existing pest management procedures

The current regulations provide for the strict control of the import of vitroplants (i.e. *in vitro* plantlets only, from licensed companies) or of other banana propagation materials or plant parts. However, any potential consequences, in case the current regulations are lifted, are not taken into consideration in the French document. No information is provided in the document concerning post-entry surveillance of plantlets produced *in vitro*.

The Panel agrees with the French document that the probability of BBrMV escaping detection during inspection procedures should be considered as high.

2.2.1.5. Probability of transfer to a suitable host

As stated in the French document, for the pathways involving banana propagation materials, including vitroplants, BBrMV would already be associated with a suitable host.

Concerning the banana fruits or leaves pathway, transfer to a suitable host requires an aphid vector. Studying the literature, the Panel confirmed that symptoms due to BBrMV have been observed on banana fruit (Thomas *et al.*, 2000), and the virus is assumed to be systemic within the banana plant, including the peel of the fruit. Viruliferous aphids may be present in banana bunches and *P. nigronervosa*, the known BBrMV vector, has been found feeding on banana fruits when population densities were high (Magee, 1927; Thomas *et al.,* 2000).

The Panel notes that studies have demonstrated that fruits of other tree fruit species can be a source of potyviruses for acquisition by aphids, such as stone fruits for *Plum pox virus* (PPV) and melon for *Papaya ringspot virus* (Labonne and Quiot, 2001; Lecoq *et al.,* 2003; Gildow *et al.*, 2004). Although there is no data on the viability of BBrMV in banana fruit or detached leaves nor any direct evidence that these organs could be a source of virus for aphid vectors, the Panel concluded that available evidence from other potyviruses suggests that aphids (and in particular the banana aphid, *P. nigronervosa*) might be able to acquire BBrMV from banana fruit or leaves or from fruit waste and then transmit it to banana plants.

The Panel concludes that the possibility exists that BBrMV could thus be transferred to a suitable host. However, in practice, the probability of such a transfer is considered low by the Panel given the sequence of low probability events that would be needed and the non-persistent nature of BBrMV transmission by aphids.

2.2.1.6. Conclusion on the probability of entry

The conclusion drawn by the French document on the probability of entry is imprecise and difficult to interpret. The document suggests that the probability of presence of the virus in vitroplants is variable, but rather low in practice and gives a rating of moderate.

After evaluating the various pathways identified, the Panel concludes that they each have a low probability for the association of the pathogen at origin, with the exception of the vitroplant pathway, which is considered to have a low to medium probability, should the current French regulations be lifted. On the other hand, the probability of the virus surviving transport or

storage and existing pest management procedures is rated as high, irrespective of the pathway considered. Lastly, the probability of transfer to a suitable host is rated as high for the pathways involving propagation material but low for the fruit and leaves pathways.

Taking these various elements into consideration, the Panel concludes that the probability of entry of BBrMV in the PRA area is low to medium.

2.2.2. Probability of establishment

2.2.2.1. Availability of suitable hosts, alternate hosts and vectors in the PRA area

The French document indicates that BBrMV appears to be restricted to *Musa* sp. Although the Panel findings confirm that this statement accurately reflects the scientific consensus, the Panel wishes to stress two additional points. Concerning the natural host range of the virus, Dale (2004) has noted that the host range studies are not comprehensive so that the existence of non-*Musa* host cannot be completely discounted. Concerning the experimental host range, the studies performed only involved mechanical transmission, which is inefficient for some viruses or some hosts and did not involve the generally more efficient aphid transmission assays. Using such approaches, Kenyon *et al.* (1997) reported the transmission of BBrMV to two tobacco species. However, this finding has been questioned, since these results have not been reproduced and a reliable BBrMV diagnostic test was not available at that time. The Panel concludes that despite the fact that current evidence limits BBrMV host range to *Musa* species, there have been no surveys for BBrMV on weed species in and around banana plantations, so there are still substantial uncertainties about the natural and experimental host range of the virus.

In the French document there is a detailed discussion about the importance of banana crops in the French overseas departments, based on data from the Agreste database of the French Ministry of Agriculture. These data were confirmed by a more recent search made by the Panel. In 2006, dessert bananas of the Cavendish sub-group were produced commercially on 7300 ha in Martinique (Agreste, 2007a) and on 2240 ha in Guadeloupe (Agreste, 2007b). In the same year, in Réunion 500 ha were cultivated with bananas (Agreste, 2007c). Data from 2005 show 355 ha of bananas in French Guiana (INSEE, 2007).

Dessert bananas, plantains and other cooking bananas are also grown in the French overseas departments for household consumption in private gardens. The importance of this production is underpinned by food consumption data for Guadeloupe and Martinique (AFSSA, 2007). In 2006 family gardens occupied 1080 ha in Martinique, 615 ha in Guadeloupe and 2890 ha in Réunion (Agreste, 2007a, b and c). In French Guiana, banana and plantain are among the associated crops of the shifting cultivation, which is practiced on 33% of the total utilized agricultural area (PDR Guyane, 2007).

Based on these data the Panel concludes that banana hosts are widely available in the four French overseas departments.

The French document identified three aphid vector species, known to be capable of experimentally transmitting BBrMV, the cotton or melon aphid, *Aphis gossypii* Glover (Homoptera: Aphididae), the corn aphid, *Rhopalosiphum maidis* Fitch (Homoptera: Aphididae), the banana aphid, *Pentalonia nigronervosa* Coquerel (Homoptera: Aphididae). In addition, the Panel found additional information that a fourth aphid species, the cowpea aphid, *Aphis craccivora* Koch (Homoptera: Aphididae) was also a vector of BBrMV (Selvarajan *et al.*, 2006).

All the four species are known to be present in the French overseas departments: *P. nigronervosa* (Cocquerel, 1859 in Vayssières *et al*., 2001; Robson *et al*., 2006), *A. gossypii (*Remillet, 1978), *R. maidis* and also of *A. craccivora (*Plénet, 1965 in Vayssières *et al.*, 2001), reported recently as vector of BBrMV in India (Selvarajan *et al*., 2006). In addition, other local aphid species may also be able to transmit BBrMV.

The overall conclusion of the Panel is that the PRA area contains an abundance of suitable host plants and all four BBrMV vector species are present.

2.2.2.2. Suitability of environment

Given the viral nature of the pathogen under consideration, and close association with the host plant, the local ecoclimatic conditions are not considered a limiting factor as long as they are suitable for the banana host.

2.2.2.3. Cultural practices and control measures

The French document does not provide information on current cultural practices and on the way(s) they may affect BBrMV. It indicates that the implementation of an eradication programme and the use of infection-free suckers as a replacement is the only effective way of controlling BBrMV.

The Panel agrees with this general statement as, due to the lack of resistant cultivars, BBrMV has to be controlled by the implementation of strict eradication programs. In the absence of absolute proof that BBrMV can cause symptomless infection, the Panel considers that visual inspection followed by removal of plants showing symptoms could be an efficient way to get rid of sources of infection. This can be achieved in banana plantations, but the widespread and scattered cultivation of banana and plantain on smallholdings and in home gardens in the French overseas departments presents a serious difficulty towards an eradication of virus source plants. The Panel further noted that it is impossible to find by visual inspection those plants that have only recently been infected and do not show symptoms.

The French document indicates that use of insecticide treatments reduces the number of aphids in the short term, but that it is difficult to achieve satisfactory control in the long term by such treatments. The Panel agrees with this statement and wishes to emphasize that the spread of non-persistently transmitted potyviruses cannot be effectively prevented by insecticide treatments owing to their extremely short acquisition time and to the fact that aphid populations residing outside of the culture, and thus not targeted by insecticide treatments, generally have an important epidemiological contribution for such viruses.

Overall, the Panel concludes that control of BBrMV, once introduced in the French overseas departments, would be difficult to achieve.

2.2.2.4. Conclusion on the probability of establishment

The Panel concludes that given the widespread availability of hosts, the presence of several vector species and the limited efficiency of the available control measures, the probability of establishment would be high.

2.2.3. Probability of spread after establishment

Given the above discussed widespread availability of hosts, the presence of several vector species and the limited efficiency of the available control measures, the Panel concludes that the probability of spread after establishment would be high.

2.2.4. Conclusion on probability of introduction and spread

The probability of introduction is rated as moderate, although this estimation is not justified or explained, it is derived from combining ratings for the probability of entry and establishment. I

The Panel concluded that the pathways identified provide a low probability of entry of BBrMV in the PRA area, with the exception of the vitroplant pathway, which is considered to have a low to medium probability should the current French regulations be lifted. The current French regulations, with the severe limitations they impose on the import of banana material, have the consequence of further reducing this risk of entry, by effectively closing two of the pathways (illegal introduction by private individuals and import of non-vitroplant propagation material), of severely limiting a third one (import of fruits), and of adding compulsory control steps to the major one (vitroplants). As a consequence, these regulations are seen by the Panel as having the effect of reducing the overall probability of entry of BBrMV in the PRA area from low/medium to extremely low.

Given the widespread availability of potential hosts, the presence of several vector species and the limited efficiency of the available control measures, the probability of establishment and the probability of spread following establishment are both considered as high by the Panel.

2.3. Assessment of potential economic consequences

2.3.1. Direct pest effects

2.3.1.1. Crop quality and/or yield losses

The main host plants of BBrMV are banana and plantain. A relatively large share of the agricultural area of Guadeloupe and Martinique is devoted to banana production and a relatively small share in French Guiana and Réunion (see section 2.2.2.1.).

The French document indicates that the symptoms of BBrMV generally appear on the pseudostem and on the bracts covering the male buds and that their severity may vary depending on cultivars. The most severe damage is the distortion of bunches with malformed fruits and the absence of sucker production. The Panel found that this description of the symptoms caused by BBrMV accurately reflects the information available in the literature.

The French document indicates that the only information available concerning the yield reduction occasioned by BBrMV infection concerns reports of losses of approx 40% in the case of the cultivars ‘Cardaba’ and ‘Lakatan’ (AAA) in the Philippines.

After reviewing the literature, the Panel concluded that more data were available on the direct effect of BBrMV in the Philippines as well as in India. The disease was present on four cultivars (‘Canara’, ‘Pisang Pulot’, ‘Maduiranga’ and ‘Morado’) in Davao, Mindanao when it was first observed in the Philippines in 1979. Within a decade, it had become widespread on local varieties (Magnaye and Espino, 1990). Roperos and Magnaye (1991) reported that an epidemic of bract mosaic in South Cotabao caused the destruction of 25,000 mats from August to December 1988. They found that several cultivars (‘Saba’, ‘Cardaba’, ‘Turakong’, ‘Viente Cohol’, ‘Dakdakan’, ‘Pulutan’, Robusta’, Ambon’, ‘Abuhon’, ‘Tukoroo’) and also wild *Musa balbisiana* were susceptible and that the disease could reduce yield by 40%. According to Bajet and Magnaye (2002), BBrMV commonly infects ‘Saba’ and ‘Cardaba’ and it also attacks Cavendish cultivars. In addition Kenyon *et al*. (1996) suggest that the virus is widespread and has been observed to reduce fruit yield by 40% in ‘Cardaba’ and ‘Lakatan’. Kenyon and co-workers documented the effects of the disease on fruit yields of ‘Lakatan’ in 1996. Data on

bunches harvested from plants with definite symptoms showed a significant reduction in the weight of the second hand and of the entire bunch.

The Panel established that the figure of 40% loss caused by BBrMV was frequently cited in the literature, although sometimes in relation to differently named varieties (Espino *et al.*, 1990; Bateson and Dale, 1995 in Rodoni *et al.*, 1997; Thomas and Magnaye, 1996 in Thomas *et al.*, 2000). Thomas *et al*. (2000) noted that ABB genome cooking banana cultivars and also cultivars in the Cavendish subgroup (AAA) on commercial plantations were affected by BBrMV in the Philippines. In commercial plantations of Mindanao, a correlation between high incidence of bract mosaic and high fruit rejection rates due to misshapen fingers has been noted (Thomas *et al*., 2000). Streak on fruits can also result in rejection. Due to its wide distribution and damage caused in the Philippines, bract mosaic disease was included by banana virologists in a list of viruses of quarantine importance in 1988 (Frison and Putter, 1989). The importance of BBrMV is demonstrated by the fact that the virus is regulated by all the countries where it is present.

In India, the disease was observed for the first time in 1966 on 'Nendran' (AAB, Plantain subgroup) and was known locally as 'kokkan' in Kerala State, but the causal agent was not known (Shanmugavelu *et al*., 1992). The failure of fruit to fill on infected plants has been noted also in India (Diekmann and Putter, 1996). BBrMV disease was identified by Rodoni *et al.* (1997) in two districts of Tamil Nadu. The infected plants showed significant reduction in height, girth, leaf area and finger weight compared to healthy ones (Selvarajan and Singh, 1997). A study conducted by Thangavelu and Singh (2000) on yield loss assessment due to BBrMV showed the following reduction in bunch weight in three cultivars in 1995/96: 'Nendran' (68%), 'Poovan' (50%) and 'Ney Poovan' (46%). In similar studies Cherian *et al*. (2002) reported yield reduction in 'Robusta' (70%) and in 'Nendran' (52%). They observed in addition that the fingers became malformed and curved, reducing the marketability of the fruit. Selvarajan and Jeyabaskaran (2006) reported that the incidence of BBrMV on 'Nendran' ranged from 5% to 36% and was higher in Kerala. They also studied the effects of BBrMV on growth and yield of this plantain cultivar in a field experiment in Tamil Nadu, where an average of 30% yield reduction and 69% reduction on bunch weight was measured in naturally infected banana plants. The yield differences between healthy and infected plants were higher in fertile soil than in saline, low fertilized soils. Severely affected plants may fail to flower and their pseudostem has stunted growth, becomes necrotic and may die.

2.3.1.2. Control measures, efficacy and costs

Introduction of BBrMV in the PRA area would probably result in efforts to reduce its spread through insecticide use to lower aphid vector populations and in efforts to eliminate the disease through the implementation of an eradication program.

The French document provides only very general, non-quantitative remarks concerning control costs. The Panel notes that the cost of running such an eradication program, should be expected to be very significant. The Panel further stresses that eradication of non-persistently transmitted viruses such as potyviruses is difficult to achieve.

On the other hand, the Panel considers the cost of diagnostic services associated with maintaining a virus-free status for the imported vitroplants to be low compared to the commercial value of the vitroplants.

2.3.2. Indirect pest effects

2.3.2.1. Export markets

The French document indicates that the economic impact would be great for the banana export market in Guadeloupe and Martinique, and that the virus could cause considerable economic loss if not detected and eradicated very quickly. It does not provide, however, quantitative estimators of the export market or of the potential losses.

The Panel documented that Martinique exported a net total of 228,358 tonnes (≈ 178 mln euros)[7] of bananas in 2005, representing 93% of local production (Aumand, 2006). In 2004, 251,695 tonnes of bananas were exported, representing 89% of the total production of banana varieties intended for export (Agreste, 2006a). In Guadeloupe, the export of bananas was 65,730 tonnes in 2004 and 51,700 tonnes (≈ 37 mln euros)[7] in 2005, *i.e.* respectively 75% and 80% of the total production of banana varieties intended for export (Agreste, 2006b). In French Guiana and Réunion, banana production is for local consumption only (DAF Guyane, 2001; Le Jeannic, 2002).

Banana production of Guadeloupe and Martinique is mainly exported, with the EU being the primary trading partner (Lassoudière, 2007). In the first half of the year 2006, 19,370 tonnes were imported into the EU from Guadeloupe, 84,607 tonnes from Martinique, while 119,261 tonnes were imported from Cameroon and 105,023 tonnes from Ivory Coast (Lassoudiére, 2007). Under the current EU regulations (Directive 2000/29/EC), the introduction of BBrMV into the French overseas departments would however not evoke quarantine restrictions to fruit trade towards EU.

The Panel concludes that introduction of BBrMV would not necessarily affect the access to export markets, but that negative effects on fruit quality and reduced production would be likely to affect exports, with potential long term negative effects should buyers seek alternative suppliers to make up for reduced production.

2.3.2.2. Social consequences

The French document does not adequately address any potential social consequences as a result of the pathogen's establishment in the PRA area and does not provide any precise figures.

The Panel determined that banana production is important for employment in Martinique and Guadeloupe. The banana industry provides 7,000 direct jobs in Martinique and 10,000 direct and indirect jobs in Guadeloupe. The additional control costs due to BBrMV may reduce the competitiveness of the banana industry in Martinique and Guadeloupe, with potential negative impacts on employment. There is however uncertainty regarding this aspect, given the uncertainties about the volume of the additional control costs (see above).

Plantain and cooking banana are an important staple food and a large fraction is household-produced (AFSSA, 2007). Since the disease is not likely to be controllable in smallholdings and family gardens, high yield losses and a potential disruption of subsistence production and consumption patterns would occur. This may also cause negative social impacts. Similar social effects are envisaged for shifting cultivation in French Guiana, where banana is one of the associated crops. There is uncertainty regarding the availability and the costs of substitution foods, should the yield of cooking banana and plantain be substantially reduced.

[7] based on average prices at departure for the first semester 2005 (Agreste 2006. La statistique agricole. Le Bulletin. Séries chronologiques, 13, Guadeloupe, 1er Semestre 2006, 4 pp.)

2.3.2.3. Environmental consequences

The document does not discuss in detail any potential environmental consequences. The Panel is of the opinion that environmental consequences that might be associated with the introduction of BBrMV would be limited, and may arise from a potential increase in insecticide applications to minimise the aphid vector population.

2.3.3. Conclusion of the assessment of economic consequences

The document concludes that the economic consequences as a result of the introduction of BBrMV into the PRA area would be serious but this estimate is poorly supported by the limited information provided in the document.

Based the information provided in the French document and on additional literature consulted, the Panel concludes that should BBrMV enter and establish in the PRA area:

- Within commercial plantations of dessert bananas the negative effects of the disease would be high. In addition, the implementation of an eradication program would result in extra costs that could further reduce the competitiveness of the banana industry in Martinique and Guadeloupe.
- Plantain and cooking banana are an important staple food and a large fraction is household-produced (AFSSA, 2007). Since the disease would not be readily controllable in smallholdings and family gardens, high yield losses and a potential disruption of subsistence production and consumption patterns could occur in all four French overseas departments, with potential negative social impacts.

Overall, the Panel therefore agrees, despite the remaining uncertainties, with the conclusion in the French document that BBrMV is likely to have negative economic and social consequences should it be introduced in the PRA area. Economic impact would be high for Guadeloupe and Martinique, where banana production for export is an important agricultural activity, but lower for French Guiana and Réunion.

2.4. Comments on the conclusion of the pest risk assessment

The final conclusion drawn by the French document is unclear. It states that the phytosanitary risk associated with BBrMV is extremely low if the pathways for introduction of plant material are well identified and that it is important to remain vigilant as regards the introduction of new varieties by private individuals.

The Panel found this conclusion to be unsound since the overall rating of “extremely low” applies only if the current French regulations remain in place and the risk assessment does not take into account the situation in the absence of the current regulations. The Panel overall disagrees with the conclusion of the French document and considers that, for the PRA area, there is:

- an extremely low probability of entry of BBrMV under the current French regulations. However in the absence of those regulations, the probability of entry would be higher and is considered by the Panel as low/medium,
- a high probability of establishment and spread of BBrMV, given the widespread availability of potential hosts, the presence of several vector species and the limited efficiency of the available control measures,
- a potential for negative economic and social consequences should BBrMV be introduced.

In addition, the Panel stresses that, should BBrMV be introduced in the PRA area, it would be very difficult, if not impossible, to eradicate it.

Therefore, the Panel's final conclusion is that BBrMV poses a risk to the banana crops of the four overseas departments and thus qualifies for risk management measures.

2.4.1. Degree of uncertainty

The Panel recognises that there are some areas of uncertainty, concerning the biology of BBrMV, such as symptom expression and host range. However, the development of new information on these aspects is considered unlikely to affect the conclusions reached by the Panel.

CONCLUSIONS AND RECOMMENDATIONS

Following analysis of the French document and from additional information sought, the Panel established that BBrMV is a well-characterised virus, for which reliable assays, mainly based on PCR, are currently available for identification. All four aphid species, known to have the ability to transmit BBrMV, are present in the French overseas departments, providing conditions suitable for its further spread after entry.

Taking into considerations these elements the Panel concludes that:

- The most important potential pathway of entry for BBrMV into the French overseas departments is through the import of infected banana propagating materials (vitroplants, suckers). Minor pathways include the introduction of infected cultivars by private individuals and the import of banana fruits and leaves.
- The current French regulations provide the means to ensure that the probability of entry of BBrMV is extremely low. In the absence of those regulations, the probability of entry would be higher, and has been considered by the Panel as low/medium. Although propagation material represents the main entry pathway, BBrMV is noted as currently restricted in distribution to a small number of countries in Asia and the Pacific.
- There is a high probability of establishment of BBrMV in the PRA area. As plant propagation material represents the main pathway for introduction, the establishment of the virus, after planting of infected material, is assured.
- There is also a high probability of spread of BBrMV following establishment in the PRA area, due to the presence of all four aphid vectors in the PRA area.
- There is a potential for negative economic and social consequences should BBrMV be introduced, in particular concerning Guadeloupe and Martinique where dessert banana crops form a major part of the agricultural economy.

The Panel recognises that there are some areas of uncertainty, concerning the biology of BBrMV, such as symptom expression and host range. However, these uncertainties are considered unlikely to affect the conclusions reached by the Panel.

The overall conclusion of the Panel is that BBrMV poses a risk to the banana crops of the four overseas departments and thus qualifies for risk management measures. BBrMV is therefore considered potentially eligible for addition to the list of harmful organisms under Directive 2000/29/EC.

DOCUMENTATION PROVIDED TO EFSA

1. Letter, dated 14 July 2006 with ref. SANCO E/1/VE/svi D(2006) 510488 from P. Testori Coggi to C. Geslain-Lanéelle.
2. Analyse du Risque Phytosanitaire BAN-v2 : *Banana bract mosaic potyvirus*. Rédaction : M. L. Caruana / CIRAD – Août 2003.

REFERENCES

AFSSA (Agence Française de Sécurité Sanitaire des Aliments) 2007. Actualisation de l'exposition alimentaire au chlordécone de la population antillaise, évaluation de l'impact de mesures de maîtrises des risques. Document technique AQR/FH/2007-219, 79 pp. Available from: http://www.afssa.fr/Documents/RCCP-Ra-ChlAQR2007.pdf and http://www.afssa.fr/Documents/RCCP-Ra-ChlAQR2007ANX.pdf

Agreste 2006a. Memento agricole 2006 (résultats 2005). Agreste Martinique – La statistique agricole, Novembre 2006, 2 pp.

Agreste 2006b. Memento agricole, Résultats 2005. Agreste Guadeloupe – La statistique agricole, Novembre 2006, 2 pp.

Agreste 2007a. Memento agricole 2007 (résultats 2006). Agreste Martinique – La statistique agricole, Novembre 2007, 2 pp. Available from: http://agreste.agriculture.gouv.fr/IMG/pdf/D97208C01_.pdf

Agreste 2007b. L'agriculture guadeloupéenne en 2006. Bilan Statistique agricole annuelle. Comptes départementaux de l'agriculture. Agreste Guadeloupe, Novembre 2007 **3**, 24 pp. Available from: http://agreste.agriculture.gouv.fr/IMG/pdf/D97107A03.pdf

Agreste 2007c. Memento agricole et rural 2007 – La Réunion (résultats 2006). Agreste Réunion – La statistique agricole, Décembre 2007 **11**, 2 pp. Available from: http://agreste.agriculture.gouv.fr/IMG/pdf/D97407A15.pdf

Aumand B 2006. 2005, l'année de tous les dangers. Antiane **66**:16-18.

Bajet NM and Magnaye LV 2002. Virus Diseases of Banana and Abaca in the Philippines. Philippine Agriculture and Resources Research Foundation, Inc., Los Banos, Laguna, Philippines, 82p.

Bateson MF and Dale JL 1995. Banana bract mosaic virus: characterisation using potyvirus specific degenerate PCR primers. Archives of Virology **140:** 515-527.

Berger PH, Adams MJ, Barnett OW, Brunt AA, Hammond J, Hill JH, Jordan RL, Kashiwazaki S, Rybicki E, Spence N, Stenger DC, Ohki ST, Uyeda I, van Zaayen A, Valkonen J and Vetten HJ 2005. Family Potyviridae. In: Virus Taxonomy : Eighth report of the International Committee on Taxonomy of Viruses. Fauquet, C.M., Mayo, M.A., Maniloff, J., Desselberger, U. and Ball, L.A. (Eds). Elsevier Academic Press San Diego, USA; 819-841.

Cherian KA, Menon R, Suma A, Nair S and Sudeesh MV 2002. Effect of banana bract mosaic disease on yield of commercial varieties in Kerala (Abstr.). In: Global conference on Banana and Plantain, Bangalore, pp.155.

Cocquerel C 1859. Notes sur quelques insectes de Madagascar et de Bourbon. Ann. Soc. Entomol. Fr. 7, 239—260. *cit in*:. Vayssières, J. F; Delvare, G.; Maldès, J. M. and Aberlenc,

H. P. 2001. Inventaire Preliminaire des Arthropodes Ravageurs et Auxiliaires des Cultures Maraicheres sur l'Ile de la Réunion. Insect Sci. Applic. **21**(1): 1-22.

Council Directive 2000/29/EC of 8 May 2000 on protective measures against the introduction into the Community of organisms harmful to plants or plant products and against their spread within the Community, *OJ*L 169, 10.7.2000, 112 pp.

DAF Guyane (Direction de l'Agriculture et de la Forêt) 2001. Agriculture. http://daf.guyane.agriculture.gouv.fr as last updated on 01 January 2001 (accessed on 20 February 2008).

Dale JL 2004. Banana Bract Mosaic Virus: The Threat of Importation of the Virus into Australia in Philippine grown bananas. In the Australian Banana Growers' Council submission No 27 for the Revised Draft Import Risk Analysis Report on the importation of bananas from the Philippines draft IRA report 2004 dated 10 September 2004.

Diekmann M and Putter CAJ 1996. FAO/IPGRI Technical Guidelines for the Safe Movement of Germplasmm. In Musa, 2nd edn, pp. 28. Edited by M. Diekmann & C. A. J. Putter. Rome: Food and Agriculture Organization of the United Nations / International Plant Genetic Resources Institute.

EPPO (European Plant Protection Organization) Standards 1997. Guidelines on pest risk analysis. Pest risk assessment scheme, PM 5/3(1). *EPPO/OEPP*, Paris (FR).

Espino TM, Exconde SB, Zipagan FB and Espino RRC 1990. Banana bract mosaic, a new disease of banana II. Isolation and purification for monoclonal antibody production. Philipp. Agric. **73**: 61-68.

FAO (Food and Agriculture Organisation of the United Nations) 2007a. International standards for phytosanitary measures 1 to 29 (2007 edition), ISPM No. 5 Glossary on phytosanitary terms (2007), Rome, 63-86.

FAO 2007b. International standards for phytosanitary measures 1 to 29 (2007 edition). ISPM No. 11 Pest risk analysis for quarantine pests including analysis of environmental risks and living modified organisms (2004), Rome, 135-160.

Frison EA and Putter CAJ 1989. FAO/IBPGR Technical Guidelines for the safe Movement of Musa Gerplasm. Rome, FAO/IBPGR, 1989. 23p.

Gildow FE, Darmsteegt V, Stone W, Schneider A, Luster D and Levy L 2004. Plum pox in America: identification of aphid vectors and a potential role for fruit in virus spread. Phytopathology **94**: 868-874.

INSEE (Institut National de la Statistique et des Études Économiques) 2007. Guyane : la région en faits et chiffres. Chiffres-clés: théme Agriculture/ Exploitations agricoles. Available from http://www.insee.fr/fr/insee_regions/guyane/rfc/chifcle_fiche.asp?ref_id=AGRTC001&tab_id=1952 as last updated on August 2007 (accessed on 20 February 2008).

JORF (Journal Officiel de la République Française) 16/02/1992. Arrêté du 3 Décembre 1991 modifiant l'arrêté du 3 Septembre 1990 relatif au contrôle sanitaire des végétaux et produits végétaux. NOR: AGRG9102552A. Journal Officiel de la République française, 16 Février 1992: 2476-2503.

JORF 19/11/1995. Arrêté du 17 Octobre 1995 portant modification de l'arrêté du 2 Septembre 1993 relatif aux exigences sanitaires des végétaux, produits végétaux et autres objets. NOR: AGRG9502249A. Journal Officiel de la République française, 19 Novembre 1995: 16997-16999.

JORF 31/08/2000. Arrêté du 31 Juillet 2000 établissant la liste des organismes nuisibles aux végétaux, produits végétaux et autres objets soumis à des mesures de lutte obligatoire. NOR: AGRG0001599A. Journal Officiel de la République française, 31 Août 2000: 13502-13506.

Kenyon L, Magnaye L, Warburton H, Warburton H, Chancellor T, Escobido E and Foot C 1996. Epidemiology and Control of banana Virus Diseases in the Philippines. NRI – Department for International Development Crop Protection Programme Project A0217/X0258 Final Technical Report, Natural Resources Institute, Chatham Maritime, UK.

Kenyon L, Warburton H, Chancellor T, Holt J, Smith M, Brown M, Thwaites R, Magnaye LC, Araño B, Loquias M and Soguilon C 1997: Identification, vector relationships, epidemiology and control of virus and bacterial diseases of banana, pp. 54 pp. Chatham: Natural Resources Institute, University of Greenwich, UK, 54 pp.

Labonne G and Quiot JB 2001. Aphids can acquire Plum pox virus from infected fruits. Acta Hort. **550**: 79-82.

Lassoudière A 2007. Le bananier et sa culture. Ed. Quae. Paris. 384 pages.

Lecoq H, Desbiez C, Wipf-Scheibel C and Girard M 2003. Potential involvement of melon fruit in the long distance dissemination of cucurbit potyviruses. Plant Dis. **87**: 955-959.

Le Jeannic F 2002. Une agriculture aux multiples facettes. Agreste **106**: 1-4. Available from: http://agreste.agriculture.gouv.fr/IMG/pdf/primeur106-2.pdf

Magee CJP 1927. Investigation on the bunchy top disease of banana. Council for Scientific and Industrial Tesearch, Melbourne, Australia, 86pp.

Magnaye LV and Espino RRC 1990. Banana bract mosaic, a new disease of banana, I. Symptomatology. Philipp. Agric. **73**: 55-59.

Marinho VLA and Batista M de F 2005. Interceptacao, pelo Servico de Quarantena, de Virus em Mudas Meristemáticas de Bananeiras Importadas. Fitopatol. Bras. **30**(5): 552.

PDR Guyane (Programme de développement rural pour la Guyane), 2007 (FEADER 2007-2013). Version 3 du 13 décembre 2007, 324 pp. Available from: http://agriculture.gouv.fr/sections/thematiques/europe-international/la-programmation-de-developpement-rural-2007-2013/la-programmation-francaise-de-developpement-rural/

Plénet A 1965. Parasites animaux des principales plantes cultivées à la Réunion, pp. 203—216. In Congrès de la Protection des Cultures Tropicales; Comptes Rendus des travaux; Chambre de Comm. et d'Ind. Marseille; 23—27 mars 1965. *cit in*:. Vayssières, J. F; Delvare, G.; Maldès, J. M. and Aberlenc, H. P. 2001. Inventaire Preliminaire des Arthropodes Ravageurs et Auxiliaires des Cultures Maraicheres sur l'Ile de la Réunion. Insect Sci. Applic. **21**(1): 1-22.

Remillet M 1978. List of insect pests of cultivated plants in French Guyana. Symposium on maize and peanut, Paramaribo, Nov. 13-18, 1978. Agricultural Experiment Station, Paramaribo 1979; 370-376.

Robson JD, Wright MG and Almeida RPP 2006. Within-plant distribution and binomial sampling of Pentalonia nigronervosa (Hemiptera: Aphididae) on banana. Journal of Economic Entomology **99**: 2185-2190.

Rodoni BC, Ahlawat YS, Varma A, Dale JL and Harding RM 1997. Identification and characterisation of banana bract mosaic virus in India. Plant Disease **81**: 669-672.

Rodoni BC, Dale JL and Harding RM 1999. Characterization and expression of the coat protein-coding region of banana bract mosaic potyvirus, development of diagnostic assays

and detection of the virus in banana plants from five countries in southeast Asia. Archives of Virology **144**: 1725-1737.

Roperos NI and Magnaye LV 1991. Status of Banana Diseases in the Philippines. In: V. Valmayor, V., Umali, B. E., Bejosano, C. P. (eds) Banana Diseases in Asia and the Pacific, International Network for the Improvement of Banana and Plantain, Montpellier, France; 52-66.

Selvarajan R and Singh HP 1997. Occurrence, geographical distribution and electron microscopy of BBrMV in India. In: International Conference on Integrated Plant Disease Management for Sustainable Agriculture, IARI, New Delhi, Nov. 10-15; 223.

Selvarajan R, Balasubramanian V, Padmanabhan B and Sathiamoorthy S 2006. Vector transmission of banana bract mosaic and banana streak viruses in India. Indian Journal of Virology, Vol. 17, Issue, 2.

Selvarajan R and Jeyabaskaran KJ 2006. Effect of Banana bract mosaic virus (BBrMV) on growth and yield of cultivar Nendran (Plantain, AAB). Indian Phytopath. **59**(4): 496-500.

Shanmugavelu KG, Aravindakshan S and Sathiamoorthy S 1992. Banana Taxonomy, Breeding and Production Technology. Metropolitan Book. Co., New Delhi, India, 456.pp.

Sharman M, Gambley CF, Oloteo EO, Abgona RVJ and Thomas JE 2000a. First record of natural infection of abaca (Musa textilis) with banana bract mosaic potyvirus in the Philippines. Australasian Plant Pathology, 29: 69.

Sharman M, Thomas JE and Dietzgen RG 2000b. Development of a multiplex immunocapture PCR with colourimetric detection for viruses of banana. Journal of Virological Methods **89**: 75-88.

Thangavelu R and Singh HP 2000. Status of banana streak virus and banana bract mosaic virus diseases in India. Pp. 364-376. In: Banana: Improvement, Production and utilization. Eds. Singh, H.P. and Chadha, K.L.

Thomas JE and Magnaye LV 1996. Banana bract mosaic disease. Musa Disease Fact Sheet No. 7. International Network for the Improvement of Banana and Plantain, Montpellier, France.

Thomas JE, Geering ADW, Gambley CF, Kessling AF and White M 1997. Purification, properties and diagnosis of banana bract mosaic potyvirus and its distinction from abaca mosaic potyvirus. Phytopathology **87**: 698-705.

Thomas JE, Iskra-Caruana M-L, Magnaye LV and Jones DR 2000. Bract mosaic. In: Jones, D.R. (ed.) Diseases of Banana, Abacá and Enset, Wallingford: CABI Publishing; 253-256.

Vayssières JF, Delvare G, Maldès JM and Aberlenc HP 2001. Inventaire Preliminaire des Arthropodes Ravageurs et Auxiliaires des Cultures Maraicheres sur l'Ile de la Réunion. Insect Sci. Applic. **21**(1): 1-22.