

Pest risk assessment made by France on *Banana mild mosaic virus* (BanMMV) considered by France as harmful in French overseas departments of French Guiana, Guadeloupe, Martinique and Réunion¹

Scientific Opinion of the Panel on Plant Health

(Question No EFSA-Q-2006-110)

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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 contains the opinion of the Panel on Plant Health on the full² pest risk assessment conducted by France on *Banana mild mosaic virus* (BanMMV) with French Guiana, Guadeloupe, Martinique and Réunion considered as endangered area.

Banana mild mosaic virus (BanMMV) is a recently characterized virus of the family *Flexiviridae* which infects banana and plantains. BanMMV has a very wide geographic distribution and its presence has been reported in Guadeloupe and Martinique.

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 of the International Standard on Phytosanitary Measures

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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).

ISPM No. 11³: Pest risk analysis for quarantine pests⁴ including analysis of environmental risks and living modified organisms (2004) by the International Plant Protection Convention (FAO, 2007b).

Although the French pest risk assessment could be improved upon, the Panel agrees with the conclusion of the French document that the phytosanitary risk of BanMMV as a single virus is extremely low.

The Panel agrees with the French analysis that BanMMV has a high probability of entry and establishment and that the international movement of large quantities of vitroplants represents the most important entry pathway. The Panel further considers that virus indexing of mother plants used for vitroplants production could provide an effective means to reduce the probability of entry of BanMMV in the area under consideration.

Although BanMMV is a pathogenic agent for banana, the Panel concludes that the economic consequences of its further entry in the French overseas departments can be considered low since BanMMV, which is present in most if not all banana growing areas of the world, does not appear to be associated with significant yield loss in banana.

However, the Panel recognises that there are several areas of BanMMV biology where information is incomplete or lacking. These areas of uncertainty include a) clarification of the host range of BanMMV, b) its symptom expression (in particular when in mixed infection with other banana-infecting viruses) and c) the possibility that the virus may have further potential for spread by a vector.

The overall conclusion of the Panel is that BanMMV is not appropriate for analysis of risk management options for French Guiana, Guadeloupe, Martinique and Réunion and is thus not potentially eligible for addition to the list of harmful organisms of Directive 2000/29/EC.

Key words: *Banana mild mosaic virus*, BanMMV, French Guiana, French overseas departments, Guadeloupe, Martinique, pest risk assessment, Réunion

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 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]

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BACKGROUND AS PROVIDED BY THE EUROPEAN COMMISSION⁵

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, 10.7.2000, p. 1), 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.

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ASSESSMENT

1. Introduction

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

1.1. General introduction to *Banana mild mosaic virus* (BanMMV)

Banana mild mosaic virus (BanMMV) is a recently described filamentous virus found in symptomatic plants of banana cultivar 'Ducasse' (ABB, syn. 'Pisang Awak') (Gambley and Thomas, 2001). Later, the virus was found to have a very wide geographic distribution and is considered likely to be present in most or all banana productions areas of the world (Teycheney *et al.*, 2005). The symptoms associated with BanMMV in banana have been reported to be generally mild, but increased symptom severity has been suggested in cases of mixed infection with other banana infecting viruses, such as Cucumber mosaic virus (CMV) (Caruana and Galzi, 1998).

1.2. The document under scrutiny

The assessment of risks of the organism is presented by the French risk assessors in a 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) of the EPPO Bulletin 27, 281-305].

Based on this document France requested *Banana mild mosaic virus* (BanMMV) 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 provided and methods applied for pest risk assessment purposes. The review was based on the principles of the International Standard on Phytosanitary Measures ISPM No. 11: 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 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 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.

1.4. General comments on the document

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

- Part I provides background information required for the assessment.
- Part II contains the assessment of the risks of the organism in subject.

The document includes 6 references. Many statements made in the document are neither substantiated by references nor supported by verifiable data. In some areas references are incorrectly cited and interpreted.

The document was compiled in 2003. Many issues have not been dealt with in detail, despite the availability of relevant information at the time of conducting the original assessment.

The Panel reviewed a translation of the original French document. Some errors were noted in relation to specific risk assessment terminology. For example, the terms probability and risk are incorrectly used as synonyms in the translated text, and use of the terms “average” and “moderate” when describing specific ratings in Part 2 of the risk assessment. In cases of doubt, the Panel has referred to the original French text.

1.5. Methodology applied for the risk assessment

The Panel considered the methodology used in the risk assessment provided in Part 2 of the document and concluded that:

- The document does not take into account the new situation in the pest risk assessment area following a future potential lifting of the current regulations.
- The probabilities of entry, establishment and spread and the potential impacts (economic, social, environmental) of the pathogen in the pest risk assessment area should be clearly outlined for each of the French overseas departments, due to their specificities related to their geographic location and the differing importance of the host plants in each region.
- 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.
- A number of estimates provided in Part 2 (Pest Risk Assessment) cannot be justified or substantiated by the information provided in Part 1 of the document.
- The method of combining risk ratings and ascribing an overall risk rating is not defined and assumes equal weighting to the questions.

Although the French document is entitled "Pest risk analysis" it contains only the pest risk assessment stage and omits the risk management component.

In general, the Panel found the French document to be difficult to assess. All steps of a pest risk assessment procedure should be fully documented. As such, references should be cited to support the statements made. In the French document, only a general and somewhat outdated or incomplete reference list is provided. This made it difficult to determine the supporting references for 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.

Lastly, the level of uncertainty relating to the information presented in the French document was in general poorly documented and discussed.

2. Evaluation of the pest risk assessment

2.1. Pest categorization

2.1.1. Identity of pest

The French document clearly identifies the pest under consideration as *Banana mild mosaic virus*. However, the document was prepared in 2003 and thus requires substantial updating. At that time BanMMV was considered as being not yet classified. The Panel found that this is no longer the case as BanMMV is now listed as an unassigned species in the family *Flexiviridae* as outlined in the 8th Report of the International Committee on the Taxonomy of viruses (Adams *et al.*, 2005).

As indicated by its status of an unassigned virus in the family *Flexiviridae*, BanMMV is only distantly related to other members of the family (Adams *et al.*, 2005). The Panel therefore concludes that there is thus no quarantine agent closely related to BanMMV.

The French document indicates that BanMMV either occurs as a symptomless infection or produces only mild symptoms in banana plants. It also indicates that some more pronounced symptoms associated with BanMMV infection have been reported for a limited number of cultivars, including 'Ducasse' (syn. 'Pisang Awak'), from which the virus was initially purified and characterized (Thomas *et al.*, 1999; Gambley and Thomas, 2001).

After analyzing the available literature, the Panel concludes that these statements accurately reflect current knowledge of BanMMV symptomatology, as indicated for example by the following statement in a recent publication: "*BanMMV infection causes transitory mild chlorotic mosaic and streak symptoms on leaves of highly susceptible cultivars and symptomless infection otherwise*" (Teycheney *et al.*, 2007, citing Thomas *et al.*, 1999).

However, the Panel wishes to emphasize that Koch's postulates have never been validated for BanMMV. Failing such a demonstration, such as could be obtained using full-length infectious cDNA clones or, possibly, inoculation of purified viral particles to susceptible hosts, assignment of particular symptoms to BanMMV relies on the observation of correlations between those symptoms and the presence of BanMMV.

As a consequence, no complete or reproducible demonstration that the symptoms observed in BanMMV-infected plants are indeed caused by BanMMV is available to date and it is possible that symptoms could be caused by another, as yet unidentified, virus.

Citing two publications (Caruana and Galzi, 1998; Thomas *et al.*, 1999), the French document further indicates that more severe disease symptoms are observed in cases of mixed infection with *Banana streak virus* (BSV) and *Cucumber mosaic virus* (CMV). After reviewing these documents, the Panel concludes that the claim for more severe symptoms in cases of co-infection with BSV is not supported by these two publications. BSV is not mentioned in Caruana and Galzi (1998), while Thomas *et al.*, (1999) explicitly state "*Mixed infections of BanMMV and BSV are common and, in such cases, symptoms are reminiscent of those caused by BSV alone*".

Concerning the claim of increased symptom severity and of the development of a specific necrosis symptom in situations of mixed infection with CMV, the work of Caruana and Galzi (1998) seems to be the primary source of the observations since the Thomas *et al.*, (1999) publication is a review, which cites Caruana and Galzi (1998) as the sole reference for this claim. Analysis of this 1998 publication is difficult because it was published before the identification of BanMMV and also because identification of BanMMV in this work relies on two indicators of unproven efficacy, (1) the observation of filamentous particles by electron-

microscopy and (2) serological reaction with a monoclonal antibody initially prepared against what was believed to be an isolate of *Banana bract mosaic virus* (BBrMV).

Even when considering as valid the identification as BanMMV of the viral particles analyzed by Caruana and Galzi (1998), the correlation observed between unusually severe and necrotic symptoms and mixed CMV-BanMMV infections was reported to be about 80% only (of 19 samples with unusual symptoms, 15 were infected with BanMMV). In addition, about 12% of samples with mixed CMV-BanMMV infection failed to show the unusual symptoms (2 samples of 17 analyzed).

Given that BanMMV is a common virus and in the absence of additional published information, the Panel therefore concludes that the Caruana and Galzi (1998) results, which show a high but partial correlation on a limited number of samples, cannot be taken as conclusive evidence that synergistic effects exist between BanMMV and CMV. Although such synergistic effects may exist, other possibilities may also explain the observations reported, so that additional research is needed to confirm this point.

The French document provides information on particle morphology and genome size of BanMMV. It also indicates that the genome sequence of an isolate from 'Ducasse' has been determined and that the diversity of BanMMV is not known.

Although the particle and genome information within the French document are correct, the diversity of BanMMV is cited as not known. This can now be completed as a result of more recent studies. Teycheney *et al.* (2005) provide an in depth analysis of the very large genetic diversity of this virus. This publication, which was not available at the time of preparation of the French documents, states, for example, that the BanMMV genetic diversity is "*in the range of those observed for the most variable plant viruses, such as several other members of the family Flexiviridae*".

The French document indicates that polyclonal or monoclonal antibodies produced against BanMMV are available and that "an ELISA test combining the polyclonal sera and monoclonal antibodies gives good results but because of the difficulties in manufacturing these reagents, no commercial kit is currently available".

In contrast to these statements, the Panel found that more recent publications, since the preparation of the French document, seem to imply that serological techniques and reagents do not provide for the efficient detection of BanMMV. For example, Teycheney *et al.* (2007) indicate that "Monoclonal antibodies raised against BanMMV (Iskra-Caruana, unpublished) can be used for the detection of the virus by ELISA, but they are highly specific of the viral strain that was used to raise them while BanMMV has been shown to display a very large molecular variability".

As a result, the Panel concludes that there are serious doubts about the suitability of an ELISA assay using the currently available monoclonal antibodies for the routine detection of BanMMV.

However, polymerase chain reaction (PCR) assays using either BanMMV-specific primers (Teycheney *et al.*, 2005) or polyvalent primers (Teycheney *et al.*, 2005; Teycheney *et al.*, 2007) used in an immunocapture format (employing BanMMV polyclonal antibodies as the capture antibodies) do provide for the efficient detection of the virus despite its large variability.

Therefore, the overall conclusion of the Panel is that suitable techniques for the efficient detection of BanMMV are currently available, even if these techniques are not those mentioned in the French document.

2.1.2. Presence or absence in PRA area⁶

Part 1 of the French document indicates that BanMMV is described in Guadeloupe in the CIRAD collection and in banana groves (Caruana and Galzi, 1998) and likely to be present in the other overseas departments.

In their analysis of the diversity of BanMMV, Teycheney *et al.*, (2005) used 82 isolates from the CIRAD Musa germplasm in situ collection located in Guadeloupe, an indication of the significant prevalence of the virus in this collection. In addition, of the isolates used in this study, 3 are indicated to have been collected in Guadeloupe and 4 in Martinique, confirming the presence of the virus in these two French overseas departments.

There is no information for the other two French overseas departments (French Guiana and Réunion), but the wide geographic distribution of BanMMV (see below) would suggest that the virus may also occur in these two Departments.

The Panel concludes that there is evidence for the presence of BanMMV in Guadeloupe and Martinique and agrees that the virus is likely to be present, as stated in the French document, in the two other French overseas departments under consideration.

2.1.3. Regulatory status in PRA area

The French document indicates that BanMMV does not feature in any national regulations or international recommendations. It then provides a detailed description of the current French regulation which impose a ban on the importation of banana material (plants and their parts, fruits, seeds) imported into the French overseas departments of French Guiana, Guadeloupe, Martinique and Réunion. Exemptions from the import ban involve a quarantine system and certification that both the country of origin and the imported material must be free of "mosaic viruses" (Annex IV/B DOM, JORF 16/02/1992). However, BanMMV is not listed in a later regulation specifically addressing the import of banana vitroplants (JORF 19/11/1995).

The Panel noted that the French regulations concerning banana viruses seem to be ambiguous in that for French Guiana, Guadeloupe and Martinique these regulations require that introduced seeds of "banana plants" (genera and hybrids: *Musa*, *Strelizia*, *Ensete*, *Heliconia*, *Orchidantha*, *Ravenala*) and their country of origin must be certified free of a number of pathogens including "mosaic viruses" (Annex IV/B DOM, JORF 16/02/1992).

This loose description of "mosaic viruses" is unclear since it is not possible from this text to know specifically which virus(es) are included. In particular, it is unclear whether BanMMV, which was discovered and named several years after this legislation was passed, is considered to be included or not.

BanMMV is not considered by the Decree of 17 October 1995 (JORF 19/11/1995) on exemptions allowing banana plant material to be brought into the French overseas departments, and which indicates that banana vitroplants may be brought in those departments, but that 'candidate plants' used as mother plants must have been quarantined for a year and indexed for the presence of four banana viruses *Banana bract mosaic virus*, *Banana bunchy top virus*, *Banana streak virus* and *Cucumber mosaic virus*.

Despite this ambiguity in the current French regulations, the Panel concludes that this legislation has the potential to limit the introduction of BanMMV into the French overseas departments, provided that suitable BanMMV detection assays are implemented. No information about the use of such assays is unfortunately provided in the French document but

⁶ PRA area is the area in relation to which a Pest Risk Analysis is conducted [FAO, 2007a].

its imprecise wording suggest that currently no specific steps are taken to ensure that imported vitroplants are free from BanMM.

BanMMV is not currently listed as a quarantine pathogen in any region of the world.

2.1.4. Potential for establishment and spread in PRA area

The presence of BanMMV in Guadeloupe and Martinique is acknowledged in the French document and confirms the potential for establishment and spread in the PRA area.

2.1.5. Potential for economic consequences in PRA area

Banana production represents a very significant portion of the agricultural activities for Guadeloupe and Martinique, but a less important one for French Guiana and Réunion. Although associated with mild mosaic symptom expression, a potential for economic consequences by BanMMV is indicated under Guadeloupe field conditions (Caruana and Galzi, 1998).

2.1.6. Conclusion of pest categorization

BanMMV is a well characterized virus for which suitable detection techniques are available. There is uncertainty as to whether BanMMV fulfils the criteria for a quarantine pest since it is known to be present in part, and possibly in all, of the PRA area and since there is uncertainty as to whether it is currently subject to control measures given the ambiguities of the current French regulations.

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 regulated importation of banana vitroplants. The second one is the hypothetical introduction of infected cultivars by private individuals.

The Panel agrees that the commercial trade of mass-propagated vitroplants represents the major means by which BanMMV-infected banana plants may gain entry into the area under consideration. Given the biology of BanMMV and the relative isolation of the various French overseas departments under consideration, introduction of BanMMV from another country by a process not involving host banana plant seems highly unlikely and only importation of propagation materiel (suckers, vitroplants) seem to provide a route for the introduction of the virus.

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

The French document rightly states that no records of BanMMV interception on traded host plants are available because the virus is not currently regulated. However, given the widespread distribution of BanMMV and the limited symptoms it causes, the probability of BanMMV to be associated with banana planting materials, including vitroplants, in the absence of control measures is considered moderate to high.

2.2.1.3. Probability of survival during transport or storage

Given the viral nature of BanMMV, the probability of survival during transport or storage of contaminated banana material is considered by the Panel to be very high.

2.2.1.4. Probability of pest surviving existing pest management procedures

The Panel considers that the availability of suitable detection assays now enables the establishment of quality control measures that would ensure that imported vitroplants are free of BanMMV. However, the French document fails to document the use of detection assays specifically targeting BanMMV.

2.2.1.5. Probability of transfer to a suitable host

The French document concludes that BanMMV presents a major risk of entry. The Panel generally agrees with this qualification. In reaching this conclusion the Panel took into account the following considerations:

- Absence of evidence for synergistic effects between BanMMV and other viruses and the widespread occurrence of BanMMV,
- the fact that like any other virus, BanMMV is spread by the vegetative propagation of infected host plants,
- the massive introduction of commercial vitroplants into at least two of the French overseas departments (Guadeloupe and Martinique).

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 states that BanMMV seems to occur only in plants of the *Musaceae* family. The Panel considers this comment to be correct but potentially misleading in implying that the range of hosts of BanMMV in the *Musaceae* may be considerable. There is no evidence yet for a large host range in the *Musaceae*. It would be more appropriate to state that banana is the only known host of BanMMV identified so far, but that further work is needed before the host range of the virus can be defined more precisely.

The French document provides a basic description of the banana cultivars grown and of the acreage under banana in the 4 French overseas departments under consideration. From analysis of additional information the Panel were able to update this information.

In 2006, dessert bananas were produced commercially on 7300 ha in Martinique (Agreste, 2007b) and 2240 ha in Guadeloupe (Agreste, 2007a). 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).

Banana, plantain and cooking bananas are grown in family gardens in the French overseas departments for household consumption. 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 (Agreste, 2007a), 615 ha in Guadeloupe (Agreste, 2007b) and 2890 ha in Réunion (Agreste, 2007c). 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).

2.2.2.2. Suitability of environment

The French document indicates that information on ecoclimatic conditions are not relevant in the case of a virus and that vectors are already present in the four overseas departments.

The Panel agrees that the life-cycle of a virus is strongly interlinked with the metabolism and cellular functioning of its host(s) so that the ecoclimatic needs of BanMMV can be considered to be essentially similar to those of its banana host.

The Panel concludes that, once introduced in infected banana planting material into a region with ecoclimatic conditions suitable for banana, BanMMV is likely to continue replicating in its host for the lifetime of this host.

The Panel disagrees with the statement made in the French document about the vectors. As there is great uncertainty about whether BanMMV can or cannot be transmitted by vector(s) under field conditions and there is no report to date identifying such vector(s). Thus, it is impossible to conclude, as the French document does, that BanMMV vectors are already present in the French overseas departments under consideration.

The Panel concludes that banana represents a very significant portion of the agricultural activities for Guadeloupe and Martinique, but a less important one for French Guiana and Réunion. This analysis is in agreement with the conclusion reached in the French document.

2.2.2.3. Cultural practices and control measures

The French document indicates that removal of infected plants and the use of pathogen-free propagation material seem to be the only effective control method known to science at the present time. It also indicates that no resistant plant has been described to date.

The Panel agrees with these statements. The Panel further stresses that the effectiveness of any eradication efforts may be limited by the lack of symptoms usually associated with BanMMV infections, which would complicate efforts to identify infected plants in the field and therefore require the use of laboratory tests.

2.2.2.4. Other characteristics of the pest affecting the probability of establishment

The French document indicates that BanMMV was "first described as a common contaminant of banana germplasm" and that "it appears to be found worldwide".

The more recent analysis of the diversity of BanMMV reported by Teycheney *et al.* (2005), provides further support to this claim, since the isolates used in this study originated from a very large number of countries including almost all the major banana growing areas of the world, in South America, Asia, Africa, Oceania and Australia. It would therefore seem that the virus has a worldwide distribution and is likely to be present in most, if not all, banana producing regions of the world.

2.2.3. Probability of spread after establishment

The French document indicates that, as with other viruses, BanMMV is spread by the movement of infected propagation material. In the case of banana, two vegetative propagation techniques have the potential to give rise to infected plants and contribute to the spread of the virus: the use of suckers or rhizome pieces and shoot-tip culturing to mass produce vitroplants.

The French document further indicates that in cases of mixed infection [BanMMV] seems to be transmitted in the same way and by the same vector as the virus with which it is associated. The Panel determined that this statement is not supported in the French document by any

specific published reference and that it is unclear from where this information is derived. The Panel considers this general scenario to be unlikely since it would represent the first (and only) case of multiple assistance for transmission by very different vectors (aphids for BBrMV and CMV, scale insects for BSV) for a plant virus.

In addition, the Panel found that two of the publications cited in the French document (Caruana and Galzi, 1998; Thomas *et al.*, 1999) seem to explicitly rule out such a possibility of assistance for transmission in the case of mixed infections between BanMMV and BBrMV. Thomas *et al.*, (1999) indicate for example "*The banana aphid, Pentalonia nigronervosa, transmitted BBrMV but not BanMMV, from banana plants infected with both viruses*".

In the case of BSV, the Panel was unable to identify a reference or statement alluding to a possible assistance of BanMMV by BSV for transmission.

The last scenario involves mixed infections of BanMMV and CMV. Thomas *et al.* (1999) specifically addressed this possibility, indicating that "*under natural conditions in Guadeloupe, plants established from virus-free tissue cultures of cultivars in the Cavendish group (AAA) subsequently became infected with CMV and BanMMV, frequently as mixed infections*" and later "*this implies that natural transmission of BanMMV was occurring, generally simultaneously with the aphid transmitted CMV (Caruana and Galzi, 1998)*".

Assuming the filamentous virus analyzed by Caruana and Galzi (1998) is BanMMV (see 2.1.1.), the results reported by these authors seem to imply that about 12% (2 out of 17) of field samples infected by BanMMV were free of CMV.

Thus, although the Caruana and Galzi (1998) work can be taken as an indication that BanMMV shows some epidemic potential under Guadeloupe field conditions, the Panel concludes that in the absence of further experimental evidence, the claim that BanMMV could be assisted by CMV in its transmission by aphids is not fully substantiated and should therefore be treated with caution.

Nevertheless, the additional information obtained by the Panel (Teycheney *et al.*, 2005) provides tentative evidence for the existence of a steep gradient of dispersion of the virus between adjacent plants. This result suggests (but does not demonstrate) the possibility of plant to plant transfer of the virus. It does not, however, provide any insight into the mechanism(s) underlying this plant-to-plant transfer, which could represent either an unsuspected consequence of cultural practices or an as yet undescribed vector-borne transmission.

Overall, the Panel concludes that there is some limited evidence to indicate that BanMMV may be able to spread from plant to plant under field conditions, but that the underlying mechanism(s) are not yet confirmed. The probability of spread through the action of (a) vector(s) after establishment is therefore rated as moderate but a high uncertainty remains associated with this rating.

2.2.4. Conclusion on probability of introduction and spread

The Panel agrees that the probability of introduction is considered as very high due to a very high risk of entry plus a high risk of establishment. The French document indicates there is the highest possible risk of establishment. The Panel agrees with this rating, based on the following considerations:

- the ecoclimatic conditions of the French overseas departments are suitable for the banana host
- these ecoclimatic conditions are unlikely to affect BanMMV

- there is converging if limited evidence that BanMMV may be able to spread under field conditions prevailing in at least one of the French overseas departments under consideration (Guadeloupe)
- BanMMV is already established in at least two of the French overseas departments under consideration

Given the high risk of entry and the high risk of establishment, the Panel agrees with the French document that BanMMV presents an overall high risk of introduction in the French overseas departments under consideration.

2.3. Assessment of potential economic consequences

2.3.1. Direct pest effects

2.3.1.1. Crop quality and/or yield losses

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 symptoms are very fleeting or even absent on the leaves of infected banana plants and that no effect on yield has been reported apart from a slight delay in fruiting. However, it also describes more severe symptoms in case of mixed infection with CMV and BSV.

When symptoms of BanMMV occur, they appear to primarily affect the leaves, but the review by Thomas *et al.*, (1999) cites unpublished observations in South America that BanMMV may cause delayed bunching and, under some circumstances, yield reductions.

Overall, the Panel concludes that there is currently insufficient information on the damage caused by BanMMV under field conditions, but that BanMMV frequently appears to be of only minor consequence.

The French document further states that BanMMV seems to have no impact when it is the only infective agent and that no one has actually tried to evaluate its potential impact. It further stresses that in cases of mixed infection its impact is considerable.

There remains very significant uncertainties about the type and severity of the symptoms caused by BanMMV in mixed infections. Although there is a possibility that mixed infections with CMV could result in more severe symptoms, in the case of mixed infections with BSV, the references cited in the French document fail to support the claim for increased symptom severity.

Even when considering as valid the identification as BanMMV of the viral particles analyzed by Caruana and Galzi (1998), the correlation observed between unusually severe and necrotic symptoms and mixed CMV-BanMMV infections was reported to be about 80% only (of 19 samples with unusual symptoms, 15 were infected with BanMMV). In addition, about 12% of samples with mixed CMV-BanMMV infection failed to show the unusual symptoms (2 samples of 17 analyzed).

Given that BanMMV is a common virus and in the absence of additional published information, the Panel therefore concludes that the Caruana and Galzi (1998) results, which show a high but partial correlation on a limited number of samples, cannot be taken as conclusive evidence that synergistic effects exist between BanMMV and CMV. Although such

synergistic effects may exist, other possibilities may also explain the observations reported, so that additional research is needed to confirm this point.

Overall, the Panel therefore concludes that there is still significant uncertainty about the symptoms that BanMMV is able to induce in banana cultivars, alone or in co-infection with other viruses, but that in most situations, BanMMV alone is unlikely to cause symptoms of significant impact.

Given the uncertainties remaining about the type and severity of the symptoms that may be caused by BanMMV alone or in combination with CMV (see above), the Panel supports the conclusions of the French document in that BanMMV alone does not have a serious impact, but cannot support that the impact of mixed infections is considerable.

2.3.1.2. Control measures, efficacy and costs

Control costs are stated as considerable but hard to quantify in the French document. The Panel does not agree with this analysis. Analysis of the French document and a review of available literature undertaken did not reveal any examples of control measures specifically targeting BanMMV.

There is insufficient information for the Panel to evaluate precisely the cost of control of BanMMV. However, for the vitroplant pathway, given that diagnostic assays would be undertaken on only a limited number of mother plants, the Panel considers these costs to be low compared to the commercial value of the vitroplants.

2.3.2. Indirect pest effects

2.3.2.1. Export markets

Martinique exported a net total of 228,358 tonnes ($\approx$ 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 ($\approx$ 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). Under the current EU regulations (Directive 2000/29/EC), the introduction of BanMMV into the French overseas departments would not evoke quarantine restrictions to fruit trade, while symptoms caused by BanMMV, if any, are unlikely to affect marketability of fruits in a drastic fashion.

Overall, the Panel finds that there is insufficient information to support the estimation by the French document of the effects of BanMMV on production and exports as considerable. This analysis of the Panel is supported by the review by Thomas *et al.* (1999) cited in the French document, which indicates that "*the economic impact of this virus is not known*".

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

2.3.2.2. Social consequences

The document does not address any potential social consequences as a result of the pathogen's establishment in the PRA area. Given the low impact BanMMV is estimated to have on banana crops, its potential social consequences are similarly estimated by the panel to be negligible.

2.3.2.3. Environmental consequences

The document does not discuss potential environmental consequences. The Panel is of the opinion that there is a low likelihood of environmental consequences due to the limited impact of BanMMV on the plant.

2.3.3. Conclusion of the assessment of economic consequences

The French document concludes that economic impact appears to be moderate to low, but is greater in the event of mixed infection with another virus.

The Panel found the economic impact of BanMMV difficult to assess from the limited information provided in the French document and in reaching its conclusion considered the following elements:

- General consensus that BanMMV alone usually causes no symptoms or very mild symptoms.
- Lack of information concerning possible synergistic effects of BanMMV and BBrMV
- Absence of evidence for synergistic effects between BanMMV and BSV
- Absence of unambiguous information about synergistic effects between BanMMV and CMV, although the possibility of exacerbated symptoms exist
- Lack of information on the prevalence of CMV and of mixed CMV-BanMMV infection in banana in the French overseas departments under consideration
- The fact that BanMMV is currently not considered to be a quarantine pathogen in any banana production area in the world
- The fact that BanMMV is already present in two of the French overseas departments, apparently without any major impact on banana crops
- The results reported by Teycheney *et al.* (2005), provide tentative evidence for the existence of a steep gradient of dispersion of the virus between adjacent plants, suggesting the possibility of plant to plant transfer of the virus.

The Panel concluded that despite the remaining uncertainties, the economic impact of BanMMV, either alone or in mixed infection, is likely to be low in the four French overseas departments under consideration.

2.4. Comments on the conclusion of the pest risk assessment

The final conclusion reached by the French document is that the phytosanitary risk of BanMMV as a single virus is extremely low. However, it then adds a general comment that it is important to remain vigilant when new varieties are introduced and to observe any change in viral diseases endemic to the PRA area so that action can be taken swiftly. Given the above considerations on economic impact assessment, the Panel agrees that the phytosanitary risk associated with BanMMV can be considered low.

Analysis of the French document, the references cited in it and of additional references has allowed the Panel to reach the following conclusions:

- 1/ BanMMV is a well characterised virus. However, there remain a lot of unknowns concerning its biological and epidemiological properties. In particular, the symptoms caused by BanMMV alone or in mixed infections, the host range of the virus and the possible vector-based transmission of the virus are not known.
- 2/ BanMMV has a large molecular variability, but suitable techniques, such as PCR-based assays, allow its reliable detection. However, there remains the possibility of the existence of divergent isolates, that could escape detection.
- 3/ BanMMV has a global distribution and is likely to be present in most, if not all, banana growing areas of the world.
- 4/ BanMMV is already known to be present in the two of the four French overseas departments, Guadeloupe and Martinique. Banana is a significant crop in these two French overseas departments, but not in the two French overseas departments for which its presence is uncertain, French Guiana and Réunion.
- 5/ If infected propagation material is introduced and planted in the French overseas departments under consideration, BanMMV will simultaneously be introduced and will remain for at least as long as the infected material is cultivated and propagated.
- 6/ BanMMV does generally not appear to be associated with a significant disease and yield loss in banana. The symptoms generally described in infected plants are either absent or mild. In some cases, more severe symptoms may appear, but the causes for this remain unknown and may include differential varietal susceptibility in banana, differential virulence of some viral isolates and synergism with other viral infections.
- 7/ There is some limited experimental evidence that BanMMV may be able to spread under natural conditions. This spread, if it exists, appears to be rather local and may result from routine agricultural practices or from the action of an unknown vector.
- 8/ BanMMV is currently not considered to be a quarantine pest by any national or international regulation.
- 9/ Current controls on the import of banana material into the French overseas departments covered by the French document under consideration have the potential to limit further BanMMV introductions. However, the efficacy of these measures is dependent on the implementation (which is not documented) of suitable detection tests.
- 10/ The use of BanMMV-free propagation material alone or in combination with the eradication of infected plants could provide an effective control of BanMMV. However, eradication could prove costly because PCR-based diagnostic procedures would be required to identify symptomless infections.

2.4.1. Degree of uncertainty

There are several areas of BanMMV biology where information is incomplete or lacking. These areas of uncertainty include a) clarification of the host range of BanMMV, b) its symptom expression (in particular when in mixed infection with other banana-infecting viruses) and c) the possibility that the virus may have further potential for spread by a vector.

In addition, there is some uncertainty relating to the presence of BanMMV in French Guiana and Réunion and the potential for environmental and social consequences which are not addressed in the French document.

CONCLUSIONS AND RECOMMENDATIONS

Although the French pest risk assessment could be improved upon, the Panel agrees with the conclusion of the French document that the phytosanitary risk of BanMMV as a single virus is extremely low.

The Panel agrees with the French analysis that BanMMV has a high probability of entry and establishment and that the international movement of large quantities of vitroplants represents the most important entry pathway. The Panel further considers that virus indexing of mother plants used for vitroplants production could provide an effective means to reduce the probability of entry of BanMMV in the area under consideration.

Although BanMMV is a pathogenic agent for banana, the Panel concludes that the economic consequences of its further entry in the French overseas departments can be considered low since BanMMV, which is present in most if not all banana growing areas of the world, does not appear to be associated with significant yield loss in banana.

However, the Panel recognises that there are several areas of BanMMV biology where information is incomplete or lacking. These areas of uncertainty include a) clarification of the host range of BanMMV, b) its symptom expression (in particular when in mixed infection with other banana-infecting viruses) and c) the possibility that the virus may have further potential for spread by a vector.

The overall conclusion of the Panel is that BanMMV is not appropriate for analysis of risk management options for French Guiana, Guadeloupe, Martinique and Réunion and is thus not potentially eligible for addition to the list of harmful organisms of 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-v4 : *Banana mild mosaic virus* – BanMMV. Rédaction : M. L. Caruana / CIRAD – Août 2003.

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